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# INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSOMIASIS RESEARCH AND CONTROL
# ISCTRC

# CONSEIL SCIENTIFIQUE INTERNATIONAL POUR LA RECHERCHE ET LA LUTTE CONTRE LES TRYPANOSOMIASES
# CSIRLT

Sixty four years of AU/ISCTRC 1949

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2013 Soixante-quatre années de l'UA/CSIRLT

**Thirty Second Meeting**
**32èmeREUNION**

**KHARTOUM, SUDAN**
**2013**

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THEME: "T&T Research and Control for Sustainable Agriculture and Rural Development: Promoting Partnership and Learning Agenda in the context of African Renaissance"

**THIRTY SECOND MEETING**

**32ème REUNION**

**KHARTOUM, SUDAN**

**2013**

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# REPORT OF THE ISCTRC SECRETARY ON THE 32nd CONFERENCE

## Opening ceremony

The 32nd Conference of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) was held at the Friendship Hall, Khartoum, The Sudan from 8th-12th September 2013. The theme of the Conference was "Tsetse and Trypanosomiasis Research and Control for Sustainable Agricultural and Rural Development: Promoting Partnership and Learning Agenda in the Context of African Renaissance".

The Conference was officially opened by the First Vice President of the Republic of The Sudan, His Excellency Ali Osman Muhammed Taha. Other dignitaries who graced the Conference were, the Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim, Commissioner for Rural Economy and Agriculture, African Union Commission, Madame Rhoda Peace Tumusiime, the Director of African Union Inter-African Bureau for Animal Resources (AU-IBAR), Prof. Ahmed Elsawalhy, and the Coordinator of African Union Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC), Dr. Hassane Mahamat.

The key note speaker, His Excellency, Ali Osman Muhammed Taha, underscored the import of the joint African Cooperation and the role of Pan Africanism in the development of Africa. He accentuated the contribution of livestock to food security and consequently the obligation of African countries to protect livestock from animal diseases. He encouraged the ISCTRC platform to continue providing the vital information that would aid the fight against T&T.

The Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim, highlighted the negative impact of trypanosomiasis on rural development of The Sudan and urged scientists and development partners to harness their energies and resources towards a sustainable solution to the problem.

The Director of AU-IBAR Prof. Ahmed El-Sawalhy, outlined the objectives of the conference and expressed his sincere appreciation for the excellent preparations made by the Government of The Sudan in hosting the conference.

The conference was further inspired through the key note address headlined 'Tsetse and Trypanosomiasis Research and Control for Sustainable Agricultural and Rural Development: Promoting partnership and Learning Agenda in the Context of African Renaissance" made by the Commissioner for Rural Economy and Agriculture, the African Union Commission, Madam Rhoda Peace Tumusiime.

**Conference participants and presentations**

Over 200 participants attended the meeting and were drawn from 22 African Member States, the African Union Commission, Universities and Research Institutions from all over the world, the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA), the Foundation for Innovative New Diagnostics (FIND), the Drugs for Neglected Diseases (DNDi) and the Global Alliance for Livestock Veterinary Medicine (GALVmed).

The conference was also motivated through deliberations on 95 papers and posters that encompassed T&T research and control activities in Member States; reports from International organizations; Human African Trypanosomiasis; Animal African Trypanosomiasis; Glossina Biology, Control and Eradication and Socio-Economics, Environment and Land Use.

The 32nd ISCTRC General Conference made recommendations to guide research and control of tsetse and trypanosomiasis for the following two years (2013-2015).

**Distribution of the proceedings of the 31st Conference**

During the Conference proceedings of the 31st ISCTRC Conference were distributed to the participants in both hard and soft copies.

**Side meetings**

Several Side meetings were held such as the one for the Working Group on non-tsetse transmitted trypanosomiasis

**38th ISCTRC Executive Committee meeting**

The 38th ISCTRC Executive Committee meeting was held at Friendship Hall, Khartoum Sudan, on 7th September 2013. In attendance were the nine (9) regional representatives of the ISCTRC Executive Committee and the Institutional members, AU-IBAR, AU-PATTEC, FAO, IAEA, PAAT and WHO. The meeting reviewed preparedness for the 32 ISCTRC Conference. A post-mortem meeting of the Committee held after the closing ceremony observed that the meeting had been of high standards but also identified some key areas that need consideration for future meetings. The meeting agreed that the 33rd ISCTRC Conference be held in either Central Africa or North Africa regions. The meeting agreed to hold a joint 33rd ISCTRC General Conference back to back with cerebrations of 15 years of PATTEC in 2015.

**Members of the Executive Committee 2013-2015**

The incoming Chair was Ahmed Hussien Abdel Rahman. and the following nine

regional Members of the Executive committee were retained:

Southern Africa: Prof Théophile Josenando, Angola and Dr. Kalinga Chilongo, Zambia

Central Africa: Dr Louis Banipe, Cameroon and Dr Victor Kande, DRC

Eastern Africa: Dr Ahmed H A Rahman, Sudan and Ms Joyce Daffa, Tanzania

West Africa: Dr Charles Mahama, Ghana and Dr Issa Degoga, Mali

Northern Africa: Dr Dia Mamdou Lamine, Mauritania

International organisation membership: FAO, IAEA, PAAT, PATTEC, WHO, ICIPE, ILRI, CIRDES.

**Reception dinner and cocktail**

Social events were held during the conference and they were very much appreciated by participants. They made the conference enjoyable and the memories will linger in the minds of participants for a long time.

**Closing ceremony**

The closing ceremony was officiated by The Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim, the Director of AU-IBAR, Prof. Ahmed Elsawalhy, the Coordinator of AU-PATTEC, Dr. Hassane Mahamat, and the incoming Chairman of ISCTRC, Prof. Ahmed Hussien Abdel Rahman.

Speaking at the closing ceremony, the incoming Chairman of ISCTRC, thanked the outgoing Chairman of ISCTRC Dr. Sadou Maiga for steering the ISCTRC over the last two years. He said that ISCTRC Conference provided an environment for sharing knowledge on T&T. He further observed that ISCTRC provided the PATTEC initiative with a strong scientific input. He thanked the First Vice President of the Sudan, His Excellency Ali Osman Muhammed Taha and the Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim for their support. He further thanked the National Organising Committee Members for their hard work and everyone who contributed to the success of the meeting.

On his part, the Director of AU-IBAR, Prof. Ahmed Elsawalhy thanked the Government and people of The Sudan for hosting the 32nd ISCTRC General Conference. He also thanked the National Organising Committee and the ISCTRC Executive Committee for working tirelessly to make the event possible. He appreciated the participation of Member States, Universities and Research Institutions, Regional and International organizations. He observed that the conference had achieved its set objectives

and said that AU-IBAR, would work with all the stakeholders in addressing the recommendations made during the conference.

While closing the meeting, the Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim thanked all the dignitaries for participating in the Conference. He paid special tributes to the scientists that were awarded certificates for having displayed winning posters. He said that he was pleased to note that women were in the forefront in the fight against T&T as witnessed by the number of women who received the certificates. He said that the recommendations made at the meeting should be implemented at the grassroot as the stakeholders expected fruits from the conference.

He further observed that the T&T plague required National and international unity to address and was pleased to note that scientists working in the T&T were unified as demonstrated during the conference. He observed that Socio-economic development goes beyond political borders and political obstacles. In thanking the ISCTRC for having honored The Sudan to host its 32nd Conference, he reiterated his country's commitment to jointly with other Arab countries, support AU-PATTEC to mobilize the necessary resources and to work with the neighboring countries on T&T control

**Dr. James K. Wabacha**

*ISCTRC Secretary, AU-IBAR*

*Nairobi, Kenya*

September, 2015

## RAPPORT DU SECRÉTAIRE DE L'ISCTRC SUR LA 32ème CONFÉRENCE

### Cérémonie d'ouverture

La 32ème Conférence du Conseil scientifique international pour la recherche et la lutte contre la trypanosomiase (International Scientific Council for Trypanosomiasis Research and Control, ISCTRC) s'est tenue au Friendship Hall, à Khartoum au Soudan, du 8 au 12 septembre 2013. Le thème de la Conférence était « Recherche et lutte contre la mouche tsé-tsé et la trypanosomiase pour l'agriculture durable et le développement rural : promouvoir les partenariats et le programme d'apprentissage dans le contexte de la renaissance africaine ».

La conférence a été officiellement ouverte par son Excellence Ali Osman Muhammed Taha, premier vice-président de la République du Soudan. Parmi les autres dignitaires qui ont honoré la conférence de leur présence étaient présents Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages, Madame Rhoda Peace Tumusiime, Commissaire chargée du développement rural et de l'agriculture, à la Commission de l'Union africaine, Prof. Ahmed Elsawalhy, Directeur du Bureau interafricain pour les ressources animales de l'Union africaine (UA/BIRA) et Dr. Hassane Mahamat, Coordinateur de la Campagne panafricaine d'éradication de la mouche tsé-tsé et de la trypanosomiase (PATTEC),.

L'orateur principal, Son Excellence, Ali Osman Muhammed Taha, a souligné l'importance de la coopération conjointe africaine et du rôle du panafricanisme dans le développement de l'Afrique. Il a attiré l'attention sur la contribution de l'élevage à la sécurité alimentaire et en conséquence l'obligation des pays africains de protéger le bétail contre les maladies animales. Il a encouragé la plateforme de l'ISCTRC à continuer à fournir les informations indispensables qui contribueraient à la lutte contre la mouche tsé-tsé.

Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages, a souligné les incidences négatives de la trypanosomiase sur le développement rural du Soudan et insisté vivement pour que scientifiques et partenaires au développement mettent à contribution leurs énergies et ressources dans le but de trouver une solution durable au problème.

Prof. Ahmed El-Sawalhy, Directeur de l'UA-BIRA, a évoqué les objectifs de la conférence et exprimé ses sincères remerciements gouvernement du Soudan pour les excellents préparatifs effectués en vue d'accueillir la conférence.

La conférence s'est inspirée également du discours d'ouverture intitulé « Recherche et lutte contre la mouche tsé-tsé et la trypanosomiase pour l'agriculture durable et le développement rural : promouvoir les partenariats et le programme d'apprentissage dans le contexte de la renaissance africaine » prononcé par Madam Rhoda Peace Tumusiimeby, Commissaire chargée du développement rural et de l'agriculture, à la Commission de l'Union africaine.

**Participants à la conférence et exposés présentés à cette occasion**

Plus de 200 participants ont assisté à la réunion. Ils provenaient de 22 États membres africains, de la Commission de l'Union africaine, d'Universités et Institutions de recherche du monde entier, de l'Organisation des Nations unies pour l'alimentation et l'agriculture (FAO), de l'Organisation mondiale de la santé (OMS), de l'Agence internationale de l'énergie atomique (IAEA), de la Fondation pour l'Innovation en matière de Nouveaux Diagnostics (FIND), de la fondation Initiative pour Médicaments contre les Maladies Négligées (DNDI) et de l'Alliance mondiale pour les médicaments vétérinaires du bétail (GALVmed)

La conférence a également été motivée par les délibérations qui ont porté sur 95 exposés et posters qui englobaient les activités de recherche et de lutte contre la mouche tsé-tsé dans les États membres ; des rapports produits par organisations internationales ; la trypanosomiase humaine africaine ; la trypanosomiase animale africaine ; la biologie des glossines, le contrôle et l'éradication ainsi que les aspects socio-économiques, l'environnement et l'utilisation des terres.

La 32ème Conférence générale de l'ISCTRC a formulé des recommandations visant à guider la recherche et la lutte contre la mouche tsé-tsé et la trypanosomiase au cours des deux années à venir (2013-2015).

**Distribution des actes de la 31ème conférence**

Pendant la conférence les actes de la 31ème conférence de l'ISCTRC ont été distribués aux participants aussi bien en copies papier qu'en copies électroniques.

**Réunions parallèles**

De nombreuses réunions parallèles se sont tenues, notamment celle du Groupe de travail sur la trypanosomiase non transmise par les glossines

**38ème réunion du Comité exécutif de l'ISCTRC**

La 38ème réunion du Comité exécutif de l'ISCTRC s'est tenue au Friendship Hall, à Khartoum au Soudan, le 7 septembre 2013. Y ont assisté les neuf (9) représentants régionaux du Comité exécutif de l'ISCTRC ainsi que les membres institutionnels, notamment l'UA-BIRA, l'UA-PATTEC, la FAO, l'AIEA, le PAAT et l'OMS. La réunion a examiné la préparation pour la 32ème conférence de l'ISCTRC. Une réunion rétrospective du comité tenue à la suite de la cérémonie de clôture a relevé que la réunion avait été de haut niveau. Elle a permis également d'identifier certains domaines clés qui nécessitent être examinés lors des futures réunions. Les participants ont convenu que la 33ème Conférence de l'ISCTRC se tiendrait en Afrique du Centre ou en Afrique du Nord. Ils ont également décidé de l'organisation d'une 33ème Conférence générale conjointe de l'ISCTRC en juxtaposition avec la célébration des 15 ans de la PATTEC en 2015.

**Membres du Comité exécutif 2013-2015**

Ahmed Hussien Abdel Rahman est devenu le nouveau Président et les neuf membres régionaux du comité exécutif suivants ont été retenus :

Afrique Australe : Prof Théophile Josenando, Angola et Dr. Kalinga Chilongo, Zambie

Afrique du Centre : Dr Louis Banipe, Cameroun et Dr Victor Kande, RDC

Afrique de l'Est : Dr Ahmed H A Rahman, Soudan et Mme Joyce Daffa, Tanzanie

Afrique de l'Ouest : Dr Charles Mahama, Ghana et Dr Issa Degoga, Mali

Afrique du Nord : Dr Dia Mamdou Lamine, Mauritanie

Organisations internationales membres : FAO, AIEA, PAAT, PATTEC, OMS, ICIPE, ILRI, CIRDES.

**Dîner et cocktail**

Des événements mondains ont été organisés pendant la conférence et ont été très appréciés des participants. Ceux-ci ont permis de rendre la conférence agréable et les souvenirs resteront gravés dans la mémoire des participants pendant longtemps.

**Cérémonie de clôture**

La cérémonie de clôture s'est déroulée en présence de Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages, Prof. Ahmed Elsawalhy, Directeur de l'UA-BIRA, Dr. Hassane Mahamat, Coordinateur de l'UA-PATTEC et Prof. Ahmed Hussien Abdel Rahman, nouveau Président de l'ISCTRC.

Dans son allocution lors de la cérémonie de clôture, le nouveau Président de l'ISCTRC remercie le Président sortant de l'ISCTRC, Dr. Sadou Maiga, pour avoir dirigé l'ISCTRC au cours des deux dernières années. Il a déclaré que la Conférence de l'ISCTRC avait offert un environnement de partage de connaissances sur la mouche tsé-tsé. Il a fait remarquer par ailleurs que l'ISCTRC apportait une solide contribution scientifique à l'initiative PATTEC. Il remercie Son Excellence Ali Osman Muhammed Taha, premier vice-président du Soudan ainsi que Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages pour leur soutien. Il remercie en outre les membres du Comité national d'organisation pour leurs efforts ainsi que toutes les personnes qui ont contribué à la réussite de la réunion.

Pour sa part, Prof. Ahmed Elsawalhy, Directeur de l'UA-BIRA a saisi l'occasion pour remercier le Gouvernement ainsi que le peuple du Soudan d'avoir accueilli la 32éme Conférence générale de l'ISCTRC. Il remercie également le Comité national d'organisation ainsi que le Comité exécutif de l'ISCTRC pour le travail inlassable qu'ils ont accompli pour rendre l'événement possible. Il a salué la participation des États membres, des Universités et Institutions de recherche, des organisations régionales et internationales. Il fait remarquer que la conférence avait atteint les objectifs qui lui avaient été fixés et déclaré que l'UA-BIRA collaborerait avec toutes les parties prenantes pour donner suite aux recommandations formulées au cours de la conférence.

Levant la séance, Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages a remercié tous les dignitaires pour leur participation à la Conférence. Il a rendu un hommage particulier aux scientifiques qui se sont vus décerner des certificats pour avoir exposé des affiches gagnantes. Il s'est dit heureux de constater que les femmes étaient à la pointe de la lutte contre la mouche tsé-tsé comme en témoignait le nombre de femmes qui ont reçu les certificats. Il déclare que les recommandations formulées lors de la réunion doivent être mises en œuvre à la base, car les parties prenantes attendaient les résultats de la conférence.

Il a en outre fait remarquer qu'une union nationale et internationale s'imposait afin de s'attaquer au fléau de la mouche tsé-tsé. Il se réjouit de constater que les

scientifiques qui collaboraient à la lutte contre la mouche tsé-tsé étaient unis, ainsi que l'a démontré la conférence. Il a fait remarquer que le développement socio-économique dépasse les frontières et obstacles politiques. Tout en remerciant l'ISCTRC d'avoir honoré le Soudan pour l'accueil de sa 32ème Conférence, il a réitéré l'engagement de son pays à soutenir l'UA-PATTEC en commun avec d'autres pays arabes afin de mobiliser les ressources nécessaires, et promet de collaborer avec les pays voisins dans la lutte contre la mouche tsé-tsé.

Dr. James K. Wabacha

Secrétaire de l'ISCTRC, UA-BIRA

Nairobi, Kenya

Septembre 2015

**SPEECHES/DISCOURS**

## SPEECH OF THE HEAD OF THE NATIONAL ORGANIZING COMMITTEE

Your Excellency the first Vice President of the Sudan:

Your Excellency the Minister of Livestock, Fisheries and Rangeland: Your Excellencies, the Ministers:

Your Excellency Madam Rhoda Peace, the Commissioner of Rural Economy and Agriculture

Prof. Ahmed El Sawalhy, Director of AU/IBAR

Representatives of WHO, FAO, IAEA, FIND and GALVMED.

The Coordinator of the PAN African Tsetse and Trypanosomosis Eradication Campaign, PATTEC, Dr. Hassane Mahamat Hassane

Country Representatives and Heads of Delegations

Deans of Veterinary Colleges

Distinguished participants

Honorable Guests

Dear colleagues

I am honored and privileged to welcome you on behalf of the national organizing committee, in this very special platform, the International Scientific Council for Trypanosomosis Research and Control (ISCTRC), where scientists from all over the world gather to discuss advances made in the field of trypanosomes and their vectors. Although this glorious biannual scientific conference had been going on for 64 years, this is the first time to be implemented in the Sudan and that makes it a special event for the scientific community in this country. For that reason, your Excellencies, allow me to greet the AU Commission for Rural Economy, AU/IBAR and the secretariat of the ISCTRC for convening it in the Sudan.

In this meeting more than 100 oral presentations and fifty posters will be presented and discussed. Besides the backbone work in the disease and vector research and control scientists always present new discoveries and innovations in the field of diagnostics, medicines and even diagnostic equipments and control devices. Also at this point allow me, your Excellencies, to greet all those scientists who came to our country from all over the world for their dedication and commitment in supporting the poor African communities that are affected by Tsetse and Trypanosomosis. The work in this field is not easy and areas

affected are very remote and those scientists really stand for it. Again the outstanding work in research and innovations costs a lot of money and support of donors such as Bill and Melinda Gates Foundation is highly appreciated. Also we recognize the role of FAO and IAEA in providing technical assistance and capacity building to African countries. As well the role of WHO in giving free treatments to people affected by Sleeping Sickness, hence saving the lives of millions living under the risk of contracting the disease.

This meeting also provides chance for young African scientists to publish their research, to meet international experts and network with them. It also provides a chance for the young African scientists to meet donors and discuss funding of their projects with them.

I would like to acknowledge the contribution of the following private sector organizations to the NOC:

The Minister of Finance, Excellency, Ali Mohmood for approving the fund that covered most of our needs including the cost of the venue (One million Sudanese pounds)

The Governor of Khartoum State, Dr. Abdel Rahman Alkhidir for providing three buses for transport and for the dinner reception for the group on Monday

WHO/FIND

The Chamber of Veterinary Inputs for offering a dinner reception to the group on Wednesday.

Mr. Ahmed Idrees for offering a dinner reception to the group on Thursday.

Your Highness, the Vice President, Your Excellency, the Minister, Your Excellency Madam, Commissioner, the distinguished scientists; you gave us the tools and means to implement this activity, if we succeed, it is because of your support, if we fail it is our mistake.

***Prof. Ahmed Hussien Abdel Rahman***

**Head of the National Organizing Committee.**

## DISCOURS DE CHEF DU COMITE NATIONAL D'ORGANISATION

Excellence, Monsieur le Premier Vice-Président du Soudan,

Excellence, Monsieur le Ministre de l'Élevage, de la Pêche et des Parcours,

Excellences, Mesdames et Messieurs les Ministres,

Excellence Madame Rhoda Peace Tumusiime, Commissaire pour l'Economie rurale et l'Agriculture de la Commission de l'Union africaine,

Monsieur le Directeur de l'UA-BIRA, Pr Ahmed El Sawalhy,

Mesdames et Messieurs les Représentants de l'OMS, de la FAO, de l'AIEA, de Find et de GALVMED,

Monsieur le Coordonnateur de la Campagne panafricaine pour l'éradication de la mouche tsé-tsé et de la trypanosomose - PATTEC, Dr. Hassane Mahamat Hassane,

Messieurs les Représentants des pays et Chefs de délégation,

Mesdames et Messieurs les Doyens des facultés vétérinaires,

Mesdames et Messieurs, participants à la Conférence,

Distingués Invités,

Chers Collègues,

Je suis honoré et privilégié de vous accueillir, au nom du Comité national d'organisation, à cette plateforme très spéciale - le Conseil Scientifique International pour la Recherche et la Lutte contre les Trypanosomoses (CSIRLT), où se réunissent des scientifiques venus du monde pour discuter des progrès réalisés dans le domaine des trypanosomiases et de leurs vecteurs. Bien que cette conférence scientifique biennale soit organisée régulièrement depuis 64 ans, c'est la première fois qu'elle se tient au Soudan, et ceci en fait un événement spécial pour la communauté scientifique du pays. Pour cette raison, Excellences, permettez-moi de saluer la Commission de l'UA pour l'Economie rurale et l'Agriculture, l'UA-BIRA et le secrétariat du CSIRLT d'avoir organisé cette conférence au Soudan.

Dans le cadre de cette réunion, plus de 100 exposés oraux et cinquante posters seront présentés et discutés. Outre le travail fondamental de recherche et de lutte contre la maladie et ses vecteurs, les scientifiques présentent toujours de nouvelles découvertes et innovations dans le domaine du diagnostic, des médicaments, des équipements de diagnostic et des dispositifs de contrôle. Permettez-moi à présent, Excellences, de saluer tous ces scientifiques venus dans notre pays en provenance des diverses parties du monde, pour

leur dévouement et leur attachement à soutenir les communautés pauvres d'Afrique qui sont affectées par la mouche tsé-tsé et la trypanosomose. Bien que le travail ne soit pas facile dans ce domaine et que les zones affectées soient très éloignées, les scientifiques sont tout de même venus dans notre pays. Encore une fois, le travail exceptionnel sur le plan de la recherche et les innovations sont très coûteux ; et nous apprécions beaucoup le soutien des donateurs comme la Fondation Bill et Melinda Gates. Nous nous félicitons également du rôle joué par la FAO et l'AIEA à travers l'assistance technique et le renforcement des capacités offerts aux pays africains. Nous remercions l'OMS qui donne des traitements gratuits aux personnes affectées par la maladie du sommeil, sauvant ainsi la vie de millions de personnes vivant sous le risque de contracter la maladie.

En outre, la présente réunion offre aux jeunes scientifiques africains l'occasion de publier leurs travaux de recherche, de rencontrer et de nouer des relations avec des experts internationaux, de rencontrer les bailleurs de fonds et de discuter de leurs projets avec eux.

Je tiens à remercier les personnalités et entités du secteur privé suivantes pour leurs diverses contributions au bon déroulement de cette conférence :

Le Ministre des Finances, son Excellence Ali Mohmood, pour avoir approuvé les fonds qui ont couvert la plupart de nos besoins, y compris le coût du lieu de rencontre (un million de livres soudanaises) ;

Le Gouverneur de l'État de Khartoum, Dr Abdel Rahman Alkhidir, pour la fourniture de trois bus de transport et pour le dîner - réception de Lundi ;

L'OMS/FIND ;

La Chambre des produits vétérinaires (Chamber of Veterinary Inputs) pour la réception et le dîner offerts à tous les participants Mercredi ;

M. Ahmed Idrees pour la réception et le dîner offerts à tous les participants Jeudi ;

Excellence Monsieur le Vice-Président, Excellence Monsieur le Ministre, Excellence Madame la Commissaire, éminents Scientifiques, vous nous avez

donné les outils et les moyens de réaliser cette activité ; si nous réussissons, ce sera grâce à votre soutien, si nous échouons, l'erreur sera venu de notre part.

***Pr Ahmed Hussien Abdel Rahman,***

**Chef du Comité national d'organisation.**

## SPEECH BY HIS EXCELLENCY MINISTER OF THE LIVESTOCK, FISHERIES AND RANGELAND

Your Excellency the first Vice President of the Sudan

Your Excellencies, The Ministers

Your Ex. Madam Rhoda Peace, the commissioner of rural economy and

Agriculture

Your Excellencies, The Ambassadors and members of the diplomatic accord

Prof. Ahmed El Sawalhy, Director of AU/ IBAR Representatives of WHO, FAO, IAEA, Find and Galvmed

The Coordinator of the PAN African Tsetse and Trypanosomosis Eradication

Campaign, PATTEC, Dr. Hassane Mahamat Hassane

Countries Representatives and Heads of Delegations

I am very much honored to welcome you in the Sudan for the thirty second meeting of the ISCTRC. I hope you will enjoy the meeting and your stay in our country.

The Sudan is one of the tsetse infested African countries and the area infested is about 50 thousand squire kilometers. In Sudan trypanosomosis which is transmitted by tsetse and other biting flies, is an important factor that limits land use and greatly hinders livestock and agricultural production, which negatively impacts on soil fertility, rendering the fertile lands of Sudan unsuitable for agricultural development and livestock improvement programmes.

As a matter of fact, 80% of Sudan's animal wealth is kept under transhumance way of herd management and is perpetually under the threat and negative influences of trypanosomosis. During the dry season, large numbers of the migratory herds of the north enter and stay in the tsetse belt where pasture and water is available. In recent years and due to successive cycles of drought and civil unrest, the nomads are forced to go deeper and stay longer in highly tsetse- infested areas, thus their animals are exposed to high trypanosome challenge and risk of infection, this consequencely leads to massive losses in terms of high morbidity, increased mortality, low fertility and reduced meat and milk yield.

Outside the tsetse fly belt trypanosome transmission is by mechanical vectors

due to extensive abundance of biting flies that cover the entire country. In addition to expenditure on importation of trypanocides of over 11 million USD annually, the epidemiological status is further complicated by the increasing occurrence of drug resistance.

The above-mentioned situation makes trypanosomosis high on the list of priorities of the Ministry of Livestock and Fisheries. Acordingly, disease surveillance and vector control programmes were conducted countrywide with special focus on two tsetse-infested areas along the migratory route of pastoralists with a high density of livestock. Moreover, the area is adjacent to countries where the disease and it's vectors are prominent.

Furthermore, a memorandum of understanding was signed with the Republic of Ethiopia in order to effectively control trypanosomosis across the region. This provided a framework for joint activities and the exchange of information regarding the disease and its impact on both countries.

The pronounced need for pastures for a growing animal population led to the adoption of an integrated approach when addressing the tsetse and trypanosomosis problem in Sudan, a situation that is applies to all African countries affected by the disease. This situation demands concerted efforts of the local communities and authorities at the national, regional and international levels.

Distinguished delegates,

The International Scientific Council for Trypanosomosis Research and Control is one of the most important scientific councils in Africa that attracts worldwide attention to the trypanosomosis problem through different events and platforms, an effort that is highly lauded and appreciated. In addition, we consider this meeting as a step forward in the organized fight against the disease, a fight that we believe we can win. I wish you a successful and fruitful meeting.

Before leaving I would also like to thank the National Organizing committee for their efforts and commitment.

Distinguished delegates

At this point I have the honor to invite the First Vice president of the Sudan to address the meeting and open the conference.

## DISCOURS DE SON EXCELLENCE MONSIEUR LE MINISTRE DE L'ELEVAGE, DE LA PECHE ET DES PARCOURS DU SOUDAN

Excellence, Monsieur le Premier Vice-Président du Soudan,

Excellences, Mesdames et Messieurs les Ministres,

Excellence, Madame Rhoda Peace Tumusiime, Commissaire pour l'Economie rurale et l'Agriculture de la Commission de l'Union africaine,

Excellences, Mesdames et Messieurs les Ambassadeurs et Membres du corps diplomatique,

Monsieur le Directeur de l'UA / BIRA, Professeur Ahmed El Sawalhy,

Mesdames et Messieurs les Représentants de l'OMS, de la FAO, de l'AIEA, de Find et de GALVmed,

Monsieur le Coordonnateur de la Campagne panafricaine pour l'éradication de la mouche tsé-tsé et de la trypanosomose –PATTEC, Dr. Hassane Mahamat Hassane,

Mesdames et Messieurs les Représentants des pays et Chefs de délégation,

Je suis très honoré de vous accueillir ici, au Soudan, pour la trente-deuxième Conférence du CSIRLT. J'espère que vous allez tirer profit de la réunion et que votre séjour sera agréable dans notre pays.

Le Soudan est l'un des pays africains infestés par la mouche tsé-tsé, et la zone infestée s'étend environ sur 50 milles kilomètres carrés. Dans notre pays, la trypanosomose, transmise par la mouche tsé-tsé et d'autres mouches piqueuses, est un facteur important de limitation des terres utilisables, qui entrave sérieusement l'élevage et la production agricole et a des effets négatifs sur la fertilité du sol, rendant les terres fertiles du Soudan inappropriées pour les programmes de développement de l'agriculture et d'amélioration de l'élevage.

En fait, 80% de la richesse animale du Soudan est maintenu dans un régime d'élevage transhumant et est perpétuellement sous la menace et les influences négatives de la trypanosomose. Pendant la saison sèche, de grands nombres de troupeaux migrateurs du Nord entrent et séjournent dans la ceinture des glossines, à la recherche des pâturages et de l'eau. Au cours des dernières années et en raison des cycles successifs de sécheresse et d'instabilité civile, les nomades ont été obligés d'aller vers des régions plus éloignées et de rester plus longtemps dans les zones fortement infestées de mouches tsé-tsé. C'est ainsi que leurs animaux ont subi des niveaux élevés d'infection, dont la

conséquence a été des pertes massives résultant des taux élevés de morbidité et de mortalité et de faible fécondité, ainsi qu'une réduction de la production de viande et de lait.

En dehors de la ceinture des glossines, la transmission mécanique existe et constitue un problème majeur qui persiste à cause de l'abondance des mouches piqueuses dans la quasi-totalité du pays. En dépit du fait que les trypanocides sont importés à un coût qui dépasse 11 millions de dollars chaque année, la situation épidémiologique est davantage compliquée par le problème de résistance croissante aux médicaments.

La situation précédemment décrite classe la trypanosomose parmi les grandes priorités du Ministère de l'Elevage et de la Pêche, et évoque les réactions prévues qui ont abouti à des programmes de surveillance et de lutte contre les vecteurs de la maladie, mis en œuvre dans tout le pays, avec un accent particulier sur deux zones infestées le long de la route migratoire des nomades, densément peuplées de bétail, adjacentes aux pays où la maladie et ses vecteurs sont très répandus.

En outre, les efforts visant à lutter contre la trypanosomose dans la région ont ouvert la voie à la signature d'un mémorandum d'accord avec la République d'Éthiopie, définissant un cadre pour des activités conjointes et un échange d'informations sur la maladie et son impact sur les deux pays.

Le besoin marqué de pâturages pour une population animale de plus en plus croissante a favorisé l'adoption d'une approche intégrée dans la lutte contre le problème de la mouche tsé-tsé et de la trypanosomose au Soudan, une situation applicable à tous les pays africains affectés par la maladie. Cette situation exige des efforts concertés de la part des communautés locales et des autorités aux niveaux national, régional et international.

Distingués Délégués,

Le Conseil Scientifique International pour la Recherche et la Lutte contre les Trypanosomiases, un des conseils scientifiques établis en Afrique, a attiré l'attention du monde entier au problème de la trypanosomose, à la faveur des différents événements et plateformes, un effort très bien accueilli et hautement apprécié. En conséquence, nous considérons cette réunion comme un pas en avant dans une lutte organisée contre la maladie, une bataille que nous gagnerons sans aucun doute. Je vous souhaite des discussions fructueuses et

productives dans cette réunion.

Avant de terminer, je voudrais également remercier le Comité national d'organisation pour ses efforts et son engagement.

Distingués Délégués,

A ce stade, il m'échoit l'honneur d'inviter le Premier Vice-Président du Soudan à prendre la parole et à ouvrir officiellement la Conférence.

## SPEECH BY HIS EXCELLENCY FIRST VICE PRESIDENT OF REPUBLIC OF THE SUDAN

Your Excellency the Minister of Livestock, Fisheries and Rangeland

Your Excellencies, The Ministers

Your Excellency Madam Rhoda Peace, the Commissioner of Rural Economy and Agriculture

Your Excellencies, The Ambassadors and members of the diplomatic corps

Prof. Ahmed El Sawalhy, Director of AU/ IBAR Representatives of WHO, FAO, IAEA, Find and Galvmed

The Coordinator of the PAN African Tsetse and Trypanosomosis Eradication Campaign, PATTEC, Dr. Hassane Mahamat Hassane Countries Representatives and Heads of Delegations Deans of Veterinary Colleges

Distinguished participants

It is my pleasure to welcome you all, especially those who came from far away to attend the thirty second meeting of the International Scientific Council for Trypanosomosis Research and Control ISCTRC convened in The Sudan. I am well informed that more than 240 scientists are gathering from different parts of the world to attend this biannual conference, this time to be held in Khartoum. They are going to discuss scientific issues related to a very serious problem affecting the agricultural development in Africa. The Scientists are going to discuss the problem of the tsetse flies and the diseases they transmit to man and animals. Many scientific papers will be presented and discussed defining the ways and means of achieving tsetse eradication and the elimination of the diseases they transmit.

In the Sudan we are implementing plans that develop sustainable resources for agriculture and animal wealth. Among those plans are the improvement of pastures, genetic improvement of local animal breeds, expansion in ranching and adoption of disease control strategies that lead to control of priority diseases that affect livestock production and export including control of tsetse flies and the diseases they transmit. The main goal of these plans is to attain food security and improve the standard of living of the people of the Sudan.

In the Sudan we are fully committed to the joint African cooperation and we believe that it is the solution to most of the African economic problems. It is quite evident that in most of the African countries the political boundaries

which are defined by the colonizers are dividing similar ethnic groups and the same ecological zones. Through the decades the transboundary movement of people and livestock between the African countries is a recognized feature that mark the way of life of large sectors of the Africans. To maximize the benefits from such mutual relations, we strongly advocate for convening joint economic projects in all fields of interest that serve the African nations. Among them are projects for elimination of diseases and pests.

Dear participants

Although Africa is rich in natural resources, numerous challenges affect agricultural development and animal production on the continent, leading huge problems of food security. Among those challenges are the agricultural pests and animal diseases. Although vast areas of Africa are rich in pastures, they are not fully utilized for animal grazing due to the presence of such pest and the diseases they transmit. This has a big negative impact on rural production and rural economy and the economic development in the continent as a whole. Therefore common thinking, and joint planning that lead to common and joint African action creates a sustainable solution to the problem. The role of scientists is to lead the way and define solutions for such problems. Conferences such as the ISCTRC provide a suitable platform to achieve this goal. I am hopeful that this conference provide solutions to some of the important questions. This would fulfill the goal of the Lome 2000 Decision of the African Head of States and Governments to eradicate tsetse and trypanosomosis from Africa.

I thank the organizers for such a well organized meeting and thank all you for coming to our Country, Sudan. I wish you fruitful deliberations and a successful meeting. Now I declare the Conference opened.

## DISCOURS DE SON EXCELLENCE LE PREMIER-VICE PRESIDENT DE LA REPUBLIQUE DU SOUDAN

Excellence Monsieur le Ministre de l'Élevage, de la Pêche et des Parcours,

Excellences Mesdames et Messieurs les Ministres,

Excellence Madame Rhoda Peace Tumusiime, Commissaire pour l'Economie rurale et l'Agriculture de la Commission de l'Union africaine,

Excellences, Mesdames et Messieurs les Ambassadeurs et Membres du corps diplomatique,

Monsieur le Directeur de l'UA-BIRA, Prof. Ahmed El Sawalhy,

Mesdames et Messieurs les Représentants de l'OMS, de la FAO, de l'AIEA, de Find et de Galvmed,

Monsieur le Coordonnateur de la Campagne panafricaine pour l'éradication de la mouche tsé-tsé et de la trypanosomiase - PATTEC, Dr. Hassane Mahamat Hassane,

Mesdames et Messieurs les Représentants et Chefs de délégation,

Mesdames et Messieurs les Doyens des facultés vétérinaires,

Distingués Participants,

J'ai le plaisir de vous accueillir tous ici au Soudan, en particulier ceux qui sont venus de loin pour assister à la Trente-deuxième Conférence du Conseil Scientifique International pour la Recherche et la Lutte contre les Trypanosomiases (CSIRLT) qui se tient aujourd'hui dans notre pays. Je suis bien informé que plus de 240 scientifiques venus des différentes parties du monde sont réunis ici pour assister à cette conférence biannuelle, qui se tient cette fois-ci à Khartoum. Ils vont discuter des questions scientifiques liées à un problème très grave qui affecte le développement agricole en Afrique. Les scientifiques vont discuter de la problématique des glossines et des maladies qu'elles transmettent à l'homme et aux animaux. De nombreux articles scientifiques seront présentés et discutés en vue de définir les voies et moyens de parvenir à l'éradication des glossines et à l'élimination des maladies transmises par ces dernières.

Au Soudan, nous mettons en œuvre des plans de développement durable des ressources agricoles et de la richesse animale. Parmi ces plans figurent l'amélioration des pâturages, l'amélioration génétique des races animales locales, l'expansion de l'élevage et l'adoption de stratégies de lutte contre

la maladie à même de conduire à une lutte effective contre les maladies prioritaires qui affectent la production et l'exportation des animaux, y compris le contrôle des mouches tsé-tsé et des maladies transmises par ces dernières. Le principal objectif de ces plans est d'atteindre la sécurité alimentaire et d'améliorer le niveau de vie du peuple soudanais.

Au Soudan, nous sommes pleinement acquis à la coopération africaine conjointe, et nous sommes convaincus que ce type de coopération est la solution à la plupart des problèmes économiques africains. Il est assez évident que dans la plupart des pays africains, les frontières politiques définies par les colonisateurs ont divisé des groupes ethniques similaires et les mêmes zones écologiques. Depuis des décennies, le mouvement transfrontalier de personnes et d'animaux entre les pays africains est une caractéristique reconnue qui marque le mode de vie de parties importantes des populations africaines. Dans l'optique de maximiser les bénéfices de ces relations mutuelles, nous préconisons fortement l'élaboration de projets économiques conjoints dans tous les domaines d'intérêt pour les nations africaines, notamment les projets d'élimination des maladies et de contrôle des parasites.

Chers Participants,

Même si l'Afrique est riche en ressources naturelles, elle reste confrontée à des problèmes de sécurité alimentaire en raison des défis qui se posent au développement agricole et à la production animale sur le continent. Parmi ces défis, on peut citer les parasites agricoles et les maladies animales. Bien que de vastes régions d'Afrique soient riches en pâturages, ceux-ci ne sont pas pleinement utilisés pour l'alimentation des animaux en raison de la présence de ces parasites et des maladies causées par ces derniers. Les parasites et les maladies ont un impact très négatif sur la production rurale et l'économie rurale et sur le développement économique du continent dans son ensemble.

Par conséquent, la solution durable à ces problèmes viendra des réflexions communes et planifications conjointes, susceptibles de conduire à des actions africaines communes et coordonnées. C'est ici qu'intervient le rôle des scientifiques pour montrer la voie à suivre et définir des solutions à ces problèmes ; et des conférences comme celle du CSIRLT sont des outils fiables qui permettront d'atteindre ces objectifs. J'espère que cette conférence sera à même de trouver des solutions à certains problèmes importants, et que ces solutions permettront d'atteindre l'objectif de la Décision des chefs d'État et de gouvernement africains de Lomé (2000) d'éradiquer la mouche tsé-tsé et la trypanosomose en Afrique.

Je remercie les organisateurs pour les bonnes dispositions prises en vue de cette réunion, et je vous remercie tous d'être venus dans notre pays, le Soudan. Je vous souhaite des délibérations fructueuses et une réunion productive. Sur ce, je déclare ouverte la Conférence.

## REMARKS BY HER EXCELLENCY MRS RHODA PEACE TUMUSIIME, COMMISSIONER FOR RURAL ECONOMY AND AGRICULTURE

- Your Excellency, First Vice President, Honourable Ali Osman Mohamed Taha
- The Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim
- Chairman of the ISCTRC Dr Sadou Maiga
- Executive Committee Members of the ISCTRC
- Representatives of International Organizations
- Eminent Scientists
- Members of the Diplomatic Corps
- The National Organizing Committee Members
- Distinguished Guests
- Ladies and Gentlemen

Your Excellency we 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 The Sudan for collaborating with the African Union Commission in the organisation and convening of this Conference, and for the warm welcome and hospitality accorded to all of us. Our gratitude goes also to our cooperating partners.

I also welcome all of you to this important conference and I wish to say that I find the theme of the conference 'Tsetse and Trypanosomiasis Research and Control for Sustainable Agriculture and Rural Development: Promoting Partnership and Learning Agenda in the context of African Renaissance' quite appropriate as it is in consonance with 'Pan Africanism and African Renaissance' which is the theme for this Golden Jubilee of the Organisation of African Unity (OAU) , the predecessor of the current African Union.

The theme of this Conference provides us with the opportunity to reflect on the progress made so far in addressing the challenges posed by Tsetse and Trypanosomiasis and the lessons learned that can be useful in informing, planning and implementation of Tsetse and Trypanosomiasis Research and Control interventions in the future. This also falls perfectly in line with the the on-going exercise of developing the Africa Agenda 2063 on a Shared

Strategic Framework for Inclusive Growth and Sustainable Development, which will be considered for adoption by the AU Assembly of Heads of State and Government in January 2014. Through this agenda, we want to achieve three objectives: firstly, to agree on the Africa we want, secondly, to set short and medium term milestones and concrete strategies on how we will get there, and thirdly, to define the role each of us should play to achieve this agenda.

Tsetse and Trypanosomiais continue to be a big challenge in rural areas of Africa. The loss due to Animal African Trypanosomiasis (AAT) is substantial and it is estimated at US$ 5 billion a year. Human sleeping sickness continues to be a public health challenge in many areas of rural Africa. Although the number of reported cases per year has declined to less than 10,000 cases, a lot still needs to be done. And this is the reason why we are here.

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 and in 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 the public health.

It was for this reason that the African Heads of State and Government, endorsed the establishment of the Pan African Tsetse and Trypanosomisis Eradication Campaign (PATTEC) aimed at elimination and eventual eradication of tsetse and trypanosomiasis in the 38 states of Africa infested with the tsetse fly vector. Under the framework of PATTEC, national projects aimed at the creation of sustainable tsetse and trypanosomiasis free areas are being implemented and the PATTEC initiative, now on its 12th year, has now a fully-fledged specialized coordination Office in the AU Department of Rural Economy and Agriculture, AU-PATTEC. 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. For this task, in the context of Africa Agenda 2063 that I just talked about, we need to reflect on the key issues and lessons that will guide our strategies and operations in Tsetse and Trypanosomiasis research and control in years ahead.

As I mentioned earlier in my address, the number of reported cases of Human African Trypanosomiasis has reduced to below 10,000 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 (HAT).
- Work in close collaboration with AU-PATTEC in the efforts that are aimed at vector control.
- Increase advocacy on the disease with emphasis on the education of policy makers so that the elimination of HAT is treated as a high priority issue.

Our Guest of Honour, Ladies and Gentlemen, allow me, to highlight more issues we need to observe for effective and sustainable tsetse and trypanosomiasis research and control. Past experiences, show that Tsetse and Trypanosomiasis control activities are effective when integrated with other rural development activities. I urge you, therefore, to consider the institutionalization of Tsetse and Trypanosomiasis control activities in the National and Regional Comprehensive Africa Agriculture Development Programme (CAADP) Compacts when they are being formulated and also in the related Investment Plans. I am glad to note that our Host, The Sudan, signed their CAADP Compact last month and we were privileged to witness the solemn occasion. CAADP provides a framework for national consultation processes. Countries should also include tsetse and trypanosomiasis control in the Poverty Reduction Strategy Papers to ensure mainstreaming of trypanosomiasis control and sustainable livelihoods at the community level. Further, it is now well known that Tsetse and Trypanosomiasis control activities contribute to all the four CAADP pillars: land and water management, private sector and market access, combating hunger and malnutrition as well as research and development.

Ladies and Gentlemen, tsetse flies know no territorial boundaries and our animal resources, being transboundary in nature are an important reservoir of sleeping sickness. In the past, areas where tsetse had been cleared were soon re-infested by tsetse flies from un-cleared areas leading to apathy and frustration among the tsetse control workers. Therefore eliminating and eventually eradicating tsetse and trypanosomiasis call for area-wide and regional approaches. At this juncture, I wish to commend the Arab Bank for Economic Development in Africa (BADEA) for the cooperation and support and for hosting last month here in Khartoum an African Ministerial Conference to advance regional collaborative strategies in combating tsetse and trypanosomiasis.

A window of opportunity now exists whereby the current fuller 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 and 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 emulate to be successful.

Important lessons can also be drawn from the Multinational Tsetse Project funded by the African Development Bank (AfDB) from 2006 to 2011 that was unique from the point of view of the level of investment that was made, and the scale of the area that was to be cleared off tsetse. Varying degrees of success were obtained in the countries that participated in the Project. It would, therefore be prudent to conduct a comprehensive post-project review of the 6 countries that took part in the Multinational Project to identify the best practices for the benefit of other countries that intend to formulate such a project and also identify factors that might hamper its implementation to the desired extent.

The challenge of tsetse and trypanosomiasis touches on several sectors, namely: agriculture, wildlife, rural development, animal health and public health, presenting one of the best 'One Health' models to date. Therefore, there is need for the various actors that transverse national, regional, continental and global level to form strategic alliances for Tsetse and Trypanosomiasis research and control. I observe with appreciation the growing interest and enhanced collaboration between institutions in all areas of Tsetse and Trypanosomaisis Research and Control as evidenced by the number of networks and consortia that have evolved over time.

Ladies and Gentlemen, availability of quality data continues to be a challenge in evidence based decision making in Tsetse and Trypanosomiasis control. There is, therefore, need for investment in quality data collection and analysis to inform the interventions.

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

Over the years, chemotherapy has been used as a tool for control of Human African Trypanosomiasis (HAT), however the main challenge has been toxicity of the drugs, drug resistance, high cost, and lack of new molecules and challenges of delivering the services to the needy in the rural areas. There is, therefore, need to sustain the gains made, by ensuring that the available technologies continue to be accessible to deserving rural communities. In this regard, public and private sector partnerships (PPP) should be encouraged to ensure that the badly needed drugs by the communities are made available when required; to provide new solutions for diagnosis; to enhance effectiveness of surveillance and case management systems and to support development of new therapies.

Our Guest of Honour, Ladies and Gentlemen, our technical experts in this field have the onerous task of ensuring the success of the control of Tsetse and Trypanosomiasis on the African continent, to facilitate accelerated rural development in the affected countries with the support of our political leaders who are well represented at this Conference. It is, therefore, my expectation that this ISCTRC Conference will deliberate and propose appropriate solutions to many of the unanswered questions in this regard, building on the experiences from best practices and success stories.

I thank you for your attention and wish you productive deliberations.

## DISCOURS DE SON EXCELLENCE MRS RHODA PEACE TUMUSIIME, COMMISSAIRE RESPONSABLE DE L'ÉCONOMIE RURALE ET L'AGRICULTURE

- Votre Excellence, Honorable Ali Osman Mohamed Taha, Premier Vice-Président
- Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages
- Dr Sadou Maiga, Président de l'ISCTRC
- Membres du Comité Exécutif de l'ISCTRC
- Représentants des Organisations internationales
- Éminents scientifiques
- Membres du Corps diplomatique
- Les membres du Comité national d'organisation
- Distingués invités
- Mesdames et Messieurs

Votre Excellence, nous sommes très honorés par votre présence à cette occasion. Par votre intermédiaire je voudrais tout d'abord exprimer ma gratitude au Gouvernement et au peuple de la République du Soudan pour leur collaboration avec la Commission de l'Union africaine à l'organisation et à la convocation de cette Conférence, ainsi que pour l'accueil et l'hospitalité chaleureux qui nous ont été réservés à tous. Nos remerciements vont également à nos partenaires de coopération.

Je vous souhaite également à tous la bienvenue à cette importante conférence et je tiens à dire qu'à mon sens, le thème de la conférence « Recherche et lutte contre la mouche tsé-tsé et la trypanosomiase pour l'agriculture durable et le développement rural : promouvoir les partenariats et le programme d'apprentissage dans le contexte de la renaissance africaine » est tout à fait approprié, car il est en adéquation avec « Panafricanisme et Renaissance africaine » qui est le thème de ce cinquantième anniversaire de l'Organisation de l'Unité africaine (OAU), ancêtre de l'actuelle Union africaine.

Le thème de cette Conférence nous offre l'occasion de réfléchir sur les progrès accomplis jusqu'à présent pour faire face aux défis posés par la mouche tsé-tsé et la trypanosomiase ainsi que les enseignements tirés qui peuvent s'avérer utiles pour informer, planifier et mettre en œuvre des actions à mener dans le

cadre de la recherche et de la lutte contre la mouche tsé-tsé et la trypanosomiase dans le futur. Ce thème s'intègre également parfaitement dans l'exercice actuel d'élaboration de l'Agenda de l'Afrique 2063 sur un cadre stratégique partagé pour une croissance à caractère inclusif et un développement durable, qui sera soumis à examen pour adoption par l'Assemblée de l'UA des chefs d'État et de gouvernement en janvier 2014. Dans le cadre de ce programme, nous souhaitons atteindre trois objectifs : premièrement, tomber d'accord sur l'Afrique que nous souhaitons, deuxièmement, fixer des échéances à court et à moyen terme ainsi que des stratégies concrètes relatives aux moyens à mettre en œuvre pour y parvenir et troisièmement, définir le rôle que chacun d'entre nous doit jouer pour réaliser ce programme.

La mouche tsé-tsé et la trypanosomiase continuent de poser un énorme défi dans les zones rurales d'Afrique. Les pertes dues à la trypanosomiase animale africaine (TAA) sont considérables et atteignent 5 milliards de dollars USD par an, selon les estimations. La maladie du sommeil humaine continue d'être un défi de santé publique dans de nombreuses régions rurales en Afrique. Bien que le nombre de cas signalés par an a diminué à moins de 10 000 cas, il reste encore beaucoup à faire. Et c'est la raison de notre présence en ce lieu.

Rétrospectivement, vous vous souviendrez que la lutte contre la trypanosomiase africaine en Afrique est engagée depuis le 20ème siècle, lorsque les effets négatifs de la maladie sur la santé humaine et animale ont été reconnus. Ces premiers efforts ont entraîné une réduction dramatique de la maladie. La réduction du fardeau de la maladie a toutefois entraîné le fléchissement de l'intérêt que les autorités du secteur public ainsi que d'autres partenaires éprouvaient à investir dans la lutte contre la maladie. Malheureusement, cette accalmie a entraîné la réapparition de la maladie et dans les années 80 et 90, la maladie avait repris son emprise sur les régions où elle avait antérieurement été maîtrisée, et de ce fait, de lourdes pertes de bétail ont été enregistrées, suivies d'effets négatifs pour la santé publique.

C'est pour cette raison que les chefs d'État et de gouvernement africains ont approuvé la mise en place de la Campagne panafricaine d'éradication de la mouche tsé-tsé et de la trypanosomiase (PATTEC) qui visait à éliminer et finalement éradiquer la mouche tsé-tsé et la trypanosomiase dans les 38 États d'Afrique infestés par le vecteur des mouches tsé-tsé. Dans le cadre de la PATTEC, des projets nationaux visant la création de zones durablement exemptes de mouches tsé-tsé et de la trypanosomiase sont en cours de mise en œuvre et l'initiative PATTEC, actuellement dans sa 12ème année, dispose désormais d'un Bureau de coordination spécialisé à part entière dans le Département de l'UA de l'économie rurale et de l'agriculture, UA-PATTEC. Depuis le lancement de l'initiative PATTEC, beaucoup d'efforts

ont été déployés et de nombreux succès enregistrés dans la lutte contre la trypanosomiase. Il reste toutefois beaucoup à faire. Pour accomplir cette tâche, et dans le cadre de l'Agenda de l'Afrique 2063 que je viens de mentionner, nous devons réfléchir sur les problèmes et enseignements clés qui orienteront nos stratégies et opérations dans la recherche et la lutte contre la mouche tsé-tsé et la trypanosomiase au cours des années à venir.

Comme je l'ai mentionné plus tôt dans mon allocution, le nombre de cas signalés de trypanosomiase humaine africaine est passé en dessous du seuil de 10 000 par an. Je vous demande de ne pas baisser la garde et de rester vigilants car les périodes antécédentes de niveaux bas de la maladie ont été suivies d'une résurgence de la maladie. En conséquence, je vous exhorte, en particulier l'Organisation mondiale de la santé (OMS) ainsi que d'autres Institutions à :

- Soutenir les efforts menés pour accompagner la lutte contre la trypanosomiase humaine africaine (THA).
- Travailler en étroite collaboration avec l'UA-PATTEC dans les efforts déployés qui visent la lutte contre les vecteurs.
- Renforcer le plaidoyer relatif à la maladie avec un accent particulier sur la sensibilisation des décideurs afin que l'élimination de la THA soit traitée en priorité.

Notre invité d'honneur, Mesdames et Messieurs, permettez-moi de souligner plusieurs autres questions que nous devons observer afin de garantir l'efficacité et la durabilité de la recherche et de la lutte contre la mouche tsé-tsé et la trypanosomiase. Les expériences passées indiquent que les activités de lutte contre la mouche tsé-tsé et la trypanosomiase s'avèrent efficaces lorsqu'elles sont menées conjointement avec d'autres activités de développement rural. Je vous exhorte, en conséquence, à envisager l'institutionnalisation des activités de lutte contre la mouche tsé-tsé et la trypanosomiase dans les contrats nationaux et régionaux du Programme intégré pour le développement de l'agriculture en Afrique (CAADP) lors de leur formulation ainsi que dans les Plans d'investissement connexes. Je suis ravie de mentionner que notre Hôte, le Soudan, a signé son contrat CAADP le mois dernier et nous avons eu le privilège d'être témoin de cette occasion solennelle. Le CAADP offre un cadre pour les processus de consultation au niveau national. Les pays doivent également intégrer la lutte contre la mouche tsé-tsé et la trypanosomiase dans les documents de stratégie pour la réduction de la pauvreté afin d'assurer la prise en compte de la lutte contre la trypanosomiase ainsi que des moyens d'existence durables au niveau des collectivités. En outre, on sait aujourd'hui que les activités de lutte contre la mouche tsé-tsé et la trypanosomiase contribuent à tous les quatre piliers du CAADP, à savoir : la gestion des terres et des eaux, le secteur privé et l'accès aux marchés, la lutte contre la faim et la

malnutrition ainsi que la recherche et le développement.

Mesdames et Messieurs, les mouches tsé-tsé ne connaissent pas de frontières territoriales et nos ressources animales, étant transfrontalières de nature, constituent un important réservoir de la maladie du sommeil. Dans le passé, les zones libérées de la mouche tsé-tsé ont été rapidement recolonisées par les mouches tsé-tsé provenant des zones non libérées entraînant apathie et frustration parmi les agents chargés de la lutte contre la mouche tsé-tsé. En conséquence, l'élimination et l'éradication définitive de la mouche tsé-tsé et de la trypanosomiase exigent qu'on définisse des approches de lutte à la fois régionales et à une large échelle. À ce moment, je voudrais féliciter la Banque arabe pour le développement économique en Afrique (BADEA) pour sa coopération et son soutien et pour avoir accueilli ici à Khartoum le mois dernier une Conférence ministérielle africaine visant à faire avancer les stratégies de collaboration régionale dans la lutte contre la mouche tsé-tsé et la trypanosomiase.

Une occasion unique s'offre aujourd'hui grâce à laquelle notre meilleure compréhension actuelle de l'écologie et du comportement de la mouche tsé-tsé a rendu possible l'intégration d'une combinaison de deux ou plusieurs technologies dans les approches de lutte à une large échelle contre les ravageurs. En ce qui concerne les solutions durables aux défis que la mouche tsé-tsé et la trypanosomiase posent, les projets de lutte doivent adopter cette approche. Je suis en conséquence heureuse de constater que les projets actuellement en cours de mise en œuvre dans le cadre de la PATTEC ont adopté cette approche, ce qui constitue une avancée que d'autres acteurs doivent imiter pour réussir.

D'importants enseignements peuvent également être tirés du Projet multinational sur la mouche tsé-tsé financé par la Banque africaine de développement (AfDB) de 2006 à 2011 qui était unique du point de vue du niveau des investissements engagés, et de l'échelle de la zone qui a été libérée de la mouche tsé-tsé. Divers degrés de succès ont été enregistrés dans les pays qui ont participé au Projet. En conséquence, il serait prudent d'effectuer un examen après-projet en profondeur de 6 pays qui ont pris part au Projet multinational afin de déterminer les meilleures pratiques au profit d'autres pays qui ont l'intention d'élaborer un tel projet et également d'identifier les facteurs susceptibles d'entraver sa mise en œuvre dans la mesure souhaitée.

Le défi de la mouche tsé-tsé et de la trypanosomiase englobe plusieurs secteurs, notamment : l'agriculture, la faune et la flore, le développement rural, la santé animale ainsi que la santé publique, présentant un des meilleurs modèles de « One Health » (santé unique) jusqu'à présent. En conséquence, il appartient

aux divers acteurs de nouer des alliances stratégiques de recherche et de lutte contre la mouche tsé-tsé et la trypanosomiase aux niveaux transversal, national, régional, continental et mondial. Je note avec satisfaction l'intérêt grandissant et la collaboration renforcée entre institutions dans tous les domaines de la recherche et de la lutte contre la mouche tsé-tsé et de la trypanosomiase, comme en témoigne le nombre de réseaux et de consortiums qui ont évolué avec le temps.

Mesdames et Messieurs, la disponibilité de données de qualité continue de constituer une difficulté dans la prise de décisions fondées sur des preuves dans la lutte contre la mouche tsé-tsé et la trypanosomiase. En conséquence, un investissement dans la collecte et l'analyse de données de qualité est essentiel pour informer toutes interventions.

En outre, de nouvelles technologies visant à lutter contre la trypanosomiase doivent être mises au point grâce à la recherche opérationnelle. Par ailleurs, en cette ère de changement climatique et de variation climatique, je suggère que des recherches soient également menées pour élucider les effets du changement climatique sur la répartition des mouches tsé-tsé ainsi que l'incidence sur la lutte contre la mouche tsé-tsé et la trypanosomiase.

Au fil des ans, la chimiothérapie a été utilisée comme instrument de lutte contre la trypanosomiase humaine africaine (THA), toutefois le défi principal a été la toxicité des médicaments, la résistance aux médicaments, les coûts élevés et le manque de nouveaux molécules ainsi que les difficultés à fournir les services aux indigents dans les régions rurales. En conséquence, il faut soutenir les progrès enregistrés, en veillant à ce que les technologies disponibles demeurent accessibles pour les communautés rurales méritantes. À cet égard, les partenariats des secteurs public et privé (PPP) doivent être encouragés afin de s'assurer que les médicaments dont les communautés ont le plus grand besoin sont mis à disposition lorsque cela s'avère nécessaire ; proposer de nouvelles solutions de diagnostic ; renforcer l'efficacité de la surveillance et des systèmes de gestion des cas et soutenir le développement de nouvelles thérapies.

Notre invité d'honneur, Mesdames et Messieurs, nos experts techniques dans ce domaine ont la lourde tâche de veiller au succès de la lutte contre la mouche tsé-tsé et la trypanosomiase sur le continent africain, de faciliter l'accélération du développement rural dans les pays touchés avec le soutien de nos dirigeants politiques qui sont bien représentés à cette Conférence. En conséquence, j'espère que cette Conférence de l'ISCTRC délibérera afin de proposer des solutions idoines aux nombreuses questions restées sans réponses

à cet égard, sur la base des enseignements tirés des meilleures pratiques et des succès enregistrés.

Je vous remercie de votre attention et souhaite que vos délibérations soient productives.

**REMARKS BY PROF. AHMED ELSAWALHY, DIRECTOR OF THE INTER AFRICAN BUREAU FOR ANIMAL RESOURCES (AU-IBAR) DURING THE OFFICIAL OPENING OF THE 32ND CONFERENCE OF THE INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSOMISIS RESEARCH AND CONTROL (ISCTRC), KHARTOUM, SUDAN, 8TH SEPTEMBER, 2013.**

- Your Excellency, First Vice President, Honourable Ali Osman Mohamed Taha
- The Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim
- Your Excellency MadameTumusiime Rhoda Peace, Commissioner for Rural Development and Agriculture, at the African Union Commission
- Excellences Ambassadors
- Chairman of the ISCTRC Dr Sadou Maiga
- Executive Committee Members of the ISCTRC
- Representatives of International Organizations
- Eminent Scientists
- Members of the Diplomatic Corps
- The National Organizing Committee Members
- Distinguished Guests
- Ladies and Gentlemen

Let me take this opportunity to sincerely thank the Government and people of Sudan for hosting the 32nd ISCTRC General Conference. I would also like to thank the National Organising Committee and the ISCTRC Executive Committee for working tirelessly to make this event possible. We are also grateful to all the organisations represented here for their willingness and commitment to work with African Union Commission (AUC) and the AU Member States. Deep appreciation goes to the distinguished guests who have put aside their busy schedules to attend this very important conference. I also thank all those institutions, men and women who have contributed immensely in the area of Tsetse and Trypanosomiasis research, and control on the African continent.

The International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) is a statutory Council of the African Union Commission with the Secretariat at the African Union Interafrican Bureau for Animal resources

(AU-IBAR) in Nairobi, Kenya. It was established in the early 60s as a vehicle to promote international cooperation in the fight against trypanosomiasis which is one of Africa's greatest constraints to socio-economic development.

The Membership of the Council includes Member States, AU-IBAR, AU-PATTEC, International organizations, Food and Agricultural Organization (FAO), World Health Organization (WHO), International Atomic Energy Agency (IAEA) and Programme against African Trypanosomiasis (PAAT).

Under the guidance and advocacy of the ISCTRC, the AU Member States have implemented successful projects and programmes to control tsetse and Trypanosomiasis.

In order to achieve its objectives, the Council facilitates information sharing and exchange on matters regarding tsetse and trypanosomiasis research and control by holding regular General scientific conferences since 1949. The 32nd ISCTRC General Conference is being held in this beautiful city of Khartoum and the theme is **'Tsetse and Trypanosomiasis Research and Control for Sustainable Agriculture and Rural Development: Promoting Partnership and Learning Agenda in the context of African Renaissance'**

Ladies and Gentlemen, this year's conference has the following objectives.

- To facilitate information sharing and exchange on tsetse, human and animal trypanosomiasis research and control;
- To disseminate scientific information on tsetse and trypanosomiasis problems;
- To review, T&T, control technologies, strategies and policy options;
- To Identify gaps in research and control;
- To make recommendations for T&T control for the next two years.

Over 300 participants will participate in this meeting and they will be drawn from AU Member States, the African Union Commission, Universities and Research Institutes from Europe and Africa, Food and Agricultural Organization (FAO); World Health Organization (WHO); International Atomic Energy Agency (IAEA); Programme against African Trypanosomiasis (PAAT), ICIPE, CIDREs, FIND, DNDi, GALVMED among others.

The ISCTRC Secretariat received 132 abstracts for consideration and 78 abstracts have been selected for oral presentations and 54 were for Poster Session.

This conference will receive and deliberate on the PATTEC and Country reports on tsetse and trypanosomiasis interventions; reports from international organizations and scientific and technical presentations on tsetse and trypanosomiasis research and control. Side meetings will also be held. Finally the meeting will propose recommendations for tsetse and trypanosomiasis research and control activities to be conducted for the next two years

Finally, Your Excellencies, Ladies and Gentlemen:

I wish to thank the Government and People of Sudan for hosting the 38th ISCTRC Executive Committee meeting yesterday and the 32nd ISCTRC conference and we sincerely appreciate the hospitality and the arrangements that you have made for this important occasion including provision of this magnificent conference facilities.

I thank you all and I wish you successful deliberations.

Thank you.

**DISCOURS DE PROF. AHMED ELSAWALHY, DIRECTEUR DU BUREAU INTERAFRICAIN POUR LES RESSOURCES ANIMALES DE L'UNION AFRICAINE (UA/BIRA) LORS DE L'OUVERTURE OFFICIELLE DE LA 32ÈME CONFÉRENCE DU CONSEIL SCIENTIFIQUE INTERNATIONAL POUR LA RECHERCHE ET LA LUTTE CONTRE LA TRYPANOSOMIASE (ISCTRC), KHARTOUM, SOUDAN, 8 SEPTEMBRE 2013.**

- Votre Excellence, Honorable Ali Osman Mohamed Taha, Premier Vice-Président
- Dr. Faysal Hassan Ibrahim, ministre de l'Élevage, des Pêches et des Pâturages
- Votre Excellence, MadameTumusiime Rhoda Peace, Commissaire chargée du développement rural et de l'agriculture, à la Commission de l'Union africaine
- Excellences Mesdames et Messieurs les Ambassadeurs
- Dr Sadou Maiga, Président de l'ISCTRC
- Membres du Comité Exécutif de l'ISCTRC
- Représentants des Organisations internationales
- Éminents scientifiques
- Membres du Corps diplomatique
- Les membres du Comité national d'organisation
- Distingués invités
- Mesdames et Messieurs

Permettez-moi de saisir cette occasion pour remercier sincèrement le gouvernement ainsi que le peuple du Soudan d'accueillir la 32éme Conférence générale de l'ISCTRC. J'aimerais également remercier le Comité national d'organisation ainsi que le Comité exécutif de l'ISCTRC pour le travail inlassable qu'ils ont accompli pour rendre cet événement possible. Nous exprimons également notre gratitude à l'ensemble des organisations représentées en ce lieu pour leur volonté et leur engagement de travailler avec la Commission de l'Union africaine (CUA) ainsi que les États membres de l'UA. Ma profonde gratitude va aux distingués invités qui ont pris sur leurs emplois du temps très chargés pour assister à cette conférence très importante. Je remercie également toutes ces institutions, hommes et femmes qui ont apporté leur immense contribution au domaine de la recherche et de la lutte contre la mouche tsé-tsé et la trypanosomiase sur le continent africain.

Le Conseil scientifique international pour la recherche et la lutte contre la mouche tsé-tsé et la trypanosomiase (ISCTRC) est un Conseil statutaire de la Commission de l'Union africaine auprès du Secrétariat du Bureau interafricain pour les ressources animales de l'Union africaine (UA/BIRA) à Nairobi, Kenya. Il a été créé au début des années 60 comme véhicule pour promouvoir la coopération internationale dans la lutte contre la trypanosomiase qui représente un des plus grands obstacles au développement socio-économique de l'Afrique.

Sont membres du Conseil : les États membres, l'UA-BIRA, l'UA-PATTEC, des organisations internationales, l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO), l'Organisation mondiale de la santé (OMS), l'Agence internationale de l'énergie atomique (IAEA) et le Programme de lutte contre la trypanosomiase africaine (PLTA).

Sous l'égide et le plaidoyer de l'ISCTRC, les États membres de l'UA ont mis en œuvre des projets et programmes fructueux visant la lutte contre la mouche tsé-tsé et la trypanosomiase.

Afin d'atteindre ses objectifs, le Conseil facilite le partage et l'échange d'informations relatives à la recherche et à la lutte contre la mouche tsé-tsé et la trypanosomiase en organisant des conférences scientifiques générales régulières depuis 1949. La 32ème Conférence générale de l'ISCTRC se tient en ce moment dans cette magnifique ville de Khartoum sur le thème : « Recherche et lutte contre la trypanosomiase pour l'agriculture durable et le développement rural : promouvoir les partenariats et le programme d'apprentissage dans le contexte de la renaissance africaine »

Mesdames et Messieurs, la conférence de cette année vise les objectifs ci-après.

- Faciliter le partage et l'échange d'informations relatives à la recherche et à la lutte contre la mouche tsé-tsé et la trypanosomiase ;
- Diffuser les informations scientifiques relatives aux problèmes liés à la mouche tsé-tsé et à la trypanosomiase ;
- Examiner les options disponibles en matière de technologies, de stratégies et de politique de lutte contre la mouche tsé-tsé et la trypanosomiase ;
- Identifier les lacunes en matière de recherche et de lutte ;
- Formuler des recommandations relatives à la lute contre la mouche tsé-tsé et la trypanosomiase au cours des deux prochaines années.

Plus de 300 participants prendront part à cette réunion et ils seront issus des États membres de l'Union africaine, la Commission de l'Union africaine, des Universités et Instituts de recherche d'Europe et d'Afrique, Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) ; l'Organisation mondiale de la santé (OMS) ; l'Agence internationale de l'énergie atomique (IAEA) ; le Programme de lutte contre la trypanosomiase africaine (PAAT), ICIPE, les CIDRE, FIND, DNDi, GALVMED entre autres.

Le secrétariat de l'ISCTRC a reçu 132 résumés pour examen et 78 résumés ont été sélectionnés pour des présentations orales et 54 ont été pour des présentations par affiches.

Cette conférence recevra et délibérera sur les rapports de la PATTEC et des différents pays sur des interventions menées contre la mouche tsé-tsé et la trypanosomiase ; des rapports issus organisations internationales ainsi que des présentations scientifiques et techniques sur la recherche et la lutte contre la mouche tsé-tsé et la trypanosomiase. D'autres réunions auront également lieu parallèlement. Enfin, la réunion formulera des recommandations concernant des activités à mener dans le cadre de la recherche et de la lute contre la mouche tsé-tsé et la trypanosomiase au cours des deux prochaines années.

Enfin, vos Excellences, Mesdames et Messieurs :

Je voudrais remercier le Gouvernement et le peuple du Soudan pour avoir accueilli hier la 38éme réunion du Comité exécutif de l'ISCTRC ainsi que la 32ème conférence de l'ISCTRC et nous vous sommes sincèrement reconnaissants de votre hospitalité et des dispositions que vous avez prises pour cette importante occasion, y compris la mise à disposition de ce magnifique centre de conférence.

Je vous remercie tous et souhaite que vos délibérations soient couronnées de succès.

Merci.

**REPORTS AND RECOMMENDATIONS**

**RAPPORTS ET RECOMMANDATIONS**

## PRESENTATIONS BY INTERNATIONAL ORGANIZATIONS

***Moderator:*** Dr Baba Soumare

***Rapporteur:*** Dr Jose Ramon Franco

### WHO (World Health Organization)

World Health Organization (WHO) has continued its support to disease endemic countries to strengthen human African trypanosomiasis (HAT) control and surveillance. Since 2009, the number of new cases of HAT annually reported to WHO is maintained below ten thousand (10,000), with seven thousand two hundred fourteen (7,214) new cases reported in 2012.

Seventy (70) millions of people, distributed over an area of approximately 1.55 million km2 in 22 of the 36 HAT endemic countries, live at different level of risk of contracting HAT. The people screened by active case-finding have reduced to lower 2,000.000 people screened annually but the health care facilities involved in passive surveillance have increased.

Supported by public-private partnerships, WHO continue ensuring access to diagnosis and to the best available treatment options. Combination of eflornithine and nifurtimox (NECT) has become first line treatment of second-stage disease in countries where the gambiense disease is endemic.

In 2013 the WHO Expert committee on HAT control and surveillance met in Geneva to update the current knowledge on the disease, strategies and tools used in control of HAT. Concerning the HAT Atlas, the mapping of HAT during the period 2000-2009 has been completed and an update to 2012 is on-going.

The continuous control measures implemented by the National Sleeping Sickness Control Programmes (SSNCP) supported by WHO, bilateral cooperation and NGOs have put the disease under control in most of the endemic countries. In this situation, today the disease is considered by WHO for the elimination and has been included on the WHO roadmap for neglected tropical diseases with a 2020 target date for its elimination as a public health problem.

Nevertheless HAT elimination is a difficult long process and requires more effort, time and funds. Disease endemic countries should be supported to

strengthen control activities, to improve the surveillance of the disease gradually integrating surveillance and control activities in the health system. Adequate and long-term funding must be available not only to implement elimination program activities but also to support research to improve current deficient control tools to engage health services in sustainable elimination process for HAT. As well, HAT elimination has to be included in the national health plans.

**FAO (Food and Agriculture Organization of the United Nations)**

The Food and Agriculture Organization of the United Nations (FAO) is active in a number of areas of interventions against tsetse-transmitted trypanosomosis. This includes implementation of specific projects, capacity development, technical assistance and normative activities.

Between 2011 and 2013, FAO projects included "Improving food security in sub-Saharan Africa by supporting the progressive reduction of tsetse-transmitted trypanosomosis in the framework of NEPAD", funded by the Government of Italy, and "Development of innovative site-specific integrate animal health packages for the rural poor (West and East Africa)", supported by the International Fund for Agricultural Development (IFAD). FAO technical cooperation projects were also implemented in Mali, Angola and Burkina Faso.

Within these projects, FAO has provided training and technical assistance to a number of affected-countries, including Burkina Faso, Chad, Ethiopia, Ghana, Mali, Kenya, Mozambique, South Africa, Sudan, Togo and Uganda. Support was also provided to international stakeholders, including WHO, IAEA, PATTEC Coordination Unit and CIRAD.

FAO has also been involved in a number of studies which have resulted in several scientific publications.

FAO has also joined efforts with IFAH, GALVmed and IAEA in the field of quality control and quality assurance of trypanocides.

**PAAT (Programme Against African Trypanosomosis)**

PAAT is an interagency collaboration that since 1997 joins together the efforts of FAO, WHO, IAEA and the African Union-Interafrican bureau for animal resources (AU-IBAR).

Within the framework of PAAT, substantial efforts have been made to improve data management and promote the utilization of Geographical Information Systems (GIS). In particular, the Atlas of human African trypanosomiasis was developed under the leadership of WHO and jointly with FAO. Also, FAO has launched the Atlas of tsetse and African animal trypanosomosis, developed in collaboration with IAEA.

FAO and IAEA have also collaborated within PAAT in the framework of the project "Applying population genetics and GIS for managing livestock insect pests". FAO has collaborated with CIRAD in a study on the impact of footbath insecticide treatment on tsetse density. FAO, IAEA and CIRAD have also provided joint technical assistance to South Africa and Mozambique, and collaborated in study on GIS and population genetics in West Africa, and in study on the release-recapture of tsetse flies between river basins in Mali.

Three meetings of the PAAT Secretariat were organized by FAO in February 2011 (Addis Ababa, Ethiopia), in September 2011 (Bamako, Mali) and in September 2012 (Vienna, Austria). Following a visit of AU-PATTEC Coordinator to FAO Headquarters (May 2012), an MoU was signed in July 2012 to formalize the collaboration between FAO and AU-PATTEC in the framework of PAAT.

PAAT also publishes two issues a year of the "Tsetse and Trypanosomosis Information Bulletin", and it contributed to a number of scientific publications on animal trypanosomosis, tsetse and sleeping sickness.

**IAEA (International Atomic Energy Agency)**

The General Conference of the (International Atomic Energy Agency) IAEA has expressed the importance of livestock development in rural communities affected by tsetse flies and trypanosomosis as a pathway out of poverty and hunger and a basis for food security and socio-economic development.

The IAEA in consultation with its international partners, particularly FAO and WHO, maintains close interaction with AU-PATTEC and provides, based on the existing memorandum of understanding with the AU, assistance to the six current national PATTEC projects in Burkina Faso, Ethiopia, Ghana, Kenya, Mali and Uganda. Currently, the IAEA supports the AU-PATTEC Plan of Action through two regional technical cooperation projects in Africa and six national projects in Chad, Ethiopia, Senegal, Uganda, Tanzania and Zimbabwe. In the past two years the IAEA provided assistance, in the form of training, expert services and equipment, to 17 Tsetse and trypanosomosis

affected Member States. The IAEA also continues to cooperate with FAO, WHO and other partners in the Programme Against African Trypanosomosis (PAAT), as a means to synergise their support to Member States' efforts.

The IAEA organized two regional training courses on 'Standardized Collection and Processing of Tsetse Flies for Molecular Tsetse Population Genetic and Morphometric Analyses' and on 'Standardized Entomological Monitoring, Data Collection and GIS-aided Data Processing as needed for Area-wide Integrated Pest Management campaigns against the Tsetse and Trypanosomosis Problem' in 2012.

The Insect Pest Control Laboratory of the Joint FAO/IAEA Division in Seibersdorf has developed an integrated management system for the tsetse salivary gland hypertrophy virus that hampers the mass-rearing of Glossina pallidipes. The adoption of this virus management system has already reduced the prevalence of the salivary gland hypertrophy virus in the *G. pallidipes* colony at Kality (Ethiopia).

The IAEA has been providing support to the Ethiopian STEP Project for the last 15 years through national and regional projects. Reviews concluded that STEP has made good progress.

Area-wide activities in Ethiopia have resulted in the suppression of Glossina pallidipes populations over most of the 25 000 km² of the project in the Southern Rift Valley, thereby protecting livestock from nagana.

Control operations included sequential aerial insecticide spraying for the suppression of tsetse populations in 5 000 km² of national parks and other high density areas, which reduced the target fly populations by more than 90 per cent. Despite the success of these activities, the results make clear that the SIT will be required to achieve full tsetse eradication in many of these areas. SIT field operations continue in Ethiopia's Deme Basin

The IAEA continues to support Senegal in implementing the pre-operational phase of an AW-IPM campaign that includes the SIT to create a zone free of Glossina palpalis gambiensis in close collaboration with other partners, namely CIRDES, FAO, the Institute of Zoology, Slovak Academy of Sciences, the CIRAD, and the US Government.

The IAEA continues to manage Coordinated Research Projects including 'Applying GIS and Population Genetics for Managing Livestock Insect Pests' and 'Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens'.

In conclusion, tsetse and trypanosomosis remains a major obstacle to rural development in significant parts of Africa. As no new methods have emerged to eradicate the various tsetse species in an area-wide and sustainable manner, the Sterile Insect Technique (SIT), as part of an integrated pest control approach, maintains its appeal as a unique and environmentally friendly nuclear application. Yet there remain challenges, including the establishment of appropriate management structures to deal with such complex and logistically demanding programmes, the development of the SIT for different species with different biologies, and the adaptation of each project to unique ecological and socio-economic conditions and requirements needed for success. The Joint FAO/IAEA Division remains committed to helping member states achieve their goals of controlling trypanosomosis in an integrated and sustainable manner through bilateral projects and collaboration with PATTEC and other partners.

## RAPPORT DE LA 2ème SEANCE : EXPOSES DES ORGANISATIONS INTERNATIONALES

***Modérateur :*** Dr Baba Soumaré

***Rapporteur :*** Dr Jose Ramon Franco

### OMS (Organisation mondiale de la santé)

L'Organisation mondiale de la santé (OMS) a continué à aider les pays aux maladies endémiques à renforcer le contrôle et la surveillance de la trypanosomiase humaine africaine (THA). Depuis 2009, le nombre de nouveaux cas de THA annuellement notifiés à l'OMS est resté en dessous de dix mille (10.000), et en 2012 le nombre de nouveaux cas signalés était de sept mille deux cents quatorze (7.214).

Soixante-dix millions de personnes, réparties sur une superficie d'environ 1,55 millions de km2 dans 36 pays où la THA est endémique, sont exposées à différents niveaux de risque de contracter la maladie. Le nombre de personnes soumises au dépistage actif est passé en dessous de 2.000,000 chaque année, tandis que les établissements de santé impliqués dans la surveillance passive ont augmenté en nombre.

Forte de l'appui des partenariats public-privé, l'OMS continue d'assurer l'accès au diagnostic et aux meilleures options de traitement disponibles. L'association eflornithine-nifurtimox (NECT) est devenue un traitement de premier choix de la maladie au deuxième stade dans les pays où gambiense est endémique.

En 2013, le Comité des Experts de l'OMS sur le contrôle et la surveillance de la THA s'est réuni à Genève pour actualiser les connaissances sur la maladie et les stratégies et outils à utiliser dans la lutte contre cette maladie. En ce qui concerne l'Atlas de la THA, la cartographie de la période 2000-2009 a été achevée, et une mise à jour jusque 2012 est en cours.

Les mesures de contrôle continu, mises en application par les programmes nationaux de lutte contre la maladie du sommeil ( PNLTHA ) et soutenues par l'OMS, la coopération bilatérale et les ONG, ont permis de maîtriser la maladie dans la plupart des pays où elle est endémique. Au regard de cette situation, la maladie fait actuellement l'objet d'un examen par l'OMS aux fins d'élimination et figure sur sa feuille de route pour les maladies tropicales

négligées, avec comme date cible 2020 pour son élimination en tant que problème de santé publique.

Néanmoins, l'élimination de la THA est un processus long et difficile, qui exige beaucoup d'efforts, de temps et de fonds. Il faudrait aider les pays où la maladie est endémique à renforcer les activités de contrôle et à améliorer la surveillance de la maladie en intégrant progressivement les activités de surveillance et de contrôle dans le système de santé. Il faut mettre à disposition des fonds suffisants et à long terme non seulement pour mettre en œuvre les activités du programme d'élimination mais également pour aider la recherche à améliorer les outils de contrôle actuellement inadéquats, afin d'engager les services de santé dans le processus d'élimination durable de la maladie du sommeil. L'élimination de la THA doit être intégrée dans les plans de santé nationaux.

**FAO (Organisation des Nations Unies pour l'alimentation et l'agriculture)**

L'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) est active dans un certain nombre de domaines d'interventions contre la trypanosomose véhiculée par la mouche tsé-tsé. Ces interventions comprennent la mise en œuvre de projets spécifiques, le renforcement des capacités, l'assistance technique et les activités normatives.

Entre 2011 et 2013, les projets de la FAO comprenaient le projet « Amélioration de la sécurité alimentaire en Afrique subsaharienne par l'appui à la réduction progressive de la trypanosomose véhiculée par les glossines dans le cadre du NEPAD » financé par le Gouvernement italien ; et le projet « Elaboration d'ensembles zoosanitaires novateurs intégrés et spécifiques aux sites pour les populations rurales pauvres (Afrique de l'Ouest et Afrique de l'Est) » soutenu par le Fonds international pour le développement agricole (FIDA). De plus, des projets de coopération technique de la FAO ont été mis en œuvre au Mali, en Angola et au Burkina Faso.

Dans le cadre de ces projets, la FAO a accordé une formation et une assistance technique à un certain nombre de pays affectés, notamment l'Afrique du Sud, le Burkina Faso, l'Ethiopie, le Ghana, le Kenya, le Mali, le Mozambique, l'Ouganda, le Soudan, le Tchad et le Togo. Elle a également accordé un soutien à des parties prenantes internationales, notamment l'OMS, l'AIEA, l'Unité de coordination PATTEC et le CIRAD. La FAO s'est également impliquée dans un certain nombre d'études qui ont abouti à plusieurs publications scientifiques. En outre, elle a joint ses efforts à ceux de l'IFAH, de GALVmed et de l'AIEA dans le domaine du contrôle-qualité et de l'assurance-qualité des trypanocides.

**PLTA (Programme de lutte contre la trypanosomose africaine)**

Le PLTA est un programme de collaboration interinstitutionnelle qui, depuis 1997, relie les efforts de la FAO, de l'OMS, de l'AIEA et du Bureau interafricain des ressources animales de l'Union africaine (UA-BIRA).

Dans le cadre du PLTA, des efforts considérables ont été déployés pour améliorer la gestion des données et pour promouvoir l'utilisation des systèmes d'information géographiques (SIG). En particulier, l'Atlas de la trypanosomiase humaine africaine a été élaboré sous la direction de l'OMS et conjointement avec la FAO. En outre, la FAO a lancé l'Atlas des mouches tsé-tsé et de la trypanosomose animale africaine, élaboré en collaboration avec l'AIEA.

La FAO a également collaboré avec l'AIEA dans le cadre du PLTA, au titre du projet «Application de la génétique des populations et des SIG dans la lutte contre les insectes nuisibles au bétail ». De plus, elle a collaboré avec le CIRAD dans une étude sur l'impact du traitement par pédiluve insecticide sur la densité des glossines. La FAO, l'AIEA et le CIRAD ont conjointement accordé une assistance technique à l'Afrique du Sud et au Mozambique, et ont collaboré dans l'étude sur les SIG et la génétique des populations en Afrique de l'Ouest ainsi que dans une étude sur le lâcher et la recapture des mouches tsé-tsé entre les bassins hydrographiques au Mali. En outre, la FAO a organisé trois réunions du Secrétariat du PLTA : en février 2011 (à Addis-Abeba en Ethiopie), en septembre 2011 (à Bamako au Mali), et en septembre 2012 (à Vienne en Autriche).

A la suite d'une visite effectuée par le Coordonnateur de l'UA-PATTEC au siège de la FAO (en mai 2012), un protocole d'accord a été signé au mois de juillet 2012 pour officialiser la collaboration entre la FAO et l'UA - PATTEC dans le cadre du PLTA.

De plus, le PLTA publie deux numéros par an du « Bulletin d'information sur la mouche tsé-tsé et la trypanosomose », et a contribué à un certain nombre de publications scientifiques sur la trypanosomose animale, les glossines et la maladie du sommeil.

**AIEA (Agence internationale de l'énergie atomique)**

La Conférence générale de l'AIEA (Agence internationale de l'énergie atomique) a exprimé l'importance du développement de l'élevage dans les communautés rurales affectées par les mouches tsé-tsé et la trypanosomiase,

car cette activité constitue pour elles un moyen de s'affranchir de la pauvreté et de la faim et une base pour la sécurité alimentaire et le développement socio- économique.

L'AIEA, en concertation avec ses partenaires internationaux, en particulier la FAO et l'OMS, entretient des liens étroits avec l'UA - PATTEC et prévoit, en vertu du Protocole d'accord existant avec l'UA, une assistance aux six projets nationaux de la PATTEC qui sont en cours au Burkina Faso, en Éthiopie, au Ghana, au Kenya, au Mali et en Ouganda. Actuellement, l'AIEA appuie le plan d'action de l'UA - PATTEC à travers deux projets régionaux de coopération technique en Afrique et six projets nationaux au Tchad, en Ethiopie, au Sénégal, en Ouganda, en Tanzanie et au Zimbabwe. Au cours des deux dernières années, l'AIEA a accordé une assistance sous forme de formation, de services spécialisés et d'équipements à 17 États membres affectés par les mouches tsé-tsé et la trypanosomiase. De plus, l'AIEA poursuit sa coopération avec la FAO, l'OMS et d'autres partenaires dans le Programme de lutte contre la trypanosomose africaine (PLTA), comme moyen de coordonner leur soutien aux efforts déployés par les États membres.

En 2012, l'AIEA a organisé deux cours de formation régionaux sur la « Normalisation de la collecte et du traitement des glossines pour la génétique moléculaire des populations de tsé-tsé et les analyses morphométriques » et sur la « Normalisation du suivi entomologique, de la collecte des données et du traitement des données assisté par SIG nécessaires pour les campagnes de lutte intégrée contre les mouches tsé-tsé et la trypanosomiase à l'échelle d'une région ».

Le Laboratoire de contrôle des insectes nuisibles de la Division mixte FAO / AIEA à Seibersdorf a mis au point un système de lutte intégrée contre le virus de l'hypertrophie des glandes salivaires des tsé-tsé qui entrave l'élevage en masse de Glossina pallidipes. L'adoption de ce système de lutte contre le virus a déjà réduit la prévalence dudit virus dans la colonie de G. pallidipes à Kality (Éthiopie).

L'AIEA a apporté un soutien au projet éthiopien STEP au cours des 15 dernières années à travers des projets nationaux et régionaux, et les examens effectués ont conclu que STEP a réalisé de bons progrès. Les activités menées à l'échelle de régions entières en Éthiopie ont abouti à la suppression de populations de Glossina pallidipes sur la majeure partie des 25 000 km² couverts par le projet dans la partie sud du Rift Valley, protégeant ainsi le bétail contre la nagana. Les opérations de lutte comprenaient la pulvérisation aérienne séquentielle d'insecticides pour la suppression des populations de glossines sur 5000 km²

de parcs nationaux et d'autres zones à forte densité de tsé-tsé, laquelle a réduit les populations de mouches cibles de plus de 90 pour cent. Malgré la réussite de ces activités, les résultats indiquent clairement que la TIS sera nécessaire pour parvenir à une éradication totale des mouches tsé-tsé dans bon nombre de ces zones. Les opérations TIS sur le terrain se poursuivent dans le bassin Deme de l'Éthiopie.

L'AIEA continue d'appuyer le Sénégal dans la mise en œuvre de la phase pré-opérationnelle d'une campagne AW-IPM qui comprend la TIS pour la création d'une zone indemne de Glossina palpalis gambiensis, en étroite collaboration avec d'autres partenaires dont le CIRDES, la FAO, l'Institut de Zoologie, l'Académie slovaque des sciences, le CIRAD et le Gouvernement américain. De plus, l'AIEA continue de gérer des projets de recherche coordonnée, notamment : « Application des SIG et de la génétique des populations de glossines pour la lutte contre les insectes nuisibles au bétail » ; et « Amélioration de la TIS contre les glossines grâce à la recherche sur leurs symbiotes et pathogènes ».

En conclusion, les mouches tsé-tsé et la trypanosomiase restent un obstacle majeur au développement rural dans des parties considérables d'Afrique. En l'absence de nouvelles méthodes à même d'éradiquer les différentes espèces de glossines à l'échelle de régions entières et de manière durable, la technique de l'insecte stérile (TIS) appliquée dans le cadre d'une approche intégrée de lutte antiparasitaire maintient son intérêt comme application nucléaire unique et respectueuse de l'environnement. Cependant, des défis restent à relever, notamment la mise en place de structures de gestion appropriées pour des programmes aussi complexes et exigeants sur le plan logistique ; le développement de la TIS pour les diverses espèces aux biologies différentes ; et l'adaptation de chaque projet aux conditions et exigences écologiques et socio- économiques uniques nécessaires à la réussite. La Division mixte FAO / AIEA reste déterminée à aider les États membres à atteindre leurs objectifs de contrôle de la trypanosomose d'une manière intégrée et durable, à travers des projets bilatéraux et la collaboration avec la PATTEC et d'autres partenaires.

## RECOMMENDATIONS

### WORLD HEALTH ORGANISATION (WHO)

The meeting RECOMENDS:

- The ISCTRC welcomes the achievements in HAT research and control. Considering these achievements showed by decreasing prevalence and the perspective of elimination, the ISCTRC recommends to WHO to

apply adapted strategies for elimination and to appropriately integrate control and surveillance activities in the health systems to guarantee the continuation of control efforts for a sustainable elimination of gambiense HAT and control of rhodesiense HAT.

- The ISCTRC encourages the efforts for development of new diagnostic and treatment tools for HAT that will pave the road for integration of treatment activities in the peripheral health system.
- WHO has to continue supporting countries where the disease is endemic in elimination process, promoting their ownership and ensuring that health decision makers keep elimination of gambiense HAT as a key objective in the national health agenda.
- WHO should continue giving support towards HAT elimination

**FOOD AND AGRICULTURE ORGANISATION (FAO)**

The meeting RECOMMENDS:

- The meeting acknowledges the continued assistance provided by the Food and Agriculture Organization of the United Nations (FAO) to a range of stakeholders involved in trypanosomosis control. The strengthened support provided to the PATTEC Initiative is especially welcomed. It is recommended that FAO assistance to trypanosomosis-affected countries be sustained, with a focus on technical assistance, capacity development, and on the management and dissemination of information.

**PROGRAMME AGAINST AFRICAN TRYPANOSOMIASIS**

The meeting RECOMMENDS:

- The meeting recognized the importance of collaborative activities between the UN agencies, the African Union Commission (AUC) and a range of stakeholders involved in T&T interventions. Activities aiming at the harmonization and dissemination of information through PAAT Information System are particularly relevant and should be strengthened.

**INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)**

The meeting RECOMMENDS:

- IAEA to support the implementation of the PATTEC Initiative by fast tracking the use of SIT in areas in which T&T are suppressed and to put emphasis on training, capacity building and the funding of technical cooperation projects.

**TO ALL THE INTERNATIONAL ORGANISATIONS**

The meeting RECOMMENDS:

- The meeting recognizes the importance of an efficient management of data in planning, implementing and monitoring interventions against African trypanosomoses. In particular, Geographic Information Systems (GIS) are increasingly used as an essential tool for an evidence-based decision making. It is recommended that efforts be scaled up to promote the development and utilization of these tools at the continental, national and sub-national level. Initiatives to develop maps of tsetse and African trypanosomoses at a range of scales (i.e. the Atlas of human African trypanosomosis, and the Atlas of tsetse and African animal Trypanosomosis) are welcome and data sharing is encouraged.

## RECOMANDATIONS

**Organisation Mondiale de la Santé (OMS)**

- Le CSIRLT se félicite des progrès accomplis dans la recherche et le contrôle de la THA. Considérant ces réalisations attestées par la diminution de la prévalence de la maladie et la perspective de son élimination, le CSIRLT recommande à l'OMS de mettre en application des stratégies adaptées pour l'élimination de la maladie et d'intégrer les activités appropriées de contrôle et de surveillance dans les systèmes de santé afin de garantir la poursuite des efforts de lutte en vue de l'élimination durable de la THA à gambiense et du contrôle de la THA à rhodesiense.
- Le CSIRLT encourage les efforts de mise au point de nouveaux outils de diagnostic et de traitement de la THA qui faciliteront l'intégration des activités de traitement dans les systèmes de santé périphérique.
- L'OMS doit continuer à soutenir les pays aux maladies endémiques dans le processus d'élimination en encourageant l'appropriation du processus d'élimination par ces pays et en s'assurant que les décideurs en matière de santé maintiennent l'élimination de la THA à gambiense comme objectif de santé dans le programme de santé national.

**FAO**

Les participants reconnaissent la valeur de l'assistance continue accordée par l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) aux diverses parties prenantes impliquées dans le contrôle de la trypanosomose. Le renforcement du soutien fourni à l'initiative PATTEC est particulièrement apprécié. Il est recommandé à la FAO de maintenir son assistance aux pays affectés par la trypanosomiase, avec un accent particulier

sur l'assistance technique, le renforcement des capacités, et la gestion et la diffusion de l'information.

**PLTA**

Les participants se félicitent du rôle du PLTA en tant que forum international pour la promotion des activités de collaboration entre les organismes de l'ONU, l'Union africaine - BIRA et diverses parties prenantes impliquées dans les interventions de lutte contre les tsé-tsé et la trypanosomiase. Les activités du PLTA visant l'harmonisation et la diffusion des informations par le biais de son système d'information sont particulièrement pertinentes et devraient être renforcées.

**AIEA**

L'UA - PATTEC et les pays affectés par la mouche tsé-tsé et la trypanosomiase (T & T) prient l'AIEA de soutenir la mise en œuvre de l'initiative PATTEC en accélérant l'utilisation de la TIS dans les zones où les T & T sont supprimées, à travers la formation, le renforcement des capacités et la mise en place de projets de coopération technique.

**Generalites**

- Les participants reconnaissent l'importance d'une gestion efficace des données dans la planification, l'exécution et le suivi des interventions de lutte contre les trypanosomoses africaines. En particulier, les systèmes d'information géographique (SIG) sont de plus en plus utilisés comme un outil essentiel pour une prise de décision fondée sur des informations factuelles. Il est recommandé que des efforts soient intensifiés pour promouvoir le développement et l'utilisation de ces outils aux niveaux continental, national et sous-national. Les initiatives visant à développer des cartes des tsé- tsé et des trypanosomoses africaines à différentes échelles (à savoir l'Atlas de la trypanosomose humaine africaine et l'Atlas des tsé-tsé et de la trypanosomiase animale africaine) sont appréciées, et le partage des données devrait être davantage encouragé.

## PATTEC INITIATIVE AND COUNTRY REPORTS

***Moderateur:*** Hassane Mahamat Hassane

***Rapporteur:*** Charles Mahama

A report presented by the PATTEC Coordinator at the African Union (Dr. Hassane Mahamat) gave a background to the Multinational Project for the Creation of Sustainable Tsetse and Trypansomiasis free areas in East and West Africa. This joint initiative involved Ghana, Burkina Faso and Mali in West Africa and Ethiopia, Uganda and Kenya in East Africa. The project was funded by the African Development Bank and the respective countries through loan agreements. The goal of the project was to contribute towards food security and the alleviation of poverty. The presenter outlined the main components of the project namely, Tsetse suppression and eradication, Capacity building, Sustainable land management and Coordination. In those countries where tsetse suppression was applied, there was a remarkable reduction in tsetse populations and an increase in livestock productivity. There is the need to quantify these impacts. Capacity building contributed to the training of technical personnel, communities, farmers, senior level personnel and policy makers. With the support of the capacity building component, the mass-rearing facilities for tsetse at Kaliti and Bobo-Dioulasso in Ethiopia and Burkina Faso respectively were upgraded. The tsetse training school of ELAT of Burkina Faso has been rehabilitated and is now functional. Sustainable land management was applied according to the peculiarities of countries concerned. The major challenges that faced the project included the frequent change of coordinators and the low level of staff retention. The PATTEC initiative has led to an appreciable increase in awareness to the T&T problem. There is an increased number of collaborating institutions including the private sector.

A report was presented by AU-PATTEC office for the period 2011-2013. The challenges addressed during 2011-2013 included capacity building and training, technical support to national systems, resource mobilization and the greater involvement of international organisations, development partners and the private sector. A case in point was the convening of a meeting between 12 African countries and the Arab Bank for the Economic Development of Africa (BADEA), which was held in Khartoum in June, 2013.

An analysis of responses from 22 African countries to the jointly prepared questionnaire of the ISCTRC and PATTEC was presented. The analysis based on the assessment of key thematic areas, such as budget allocation, staff strength, tsetse situation etc, provides a clear profile of member countries that presented their responses. It was encouraging to note that there is a general

increase in support to T&T Control in member countries. The analysis, for example, makes it possible to identify countries that need priority in capacity building.

Tanzania reported work that focused on advocacy and treatment of African Animal Trypanosmiasis training of medical and veterinary staff and the mapping of health facilities.

A report presented by Nigeria, informed the conference that Bauchi State had signed a memorandum of understanding with PATTEC Nigeria for the control of tsetse. The report also indicated that HAT baseline studies have been conducted in various districts of Nigeria. Changes observed in Land use management are likely to affect tsetse habitat. A survey conducted in Jigawa State yielded no fly catches. A 3 year monitoring plan has been put in place to ascertain the absence of flies.

Angola reported an integrated approach to T&T involving tsetse control (ground spraying) as well as the treatment of AAT an HAT. Screening is carried out in both animals and man. There is a conscious effort to retain young personnel through training and motivation.

Ivory Coast reported that despite the existence of high numbers of trained personnel there was a general lack of equipment and other facilities for HAT control.

A report from Zambia showed that the most affected areas in T&T are in the Eastern, Southern and Western provinces. The major T&T control activities since 2011 have been, (1) Baseline surveys and surveillance in some 7000 km2 in the Western province, (2) investigative surveys/surveillance in parts of Lusaka, Muchinga, Southern and Western provinces (survey area ~10,000 km2), and (3) Tsetse control operations with application of odour-baited Targets in form of (i) two artificial tsetse barriers, one on border with Angola and Namibia (600 km2) the other on border with Malawi (300 km2); (ii) a 500 km2 area in the Western province, and (iii) a privately funded operation (by a wildlife tourism camps) in the Eastern province (area ~400 km2). Depending on location, these may be categorised as being within or outside the PATTEC facilitated Kwando-Zambezi Tsetse Eradication Regional Project. In terms of current plans, an aerial spraying operation was funded and scheduled for 2013 (area~6,000 km2), but the activity had to be rescheduled to 2014 due to challenges with tender process. Future plans focus largely on the 2007 PATTEC oriented concept note and draft project proposal for tsetse eradication in the Luangwa-Zambezi tsetse belt that extends into Malawi, Mozambique and Zimbabwe. Among the major constraints is inadequate and inconsistent

funding in relation to the strategy and plans in place, and lack of a clear process to practically domesticate the PATTEC agenda

Screening for HAT in Uganda was reported. About 14,000 people were screened under the multinational tsetse project. An area of 30,000 square kilometer has been delineated for tsetse control. It is estimated that the total project cost will be 19 million Dollars. Uganda has expressed the intention to submit this project proposal to BADEA.

A report on the Platform for the Control of HAT in Central Africa and East Africa was presented. There are currently eight countries in the platform. The main objective of the platform is to strengthen capacities in clinical research for HAT control in member states.

South Sudan reported recent development in T&T control. Efforts have been made to intensify surveys of both AAT and HAT with a view to developing appropriate control strategies.

Senegal presented an update on efforts being made to eradicate G. tachinoides in the area of Nyaies. Comprehensive studies have been conducted in entomology, parasitology, and sterile insect releases. The results and analysis of these studies have paved the way for the initiation of the SIT phase to be preceded by tsetse suppression.

An integrated control of riverine tsetse (G. tachinoides and G. palpalis gambiensis) with the SAT as the main tool was reported by Ghana. The report showed the integration of other tsetse control methods ("Pour on" application, targets, and ground spraying) along with SAT. A marked reduction in tsetse population (99.6%) has been maintained by sustained target deployment. There is on-going discussion on how to improve the SAT for the West African Sub-region.

The Democratic Republic of Congo, reported activities in HAT control. Emphasis has been on the treatment of HAT cases. Challenges related to drug use and diagnosis was highlighted as very important.

Burkina Faso PATTEC presented a report on T&T activities. The importance of community participation was underscored. The application of SAT in collaboration with Ghana was shown to have contributed to a marked reduction

in tsetse populations as well as a marked reduction in AAT prevalence in cattle from 12% to 0.31% based on a bimonthly monitoring plan. The low numbers of tsetse flies now justifies the use of the SIT for eradication. In this regard the tsetse mass rearing to be done in Burkina Faso will be vital. The high level political will in Burkina Faso gives a strong foundation for the sustainability of the eradication effort.

## RECOMMENDATIONS

1. The ISCTRC encourages research aiming at the control of Non-tsetse Transmitted Animal Trypanosomoses (NTTAT), support the recommendation of the 9th Conference of Ministers in Charge Of Livestock urging the OIE to create an Ad-hoc Working Group on Animal Trypanosomoses and acknowledge the MOU between the OIE and the AU- PATTEC Coordination Office;
2. The ISCTRC recommends AU-PATTEC to speed up control quality standards for traps and targets in order to ensure reliability and efficacy of proposed products in the market;
3. The Conference urges partners working in the field of research to share data with all relevant stakeholders in the field of T&T, collaborate and work in a transparent manner as well as acknowledge individuals, programmes and projects that have contributed to the studies, reports, among others that will contribute to the implementation of the PATTEC Initiative.

## RAPPORTS DE L'INITIATIVE PATTEC ET DES PAYS

***Modérateur :*** Hassane Mahamat Hassane

***Rapporteur :*** Charles Mahama

Le rapport présenté par le Coordonnateur de la PATTEC à l'Union africaine (Dr Hassane Mahamat) a donné un aperçu du Projet multinational pour la création de zones durablement indemnes de mouche tsé-tsé et de trypanosomiase en Afrique de l'Est et de l'Ouest. Cette initiative conjointe a impliqué le Ghana, le Burkina Faso et le Mali en Afrique de l'Ouest, et l'Éthiopie, l'Ouganda et le Kenya en Afrique de l'Est. Le projet a été financé par la Banque africaine de développement et les pays concernés, à travers des conventions de prêt. L'objectif du projet était de contribuer à la sécurité alimentaire et à l'allègement de la pauvreté. L'orateur a donné un aperçu des principales composantes du projet, à savoir : la suppression et l'éradication des mouches tsé-tsé ; le renforcement des capacités ; la gestion durable des terres ; et la coordination. Dans les pays où la suppression des glossines a été effectuée, il y a eu une diminution remarquable des populations de glossines et une augmentation de la productivité du bétail. Il est nécessaire de quantifier ces impacts. Le renforcement des capacités a contribué à la formation du personnel technique, des communautés, des éleveurs, des cadres supérieurs et des responsables de l'élaboration des politiques. A la suite de l'appui accordé par la composante de renforcement des capacités, les installations d'élevage en masse des tsé-tsé à Kaliti et à Bobo –Dioulasso, respectivement en Ethiopie et au Burkina Faso, ont été améliorées. L'école de formation sur la mouche tsé-tsé – ELAT - au Burkina Faso a été réhabilitée et est actuellement opérationnelle. La gestion durable des terres a été mise en application, en fonction des particularités des pays concernés. Les principaux défis auxquels le projet a dû faire face comprenaient le changement fréquent des coordonnateurs et le faible niveau de fidélisation du personnel. L'initiative PATTEC a conduit à une augmentation significative de la sensibilisation au problème des tsé-tsé et de la trypanosomiase. On a noté une augmentation du nombre d'institutions collaboratrices, y compris le secteur privé.

Le bureau de l'UA - PATTEC a présenté un rapport sur la période 2011-2013. Les défis abordés au cours de cette période 2011-2013 comprennent le renforcement des capacités et la formation, l'appui technique aux systèmes nationaux, la mobilisation des ressources et l'implication accrue des organisations internationales, des partenaires au développement et du secteur privé. Un exemple typique a été la convocation d'une réunion entre 12 pays africains et la Banque arabe pour le développement économique de l'Afrique (BADEA), qui s'est tenue à Khartoum au mois de juin 2013.

Une analyse des réponses de 22 pays africains à un questionnaire préparé conjointement par le CSIRLT et la PATTEC a été présentée. Cette analyse, fondée sur l'évaluation des domaines thématiques clefs telles que l'allocation budgétaire, la force du personnel, la situation des tsé-tsé, etc., donne un profil clair des pays membres qui ont présenté leurs réponses. Il est encourageant de constater une augmentation générale de l'appui au contrôle des glossines et de la trypanosomiase dans les pays membres. L'analyse permet par exemple d'identifier les pays prioritaires en matière de renforcement des capacités.

La Tanzanie a relaté des travaux centrés sur la formation du personnel médical et vétérinaire au plaidoyer et au traitement de la trypanosomiase animale africaine et sur la cartographie des établissements de santé.

Concernant le rapport du Nigeria, l'orateur a informé les participants que l'État de Bauchi avait signé un protocole d'accord avec PATTEC-Nigeria pour le contrôle des mouches tsé-tsé. Il a également indiqué que des études de base sur la THA avaient été menées dans divers districts du Nigeria. Les changements observés au niveau de la gestion de l'utilisation des terres sont susceptibles d'affecter l'habitat des glossines. Une enquête menée dans l'État de Jigawa n'a indiqué aucune capture de mouches. Un plan de suivi de 3 ans a été mis en place pour s'assurer de l'absence de mouches.

L'Angola a présenté un rapport sur une approche intégrée de lutte contre les tsé-tsé et les trypanosomiases impliquant le contrôle des glossines (pulvérisation effectuée au sol) et le traitement de la TAA et de la THA. Le dépistage est réalisé chez les animaux et l'homme. Le pays fait un effort délibéré de fidélisation du personnel jeune à travers la formation et la motivation.

La Côte d' Ivoire a indiqué qu'en dépit de l'existence de grands nombres d'effectifs qualifiés il y avait un manque général de matériel et d'autres moyens de contrôle de la THA.

Dans son rapport, la Zambie a indiqué que les zones les plus affectées par la mouche tsé-tsé et la trypanosomiase se trouvent dans les provinces de l'Est, du Sud et de l'Ouest. Parmi les principales activités de contrôle des glossines et de la trypanosomiase menées depuis 2011 figurent : (1) les enquêtes de référence et la surveillance sur près de 7000 km2 dans la province de l'Ouest ; (2) les enquêtes exploratoires / surveillance dans certaines parties de Lusaka, de Muchinga, des provinces du Sud et de l'Ouest (zone d'étude de ~ 10.000 km2 ) ; et (3 ) les opérations de lutte contre les glossines avec l'utilisation de cibles à appâts olfactifs. Celles-ci sont sous forme de : (i) deux barrières anti-

glossines artificielles - une à la frontière avec l'Angola et la Namibie (600 km2) et l'autre à la frontière avec le Malawi (300 km2) ; (ii) une zone de 500 km2 dans la province de l'Ouest ; et (iii) une opération de financement privé (par un camp de tourisme de faune) dans la province de l'Est (zone de ~ 400 km2). Selon l'endroit, elles peuvent être classées comme étant à l'intérieur ou à l'extérieur du Projet régional Kwando - Zambèze pour l'éradication des glossines soutenu par la PATTEC. Pour ce qui est des plans actuels, une opération de pulvérisation aérienne avait reçu un financement et prévue pour 2013 (zone de ~ 6.000 km2), mais l'activité a dû être reportée à 2014 en raison des problèmes liés au processus d'appel d'offres. Les plans futurs se concentrent en grande partie sur la note conceptuelle de 2007 orientée par la PATTEC et un avant-projet sur l'éradication des glossines dans la zone à tsé-tsé de Luangwa – Zambèze, qui s'étend au Malawi, au Mozambique et au Zimbabwe. Parmi les contraintes majeures, figurent l'insuffisance et l'instabilité du financement par rapport à la stratégie et aux plans en place, et l'absence d'un processus clair pour la domestication pratique du programme PATTEC.

L'Ouganda a présenté un rapport sur le dépistage de la THA. Près de 14.000 personnes ont fait l'objet d'un test de dépistage dans le cadre du projet multinational de lutte contre les glossines. Une zone de 30.000 kilomètres carrés a été délimitée pour la lutte contre les glossines. On estime à 19 millions de dollars le coût total du projet. L'Ouganda a exprimé son intention de soumettre cette proposition de projet à la BADEA.

Un rapport sur la Plate-forme pour le contrôle de la THA en Afrique centrale et en Afrique de l'Est a été présenté. La plateforme compte actuellement huit pays, et son principal objectif est de renforcer les capacités en matière de recherche clinique pour la lutte contre la THA dans les États membres.

Le Sud-Soudan a présenté un rapport sur les éléments nouveaux en matière de contrôle des tsé-tsé et de la trypanosomiase. Des efforts ont été déployés pour intensifier les études sur la TAA et la THA en vue d'élaborer des stratégies de lutte appropriées.

Le Sénégal a présenté une mise à jour sur les efforts déployés pour éradiquer G. tachinoides dans la zone des Nyaies. Des études approfondies ont été menées en entomologie, parasitologie, et lâchers d'insectes stériles. Les résultats et l'analyse de ces études ont ouvert la voie pour le lancement de la phase TIS qui sera être précédée par la suppression des glossines.

Le Ghana a présenté un rapport sur la lutte intégrée contre les glossines fluviales (G. tachinoides et G. palpalis gambiensis) utilisant comme principal outil la TSA. Le rapport a montré l'intégration d'autres méthodes de contrôle des mouches tsé-tsé (application épi-cutanée ou pour-on, cibles, pulvérisation au sol) avec la TSA. Une réduction nette des populations de glossines (99,6%) a été maintenue grâce au déploiement soutenu de cibles. Des discussions sont en cours sur la façon d'améliorer la TSA dans la sous-région de l'Afrique de l'Ouest.

La République démocratique du Congo a présenté les activités relatives à la lutte contre la THA. Elle a mis un accent particulier sur le traitement des cas de THA. Elle a souligné que les défis liés à l'utilisation de médicaments et au diagnostic sont très importants.

PATTEC -Burkina Faso a présenté un rapport sur les activités de lutte contre les glossines et la trypanosomiase, et a souligné l'importance de la participation communautaire. Elle a montré que l'application de la TSA en collaboration avec le Ghana a contribué à une réduction nette des populations de glossines et de la prévalence de la TAA chez les bovins - de 12% à 0,31 % - sur la base d'un plan de surveillance bimensuelle. Les faibles nombres de mouches tsé-tsé justifient désormais l'utilisation de la TIS pour l'éradication. A cet égard, l'élevage en masse de tsé-tsé, qui va être entrepris au Burkina Faso, sera crucial. La volonté politique au haut niveau au Burkina Faso donne une base solide pour la durabilité de l'effort d'éradication.

## RECOMANDATIONS

1. Le CSIRLT encourage les recherches visant le contrôle des trypanosomoses non transmises par les mouches tsé-tsé (NTTAT), appuie la recommandation de la 9ème Conférence des ministres en charge de l'élevage exhortant l'OIE à créer un groupe de travail ad hoc sur les trypanosomoses animales et prend acte du protocole d'accord entre l'OIE et le Bureau de coordination de l'UAPATTEC ;
2. Le CSIRLT recommande à l'UA-PATTEC d'accélérer les normes de qualité pour les pièges cibles et écran afin d'assurer la fiabilité et l'efficacité des produits proposés sur le marché ;
3. Les participants à la conférence exhortent les partenaires engagés dans les recherches à partager les données avec toutes les parties prenantes concernées dans le domaine T & T, à collaborer et à travailler dans la transparence, et à reconnaître le rôle des individus, des programmes et des projets qui ont enrichi, entre autres, les études et rapports qui contribueront à la mise en oeuvre de l'initiative PATTEC.

## REPORT AND RECOMMEMENDATIONS ON HUMAN AFRICAN TRYPANOSOMIASIS (HAT)

***Moderateur:*** Josenando Theophile

***Rapporteur:*** Enock Matovu

### Rapporteur Report

### Theme 2: Human African Trypanosomiasis

### Sessions 6 and 7: Epidemiology

Session 6 started with an invited talk from the WHO (Jose Ramon Franco) on sustainable efforts for HAT elimination. The rationale for elimination is the ever declining global incidence. Key events leading to the present, such as World Health assembly (WHA) declaration, decision by African heads of government to launch PATTEC, WHO signing a public-private agreement with drug companies to ensure drug availability and to assist in implementation, were highlighted. Finally WHO regional committee (AFRO) and ISCTRC endorsed the elimination campaign in 2005, that its now considered feasible. WHO included HAT in the Neglected Tropical Diseases (NTD) roadmap for elimination. Milestones were set, to first eliminate HAT as a public health problem by 2020. The ultimate goal is to interrupt *T. b. gambiense* (Tbg) transmission (reduce incidence to zero) by 2030. Given the complex epidemiology, the WHO does not presently consider *T. b. rhodesiense* (Tbrh) elimination feasible. The need to examine and understand circumstances in the different endemic areas prior to elimination campaign was emphasized e.g. some have high and others moderate transmission; for the case of Tbrh some areas Tanzania Malawi have reservoir in wild animals, while in Uganda and parts of Tanzania domestic animals (cattle) seem to be the key reservoirs that are more easily addressed; while for Tbg, humans are the principal reservoir. Feasibility for Tbg elimination was reportedly favored by the available new diagnostics, assured drug supplies (also safer) and the good political will. Different approaches to Tbg elimination including surveillance (active and passive), treatment and vector control tailored to prevailing circumstances, in the different endemic areas were outlined.

The key note address was followed by several papers on epidemiology. A paper from Malawi reported very high tsetse densities and infection rates in which 56% of midgut infections were of the brucei group and 5.3% actually being *T. b. rhodesiense* (SRA positive). Another paper from Côte d'Ivoire and Burkina Faso dwelt on historical perspectives into exchange of sleeping sickness between the two countries by infected migrants. There is presently a reintroduction of HAT in Burkina-Faso from Côte d'Ivoire posing a risk for re-

surgence, while Côte d'Ivoire remains hypoendemic with active transmission ongoing. In such a situation, passive surveillance integrated in health system coupled to training of health workers, targeted intervention backed up by a reactive mobile team, as well as also research into human/animal reservoirs are recommended.

The following paper presented on research into affordable tsetse control in Gambian HAT foci, justified by the hitherto high expense of using traps on riverline. It was reported that the developed tiny targets proved to be twice as efficient at killing flies as biconical traps. They have successfully eliminated tsetse from 2 islands in Kenya within 3-4 months, while in Uganda they reduced fliy catches by more than 90% within 4-5 months. The cost was reportedly reduced from $572-1145/km2/year using conventional targets to 75/km/yr. This technology was considered suitable for implementation over wider areas in endemic countries, involving community participation for success. It was reported that by modeling a drop of 70% in fly infestations would be sufficient to disrupt transmission, that high impact would be possible even if professional teams work with a paltry 1/5 efficiency.

The last paper in this session was on investigation Apol 1 mutations (G1 and G2) and their potential role in HAT susceptibility. Emerging evidence suggests that some Apol 1 polymorphism may provide a degree of resistance to Tbg that could be exploited for new interventions including vaccines and drugs.

Session 7 started with a presentation on the atlas of HAT, giving updates since the last ISCTRC notably those to-date 152,268 cases (91% of cases reported 2000-2009) have been mapped and that about 170,000 cases have been included in the database. The utility of this map for elimination campaigns, e.g. planning interventions up to village level, monitoring and evaluation was stressed. A related presentation reported use of the database to generate a current HAT risk map, which was justified by the need to replace old estimates that were inaccurate and based on expert opinion. These risk maps will be useful to act as indicators/monitoring and evaluation tools during elimination programs.

The following paper dwelt on a multi agent system for simulating sleeping sickness, pointing out proportions of exposed vectors likely to get mature transmissible infections (2%). On the other hand it was reported that a pig can hold transmissible Tbg (act as reservoir) for 4 months, while in Humans this happens during the first 6 months of infection. In a subsequent paper from the same presenter, it was revealed by a study in Cameroon that the risk of transmission is not necessarily determined by vector densities.

A paper on setting a model for Tbrh HAT elimination in Uganda was presented. It was based on the fact that cattle are the major reservoirs of Hat in eastern Uganda. The model incorporates strengthened HAT suspicion and referral of slides to a health centre IV where trypanosome detection using modernised facilities is possible, screening and block treatment of domestic animals in addition to application of deltamethrin pour-ons. Successes in reduction of infections in animals were reported but a more aggressive tsetse control approach recommended, in addition to considering small ruminants which also act as reservoirs despite their smaller contribution.

**Session 8: Diagnosis**

The first paper was on exploration of the on spliced leader as a diagnostic target. The spliced leader is a unique characteristic of mRNA transcripts in trypanosomatids. It is an abundant target, present as at least 9000 molecules in a single trypanosome; given the unstable nature of RNA, detection of the spliced leader would indicate current infection. In their study, the observed sensitivity was 100tryps/ml as detection limit. The need to explore its transformation into a user friendly diagnostic was highlighted, but it was noted that success of this would depend on finding appropriate and cheap means to process and preserve RNA under field conditions. The following paper was about the HAT Sero K-set recently developed for sleeping sickness serodiagnosis that shows excellent diagnostic performance under field conditions and that is available for validation and roll out.

A presentation about development of non-human infective tryps expressing Litat 1.3 or 1.5 VSGs, aimed to make recombinant Trypanosoma brucei brucei expresse antigens from Tbg. This would guarantee continued supply of diagnostic antigens by a safer and cheaper in vitro system. To date human infective trypanosomes are propagated in laboratory animals for isolation of antigens. This project will enable working with non-human infective trypanosomes able to grow in vitro. It was reported that LiTat 1.3/1.5 had been successfully planted downstream of promoter for VSG221 and the resultant recombinant antigens proven to work just like native ones. However it was noted that the Apol 1 obstacle has to be overcome if these trypanosomes are to be used in the trypanolysis test.

The following paper reported on the development of the HAT SD-Bioline RDT supported by FIND, which shows excellent diagnostic performance. Its appropriate use (passive or active) would depend on prevailing circumstances in the endemic countries

A presentation about malaria RDTs in HAT endemic areas reported presence of false positives in sleeping sickness cases. This might lead to misdiagnosis of HAT cases especially in areas where microscopy is not routinely carried out after positive malaria RDT. Health workers should be sensitized about this, to bear in mind that HAT may still be present when the malaria RDT is positive.

The following paper was on investigation of drug sensitivity and molecular markers in trypanosomes recovered from melarsoprol relapsing patients in DRC. Drug resistance was indicated in mouse experiments; no molecular markers are discovered yet, but research in aquaglyceroporin is on-going. Preservation of this vital resource of Tbg stocks from relapses was commended.

A presentation on the short Pentamidine regimen (3 vs 7 days) reported that follow-up 10 years after treatment revealed that success rates were comparable; thus those 3 days appears to be just as efficient as 7 days, but exhaustive statistical analysis should be done to get to more concrete conclusions. A new study with good follow-up should be initiated.

The performance of NECT field IIIB in which no exclusion criteria were put in place in order to investigate this regimen in real life was presented. This study included children and pregnant women. The success rate was reported as 94.3%, and importantly, there was no difference in children and adults. The observed higher fatalities (3.5% compared 0.6-2.1% in previous clinical trials) were explained as resulting from absence of exclusion unlike in the earlier clinical trials. Similarly the observed weights of babies born to treated mothers were attributed to the fact that they were HAT patients, that this rather than NECT could have contributed to slowed growth. After this study NECT has been included in the WHO essential medicines list for children.

Sesion 10 was a collection of rather unrelated papers and a film on "HAT –Alseny's dream and the blue flag". The first paper was on luminescent multiplex viability assay for Tbg, justified by the need for a test usable with human infective (Tbg) rather than Tbb for drug screening to ensure reliable data from such. In this study Tbg was transformed with the Renilla luciferase gene without compromising trypanosome growth. Luciferase activity was then used together with ATP quantification to assess trypanosome viability following drug exposure. The transformed parasites can be traced also in vivo in experimental mouse infections by bioluminescence imaging.

A paper on prohibitions related to HAT treatment in DRC was presented. It explored reasons that could lead to diagnosed patients shunning treatment and their basis/origins. Existing taboos were highlighted consideration that Melarsoprol is a strong (Toxic) drug not suitable for human body (NECT being the contrary), peer advise against hot food, not to go into the sun, have

sex etc. were highlighted. These reportedly could lead to people shunning treatment due the belief that failure to observe these lead to death. However it was not clear what proportion of diagnosed cases get lost to treatment. It was agreed that communication to ensure that the right messages are passed on was vital to overcome these taboos, training for both health workers and community opinion leaders was recommended.

Next was a paper about the role of livestock in the epidemiology of HAT in Tanzania. It was reported that northern Tanzania has an active Tbrh transmission foci, while those in the southern remain silent even in presence of animal movement from the north. This paper highlighted the need to strengthen control efforts to preempt HAT re-emergence.

## RECOMMENDATIONS:

1. Endemic countries should own the elimination campaigns and ensure that policy makers embrace this as priority; capacity for implementation should be built funded from local sources and partners.
2. Appropriate integration of control and surveillance activities in the peripheral health systems is recommended to optimize the detection and management of cases and the surveillance on the road to sustainable elimination of gambiense HAT and control of rhodesiense HAT.
3. The arrival of newly developed diagnostic tests for sleeping sickness is welcomed. The research in new diagnostic tools for HAT is encouraged. It is recommended that these new tools should be adequately validated before being included in the WHO strategy for elimination of gambiense sleeping sickness and being adopted by the national control programmes in the endemic countries.
4. Despite the reduction in the number of cases and availability of efficient treatment for gambiense HAT, ISCTRC recommends to continue efforts in research of new medicines safer and easier (oral) to use, that will facilitate sustainable integration of treatment activities in the peripheral health system.
5. Care should be taken in future clinical trials to ensure they are executed to full completion including follow-up.
6. Measures should be put in place to ensure that health workers are adequately trained and re-trained for proper diagnosis and management of cases with NECT and other upcoming drugs.
7. Additional indicators for elimination should be developed.
8. Research in xenomonitoring for detection of human infective trypanosomes in vectors to evaluate HAT elimination and to help prioritize areas for

intervention should be undertaken.

9. Tiny targets should be evaluated over wider areas in endemic countries; community participation to ensure success was encouraged.
10. Training of staff in endemic countries to ensure access and utilization of the HAT atlas for informed/guided interventions should be done.
11. Screening for more diagnostic antigens that would maximize coverage/ detection of all circulating strains should continue.
12. Sociologists, anthropologist and similar fields should be involved in research and control program as a measure to ensure success of programs by improved communication an acceptability of intervention by the affected communities

## RAPPORT ET RECOMMANDATIONS SUR LA TRYPANOSOMIASE HUMAINE AFRICAINE (THA)

***Modérateur:*** Josenando Theophile

***Rapporteur:*** Enock Matovu

### Rapport du rapporteur

### Thème 2 : Trypanosomiase humaine africaine

### Sessions 6 et 7: Épidémiologie

La 6ème session s'est ouverte sur une allocution de M. Jose Ramon Franco, représentant de l'OMS,sur les efforts durables déployés en vue de l'éradication de la THA. Les raisons invoquées pour justifier cette éradication tiennent à la baisse constante du taux de prévalence mondial. Les principaux événements, notamment la déclaration de l'Assemblée mondiale sur la santé (AMS) ayant mené à la présente décision des chefs de gouvernement africains de lancer la PATTEC (Campagne panafricaine d'éradication des glossines et des trypanosomoses), la signature par l'OMS d'un accord public-privé avec des compagnies pharmaceutiques visant à assurer la disponibilité des produits et à aider à la mise en œuvre, ont été soulignés.Finalement, le Comité régional de l'OMS (AFRO) ainsi que l'ISCTRC ont soutenu la campagne d'élimination en 2005, désormais considérée comme réalisable. L'OMS a inclus la THA dans sa feuille de route pour l'élimination des Maladies tropicales négligées. Des objectifs intermédiaires ont été fixés en vue d'éliminer en premier lieu la THA comme problème de santé publique à l'horizon 2020. L'objectif final consiste à interrompre la transmission de la T. b. gambiense (Tbg) (réduire l'incidence à zéro) à l'horizon 2030. En raison de l'épidémiologie complexe, l'OMS ne considère actuellement pas l'élimination de la T. b. rhodesiense (Tbrh) comme réalisable. L'accent a été mis sur la nécessité d'examiner et de comprendre les circonstances qui prévalent dans les différentes zones d'endémie préalablement à toute campagne d'élimination, p. ex. certaines présentent une transmission élevée et d'autres une transmission modérée. En ce qui concerne le cas de la Tbrh, dans certaines régions de la Tanzanie et du Malawi les animaux sauvages constituent le réservoir d'infection, tandis qu'en Ouganda et des régions de la Tanzanie les animaux domestiques (les bovins) semblent constituer les réservoirs importants avec lesquels il est plus facile d'obtenir de meilleurs résultats. Cependant, en ce qui concerne la Tbg, les hommes constituent le principal réservoir. La possibilité de l'élimination de la Tbg aurait été favorisée par la disponibilité du nouveau diagnostic, la garantie de la fourniture de médicaments (également moins dangereux) ainsi que la volonté politique. Diverses manières d'aborder l'élimination de la Tbg dans les différentes zones d'endémie ont été exposées, notamment la surveillance (active et passive), le traitement ainsi qu'une lutte contre les vecteurs adaptée

en fonction des circonstances données.

Le discours d'orientation générale a été suivi de la présentation de plusieurs exposés sur l'épidémiologie. Un exposé du Malawi a signalé de très fortes densités de mouches tsé-tsé et des taux d'infections au nombre desquels 56 % des infections du tube digestif relevaient du groupe de brucei et 5,3 % correspondant en réalité à des T. b. rhodesiense (SRA positif). Un autre exposé de la Côte d'Ivoire et du Burkina Faso s'est étendu sur l'angle historique de l'échange de la maladie du sommeil entre les deux pays par le biais de migrants infectés. Une réintroduction de la THA est actuellement observée au Burkina-Faso à partir de la Côte d'Ivoire présentant un risque de résurgence, tandis que la Côte d'Ivoire demeure hypoendémique avec une transmission active continue. Dans ces conditions, les recommandations suivantes ont été formulées : une surveillance passive intégrée au système de santé associée à la formation des agents de santé, des interventions ciblées appuyées par une équipe mobile réactive, ainsi que des recherches sur les réservoirs humains/animaux.

L'exposé suivant, sur la recherche menée sur la lutte économique contre les mouches tsé-tsé dans les foyers de THA en Gambie, se justifie par les dépenses jusqu'ici très élevées engendrées par l'utilisation de pièges au bord de la rivière ou du fleuve. Le rapport a indiqué que les cibles minuscules développées se sont avérées deux fois plus efficaces dans l'élimination des mouches que les pièges biconiques. Celles-ci ont permis d'éliminer avec succès les mouches tsé-tsé sur 2 îles au Kenya en l'espace de 3 à 4 mois tandis qu'en Ouganda elles ont réduit les captures de mouches de plus de 90 % en l'espace de 4 à 5 mois. Les coûts auraient été réduits de 572 à 1 145 dollars USD/km2/an avec l'utilisation des cibles classiques à 75/km2/an. Cette technologie a été considérée comme adaptée à la mise en œuvre sur des zones plus vastes dans les pays d'endémie, impliquant pour sa réussite la participation communautaire. Le rapport a indiqué que la modélisation d'une baisse de 70 % des infestations de mouches serait suffisante pour perturber la transmission, et qu'une incidence élevée serait possible même si des équipes professionnelles travaillent avec 1/5 d'efficacité seulement.

Le dernier exposé de cette session a porté sur la recherche sur les mutations (G1 et G2) d'Apol 1 et leur rôle potentiel dans la prédisposition à THA. Des indices laissent à penser qu'une certaine quantité de polymorphisme Apol 1 peut offrir un certain degré de résistance à la Tbg qui peut être exploité pour de nouvelles interventions, y compris des vaccins et des médicaments.

La 7ème session s'est ouverte avec une présentation sur la cartographie de

la THA en faisant le point depuis le dernier ISCTRC. Jusqu'à présent 152 268 cas (91 % des cas signalés entre 2000 et 2009) ont été cartographiés et environ 170 000 cas ont été inclus dans la base de données. L'accent a été mis sur l'utilité de cette carte pour les campagnes d'élimination, p. ex la planification d'interventions jusqu'au niveau du village, la surveillance ainsi que l'évaluation. Une présentation liée au sujet a fait état de l'utilisation de la base de données pour générer une carte actuelle des risques liés à la THA, que justifie la nécessité de remplacer les anciennes estimations qui étaient inexactes et fondées sur des avis d'expert. Ces cartes des risques seront d'une grande utilité pour servir d'indicateurs/outils de surveillance et d'évaluation pendant la mise en œuvre des programmes d'élimination.

L'exposé suivant s'est étendu sur un système multi agents pour simuler la maladie du sommeil, faisant remarquer les proportions de vecteurs exposés susceptibles de devenir des infections transmissibles matures (2 %). Par ailleurs, il a été signalé qu'un cochon peut être porteur de la Tbg transmissible (agir comme réservoir) pendant 4 mois alors que chez l'homme cela se produit pendant les 6 premiers mois d'infection. Dans un exposé ultérieur présenté par le même intervenant, celui-ci a indiqué qu'une étude menée au Cameroun a révélé que le risque de transmission n'est pas nécessairement déterminé par les densités de vecteurs.

Un exposé sur la définition d'un modèle pour l'élimination de la THA Tbrh en Ouganda a été présenté. Celui-ci était fondé sur le fait que les bovins constituent les réservoirs importants de THA à l'est de l'Ouganda. Le modèle intègre un soupçon renforcé de THA et l'envoi de diapositives à un centre de santé IV où la détection des trypanosomes est possible au moyen d'installations modernisées, de dépistage et de traitement en groupe des animaux domestiques outre l'application en « pour-on » de la deltaméthrine. Des succès dans la réduction des infections chez les animaux ont été signalés  mais une méthode de lutte plus agressive contre les mouches tsé-tsé est recommandée, outre la prise en considération des petits ruminants qui agissent également comme des réservoirs malgré leur plus petite contribution.

**Session 8 : Diagnostic**

Le premier exposé a porté sur l'exploration de la séquence de tête épissée (spliced leader) comme cible diagnostique. La séquence de tête épissée (spliced leader) est l'unique caractéristique des produits de transcription d'ARNm chez les trypanosomatidae. Il s'agit d'une cible abondante, présente sous forme d'au moins 9 000 molécules dans un seul trypanosome ; étant donnée la nature instable de l'ARN, la détection la séquence de tête épissée (spliced leader) indiquerait l'infection en cours. Dans leur étude, la sensibilité observée équivalait à 100 tryps/ml comme limite de détection. La nécessité

d'explorer sa transformation au moyen d'un diagnostic simple à utiliser a été soulignée, mais il a été mentionné que la réussite de cette approche dépendrait de la disponibilité de moyens adaptés et bon marché pour traiter et conserver l'ARN dans des conditions réelles. L'exposé suivant traitait du « HAT Sero K-set » dernièrement développé pour établir le sérodiagnostic de la maladie du sommeil qui indique d'excellentes performances diagnostiques dans des conditions réelles et qui est disponible pour validation et déploiement.

Une présentation sur le développement de trypanosomes contagieux non humains exprimant des VSG Litat 1.3 ou 1.5, visait à faire exprimer au Trypanosoma brucei brucei combinant des antigènes à partir de Tbg. Ce développement garantirait la fourniture permanente d'antigènes diagnostiques par un système in vitro plus sûr et moins coûteux. Jusqu'à présent, les trypanosomes contagieux humains sont multipliés chez les animaux de laboratoire afin d'isoler des antigènes. Ce projet permettra de travailler avec des trypanosomes contagieux non humains capables de se reproduire in vitro. Le rapport indique que le LiTat 1.3/1.5 avait été planté avec succès en aval du promoteur de VSG221 et que les antigènes recombinants qui en ont résulté ont fait leur preuve tout comme des antigènes natifs. Il a toutefois été mentionné que l'obstacle de l'Apol 1 doit être surmonté si ces trypanosomes doivent être utilisés dans le test de trypanolyse.

L'exposé suivant a présenté le développement du RDT HAT SD-Bioline appuyé par FIND, qui indique d'excellentes performances diagnostiques. Son utilisation correcte (passive ou active) dépendrait des circonstances qui prévalent dans les pays d'endémie.

Une présentation sur les RDT du paludisme dans les zones d'endémie de THA a signalé la présence de faux positifs dans des cas de maladie du sommeil. Cela peut entraîner des erreurs de diagnostic de cas de THA, en particulier dans les zones où la microscopie est effectuée régulièrement à la suite d'un RDT positif au paludisme. Les agents de santé doivent être sensibilisés à cette question et garder à l'esprit que le THA peut toujours être présent lorsque le RDT du paludisme est positif.

L'exposé suivant portait sur la recherche sur la sensibilité aux médicaments ainsi que les marqueurs moléculaires dans les trypanosomes prélevés sur des patients récidivants sous Melarsoprol en RDC. La résistance aux médicaments avait été indiquée dans des expériences menées sur des souris ; aucun marqueur moléculaire n'a encore été découvert, mais la recherche sur les aquaglycéroporines se poursuit. La préservation de cette ressource vitale de stocks de Tbg contre toutes rechutes a été saluée.

Une présentation sur le traitement de courte durée à la Pentamidine (3 jours contre 7) a indiqué qu'un suivi effectué 10 ans après le traitement a révélé que les taux de réussite étaient comparables. Il apparaît ainsi que 3 jours semblent être tout aussi efficaces que 7 jours, mais une analyse statistique exhaustive doit être réalisée afin d'aboutir à des conclusions plus concrètes. Une nouvelle étude assortie d'un bon suivi doit être lancée.

Les performances du NECT field IIIB dans lequel aucun critère d'exclusion n'a été mis en place afin d'étudier ce traitement dans la vie réelle ont été présentées. Ladite étude portait sur des enfants et des femmes enceintes. Le taux de réussite a été signalé comme étant de l'ordre de 94,3 %, et ce qui est plus important, il n'existait aucune différence chez les enfants et les adultes. Le nombre de décès plus élevé observé (3,5 % par rapport à 0,6 à 2,1% dans les essais cliniques antérieurs) s'expliquait comme découlant de l'absence d'exclusion à la différence des essais cliniques antérieurs. De même, les poids observés des bébés nés de mères traitées ont été attribués au fait qu'ils étaient des patients atteints de THA, et que ce facteur au lieu du NECT pourrait avoir contribué au ralentissement de la croissance. À la suite de cette étude, le NECT a été inscrit dans la liste des médicaments essentiels pour enfants de l'OMS.

La 10ème session a été un ensemble d'exposés plutôt disparates ainsi qu'un film intitulé « THA : Le rêve d'Alseny et le pavillon bleu ». Le premier exposé portait sur le titrage de viabilité multiplexe luminescent pour détecter le Tbg, justifié par le besoin d'un test usable avec le (Tbg) contagieux humain au lieu du Tbb pour le criblage des médicaments afin de garantir des données fiables à partir de ceux-ci. Dans cette étude, le Tbg a été transformé avec des gènes Renilla luciferase sans compromettre la croissance des trypanosomes. L'activité de Luciferase a ensuite été utilisée en association avec la quantification d'ATP pour évaluer la viabilité des trypanosomes suite à une exposition aux médicaments. Les parasites transformés peuvent également être retrouvés in vivo dans les infections expérimentales de souris grâce à l'imagerie par bioluminescence.

Un exposé sur les interdictions liées au traitement de la THA en RDC a été présenté. Il a étudié les raisons susceptibles d'entraîner le rejet d'un traitement par des patients diagnostiqués ainsi que leur fondement ou leurs origines. Les tabous existants ont été soulignés en prenant en considération le fait que le Melarsoprol est un médicament puissant (Toxique) non adapté à l'organisme humain (contrairement au NECT). Les pairs déconseillent les aliments chauds, l'exposition au soleil, les rapports sexuels, etc. Ces interdits pourraient pousser les patients à rejeter un traitement en raison de la croyance que le non-respect de ceux-ci entraîne la mort. La proportion de cas diagnostiqués échappant au traitement n'était toutefois pas clairement indiquée. Il a été convenu qu'une

communication consistant à s'assurer de faire passer les messages appropriés était cruciale pour surmonter ces tabous ainsi que la formation des agents de santé et des leaders d'opinion des collectivités.

Ensuite, un exposé a été présenté sur le rôle du bétail dans l'épidémiologie de la THA en Tanzanie.

Il a été signalé que le nord de la Tanzanie présente des foyers de transmission active du Tbrh, tandis que ceux rencontrés au sud demeurent silencieux même en présence de déplacement d'animaux en provenance du nord. Cet exposé a souligné la nécessité de renforcer les efforts de lutte visant à prévenir la réapparition de la THA.

## RECOMMANDATIONS

1. Les réalisations dans la recherche et la lutte contre THA sont encourageantes mais compte tenu de la réduction de la prévalence et des perspectives d'éradication, l'ISCTRC recommande la sensibilisation sur les défis en ce qui concerne la viabilité des efforts actuels de lutte contre la maladie du sommeil.
2. Les pays à THA endémique devraient s'approprier les campagnes d'éradication et s'assurer que les responsables politiques les adoptent cela; des capacités pour la mise en œuvre devraient être mises en place grâce au financement de provenant de sources locales et des partenaires.
3. L'intégration appropriée des activités de lutte et de surveillance dans les systèmes de santé périphériques est recommandée pour maximiser la détection et la gestion des cas ainsi que la surveillance sur la voie de l'éradication durable de THA gambiense et la lutte contre THA rhodesiense.
4. L'arrivée de test de diagnostic nouvellement développés pour la maladie du sommeil est la bienvenue. La recherche de nouveaux outils de dépistage pour THA (y compris les nouveaux antigènes) est encouragée. Il est recommandé que ces nouveaux outils soient convenablement validés avant d'être inclus dans la stratégie de l'OMS pour l'éradication de la maladie du sommeil gambiense et pour être adoptés par les programmes nationaux dans les pays endémiques.
5. Malgré la réduction du nombre de cas et la disponibilité de traitement efficace pour la gambiense, l'ISCTRC recommande de poursuivre les efforts dans la recherche de nouveaux médicaments plus sûrs et plus faciles (administration par voie orale) à utiliser, qui faciliteront l'intégration des

activités de traitement dans le système de santé périphérique.

6. Des précautions doivent être mises en place lors des futurs essais cliniques afin de s'assurer qu'ils soient complètement réalisés, y compris le suivi.
7. Des mesures doivent être mises en place pour veiller à ce que les agents de santé reçoivent une formation appropriée et pour qu'ils reçoivent une formation supplémentaire en vue d'un bon diagnostic et une bonne gestion des cas avec NECT ainsi que d'autres médicaments à venir.
8. Des indicateurs supplémentaires pour l'éradication doivent être développés.
9. La recherche sur le xéno-suivi pour la détection de trypanosomes infectieux humains dans les vecteurs afin d'évaluer l'élimination deTHA et aider dans la hiérarchisation des zones d'intervention doit être effectuée.
10. Les cibles minuscules doivent être évaluées sur des régions plus larges dans les pays endémiques, la participation de la communauté doit être encouragée pour s'assurer du succès.
11. La formation du personnel dans les pays endémiques afin de veiller sur l'accès et l'utilisation de l'atlas THA en vue d'interventions éclairées/ guidées doit être effectuée.
12. Le dépistage de plus d'antigènes diagnostic qui contribuerait à maximiser la couverture/détection de toutes les souches en circulation doit se poursuivre.
13. Les sociologues, les anthropologues et des spécialistes des domaines similaires devraient être impliqués dans le programme de recherche et de contrôle en tant que mesure pour s'assurer du succès des programmes par l'amélioration de la communication et du l'obtention du consentement des communautés touchées aux interventions.

## REPORT AND RECOMMENDATIONS ON AFRICAN ANIMAL TRYPANOSOMIASIS (AAT)

***Moderateur :*** Khitma Hassan Almalik

***Rapporteur :*** Giuliano Cecchi

The keynote address focused on challenges and opportunities in multi-sectoral approaches to African animal trypanosomiasis. The importance of political commitment, involvement of beneficiary communities, research, and the involvement of all stakeholders (national and international governments, donors, international organizations, NGOs, private sector) was stressed. The main challenges to eradication were identified in the size of affected areas, mass rearing, managerial and logistic capacities, the transboundary and multinational dimension of tsetse infestation, insecurity in some affected areas and problematic sustainability of funding. Drug resistance, environmental considerations, mechanical transmission, sustainability of assets were also cited among the challenges to successful interventions against tsetse-transmitted trypanosomosis.

Opportunities were also highlighted. The existence of a committed range of stakeholder was stressed which included International Organizations, PATTEC, research institutes and NGO. The commitment of several international donors also gives reason for optimism. The need to consider novel approaches was also highlighted, including the option of controlling and live with a reduced burden of the disease, waiting for conditions that are conducive to elimination and ultimate eradication.

The first presentation focused on a framework for community- and farmer-based management of trypanosomosis in cattle, based on integration of vector and parasite control. Given the rarity of sustainable eradication programmes, emphasis was placed on local integrated pest management (L-IPM) in order to reduce tsetse density enough to prevent or reduce transmission of AAT and prevent the spread of trypanosome resistant strains. A range of farmer-based AAT control strategies were proposed, depending on the eco-epidemiological cycles and catte breed/rearing systems. Knowledge gaps for an optimal implementation of these strategies were also outlined.

The second presentation addressed the leveraging on an oxaborole in clinical trials for HAT to develop novel compounds to treat Animal African Trypanosomosis (AAT). SCYX7158 is currently in phase 1 and has the potential to be a major advancement as a treatment for HAT. AN7973 derived

from HAT program showed single dose cure of T. congolense infection. AN7973 Showed 100% cure of T. congolense in goats and cattle 100 days after single 10 mg/kg Dose. No safety pharmacology issues were found and good target animal safety in cattle at 3x efficacious dose was demonstrated. However, AN7973 shows efficacy against T. vivax but not sufficient for single dose cure.

Requirement of efficacy against T. congolense and T. vivax strain precludes development of T. congolense-only drug. Further efforts to develop higher potency and metabolically stable back-up oxaborole to AN7973 that can meet the single-dose cure in cattle infected with both T. congolense and T. vivax look promising.

A related presentation addressed the next generation of medicines and diagnostics for animal African trypanosomosis, and the activities of GALVMed. These focus on the development of Novel field Diagnostic tools, improved trypanocide drugs (Chemotherapy), vaccine. Also, attention is paid to baseline evaluation of current control tools & compliance with quality standards for development of products.

A different presentation focused on emerged crisis caused by AAT in the Karamoja pastoral ecosystem (Uganda). The study presented first evidence of trypanosomal infection in cattle from Kotido district in Karamoja region, northeast Uganda. 706 cattle were tested by micro-hematocrit Buffy coat, &thick/thin film techniques, and overall prevalence of 5.2% was found (37/706). Concurrent infections with TBDs & helminthosis resulted in higher case mortality. The study also provided evidance of T.simae infection in cattle. The need for further studies in the region was highlighted.

The Atlas of tsetse and AAT was also presented. The Atlas is an initiative of FAO, jointly implemented with IAEA, in the framework of the Programme against African Trypanosomosis (PAAT). The goal of the initiative is to assist endemic countries in better managing, analyzing and sharing entomological and parasitological data, for improved, evidence-based decision making. To achieve this goal, contemporary, georeferenced data on the occurrence of Glossina species and AAT at the continental level are being assembled. General structure, products and outputs of the Atlas were outlined. In particular, details were provided on the development of continental maps of African animal trypanosomosis, and preiminary results were presented for Ethiopia, Kenya and Uganda. 131 relevant publications were identified and processed for these three countries, and 520 distinct geographic locations were mapped. Maps of occurrence, absence/presence and prevalence were presented, based on different diagnostic methods. It was stressed that developing contemporary global maps of AAT and tsetse will require sustained efforts, and only the

full engagement of and collaboration with PATTEC, National Animal Health Authorities and Research Institutes and will enable to meet the main goal of the initiative, which is to assist endemic countries in developing evidence for an informed and effective decision making.

A national-level application of the Atlas of tsetse and AAT was provided in the presentation entitled "The spatial distribution of bovine trypanosomosis in tsetse-infested areas of Sudan: past & present". In 2011 the Government of Sudan launched the project "Control of trypanosomosis & tsetse fly in Sudan", which includes a mapping component for AAT and its vectors. The mapping activity is an initiative of the Veterinary Research Institute (VRI) of Sudan, and it is technically supported by the FAO, in the framework of PAAT. Data sources for the study inluded scientific papers, MSc and PhD thesis, government reports. The focus was on bovines trypanosomosis, and all data collected from 1960 onwards were included. Targeted field surveys were conducted in 2011-2013 to complete and update information in the Blue Nile state (trypanosomes species) and South Darfur (tsetse fly distribution). Two species of tsetse flies are presently found in Sudan, G . m. submorsitans and G. fuscipes fuscipes. Their distribution is limited to two spates (South Darfur and Blue Nile). By contrast, animal trypanosomosis is present in a vast area, even at distances of hundreds of kilometers from tsetse infestation. Transmission in tsetse-free areas is sustained by mechanical transmission, probably aided by regular reintroductions from tsetse-infested areas through animal movement (transhumance and pastoralist). The mapping activities in Sudan have contributed to designing and implementing appropriate strategies for control interventions.

One presentation addressed parasitological prevalence of bovine trypanosomosis in Kubo Division of Kwale County of Costal Kenya. A cross-sectional survey of 584 adult cattle was conducted. Ten different locations were covered and a parasitological method was used for blood diagnosis. Entomological data were also collected. An overall prevalence of 33.9% was detected, with infections caused by T. vivax and T. congolense. Three species of Glossina were captured: G. pallidipes, G. brevipalpis and G. austeni. The findings of the study were used to plan large scale field trials for the validation of a new tsetse repellent technology.

A different presentation reported on the heterogeneity in the prevalence and intensity of bovine trypanosomiasis in the post-conflict districts of Amuru and Nwoya, Northern Uganda. A stratified random sampling technique was used with age and sex taken as strata. 814 blood samples were collected. Both parasitological (HCT) and molecular (ITS PCR) diagnostic techniques were used. The overall prevalence in cattle was 40.8% with 77% of infections

caused by T. vivax. Other infections were caused by T. congolense 'Forest type' (9.9%), T. congolense 'savannah' (10.5%), T. congolense 'kilifi' (1.5%). Mixed infections (T. vivax and T. congolense) constituted 3%.

Another presentation focused on the prevalence of animal trypanosomiasis and the corresponding immune responses in naturally infected cattle in Gulu district. 1329 local cattle were screened, and 107 positive were found suing the HCT diagnostic technique. PCR results indicated frequent mixed trypanosome infections. Plasma concentrations of cytokines were also quantified using a commercial bovine cytokine ELISA kits (TSZ ELISA™). Results indicate that cytokine levels were not dependant on infecting species or whether it was mixed or single infection.

One study presented the Proline racemase gene based PCR: an alternative T. vivax specific diagnosis. In case of T. vivax, most PCR primers usually are based on West African genotypes. However, in East Africa, other T. vivax genotypes circulate. The proline racemase gene (PRAC), is found in the genome of West African T. vivax. The study demonstrated that TvPRAC PCR can detect the presence of West African, and east African T. vivax strains (from tsetse and non-tsetse regions) as well as Latin American strains. TvPRAC PCR can be used as species specific molecular tool for identification of T. vivax infection and diagnosis of disease caused by this trypanosome. Specificity of TvPRAC in insect vector remains to be assessed.

The development of rapid diagnostic tests for surra based on recombinant Trypanosoma evansi RoTat 1.2 variant surface glycoprotein was presented. The objective of the study was to develop an animal-friendly, rapid serodiagnostic test for surra based on recombinant RoTat 1.2 expressed in the yeast Pichia pastoris. Results demonstrated that rRoTat 1.2 is expressed in Pichia pastoris GlycoSwitch™ M5 yield: ~ 20 mg / liter cell culture. rRoTat 1.2 VSG has diagnostic potential, and recombinant VSG eliminates need of laboratory animals for antigen production. Latex agglutination and lateral flow should be developed, which are applicable on any host species, ensure high sensitivity and specificity, are thermostable, and allow a rapid readout.

Last, the TRYRAC project was presented. TRYRAC (Trypanosomosis Rational Chemotherapy) is an EU funded project launched in March 2012. The project aims to (i) develop tools to detect trypanocidal drug resistance and establish local capacity and capability to diagnose drug resistance and to conduct trypanocidal drug quality control; (ii) determine prevalence of trypanocide resistance and quality of trypanocidal drugs on local markets in Ethiopia, Mozambique and Togo; (iii) Develop and test best-bet integrated

strategies to improve effectiveness of trypanocides and minimize and control trypanocide resistance; (iv) develop and use delivery systems to support control strategies; (v) determine impact of intervention on the livelihoods of smallholders.

## RECOMMENDATIONS

1. The presentations reflect a focus on the development of new drugs and the promotion of novel tools (e.g . Geographic Information Systems – GIS). The meeting welcomes this emphasis and recommends that efforts in this direction be sustained.
2. It is noticed that there is limited interaction between the HAT and AAT research. It is recommended that efforts be made to promote collaborative studies that bring together the different dimensions of trypanosomoses in a One Health perspective.
3. Recognizing the role of chemotherapy as a major tool for control of animal trypanosomosis and noting the slow pace of production of new trypanocides and appreciating the role of the national programme in the management of these drugs, regulatory authorities in the African countries are requested to test the qualities of trypanocides in their respective countries.

## RAPPORT SUR LA TRYPANOSOMOSE ANIMALE AFRICAINE

***Modérateur :*** Khitma Hassan Almalik

***Rapporteur :*** Guiliano Cecchi

Le discours liminaire a porté essentiellement sur les défis et opportunités présentés par les approches multisectorielles vis-à-vis de la trypanosomiase animale africaine. L'importance de l'engagement politique, de la participation des communautés bénéficiaires, de la recherche et de l'implication de toutes les parties prenantes (gouvernements nationaux et étrangers, bailleurs de fonds, organisations internationales, ONG, secteur privé) a été soulignée.

Les principaux défis pour l'éradication ont été identifiés au niveau de l'étendue des zones affectées, de l'élevage en masse, des capacités en gestion et logistique, de la dimension transfrontalière et multinationale de l'infestation des mouches tsé-tsé, de l'insécurité dans certaines zones affectées et de la durabilité problématique du financement. La résistance aux médicaments, les considérations environnementales, la transmission mécanique, la pérennité des actifs ont également été cités parmi les défis qui entravent la réussite des interventions de lutte contre la trypanosomose véhiculée par les glossines.

Les opportunités présentées par ces approches ont également été mises en exergue. L'existence d'un éventail de parties prenantes acquises à cette cause a été soulignée, et celles-ci comprennent des organisations internationales, PATTEC, des instituts de recherche et des ONG. L'engagement de plusieurs bailleurs de fonds internationaux nous donne également des raisons d'être optimistes. La nécessité d'envisager de nouvelles approches a également été mise en évidence, y compris l'option de contrôler et de vivre avec un fardeau réduit de la maladie, en attendant des conditions propices à son élimination et à son éradication définitive.

Le premier exposé était focalisé sur un cadre communautaire et pastoral de lutte contre la trypanosomose bovine, fondé sur l'intégration du contrôle du vecteur et des parasites. Compte tenu de la rareté des programmes d'éradication durable, un accent particulier a été mis sur la lutte intégrée contre les mouches (L -IPM) au niveau local afin de réduire suffisamment la densité des glossines pour prévenir ou réduire la transmission de la TAA et empêcher la propagation de souches de trypanosomes rebelles. Des stratégies de lutte contre la TAA au niveau de la ferme ont été proposées, en fonction des cycles éco-épidémiologiques et des races de vaches / systèmes d'élevage. Les lacunes en termes de connaissances, qui constituent un obstacle à une mise en

œuvre optimale de ces stratégies, ont également été soulignées.

Le deuxième exposé a abordé l'utilisation de l'oxaborole dans les essais cliniques sur la THA en vue de développer de nouveaux composés pour le traitement de la trypanosomose animale africaine (TAA). SCYX7158 est actuellement dans la phase 1 et a le potentiel d'être une avancée majeure comme traitement de la THA. AN7973 a montré une guérison de l'infection à T. congolense par une dose unique. AN7973 a montré une guérison à 100 % de T. congolense chez les caprins et les bovins 100 jours après une dose unique de 10 mg/kg. Il n'y a pas eu d'indication de problèmes pharmacologiques liés à l'innocuité, et une bonne sécurité de l'animal cible chez les bovins à une dose 3 fois efficace a été démontrée. Cependant, AN7973 montre une efficacité contre T. vivax mais qui n'est pas suffisante pour une cure à dose unique. L'exigence d'efficacité contre les souches de T. congolense et T. vivax ne permet pas la mise au point d'un médicament uniquement contre T. congolense. Des efforts supplémentaires pour la mise au point d'un oxaborole très puissant et métaboliquement stable d'appoint à AN7973, capable de guérir en une dose unique les bovins infectés à la fois par T. congolense et T. vivax, semblent prometteurs.

Un exposé similaire s'est penché sur la prochaine génération de médicaments et de diagnostics pour la trypanosomose animale africaine et les activités de GALVmed. Celles-ci mettent l'accent sur le développement de nouveaux outils de diagnostic sur le terrain, l'amélioration des médicaments trypanocides (chimiothérapie) et les vaccins. En outre, une attention particulière est prêtée à l'évaluation de base des outils de contrôle actuels et au respect des normes de qualité pour le développement de produits.

Un exposé différent s'est concentré sur l'apparition d'une crise causée par la TAA dans l'écosystème pastoral de Karamoja (Ouganda). L'étude a d'abord présenté les premières preuves d'infection trypanosomienne chez les bovins du district de Kotido de la région de Karamoja dans le nord-est de l'Ouganda. 706 bovins ont été examinés en utilisant les techniques du micro-hématocrite, la couche leuco-plaquettaire, la goutte épaisse / frottis, et la prévalence globale était de 5,2 % (37/ 706). Les co-infections par les MTT et les helminthes ont conduit à une forte mortalité. L'étude a également fourni des preuves d'infection à T.simae chez les bovins. La nécessité de poursuivre les études dans la région a été soulignée.

L'Atlas de la mouche tsé-tsé et de la TAA a également été présenté. L'Atlas est une initiative de la FAO, mise en œuvre conjointement avec l'AIEA, dans le cadre du Programme de lutte contre la trypanosomose africaine (PLTA). L'objectif

de cette initiative est d'aider les pays où la maladie est endémique à mieux gérer, analyser et partager les données entomologiques et parasitologiques en vue d'améliorer la prise de décisions fondée sur des informations factuelles. Pour atteindre cet objectif, les données contemporaines et géo-référencées sur la présence d'espèces de glossina et de la TAA au niveau continental sont en cours de collecte. La structure générale, les produits et les résultats de l'Atlas ont été présentés. En particulier, des informations détaillées ont été données sur l'élaboration de cartes continentales de la trypanosomose animale africaine, et les résultats prémilitaires ont été présentés pour l'Éthiopie, le Kenya et l'Ouganda. 131 publications pertinentes ont été identifiées et traitées pour ces trois pays, et 520 localités géographiques distinctes ont été cartographiées. Les cartes montrant l'apparition, l'absence / présence et la prévalence ont été présentées, sur la base des différentes méthodes de diagnostic. L'orateur a souligné que l'élaboration de cartes mondiales contemporaines de la TAA et de la mouche tsé-tsé exigera des efforts soutenus, et c'est seulement l'engagement complet et la collaboration avec la PATTEC, les autorités nationales de santé animale et les instituts de recherche qui permettra d'atteindre le principal objectif de cette initiative, qui est d'aider les pays où la maladie est endémique à développer des informations factuelles pour une prise de décision éclairée et efficace.

Une application au niveau national de l'Atlas de la mouche tsé-tsé et de la TAA a été présentée dans l'exposé intitulé « Répartition spatiale de la trypanosomose bovine dans les zones infestées du Soudan : passé et présent ». En 2011, le gouvernement du Soudan a lancé le projet intitulé « Contrôle de la trypanosomose et des mouches tsé-tsé au Soudan », qui comprend un volet de cartographie de la TAA et de ses vecteurs. L'activité de cartographie est une initiative de l'Institut de recherche vétérinaire (VRI) du Soudan, et elle est techniquement appuyée par la FAO dans le cadre du PLTA. Les sources de données de l'étude comprenaient des articles scientifiques, des mémoires de maîtrise et des thèses de doctorat et des rapports gouvernementaux. L'élement central était la trypanosomose bovine, et toutes les données recueillies à partir de 1960 ont été incluses dans l'étude. Des enquêtes de terrain ciblées ont été menées en 2011-2013 pour compléter et mettre à jour les informations dans l'État du Nil Bleu (espèces de trypanosomes) et le Sud du Darfour (répartition des mouches tsé-tsé). Deux espèces de mouches tsé-tsé sont actuellement présentes au Soudan, à savoir G. m. submorsitans et G. fuscipes fuscipes. Leur répartition se limite à deux zones à crues (Sud du Darfour et Nil Bleu). Par contre, la trypanosomose animale est présente dans une vaste zone, même à des distances de plusieurs centaines de kilomètres des zones d'infestation de tsé-tsé. La transmission dans les zones indemnes de glossines est maintenue par la transmission mécanique, probablement facilitée par les réintroductions régulières à partir de zones infestées à la suite de mouvement d'animaux (transhumance et pastoralisme). Les activités de cartographie au Soudan ont contribué à la conception et à l'exécution de stratégies appropriées pour les

interventions de lutte contre la maladie.

Un exposé a abordé la prévalence parasitaire de la trypanosomose bovine dans la Division de Kubo dans le comté de Kwale de la région côtière du Kenya. Une étude transversale de 584 bovins adultes a été menée. Dix localités différentes ont été couvertes, et des tests parasitologiques ont été utilisés pour l'examen de sang. Les données entomologiques ont également été recueillies. Une prévalence globale de 33,9 a été notée, les infections étant causées par T. vivax et T. congolense. Trois espèces de glossines ont été capturées : G. pallidipes, G. brevipalpis et G. austeni. Les résultats de l'étude ont été utilisés pour planifier des essais sur terrain à grande échelle en vue de la validation d'une nouvelle technologie insectifuge (contre les tsé-tsé).

L'exposé suivant a fait rapport sur l'hétérogénéité de la prévalence et l'intensité de la trypanosomiase bovine dans les districts sortis des conflits d'Amuru et de Nwoya, dans le nord de l'Ouganda. Une technique d'échantillonnage aléatoire stratifié a été utilisée, l'âge et le sexe étant pris comme strates. 814 échantillons sanguins ont été prélevés. Les techniques de diagnostic parasitologique (HCT) et moléculaire (ITS PCR) ont été utilisées. La prévalence globale chez les bovins était de 40,8 %, dont 77% des infections causées par T. vivax. Les autres infections étaient causées par T. congolense « type forêt » (9,9%), T. congolense de « type savane » (10,5%) et T. congolense « kilifi » (1,5%). Les infections mixtes (T. vivax et T. congolense) constituaient 3%.

Un autre exposé s'est focalisé sur la prévalence de la trypanosomiase animale et les réponses immunitaires correspondantes chez les bovins infectés naturellement dans le district de Gulu. 1329 bovins de race locale ont été examinés, et 107 ont montré une séropositivité par la technique diagnostique HCT. Les résultats de la PCR ont révélé de fréquentes infections trypanosomiennes mixtes. Les concentrations de cytokines dans le plasma ont également été quantifiées à l'aide de kits commerciaux ELISA de mesure de cytokine chez les bovins (TSZ ELISA ™). Les résultats révèlent que les taux de cytokines ne dépendaient pas des espèces responsables de l'infection ; ils n'ont pas indiqué s'il s'agissait d'une seule infection ou d'une infection mixte.

Une étude a présenté la PCR basée sur le gène de racémase proline (Proline racemase gene-based PCR) : un diagnostic alternatif précis de T. vivax. Dans le cas de T. vivax, la plupart des amorces PCR sont généralement fondées sur les génotypes ouest-africains. Cependant, d'autres génotypes de T. vivax circulent en Afrique de l'Est. Le gène de racémase proline (PRAC) se trouve dans le génome de T. vivax ouest-africain. L'étude a démontré que TvPRAC PCR peut détecter la présence de souches ouest-africaines et est-africaines

de T. vivax (à la fois dans les régions à tsé-tsé et celles exemptes de tsé-tsé) et de souches d'Amérique latine. TvPRAC PCR peut être utilisée comme outil moléculaire spécifique par espèce pour l'identification de l'infection à T. vivax et le diagnostic de la maladie causée par ce trypanosome. La spécificité de TvPRAC chez les insectes vecteurs n'a pas encore été évaluée.

La mise au point de tests diagnostiques rapides pour la surra basés sur la glycoprotéine de surface du variant RoTat 1.2 recombinant de Trypanosoma evansi a été présentée. L'objectif de l'étude était de mettre au point un test de sérodiagnostic rapide respectueux des animaux pour la surra, basé sur le RoTat 1.2 recombinant exprimé dans la levure Pichia pastoris. Les résultats ont démontré que rRoTat 1.2 est exprimée dans Pichia pastoris GlycoSwitch™ M5 yield : ~ 20 mg / litre en culture cellulaire. La glycoprotéine de surface du variant rRoTat 1.2 a un potentiel de diagnostic et la glycoprotéine recombinante du variant élimine le besoin d'animaux de laboratoire pour la production d'antigènes. L'agglutination au latex et le flux latéral devraient être développés, car ils sont applicables à toute espèce hôte, assurent une sensibilité et une spécificité élevées, sont thermostables, et permettent une lecture rapide.

Enfin, le projet TRYRAC a été présenté. TRYRAC (chimiothérapie rationnelle de la trypanosomiase) est un projet financé par l'UE, qui a été lancé en mars 2012. Le projet vise à : (i) développer des outils pour détecter la résistance aux trypanocides et déterminer les capacités locales à diagnostiquer la résistance aux médicaments et à effectuer un contrôle-qualité des trypanocides ; (ii) déterminer la prévalence de la résistance aux trypanocides et la qualité des trypanocides sur les marchés locaux en Éthiopie, au Mozambique et au Togo, (iii) développer et tester les stratégies intégrées les plus prometteuses pour améliorer l'efficacité des trypanocides et minimiser et contrôler la résistance aux trypanocides ; ( iv ) élaborer et utiliser des systèmes de prestation pour soutenir les stratégies de contrôle ; et ( v) déterminer l'impact de l'intervention sur les moyens de subsistance des petits éleveurs.

## RECOMMANDATIONS

1. Les exposés reflètent un intérêt particulier pour le développement de nouveaux médicaments et la promotion de nouveaux outils (par exemple les systèmes d'information géographiques - SIG).
2. Les participants se félicitent de cette perspective adoptée et recommandent que des efforts soient maintenus dans ce sens. On remarque que les relations entre les recherches sur la THA et celles portant sur la TAA sont faibles. Il est recommandé de faire des efforts pour promouvoir des études collaboratives qui rassemblent les différentes dimensions des trypanosomoses dans une perspective Une Seule Santé.

## REPORT AND RECOMMEMENDATIONS ON GLOSSINA BIOLOGY

***Moderator:*** Chilongo Kalinga

***Rapporteur:*** Joyce Daffa

***Summary of papers:***

| Biology (3 papers) | Symbionts (2 papers) | Control (5 papers) | Genetics (3 papers) | Not presented (4 papers) |
|---|---|---|---|---|
| 4.07 | 4.03 | 4.09 | 4.01 | 4.02 |
| 4.10 | 4.06 | 4.12 | 4.04 | 4.08 |
| 4.11 | | 4.14 | 4.05 | 4.13 |
| | | 4.15 | | 4.16 |
| | | 4.17 | | |
| ***5.01 was presented in this session*** | | | | |

The session was preceded by a key note address on **"Investment in new knowledge and tools for control of Glossina : Current Status and Future Perspectives"** – Prof Lehane. It has been observed that there no much work done in the field of Glossina in the past 18 months (2012-2013) as compared to the work done on Mosquitoes. In this period there were 44 and 1510 new publications on Glossina and mosquitoes respectively. For example, has been no insecticide trial in place. Insecticide trials have been conducted on Ivermectin only; there is more to be done in this field to support effective and efficient T&T eradication. He appreciated the political support availed by AU countries. He expressed confidence in T&T tools available; however there is a problem of commonality near to the end of the delivery chain of T&T eradication. It is hard for individual countries to succeed and therefore need to refine / reconsider regional approaches to T&T eradication. He encouraged the involvement of the Private sector (considering hiring terms) to collaborate with professionals to create regional level teams to work under AU-PATTEC to accelerate the eradication process. Following the plenary key note presentations, papers were presented as shown in the table above. Summaries of major observations in each specific sub sections were as follows:

### Biology (3 papers)

The three papers brought out findings on the potential of Morphometrics as a tool to check for existence of tsetse subpopulations with special emphasis on Zambia; performance of sterile male tsetse flies in a SIT control operations in Senegal after their importation from Burkina Faso; and sampling for Tabanids and Muscids in Sudan.

**Symbionts (2 papers)**

It was explained that increased density of symbionts in the gut of tsetse flies causes depletion of energy and hence affects all developmental stages of the host fly (egg, larva, and pupa); and also that the SGHV virus in sterile males gives advantage to wild males as the virus competes for energy in the sterile flies hence affecting their activeness and survival.

**Control (5 papers)**

It was noted that the high tsetse challenge found in wildlife conservation areas in most countries requires multi-sectoral involvement and approaches towards eradication, and to prevent reinvasion.

**Genetics (2 papers)**

The two papers showed that there was high genetic diversity (variation) among isolated Glossina population in the study sites in Uganda and Guinea Conakry. Incompatibility in mating and other factors can be used to guide planning and choice of control/eradication techniques of different species. This temporal genetic variation can be integrated in sustainable Area-wide pest management programmes towards eradication.

## RECOMMENDATIONS

- Research findings are of value only if they can be applied practically and effectively on the ground and contribute to elimination of T&T. As such it would be best to have research work and findings that serve in this context.
- The available technologies are adequate with regard to successful eradication of T&T; and a significant supply of resources exists. The main difficulty is lack of capacity to deploy teams on the ground to undertake a systematic T&T eradication process. There is therefore need to facilitate creation of such teams specifically at region to implement control/ eradication operations systematically from one tsetse belt to the next in the context of the PATTEC Vision
- Research work that facilitates availability of information on impact of T&T and, benefits of control/eradication efforts, are critical and should be encouraged - as such greatly assist in realizing effective advocacy T&T eradication with regards to resource mobilization e.tc.
- For tsetse (and other insect pest) control tools, specifications in terms of testing and guidelines should be defined using a 3rd party internationally

independent body that will provide an approval/recommendations.

- The Conference urges the AU-PATTEC Coordination Office to integrate within its AW-IPM strategy, communities' participation through active training of veterinary services department and active collaboration with farmers/herders associations;

## RAPPORT ET RECOMMANDATIONS SUR LA BIOLOGIE DE LA GLOSSINA

***Modérateur :*** Chilongo Kalinga

***Rapporteur :*** Joyce Daffa

| Biologie (3 exposés) | Symbiotes (2 exposés) | Contrôle (5 exposés) | Génétique (3 exposés) | Non présentés (4 exposés) |
|---|---|---|---|---|
| 4.07 | 4.03 | 4.09 | 4.01 | 4.02 |
| 4.10 | 4.06 | 4.12 | 4.04 | 4.08 |
| 4.11 | | 4.14 | 4.05 | 4.13 |
| | | 4.15 | | 4.16 |
| | | 4.17 | | |
| ***5,01 a été présenté au cours de cette session*** | | | | |

La session a été précédée d'un discours d'ouverture portant sur « **L'investissement dans les connaissances et les nouveaux outils pour la lutte contre la Glossina : Situation actuelle et perspectives futures** » – Prof Lehane. On constate qu'aucun travail n'a été accompli dans le domaine de la Glossina au cours des 18 derniers mois (2012-2013) par rapport aux travaux qui ont porté sur les moustiques. Dans cette période il y a eu 44 et 1 510 nouvelles publications, sur la Glossina et les moustiques respectivement. Ainsi, aucun essai d'insecticides n'a été mis en œuvre. Des essais d'insecticides ont été menés uniquement sur l'Ivermectin ; il reste encore beaucoup de travail à faire dans ce domaine pour soutenir de manière efficace et efficiente l'éradication des mouches tsé-tsé. Il s'est dit reconnaissant du soutien politique apporté par les pays de l'UA. Il a exprimé toute sa confiance envers les outils de lutte contre les mouches tsé-tsé disponibles ; il existe toutefois un problème au niveau du bout de la chaîne de process d'éradication des mouches tsé-tsé. Il difficile pour chaque pays de réussir, d'où la nécessité d'affiner et de repenser des approches régionales visant l'éradication des mouches tsé-tsé. Il a exhorté à l'implication du secteur privé (étant donné les modalités d'embauche) pour coopérer avec les professionnels afin de créer des équipes au niveau régional afin de travailler sous l'égide de l'UA-PATTEC pour accélérer le processus d'éradication. Suite aux discours d'ouverture, des exposés ont été présentés, tel qu'indiqué dans le tableau ci-dessus. Les résumés des principales observations faites dans chaque sous-section spécifique se présentent comme suit :

### Biologie (3 exposés)

Les trois exposés ont mis en évidence des conclusions relatives au potentiel que présente la Morphométrie en tant qu'outil pour vérifier l'existence de

sous-populations de mouches tsé-tsé en mettant particulièrement l'accent sur la Zambie ; la performance de mouches tsé-tsé mâles stériles dans des opérations de lute SIT au Sénégal après leur importation du Burkina Faso ; et des prélèvements effectués pour détecter des Tabanidés et des diptères Muscidae au Soudan.

**Symbiotes (2 exposés)**

Selon les explications, la densité accrue des symbiotes dans les boyaux des mouches tsé-tsé engendre l'épuisement d'énergie et de ce fait affecte tous les stades de développement de la mouche hôte (œufs, larves et chrysalides). En outre, le virus SGHV chez les males stériles donne l'avantage aux mâles sauvages, car le virus fait concurrence pour de l'énergie chez les mouches stériles, affectant ainsi leur activité et leur survie.

**Contrôle (5 exposés)**

On constate que l'énorme difficulté que posent les mouches tsé-tsé présentes dans les zones de conservation de la faune dans la plupart des pays nécessite une participation et des approches multisectorielles pour l'éradication,ainsi que pour prévenir toute nouvelle invasion.

**Génétique (2 exposés)**

Les deux exposés ont démontré l'existence d'une diversité (variation) génétique élevée au sein de la population isolée de Glossina dans les sites d'étude en Ouganda et en Guinée Conakry. L'incompatibilité au niveau de l'accouplement et d'autres facteurs peuvent être utilisés pour orienter la planification ainsi que le choix des techniques de contrôle/d'éradication des différentes espèces. Cette variation génétique temporelle peut être intégrée dans les programmes de lutte à une large échelle contre les ravageurs dans un but d'éradication.

## RECOMMANDATIONS

- Les résultats des recherches n'ont de valeur que lorsqu'ils peuvent être appliqués de manière pratique et efficace sur le terrain et contribuer à l'élimination des T & T. A ce titre, il serait préférable d'avoir des travaux et résultats de recherche utiles dans ce contexte.
- Les technologies disponibles sont adéquates par rapport à l'éradication réussie des T & T et il existe une offre importante de ressources. La principale difficulté réside dans le manque de capacités à déployer des équipes sur le terrain pour procéder à un processus d'éradication systématique des T & T. Il est donc nécessaire de faciliter la création de

telles équipes particulièrement au niveau régional pour mettre en oeuvre des opérations de contrôle / d'éradication systématique allant d'une zone à glossines à une autre dans le cadre de la Vision PATTEC.

- Les travaux de recherche qui facilitent la disponibilité de l'information sur l'impact des T & T et les avantages des efforts de contrôle / éradication sont cruciaux et devraient être encouragés. A ce titre, ils contribuent largement à un plaidoyer efficace pour l'éradication des T & T en ce qui concerne la mobilisation des ressources.
- En ce qui concerne les outils de contrôle des tsé-tsé (et d'autres insectes nuisibles), les spécifications en matière de tests et de directives devraient être définies en faisant appel à un organisme indépendant international tiers qui sera chargé de les approuver / fournir des recommandations.
- La Conférence exhorte le Bureau de coordination de la PATTEC-UA à intégrer au sein de sa stratégie AW-IPM/GIRER, la participation des communautés à travers la formation active du département des services vétérinaires et la collaboration active avec les associations d'agriculteurs / d'éleveurs.

## LAND USE, ENVIRONMENT AND SOCIO- ECONOMY

***Moderator:*** Fayga Hussein Ballal AWAD

***Rapporteur:*** Louis BANIPE

**Sessions 19 and 20**

This session was comprised of presentations of several types, including socioeconomic effects of trypanosomoses and their vectors. The presentation highlighted effects of the disease at several levels. Concerning HAT, the following can be noted:

- Decreased production
- Difficult or delayed development
- Depopulation of rural areas in favour of urban areas
- Significant expenses related to the disease, causing huge deficits.

Concerning TAA, adverse effects are also significant, and include among others: decreased production, work force and yields, and lower resistance to other diseases.

As regards public-private partnership, while it is interesting to note the commitment of both sectors, there still remain some critical coordination problems. Besides, the challenges facing partners are related to diseases and other issues occurring at the same time as the need to tackle trypanosomiasis. There is also the issue of prioritizing interventions.

The presentation is about the skills and knowledge of farmers on trypanosomosis and its vectors. It reveals that farmers have real knowledge on the issue. The various control methods applied are not entirely unknown to them. They also advocate transhumance as a means of breaking the cycle of infestations.

AU-IBAR's information system ARIS2 is a tool for centralizing data on animal health. There is a sub-module which is devoted to TAA and THA. This information is expected to raise awareness on field activities and to help better guide development partners.

Climate change remains a major challenge in the control of trypanosomoses and their vectors. Indeed, climate variations lead to changes which play an important role in the reduction of tsetse fly prevalence but create at the same time a breeding ground for the occurrence of new vectors - tabanids and stable flies. At this rate, it is very important to take into account these vectors in the fight against trypanosomoses.

At the end of these presentations, some recommendations were made:

## RECOMMENDATIONS

- It is important to have programs that take into account country programs. The economic component should also be considered ;
- Rural communities (beneficiaries of programs) should be regularly involved in activities targeted at them. This would improve sustainability of actions ;
- There is a need to harmonize information to make a better use of it.

## UTILISATION DES TERRES, ENVIRONNEMENT ET SOCIOECONOMIE

***Modérateur:*** Fayga Hussein Ballal AWAD

***Rapporteur:*** Louis BANIPE

**Sessions 19 et 20**

Cette session a comporté des présentations de plusieurs natures

Il s'agit notamment des impacts et des aspects socio- économique des trypanosomoses et leurs vecteurs : L'exposé a mis en exergue les impacts à plusieurs niveaux de cette maladie. Our ce qui est de la THA, on peut noter :

- La diminution des productions
- Les développements sont difficiles voire retardés
- Le dépeuplement des zones rurales au profit des zones urbaines.
- Les dépenses liées à cette maladie sont très importantes et occasionnent de manques à gagner énormes

Pour ce qui est de la TAA, les effets néfastes ne sont pas les moindres. Aussi peut- on citer entre autres : la baisse des productions, de la force de travail, des rendements, de même une faible résistance aux autres maladies.

Pour ce qui est du partenariat secteur public et secteur privé, s'il est fort intéressant de noter l'engament des uns et des autres, il ne demeure pas moins que souvent de problèmes de coordination se posent avec une certaine acuité. Par ailleurs les défis auxquels les partenaires sont confrontés restent les autres maladies et problèmes qui sont soulevés en même temps qu'il faut faire face aux trypanosomoses. Il se pose alors le problème de priorisation des interventions.

De l'exposé sur les compétences et les connaissances des éleveurs en, matière de trypanosomoses et des vecteurs, Il ressort que ces derniers (éleveurs) ont de connaissances certaines. Et même les différentes methodes de luttes appliquées ne leur sont pas totalement inconnues. Ils justifient d'ailleurs que les transhumances sont faites à dessein pour briser le cycle des infestations.

La mise en place d'ARIS-2 par l'UA- BIRA est un outil de centralisation des données en matière de santé animale. Dans le sous- module consacré à la TAA et la THA, les informations sont attendues pour mieux connaitre les activités de terrain et mieux savoir comment guider les partenaires au développement de venir en aide.

Les changements climatiques restent un grand challenge pour la lutte contre les trypanosomoses et leurs vecteurs. En effet, ces variations entrainent de modifications qui si elles sont importantes pour la réduction de la prévalence des mouches tsétsés, ils militent pour l'apparition de nouveaux vecteurs que sont les tabanidés et les stomox. A ce rythme, il est très important de tenir compte de ces derniers vecteurs dans la lutte contre les trypanosomoses.

A la fin de ces présentations, quelques recommandations ont été faites :

## RECOMMANDATIONS

- L'importance d'avoir des programmes qui tiennent compte des programmes des pays. Le volet économique devra désormais être considéré.
- Les communautés rurales (bénéficiaires des programmes devraient être régulièrement associées dans les activités menées à leur endroit. Ce qui permettrait une meilleure pérennisation des actions.
- Le besoins d'harmonisation des informations pour leur meilleure exploitation.

## REPORT AND RECOMMENDATIONS ON POSTERS

***Moderator:*** Lamine M. Dia

***Rapporteur:*** Gift Wanda

The Moderator opened the session by reminding conference participants that posters should not be considered as second class presentations, but rather as proper scientific papers meant to help young scientists to publish their work and to get exposed to the international scientific community.

- From a total of 54 posters accepted for the conference, only 25 were posted.
- Out of 15 posters accepted only 5 posters were available on the theme of HAT. The information presented in these posters included epidemiology, diagnosis and immunology.
- 14 posters out of 20 accepted for AAT were posted. The posters addressed epidemiology, chemotherapy and control
- 4 posters out of 18 accepted in the field of Glossina biology were posted. The posters covered vector distribution, population structure and infection rates, control, and vector diversity.
- One poster was on the design of an animal house for experiments

**RECOMMENDATION**:

- The ISCTRC Conference noted with satisfaction that the posters accepted for display were addressing operational research. The conference urges scientist wishing to present posters in future to maintain this trend so as to contribute meaningfully to the fight against T&T.

## SESSION DES POSTERS

***Modérateur:*** Lamine M. Dia

***Rapporteur:*** Gift Wanda

Le modérateur a ouvert la séance en rappelant aux participants à la conférence que les posters ne doivent pas être considérés comme des communications de deuxième ordre, mais plutôt comme de véritables documents scientifiques destinés à aider les jeunes chercheurs à publier leurs travaux et être en contact avec la communauté scientifique internationale.

Sur un total de 54 posters retenus pour la conférence, seuls 25 ont été présentés.

Sur 15 posters retenus pour le thème sur la THA, seuls 5 posters étaient disponibles. Les informations qui y été présentées comprennaient l'épidémiologie, le diagnostic et l'immunologie.

Des 20 posters retenus pour la TAA, quatorze (14) ont été présentés. Ces posters portaient sur l'épidémiologie, la chimiothérapie et le contrôle de la trypanosomiase.

- Sur 18 posters retenus dans le domaine de la biologie des glossines, 4 posters ont été présentés. Ces posters portaient sur la répartition vectorielle, la structure des populations et les taux d'infection, le contrôle et la diversité des vecteurs.
- Un (1) poster portait sur la conception d'un local pour animaux pour les besoins d'expérimentation.

## RECOMMANDATIONS

- Les participants à la conférence du CSIRLT ont noté avec satisfaction que les posters retenus ont abordé la recherche opérationnelle. Ils exhortent les chercheurs souhaitant présenter des posters à l'avenir à maintenir cette tendance afin de contribuer de façon significative à la lutte contre les tsé-tsé et les trypanosomiases.

## REGIONAL AND COUNTRY REPORTS

## RAPPORTS NATIONAUX ET REGIONAUX

# TSETSE AND TRYPANOSOMIASIS MANAGEMENT IN TANZANIA 2011-2013

# LE CONTROL DE LA MOUCHE TSETSE ET LA TRYPANOAOMIASE EN TANZANIE DE 2011 A 2013

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*Tanzania*

## Résumé

La trypanosomiase humaine et animale transmise par la mouche tsétsé est endémique en Tanzanie et est parmi les principaux obstacles à l'agriculture et le développement rural durable (ADRD). La forme aiguë de cette maladie chez l'homme est depuis longtemps un problème socio-économique majeur dans les régions ouest et nord de la Tanzanie qui présentent un risque élevé à environ 4 millions de personnes. Cinq (5) nouveaux cas de maladie du sommeil (SS) ont été signalés dans 3 districts à savoir Kibondo, Kaliua et Same dans 3 régions comparé à 2 cas en 2012. La Trypanosomose animale (Nagana) est largement répandue dans toutes les régions avec plus de 7 millions de bovins à risque. Toutefois, la non-déclaration de la maladie est un problème en raison du faible nombre de districts qui font de rapports sur les 26 régions infestées. En 2010/11 les districts qui ont fait de rapports étaient 13 provenant de 8 régions avec 511 cas et 37 décès dans 26 foyers, tandis qu'en 2011/12 les rapports de 9 régions ont montré qu'il y avait eu 422 cas, 21 décès dans 29 foyers et 53102 bovins qui sont à risque dans 15 districts.

Par ailleurs, le Réseau pour la cartographie des trypanosomiases africaines en Tanzanie (NetMATT), créé en 2009 en collaboration avec la Fondation pour de nouveaux diagnostics innovants (FIND) a exécuté un plan de travail de 2 ans qui a permis la sensibilisation et la collecte d'information sur la maladie du sommeil pour les 5 dernières années, de 2007 à 2012 sur la lutte contre les glossines, les zones d'interface entre le bétail et la faune sauvage, et l'inventaire des infrastructures de santé capables de faire le diagnostic et de traiter les cas de maladie du sommeil.

## Summary

Tsetse transmitted human and animal trypanosomoses are endemic in Tanzania and one among major obstacles to Sustainable Agriculture and Rural Development (SARD). The acute form of the human disease has long been a major socio-economic problem in western and northern regions of Tanzania posing a high risk to about 4

million people. Five (5) new cases of Sleeping sickness (SS) have been reported from 3 districts namely Kibondo, Kaliua and Same in three regions compared to 2 cases in 2012. Animal trypanosomosis (Nagana) is wide spread in all regions with more than 7 million cattle at risk. However, under-reporting is a problem due to low numbers of cases reported from districts in 26 infested regions. In 2010/11, 13 districts from 8 regions reported 511 cases and 37 deaths from 26 foci; whereas in 2011/12, 15 districts from 9 regions reported 422 cases, 21 deaths from 29 foci and 53,102 cattle at risk.

Furthermore, the Network for Mapping of African Trypanosomiasis in Tanzania (NetMATT) established in 2009 in collaboration with Foundation for Innovative New Diagnostics (FIND) has completed 2 years workplan that enabled sensitization and collection of Sleeping Sickness information for the past 5 years (2007-2012); tsetse control in livestock and wildlife interface areas; and inventory on the capacity of health facilities to diagnose and treat Sleeping Sickness.

This report highlighted issues on the research and control of tsetse, Sleeping Sickness and Nagana; as well as the NetMATT outputs for the period 2011 to 2013.

## Introduction

Tsetse flies are vectors of economic importance that normally prevent usage of land for settlement, crop farming and livestock grazing consequently hindering rural development and food security. Tsetse-transmitted Trypanosomoses are important causes of morbidity, mortality, and increased health care costs in both public and veterinary health services. Currently, between 40,000 and 50,000 people are estimated to be infected with HAT (WHO 2012); while AAT causes about 3 million cattle deaths with approximately 35 million doses of trypanocidal drugs being administered to treat it. Nagana has a severe impact on agriculture, with economic losses in cattle production alone being in the range of US$ 1.0 - 1.2 billion on the African continent. In Tanzania about 32.8% of the country is infested by seven (7) tsetse species namely; Glossina pallidipes, G. morsitans, G. swynnertoni, G. longipennis, G, fuscipes, G. austeni and G .brevipalpis (Map 1). AAT caused by T. congolense, *T. brucei*, and *T. vivax* is wide spread, whereas acute Rhodesience HAT is localized in western areas and part of northern areas; but sporadic incidences of HAT did occur in non-endemic areas such as Mkomazi game reserve in Kilimanjaro region in 2013 (Map 2). About 4 million people are at risk, however, the risk of contracting Human African Trypanosomoses has been decreased due to increased advocacy and use of integrated technologies for vector and parasite control in all affected areas. This report highlights on progressive made on activities undertaken for in tsetse and trypanosomiasis control from 2011 to 2013.

**Activities implemented in 2011 -2013**

During the period 2011 to 2013, Tanzania has been implementing various activities including tsetse surveys and monitoring; advocacy at all levels for promotion insecticide treatment of cattle and screens or targets in the control of tsetse-transmitted human and animal trypanosomosis. For HAT activities, the focus areas were those districts reporting HAT or those at high risk such as Urambo, Kaliua, Uvinza  Kigoma, Uvinza, Kasulu, Kibondo and Mpanda districts in western zone.

*Tsetse Survey, Mapping and Animal African Trypanosomiasis (AAT) Control*

Tsetse transmitted AAT is widely spread in all regions and districts in Tanzani despite the low index of reporting (Table 1).This is supported by presence of tsetse flies as revealed by the tsetse survey for mapping tsetse distribution in the country conducted in 23 regions. The map indicated significant changes in tsetse distribution, having declined from 60% infestation to 32.8% infestation in 2012 (Map 1). This is in comparison to maps of 1948 and 1970s (Department land & mines (1948); Atlas of Tanzania (1967) and Ford and Katondo (1973 &1977); Katondo K.M (1984). Despite the decrease in the land area under tsetse-infesttaion, tsetse populations are stable in National Parks, Game reserves and Wildlife Management areas (Table 2).

Several factors contributed to the reduction of tsetse limits from 60% to about 33% in the country. Among which is climatic changes (Rogers D. 1979, Hendricks et. al 2004 and Terblanche et. al 2008). Others include, encroaching on native vegetation by extensive human development such as farm expansion, expanding human settlements, livestock grazing and deforestation for timber (Reid, et. al 1997 and Cecchi G et. al.2008). Ticks and Tick-borne disease control by the using acaricides that have dual effect as insecticides, particularly the synthetic pyrethroids. This trend of diminishing tsetse fronts is a promising step towards control and elimination of African Trypanosomiasis (Kagbadouno et al 2011). However, the fact that Tsetse and Trypanosomiasis are dynamic and transboundary in nature; monitoring is recommended as the currently infested areas fronts may expand or shrink due to intrinsic and extrinsic factors including environment and climate changes.

*Advocacy, Monitoring and Control of Tsetse and Trypanosomiasis*

*Advocacy*

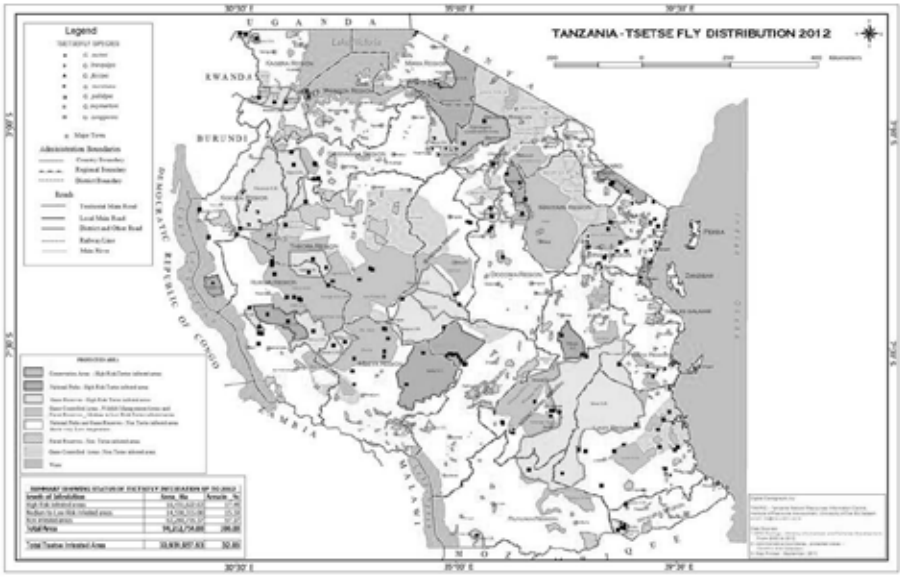
Awareness raising on T&T is aimed at decreasing occurrence of new AAT and HAT cases by increasing suspicion and capacity for accurate diagnosis and early case detection to ensure early treatment. To achieve this, Information, Education and Communication (IEC) materials for AAT and HAT have been

produced and distributed country-wide in affected areas in form of Posters ( 2000), brochures (7500), Leaflet, Fact sheets & calendars. Television and radio spot were also produced as another means of sensitization for AAT and HAT.

**Table 1:** Reported Cases of Animal African Trypanosomiasis

| **RE-PORT-ING** | **2011** | | | **2012** | | | **2013** | | |
|---|---|---|---|---|---|---|---|---|---|
| **RE-GIONS** | **9** | | | **6** | | | **5** | | |
| **DIS-TRICTS** | **12** | | | **8** | | | **8** | | |
| **FOCI** | **19** | | | **12** | | | **13** | | |
| | ***Cases*** | ***Death*** | ***At Risk*** | ***Cases*** | ***Death*** | ***At Risk*** | ***Cases*** | ***Death*** | ***At Risk*** |
| | 389 | 21 | 36752 | 72 | 0 | 24306 | 335 | 2 | 21807 |

*Source: Epidemiology unit – Ministry of Livestock &Fisheries Development (Under reporting is a major problem)*




*Map1. Tsetse Distribution in Tanzania- New map 2012*

**Table 2:** Summary Showing Status of infestation up to 2012

| Level of Infestation | Area -Ha | Area in % |
|---|---|---|
| High Risk Infested Areas | 16,431,622.63 | 17.44 |
| Medium to Low Infested areas | 14,500,335.00 | 15.39 |
| None Infested Areas | 63,280,796.37 | 67.17 |
| **Total Area** | **94,212,754.00** | **100.00** |

**HAT Monitoring**

HAT is endemic in western and Northern regions of Tanzania. Monitoring is on going in all health facilities in endemic regions and hot spot foci. Sentinel sites were established in Nguruka – Kigoma and Kaliua – Tabora. Two cases were reported in 2011 from Serengeti and Babati districts in Mara and Manyara regions respectively. In 2012 there was one case from Urambo district in Tabora region. An upsurge of cases was observed in early 2013 whereby 5 new cases were reported from Kigoma region in Kibondo district - 3 cases; Tabora region in Kaliua district – 1 case; and Kilimanjaro region in Same district – 1 case.

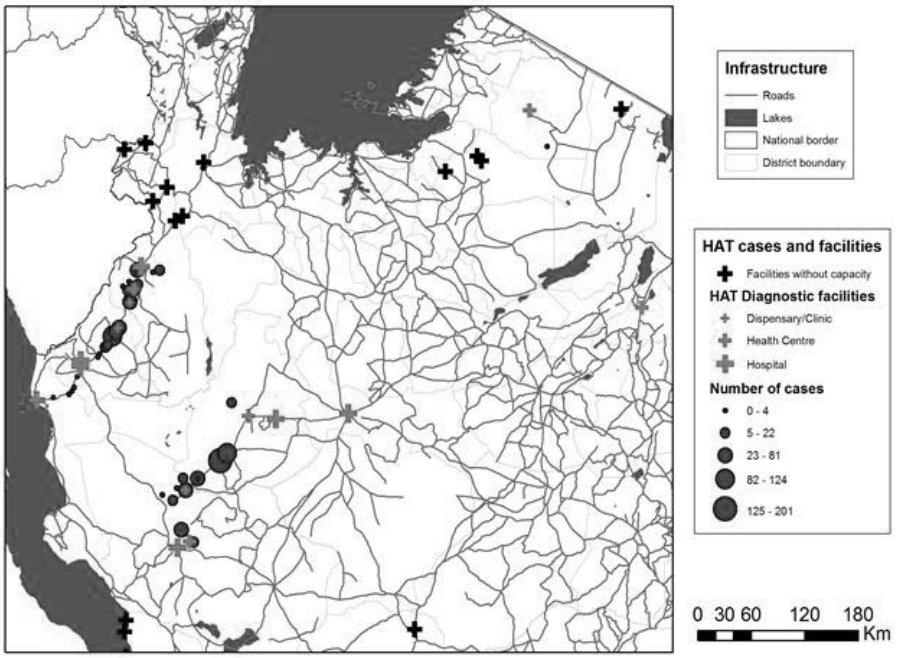
Another activity conducted was inventory of health facilities to identify their location and capacities for HAT diagnosis and treatment which was undertaken by the Network for mapping of African Trypanosomiasis in Tanzania (NetMATT) in collaboration with Foundation for New Innovative Diagnostics (FIND). The health facilities in HAT endemic areas were visited. Their positions were assumed to be the centres for the respective catchment areas or affected population. Geographical coordinates were taken using the GPS. In addition, the capacity of the health facilities to diagnose and treat HAT was assessed. The village, ward, division, district and region in which a health facility was located were recorded. A total of 20 treatment centers (in 20 villages) in six regions of Tanzania mainland were visited. These included 8 dispensaries, 6 health centers and 6 hospitals. Most (80%, n=20) of health facilities in the surveyed areas were owned by the Tanzanian Government. Generally understaffing was observed across all health facilities surveyed. Of the surveyed health facilities, 11 (55%) had functioning light microscopes with only four hospitals in this category. Only 8 (40%) health facilities had haematocrit centrifuge machines of which only 4 facilities had haematocrit capillary tubes in stock. The map were developed by University of Dar es Salaam - Institute of Resource Assessment (IRA) using the collected data (Map 3).

**Challenge**

It is difficult to sustain achievement due to low funding for monitoring following reporting of low cases of HAT and AAT. Lmited monitoring allows occurrence of high number of sporadic in areas where HAT and AAT were previously contained.




***Map 2.*** *Regions reported HAT cases in 2011- 2013*




***Map 3.*** *Health Facilities in HAT Endemic Areas -2012*

## The Way forward

The lead ministries responsible for health and livestock have to strengthen multi-sectoral collaboration and advocate for increased budgets for capacity building, research and implementation of eradication programmes for management of Tsetse and Trypanosomiasis

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# CURRENT STATUS OF TSETSE FLIES (GLOSSINA SPP.) IN JIGAWA STATE, NORTH-WEST NIGERIA.

# SITUATION ACTUELLE DES MOUCHES TSE-TSE (GLOSSINA SPP.) DANS L'ETAT DE JIGAW AU NORD-EST DU NIGERIA

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*Keywords: Tsetse flies, Baseline data, Biting flies, Mechanical transmission, Jigawa State,*

## Résumé

La Campagne panafricaine pour l'éradication de la mouche tsé-tsé et de la trypanosomose (PATTEC) – antenne du Nigeria, dans son effort soutenu d'éradiquer la mouche tsé-tsé et la trypanosomose du pays, a mené une enquête entomologique dans l'État de Jigawa pour recueillir des données de base avant l'institution de mesures de contrôle/éradication de la mouche tsé-tsé dans ledit État. L'enquête a été motivée par le manque d'information sur les glossines et la trypanosomose dans cet État, la dernière mise à jour datant des années 70. Vingt-six des 27 collectivités locales ont été étudiées pour déterminer la situation concernant les mouches tsé-tsé et autres mouches piqueuses, en utilisant 120 pièges biconiques et 20 pièges à Nitse. Les pièges ont été posés à des distances variant de 100 à 120 mètres dans des présumés habitats géo-référencés de glossines, et ont été récoltés toutes les 24h pendant 72h avant la réinstallation. Les mouches capturées ont été identifiées et comptées, et la densité et la distribution des populations ont été déterminées. Bien qu'aucune mouche tsé-tsé n'ait été prise dans tous les blocs étudiés, d'autres mouches piqueuses et non piqueuses d'importance médicale et vétérinaire, à savoir Stomoxys spp, Tabanus spp, Chrysops, Musca spp etc. ont été capturées, présentant de très faibles densités de population. Les îlots forestiers isolés, qui représentent des reliques de savane boisée/zone à morsitans, étaient encore visibles. La plupart de la végétation avait été enlevée et les superficies converties en terres agricoles extensives. Les températures ambiantes moyennes et l'humidité relative enregistrées au cours de la période variaient respectivement de 230C à 350C et de 39% à 76%. Cette enquête a noté plusieurs changements au niveau de la flore, de la faune et des conditions climatiques de l'État, qui peuvent être attribués aux effets de la croissance démographique/des activités humaines et au réchauffement de la planète. Etant donné qu'une enquête parallèle sur la situation de la maladie chez les animaux a révélé une prévalence de 3,5%, il est possible que la maladie ait

été importée suite au déplacement vers les États voisins infestés de mouches tsé-tsé, la transmission étant maintenue par des vecteurs mécaniques. Les données obtenues sont évocatrices d'une redéfinition de la limite nord de la répartition des glossines à partir du 12oN de latitude jusqu'à la limite sud de l'État. Cependant, la déclaration de l'État de Jigawa comme indemne de tsé-tsé devra être soumise à une surveillance entomologique saisonnière et une évaluation pendant 3 années consécutives.

**Mots-clés:** données de base, mouches tsé-tsé, mouches piqueuses, transmission mécanique, État de Jigawa

## Summary

The Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC)-Nigeria in her continued effort to eradicate tsetse flies and trypanosomiasis from Nigeria, conducted an entomological survey in Jigawa State to collect baseline data before the institution of tsetse control/eradication measures in the State. This is in view of the dearth of information on tsetse and trypanosomiasis in the state, with last update in the 70s. Twenty six of the 27 LGAs were surveyed for tsetse flies and other biting flies using 120 Biconical and 20 Nitse traps. Traps were pitched at distances varying from 100 - 120 meters apart in suspected tsetse habitats, geo-referenced and were harvested every 24hrs for 72hrs before relocation. Flies caught were identified, counted and the population density and distribution were determined. Although no tsetse fly was caught in all the blocks surveyed, other biting and non-biting flies of medical and veterinary importance, viz Stomoxys spp, Tabanus spp, Chrysops, Musca spp etc were caught, showing very low population densities. Isolated forest islands which represent relics of the woodland savannah/morsitans belts were still visible. Most of the vegetation had been removed and the areas converted into extensive farm lands. Average ambient temperatures and relative humidity recorded during the period ranged from 230C to 350C and 39% to 76% respectively. This investigation has recorded several changes in the flora, fauna and climatic conditions of the state which may be attributed to the effects of the human population increase/activities and the global warming. Since a parallel investigation of the disease situation in livestock revealed prevalence of 3.5%, the disease could have been imported while through faring the neigbouring tsetse infested States, with the transmission being sustained by mechanical transmitters. The data obtained is suggestive of a redefinition of the northern limit of tsetse distribution from latitude 12oN to the southern limit of the State. However, the declaration of Jigawa State as tsetse free would be subject to seasonal entomological monitoring and evaluation for 3 consecutive years.

**Keywords:** Baseline data, Tsetse flies, Biting flies, Mechanical transmission, Jigawa State,

**Introduction.**

Eleven Glossina species infest about 75% of the land area of Nigeria (Nash 1948). Four of these tsetse species viz; Glossina m. submorsitans, Glossina p. palpalis, Glossina tachinoides and Glossina longipalpis are of great economic importance, in view of their role in the transmission of trypanosomiasis to man and livestock. The riverine species (the palpalis group) are most widely distributed (reaching the Atlantic coast from Latitude 12oN (Figure 1) (Keay, 1953), while the Savannah woodland species (the morsitans group) which occur in belts of different sizes in the far north and central areas are by far the most dangerous vectors of trypanosomiasis in livestock. Recent survey of tsetse in a Farm Resort in central Nigeria revealed presence of G. tachinoides at a density of 1.2 flies/trap/day (Dede, *et al.,* Pers. Com).

Trypanosomes are single cell blood parasites that cause the disease, trypanosomiasis, otherwise known as Nagana or Sammore in livestock and Sleeping Sickness in humans. The disease in Nigeria has severe impact on livestock, humans and other agricultural production systems. Recent survey by the Nigerian Institute for Trypanosomiasis Research (NITR) of Human African Trypanosomiasis (HAT) in Delta state, shows that of the 840 examined, more than 20.0% were found positive, with about 5.0% in advanced stage of the disease (Edeghere, *et al.,* 1989). The disease in livestock is severe and widespread. Survey reports in ruminants between 1989 and 1991 showed overall prevalence rates of 4.3% in cattle, 1.6% in sheep and 1.0% in goats (EEC- Trypanosomiasis control project, 1989-1992). Similarly, between 1993 and 1996 prevalence rates of the disease cattle, sheep and goats were 10.0%, 8.6% and 8.1% respectively across the agro-ecological zones of the country (Onyiah, 1997). Results of trypanosomiasis and brucellosis survey on livestock in the Nagari Farm Resort showed trypanosomiasis prevalence of 2.3% (Evuti, et al, 2004).

Tsetse and trypanosomiasis are among the greatest impediments to the growth of livestock industry, and account for the failure to exploit the very large grazing potentials provided in about 54% of the total land area of the country. Large areas of the sub-humid zone would have been ideal for ranching, raising of cattle and other domestic animals if not for the presence of tsetse and trypanosomiasis. Studies conducted in West Africa on the impact of tsetse and trypanosomiasis on livestock and agriculture revealed that, in the tsetse-infested areas of moist sub-humid regions of Nigeria, village cattle are virtually absent, despite high population density, land pressure, intensive cereal cropping and a favourable length of growing period (Rogers, et al, 1994). Therefore, in otherwise identical agro-ecological sets of circumstances, it is the presence of tsetse alone that prohibits the keeping of cattle on a more permanent basis. (Rogers, et al, 1994). The effect of tsetse and trypanosomiasis may be readily demonstrated by the sub-continental cattle distribution. It is estimated that of

the 165 million cattle in sub-Saharan Africa, only 10 million are located in tsetse-infested areas, while the remainder is distributed on the periphery. It is no coincidence therefore that areas where tsetse occurs are areas of lowest protein intake, due to desertion of the areas by principal cattle raisers, as a result of threat from tsetse challenge and trypanosomiasis risks.

Reports by FAO and WHO indicated that, about 50 million cattle, tens of millions of ruminants and over 60 million people are at risk of trypanosomiasis infection. The cost implication of the menace posed by this disease is estimated at about US $5 billion per annum in Sub-Saharan Africa annually, apart from more than US $500 million spent annually in the use of imported trypanocides. The wide spread of tsetse and trypanosomiasis across Nigeria from the north to the south have serious economic and health implication on human and livestock production in Nigeria. It is estimated that US $70 million is lost annually on cattle alone in six northern states of Nigeria alone, while livestock losses due to trypanosomiasis in the country are put at US $192 million annually. About US $1.6 million was spent as cost on reclamation in the Sudan and Northern Guinea Savanna zones of Nigeria between 1954 and 1983.

In view of the huge socio-economic impact of tsetse and trypanosomiasis on both human and animal resources, it became inevitable for various control/ eradication measures to be applied. These include selective vegetation clearance, game elimination, ground and aerial spray of insecticides, use of insecticides treated targets, screens and live baits, the use of sterile insect technique (SIT) and the use of prophylactic and therapeutic measures to reduce losses in livestock and human. Chemical insecticides such as Dieldrin, DDT and endosulfan have been used in the late 60s and 70s for the control of tsetse fly in Jigawa state and other areas in the Sudan savanna, Guinea savanna and Lake Chad regions of country. The operation achieved reclamation of approximately 200,000$Km^2$ of land area from tsetse (Davies and Blasedale, 1960, Davies, 1971). Similarly, in recent times, repeated dusting of the area with insecticides against Quella birds have been undertaken by the Federal Ministry of Agriculture and rural Development (Capt. Yombe, Pers. Com).

Following the endorsement of the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) by the African Heads of States and Government in 2000 aimed at freeing the African continent of the tsetse and trypanosomiasis, the PATTEC-Nigeria initiated action in 2003 to eradicate tsetse from Nigeria, beginning from the North-West and North-East geopolitical zones. Consequently, a multidisciplinary team from the Nigerian Institute for Trypanosomiasis Research (NITR) and major stakeholders Ministries (Federal Ministries of Agriculture and Rural Development, Health and Environment)

undertook a 2-week survey to obtain entomological, parasitological and socio-economic baseline data of the entire Jigawa State (North-west zone) to form the basis for initiating tsetse and African trypanosomiasis control/eradication.

The survey was intended to collect entomological baseline data prior to institution of sustainable environmentally friendly tsetse control measures, and monitoring the impact in Jigawa State. Tsetse and trypanosomiasis eradication in Jigawa State will no doubt boost livestock production, human health; contribute to food security and poverty alleviation which are cardinal to the agenda of the present Nigerian Government.

## Materials and Method

*Description of study area*

Jigawa State is located between latitude 10o 55I and 13o 05INorth and longitude 8o 07I and 10o 37IEast in the north western geopolitical zone of Nigeria. The state is contiguous with Niger Republic in the North, Yobe State in the North-East, Katsina State in the North-West, Kano State in the West, Kaduna State in the South-West and Bauchi State in the South and East. The vegetation of the state is Sudan Savannah with northern fringes tending to Sahel. The occupation of the inhabitants is mainly agrarian with great potential for mechanized agriculture and animal traction. Rice and wheat are cultivated at the flood plains, while millet, guinea corn and maize are cultivated at the hinterland. The major part of the state is traversed by the famous river Hadejia and its tributaries which serve as the main source of water for dry season irrigation farming. Few earth dams have also been provided by government to aid dry season farming.

Jigawa State holds a population of about 4.3 million people. It has an estimated 3,594,913 million cattle; 3,072,657 million goats; 3,069,167 million sheep [source Jigawa Agricultural and Rural Development Authority (JARDA), Evaluation and Monitoring Unit] and more than 5.5 million chickens. The State is also rich in other animals like Camels – 7,500 and Donkeys – 13,000. An international cattle market is located at Maigateri in Maigateri Local government area of the state close to the border with the Niger Republic.

*Study Design (Sampling frame work)*

Jigawa State was selected as a sub-zone of the North-West geopolitical zone for commencement of the project activities. Stratified random sampling method was adopted for the study. The state was delineated into 6 operational blocks (A, B, C, D, E & F) (Figure 2) that made the study strata. Each of these blocks consist of 4 to 5 Local Government Areas (LGAs) of the 27 LGAs in the

State. Advantage of the northerly tsetse free stripe from latitude 12oN to the border with Niger Republic was taken as a natural barrier. Operational sites were randomly selected based on riverine vegetation, forest islands, relics of morsitans belts, human habitation, etc.

## Materials and Methods

The baseline survey was undertaken after an earlier pre-survey visit to the State. For effective coverage of the state, the team split into two sub-teams. Tsetse species and their distribution were evaluated using a total of 120 Biconical traps (Challier and Laveissiere, 1973) and 20 Nitse traps (Omoogun et al, 1991). Traps were pitched at distances varying from 100 - 120 meters apart, along riparian vegetation along river banks, relics of morsitans belts, forest-islands, pools of water, fringing forests, human habitation and were left for 72hrs before removal and relocation. Traps were checked and catches harvested every 24hours. Each trap position was geo-referenced using Garmin 76csx GPS machine. Flies caught were identified, counted and recorded to determine population density and distribution.

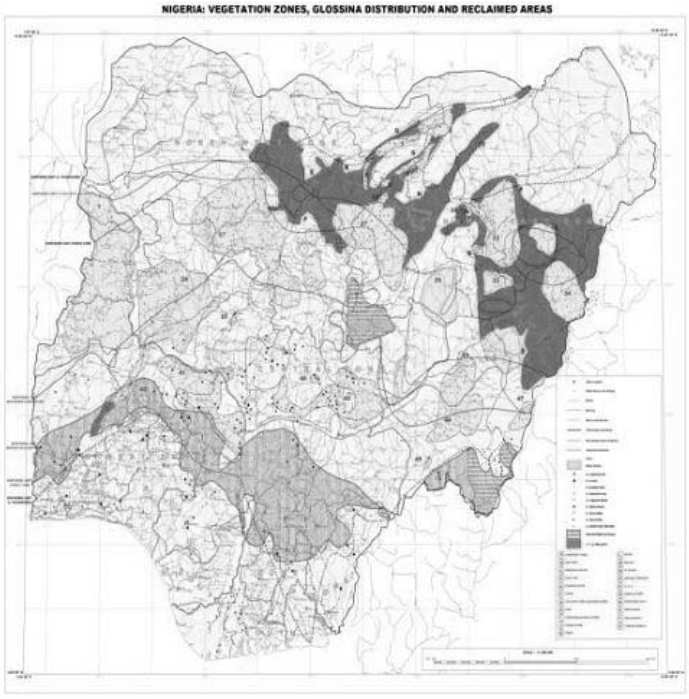



***Figure 1:*** *Jigawa State delineated into six operational blocks of 4-5 Local Government Areas*

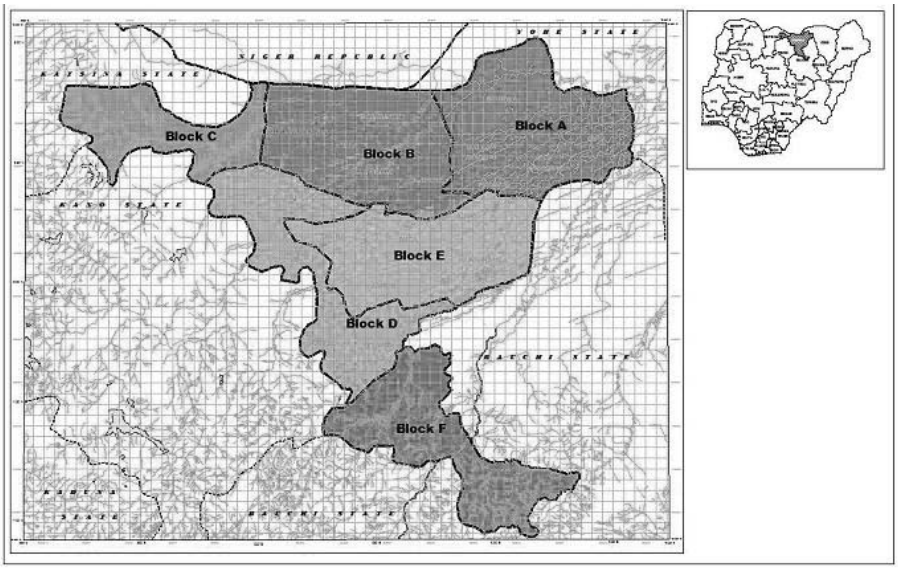
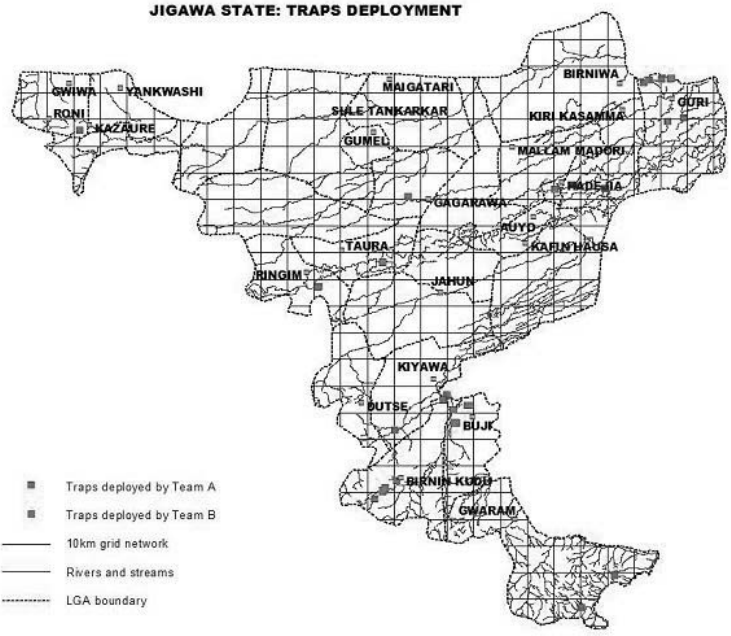



***Figure 2:*** *Trap deployment in Jigawa State, Nigeria, November, 2011*




*Project review meetings*

Three project implementation review meetings were held; one preview, mid and terminal reviews where sub-teams members exchanged notes, problems and areas of achievement were highlighted and solutions proffered where necessary.

## Results

*Tsetse flies, other biting and non-biting flies*

No tsetse was caught in all the blocks surveyed. However, other biting and non-biting flies of medical and veterinary importance such as Stomoxys calcitrans, Tabanus spp, Chrysops and Musca spp were caught as shown on Table 1. Figure 3 shows trap deployment in the State. The woodland savannah natural habitat for morsitans group tsetse species has been reduced to its relics, without record of tsetse flies presence. Most of the vegetation had been removed and the areas converted to extensive farm lands (Plate I) or are being threaten by activities of nomads that abound in the State (Plate II). With the exception of snakes and rabbits, no large wild animal was encountered in all the blocks surveyed. Average ambient temperatures and relative humidity recorded during the period ranged from 23oC to 35oC and 39% to 76% Relative Humidity respectively. Areas along streams and river courses had lower temperatures and higher humidity. The land was generally undulating due to sand dunes cress-crossing from river beds to highlands with elevations ranging from 351meters to 463meters above sea level.

*Project review meetings*

It was observed that the team made impressive coverage of almost the whole state with 20-23 LGAs covered.

## Discussion

Tsetse species and their distribution in Jigawa State was last updated in the late 60s. The State had haboured Glossina m. submorsitans, G.tachinoides and Glossina p.palpalis. The last two were distributed along river courses, while the morsitans group species was distributed in belts of different sizes. Parts of the State falls within the 200,000km2 area that was reclaimed in the North-east and North-west corridors of the country using aerial insecticide application during the 1960 eradication campaign (Davies and Blasdale, 1960; Davies, 1971). This control operation freed the area of Glossina tachinoides, G.p.palpalis and G. m. submorsitans, hitherto, known to pose a very serious threat to human health, agricultural and livestock production in the State. History of past spraying of the areas with insecticides at different locations was recounted by the elderly. The results obtained in this survey, lend credence to achievements of the 1960s reclamation campaign. Amongst reasons that could be advanced to explain why tsetse could not be picked in the present survey in Jigawa State are:

**Table 1:** Categories of animals screened and prevalence rates in the 20 LGAs surveyed in Jigawa State by the Parasitology team, December, 2011.

| S/N | Local Government Council | Coordinates of Sampling Points | Categories of Animal Sampled | | | | | TOTAL | No. (%Prevalence) of trypanosomiasis |
|---|---|---|---|---|---|---|---|---|---|
| | | | CATTLE | SHEEP | GOAT | HORSE | DONKEY | | |
| 1 | Dutse | X 028587<br>Y 1327414 | 111 | 3 | - | - | - | 114 | 2 (1.75%) |
| 2 | Buji | X 0579553<br>Y 1287070 | 67 | 15 | - | - | - | 82 | 1 (1.22%) |
| 3 | Kiyawa | X 0566442<br>Y 1302442 | 135 | 4 | - | - | - | 139 | 0 (0%) |
| 4 | Miga | X 0564957<br>Y 1349236 | 95 | 10 | 20 | - | 5 | 130 | 2 (1.54%) |
| 5 | Auyo | X 0603947<br>Y 1365043 | 100 | 8 | - | - | - | 108 | 6 (5.56%) |
| 6 | Malan maduri | X 0609958<br>Y 1376404 | 146 | 7 | - | - | - | 153 | 18 (11.76%) |
| 7 | Guri | X 0650088<br>Y 1407010 | 90 | - | 10 | - | - | 100 | 11 (11%) |
| 8 | Taura | X 0538473<br>Y 1355909 | 112 | 7 | - | - | - | 119 | 3 (2.52%) |

| S/N | Local Government Council | Coordinates of Sampling Points | Categories of Animal Sampled | | | | | TOTAL | No. (%Prevalence) of trypanosomiasis |
|---|---|---|---|---|---|---|---|---|---|
| | | | CATTLE | SHEEP | GOAT | HORSE | DONKEY | | |
| 9 | Maigatari | X 0542884<br>Y 1411857 | 61 | 9 | - | - | - | 70 | 3 (4.29%) |
| 10 | Birinin kudu | X 054859<br>Y 1263576 | 130 | - | - | - | - | 130 | 9 (6.92%) |
| 11 | Gwaram | X 0586406<br>Y 1252364 | 3 | - | - | - | - | 3 | 0 (0%) |
| 12 | Jahun | X 0571637<br>Y 1332206 | 156 | - | - | - | - | 156 | 0 (0%) |
| 13 | Kafin hausa | X 0599194<br>Y 1343482 | 100 | - | - | - | - | 100 | 2 (2%) |
| 14 | Kaugama | X 0580686<br>Y 1377136 | 110 | - | - | - | - | 110 | 1 (0.9%) |
| 15 | Hadeja | X 0615178<br>Y 1382285 | 115 | - | - | - | - | 115 | 0 (0%) |
| 16 | Kirikasama | X 0619143<br>Y 1383059 | 52 | 15 | 10 | - | - | 77 | 1 (1.29%) |

| S/N | Local Government Council | Coordinates of Sampling Points | Categories of Animal Sampled | | | | | TOTAL | No. (%Prevalence) of trypanosomiasis |
|---|---|---|---|---|---|---|---|---|---|
| | | | CATTLE | SHEEP | GOAT | HORSE | DONKEY | | |
| 17 | Birniwa | X 0639770<br>Y 1411215 | 78 | 13 | 17 | 1 | - | 109 | 2 (1.83%) |
| 18 | Gagarawa | X 0555636<br>Y 1371523 | 81 | 15 | 15 | - | - | 111 | 0 (0%) |
| 19 | Sule tankarkar | X 0525034<br>Y 1371523 | 76 | 24 | - | - | - | 100 | 0 (0%) |
| 20 | Kazuare | X 0432274<br>Y 1398741 | 77 | 31 | 1 | - | - | 109 | 5 (4.59%) |



**Plate 1:** *Morsitans belt 14 in Birnin Kudu Local Government Area, Jigawa State, Nigeria completely reduced to a farm land*



**Plate 2:** *Relics of Morsitans belt 8 in Guri Local Government Area of Jigawa State, Nigeria being destroyed by activities of Nomads.*

**Table 2:** Prevalence of trypanosomes in the categories of ruminants sampled in December, 2011 from Jigawa State, Nigeria

| Trypanosome species | | | | | |
|---|---|---|---|---|---|
| **Animal species** | *T.vivax* | *T. congolense* | T. brucei | Total | **P-value** |
| Cattle | 3 | 38 | 19 | 60 | 0.239 |
| Sheep | 0 | 0 | 6 | 6 | 0.184 |
| Goats | 3 | 0 | 0 | 3 | 0.298 |
| | 3 (4.60) | 38 (57.60) | 25 (28.80) | 69 | |

***Note:*** *Data in parenthesis are percentages*

**Table 3:** Sex Difference in Trypanosome Prevalence in the Different Categories of Animal Screened by the Veterinary team, December, 2011.

| **Animal Species** | **Sex** | **No. of Sample Examined** | **No. of Positive Samples** | **P-Value** |
|---|---|---|---|---|
| Cattle | Male | 300 (15.83) | 20 (4.00) | 0.987 |
| | Female | 1,589 (8.40) | 40 (9.20) | |
| Sheep | Male | 30 (18.64) | 1 (2.00) | 0.303 |
| | Female | 131 (8.14) | 5 (22.22) | |
| Goats | Male | 13 (17.80) | 0 (0.00) | 0.356 |
| | Female | 60 (8.22) | 0 (0.00) | |

*Infection rate does not depend on animal gender (p >0.05)*

***Note:*** *In parenthesis are the percentages*

**Table 4:** Sensitivity of Different Diagnostic Techniques used in Trypanosome and Microfilaria Detection in Animals Screened in Jigawa State by the Veterinary team, December, 2011.

| **Diagnostic Method** | **No. Animals Examined** | **No. of Animals Trypanosome Positive (%)** | **No. of Microfilaria Positive (%)** |
|---|---|---|---|
| Wet Blood Film | 2135 | 37 (1.74) | 0 (0.0) |
| Giemsa Stained (thin) | 2135 | 24 (1.13) | 10 (0.47) |
| Buffy-Coat | 2135 | 66 (3.09) | 42 (1.97) |
| Haematocrit centrifugation | 2135 | 66 (3.09) | 42 (1.97) |

**Table 5:** Mean PVC values of the Infected and Non-infected animals Screened in Jigawa state by the Veterinary team, December, 2011.

| Animal Species | Trypanosome Infected (PCV %) Mean +SE | Non-Infected (PCV %) Mean +SE |
|---|---|---|
| Cattle | 20.22+2.31 | 35.09+5.71 |
| Sheep Goats | 20.39+3.50 | 31.76+7.32 |
| Goats | 19.41+3.69 | 32.76+4.72 |

1. there was no re-infestation after the 1960s reclamation programme.
2. the continuous dosing of quillatox into Quella birds brooding sites along the length and breadth of the Hadejia/Kamadugou/Yobe wet lands, where a lot of rice, millet and sorghum are being cultivated (Hassan, Pers. Com)
3. Human population increase/activities such as farming, firewood gathering, rural expansion and road construction were observed to be highly pronounced in the State. Most of the vegetation which earlier served as tsetse habitats have been destroyed. Indeed large markets of firewood were conspicuously seen in the course of this survey. Also most of the riparian vegetations on the banks of rivers/streams were cut down and the reclaimed land was being used for cultivation of tomatoes, pepper, onions and other vegetables. Continuous encroachment into natural forest reserves were noted in places like Gurmina Forest Reserve in Birnin Kudu LGA (Coordinate P0544348 and H1259215), Government Forest Reserve at Gabta Village (P0637942 and H1380914), Baturia Forest Reserve (P0638282 and H1380623) (Plate 2). As reported by Bourn (1983) and Jordan (1986), the above observed activities have resulted in tremendous ecological changes due to massive deforestation and an overall reduction in the natural tsetse habitats, the wildlife reservoir host, and the corresponding alteration in the pattern of tsetse distribution in the State and the country at large (Dede et al, 1998). It has been estimated that human population density of 8 – 40 person/km2 are capable of driving out the game that are natural host of both trypanosomes and the tsetse vector (Hendry, 1979). This may have been responsible for the disappearance of the fly's preferred blood meal sources, the wild bovidae (Weitz, 1963), probably poached out of the State. While the morsitans group species showed high selection in their host preference and habitat, G. tachinoides and G.p.palpalis may have been displaced permanently by the total disappearance of the riverine vegetation cover. On the contrary, re-infestation of other similarly tsetse reclaimed areas in the north-east zone have been reported (Bature, 1981). Perhaps, this may be attributed principally to lack of proper agricultural land development programme. The tsetse reclaimed BICOT I field area also became re-infested due lack of planed agricultural land use development programme (BICOT, 1991).
4. The phenomena of climate change and desert encroachment have gripped the state seriously. At the northern fringes of the state, sand dunes were

conspicuous, an indication of desertification. The vegetation was reduced to thorny acacia plants without shade. Temperatures were generally high with low relative humidity recorded in most of the areas surveyed. Tsetse flies may find it difficult to survive in these unfavorable conditions. It is obvious from our findings that latitude 120 N, the northern limit of tsetse distribution may no longer be tenable since tsetse could not be picked at the southern limit of the State on latitude 10o55”N. Although some isolated relics of the woodland savannah morsitans belts are still present that could support tsetse, the hashed climatic conditions was probably unfavourable for tsetse habitation

Since report of a parallel investigation in resident and transhumant livestock indicated a prevalence rate of 3.05% (Kalejaiye, pers, com). Also since the socio-economic report of a parallel investigation showed that the nomads often times graze far into the neighbouring tsetse infested States (Njoku pers com). It is therefore imperative that these transhumant cattle while through-faring these tsetse infested areas during rainy and dry season migration, may receive an infective bite and thus acquire the disease. When the transhumant cattle return or while through faring the State northward, the infected ones amongst the transhumant cattle may provide sources of infection to the susceptible livestock breeds that are solely kept in the State. Once the disease has been introduced, the spread in the absence of the tsetse vector may be sustained when these infected animals are fed upon by mechanical transmitters viz Stomoxys calcitrans, Tabanus spp Haematopota spp, Haematobia spp. (Stephen, 1966; Riordan, 1972; Agu & Bajeh, 1986, Dede, 2004), which were caught in this investigation.

Environmental assessment of most LGAs surveyed revealed that much of the faunal and floral resources of the state including vegetal components, fish, reptiles, birds and mammals have been affected negatively due to anthropogenic pressure and climatic stress. Birds were the most represented class of vertebrates in the area as more species of birds were recorded than species from other guilds of fauna. Wild animals that use to characterize the area were absent or may have temporarily relocated. Similarly, most of the vegetation cover in areas surveyed were disturbed and degraded due to anthropogenic pressure and stress from climatic variations experienced in the northern arid regions of the country. Indices of anthropogenic disturbances evident in the study area suggested that the habitat condition is poor with little prospect of adequate vegetation cover for tsetse flies habitation.

This survey was carried out during the dry season, which may not be adequate to rule out non-presence of tsetse and the true population density of other biting and non-biting flies of veterinary and medical importance in the state particularly in areas with riparian vegetation conducive for tsetse breeding. A similar wet season entomological baseline data collection will be needed to ascertain the seasonality of tsetse population dynamics in the State.

In conclusion, the data obtained is suggestive of a southward shift in the northern limit of tsetse distribution from its present latitude 12oN to the southern limit of the State. However, the declaration of Jigawa State as tsetse free would be subject to seasonal entomological monitoring and evaluation for 3 consecutive years.

**Constraints:** The team was constraint by lack of motorized boats and life jackets, three members of the Entomology team almost lost their lives when a canoe conveying them capsized while trying to cross river Hadejia to set traps on the other side of the river.

**Recommendations:** We wish to recommend as follows (1) that in future tsetse control/eradication programmes, targeted at the morsitans and the palpalis group species, rural expansion and land use development programme should be integrated into the control programme. This is in view of their associated negative effects on tsetse habitats and the wild hosts through land use agricultural practices, pouching, road construction etc (2) In order to protect resident livestock in Jigawa State from the threats of trypanosomes infection as well encourage the herdsmen to settle in the existing grazing reserves, the Jigawa State Government should enact a law that would restrict nomads practicing transhumant system of animal husbandry to the State. (3) Since tsetse distribution is season dependant, it is strongly recommended that a wet (rainy) season survey should be undertaken to provide a more comprehensive and dependable data for valid conclusions to be drawn (4) Provision of motorized speed boats and live jackets are necessary in surveys to be conducted in riverine areas.

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# SITUATION DE LA TRYPANOSOMIASE EN ANGOLA 2011- 2012
# RAPPORT PAYS

*Dr. Don Paul Makana , Dr. Morgado Ngudivita Paulo, Sr. Félix Makiadi Donzoao, Sr. Filipe Ndombe wa Ndombe, Prof. Droutor Josenando Théophile.*

## Introduction

La République de l' Angola est l'un de 36 pays africains endémiques de la trypanosomiase. Sa superficie est de 1.246.700 Km2 avec une division administrative en 18 provinces dont 14 glossinées et parmi lesquelles 7 endemiques de la Trypanosomiase Humaine Africaine(THA), citons: Bengo, Kuanza Norte, Kuanza Sul, Luanda, Malange, Uige e Zaire.

Pour la Trypanossomiase Animale Africaine (TAA) l angola seraient affecté dans dix provinces.

Pour comprendre le contexte epidemiologique de la tripanossomiase, rappelons que l´Angola fait frontière avec le Congo Brazzaville, le Congo Kinshasa, la Zambie et la Namibie qui sont aussi affectés par la Trypanosomiase.

La situation de ce fléau que nous allons rapporter est La volonté politique et les efforts de l' Exécutif angolais sans oublier le concours de partenaires nationaux et internationaux on fait que le programme national pu réaliser les activités que nous allons relater relatives aux années 2011-2012.

## Objectif

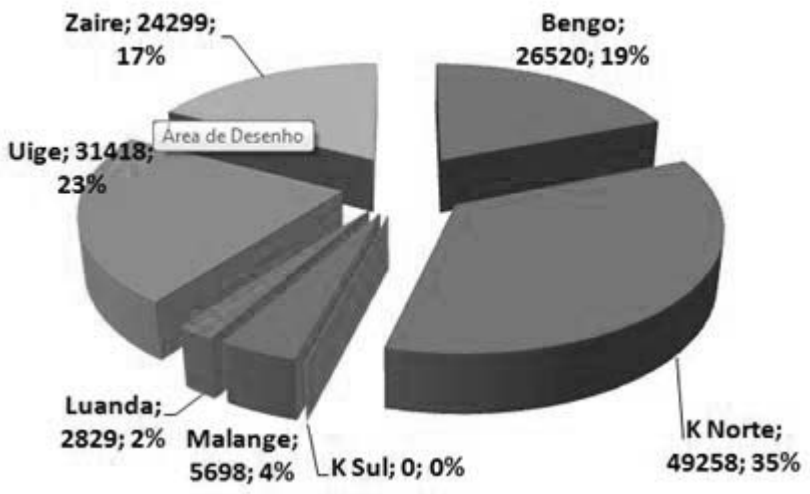
Rapporter les activités menées par le programme angolais inseré au sein de L' Instituto de Combate e Controlo das Tripanossomiases durant les deux dernières années 2011-2012.

## *Methodologie*

Le rapport que nous présentons est le fruit de données obtenues a partir des divers documents du travail du programme national, les cahiers de charge de nos centres specialisés en diagnostic passif et la prise en charge des malades du sommeil, les fiches du travail des tournées des nos équipes mobiles versées dans le depistage actif et la lutte antivectorielle dans les provinces endemiques et aussi des analyses effectuées par notre personnel experimenté, et par

l´OMS, PATTEC sans oublier les autres partenaires scientifiques durant les deux années 2011-2012.

Pendant les années 2011 et 2012, nos centres spécialisés en diagnostic passif, traitement et suivi des malades ainsi que nos équipes mobiles ont examiné et obtenu les résultats suivants :




En 2011:

La population totale prospectée était de 127.949 personnes dont 35.893 en passif et 91.966 en actif.

Cent cinquante et quatre (154) nouveaux cas avaient été détectés dont 117 en passif et 37 en actif. Aucun cas de décès était enregistré.

Sur les 127.949 personnes prospectées, 35% en avaient été dans la province de Kwanza Norte avec 29% de nouveaux cas de tous les malades de l' année 2011.

Dans la province de Uige, 23% de la population y avait été prospectée avec 15% de malades diagnostiqués.

La Province de Kwanza Sul était le maillon faible dans la prospection.




*Equipe mobile de diagnostic á Mbanza Kongo*

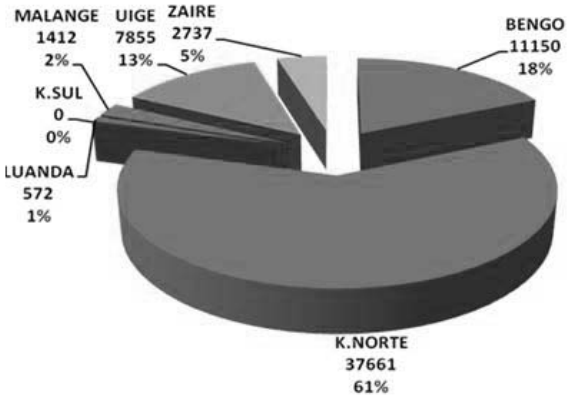


*Concentration des équipes mobiles de LAV et de diagnostic á Mbanza Kongo*

Les équipes de la lutte anti vectorielle ont placé 11.898 pièges monoconiques de Lancien-Goutteux ayant capturé 2.363.122 glossines.

*En 2012:*

La population totale examinée était de 61.387 personnes dont 47.447 en passif et 13.940 en actif. Soixante-neuf (69) nouveaux cas avaient été détectés dont 65 en passif et 4 en actif. Aucun cas de décès était enregistré.




Concernant la lutte anti vectorielle, nous avons utilisé les pièges Lancien-Goutteux, des appareils pulvérisateurs et fumigateurs. 13.618 pièges mono coniques de Lancien-Goutteux étaient placés ayant capturé 2.963.320 glossines.



*Piegeage et fumigation á Mbanza Kongo*

Dans les activités de LAV et de la trypanosomose animale nous sommes secondé par l' Institut des services vétérinaires (ISV) et l'Institut de Investigation vétérinaire (IIV) du ministère de l' Agriculture, du Développemenet Rural .

**Discussion**

Selon les analyses réalisées, il a été observé une baisse de fréquence de la population dans les activités des équipes mobiles réalisées durant l'année 2011, soit une réduction de 50% en rapport a l'année précédente, aussi il est toutefois important de savoir que la population qui se présente volontairement aux activités des EM est majoritairement constituée d'enfants et des viellards qui restent au village, ayant peu de contact avec les glossines. L´absenteisme de la population est d a la mauvaise interpretation du concept democratie qui ne pas synonyme de la négligeance.

Nous signalons que les malades ont été détectés avec une dispersion par rapport aux localités de leurs origines.

D' une manière génèrale le depistage passif est resté stable dans toute les provinces. La province de Kwanza Norte avec la stratégie de dépister systématiquement au CATT tous les patients qui consultent les unités sanitaires locales, ont pu consulter une moyene de 45.4% de la population totale examinée durant les deux années.

Il a été observé aussi une diminution de la capacité globale de confirmation de seropositifs a la parasitologie. Le Centre de Référénce de Viana CRIV-DT a été plus efficace avec 69,2% de CATT+ confirmé en T+, suivi de Bengo avec 27 % ; les provinces de Kwanza sul et Malange ont été moins éfficaces.

**Conclusion**

Le nombre de Nouveaux Cas (NC) parrait être propotionnel à la population prospectée. La couverture est faible , elle est inferieure à 5%, le taux de confirmation ne nous est pas satisfaisant.

Nous projetons réorganiser les activités pour atteindre tune bonne partie de la population dans les villages et renforcer les capacités des techniciens.

**Perspectives.**

Effectuer des depistages systématiques, appuyés par la LAV. La priorité des interventions de depistages auront un caractère prioritaire ciblées.

Les enquetes epidemiologiques et entomologiques sont visées être d´une grande importance pour nous aider á cibler les zones d´interventions.

Le programme attend élargir les activités dans le cadre de recherche sur les autres parasitoses tropicales au sein de son centre de référence de Viana.

**Remerciements.**

Nos remerciements s´adressent particulièrement à notre l´Exécutif Angolais pour son important appui au programme, sans oublier les partenaires nationaux et internationaux.

Nos remerciements s´adressent également a tous les travailleurs de l´ICCT pour leur engagement et dévouements au travail.

# REGIONAL PLATFORM FOR CAPACITY BUILDING FOR CLINICAL TRIALS ON SLEEPING SICKNESS, SEVEN YEARS OF CONTRIBUTION AND INNOVATIVE ACHIEVEMENTS

# PLATEFORME REGIONALE DE RENFORCEMENT DE CAPACITE POUR LES ESSAIS CLINIQUES DANS LA MALADIE DU SOMMEIL, SEPT ANNEES DE CONTRIBUTION ET REALISATIONS INNOVANTES.

*Augustin Kadima Ebeja ; Wilfried Mutombo ; Victor Kande BetuKumeso ; Josenando Théophile ; Stéphane Ngampo ; Charles Wamboga ; Intisar Elrayah ; Olaf ValverdeMordt.*

## Summary

Brazzaville, Republic Congo, Central African Republic, Chad, Uganda, South Sudan and Sudan). Officials of control programs, and partners involved in the clinical research against the Sleeping Sickness, recognized the need for new and simplified diagnostic tools and treatment. The recent resolution EB132.R7 approved in the 66th general assembly meeting of the WHO strengthens the commitment of eliminating neglected diseases such HAT, including clinical research in endemic countries. We must strengthen the ethical review of protocols and standards for regulatory review, adapt infrastructure and get qualified human resources from affected countries to ensure national ownership of the research. Five hundred and fifty (550) people (doctors, nurses, laboratory technicians, clinical fellows, pharmacists) participated in the training. The contents of the training were: Good clinical and laboratory practices, methodology of clinical trials, the clinical management of patients, clinical monitoring, organization and functions of ethics committees and pharmacovigilance. The establishment of a functional network (communication and exchanges tools), but also the results of studies such as NECT or the development of new methods of diagnostic with visible impact that are subsequently used in the countries involved, these are the objectives of the Platform.

## Résumé

Crée en 2006 pour favoriser la réalisation des essais cliniques et une dynamique de coordination régionale entre les pays affectés par la Trypanosomiase Humaine Africaine, afin de contribuer à la résolutionde ce problème commun; la Plateforme regroupe ce jour huit pays (Angola, Congo Brazzaville, République Démocratique du Congo; République Centrafricaine, Tchad, Ouganda, Sud Soudan et Soudan).

Des responsables des Programmes de lutte, et les partenaires impliqués dans la

recherche cliniquecontre la Maladie du Sommeil, ont constaté un besoin de nouveaux outils simplifiés pour le diagnosticet traitement.

La récente résolution EB132.R7 approuvé dans la 66eme Assembléegénérale de l'OMS renforce l'avance vers l'élimination des maladies négligéescomme la THA, en incluant des recherches cliniques dans les pays endémiques. Il faut renforcer les standards d'examen éthique des protocoles et de revue réglementaire, adapter les infrastructures et obtenir des ressources humaines qualifiées issus des pays affectés pour garantir une appropriation nationale de la recherche.

550 personnes ont participé aux formations (médecins, infirmiers, laborantins, moniteurs cliniques, pharmaciens).

Les contenus des formations ont été: Bonnes Pratiques Cliniques et de Laboratoire ; La méthodologie des essais cliniques, la prise en charge clinique des malades, le Monitorage clinique, organisation et fonctions des Comités d'éthique et Pharmacovigilance.

La mise en place d'un réseau fonctionnel (outils de communications et échanges), mais surtout des résultats des études comme le NECT ou le développement denouvelles méthodes diagnostiques à impacte visible qui sont par la suite utilisés dans les pays, ce sont les cibles de la Plateforme.

Les responsables des Programmes de lutte contre la Maladie du sommeil, avec leurs partenaires impliqués dans la recherche clinique, ont constaté un manque criant des outils de diagnostic ainsi que de nouveaux traitements.

Alors que les Objectifs du Millénaire exigent entre autre l'élimination des endémies comme la THA, d'où la grande nécessité de réaliser les recherches cliniques dans ces pays. Certains obstacles d'ordre réglementaires, des infrastructures et de ressources humaines qualifiées ont été constatés dans les endroits reculés où doivent être diagnostiqués et traités les malades.

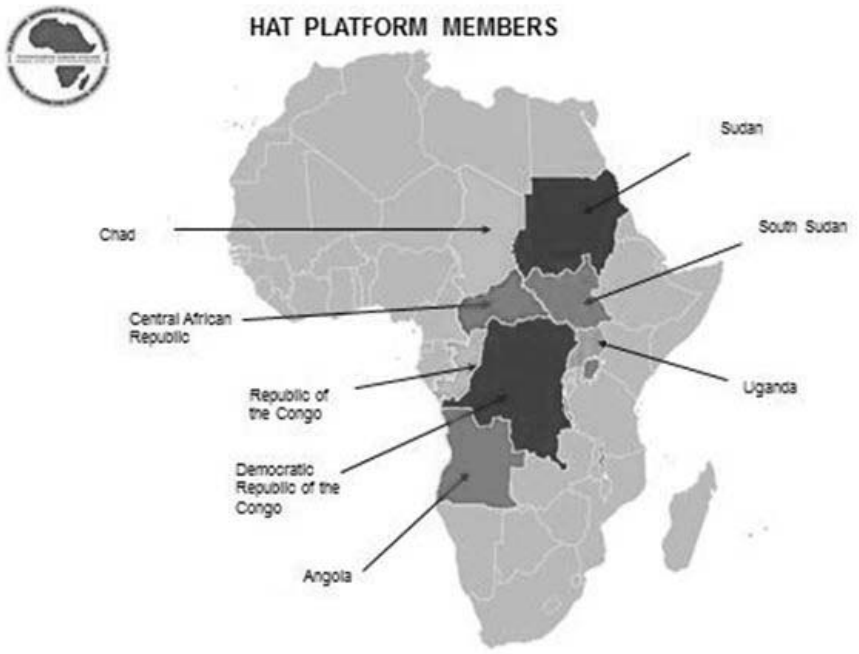
Crée en 2005 pour favoriser les conditions standards de réalisation des essais cliniques et l'obtention d'une dynamique régionale entre les pays affectés par la THA, afin de vite atteindre les objectifs et résoudre ce problème commun ; la Plateforme regroupe ce jour huit pays (Angola, Congo Brazzaville, République Démocratique du Congo ; République Centrafricaine, Tchad, Ouganda, Sud Soudan et Soudan).

Le bilan de ces sept années est probant quant au nombre de personnes formées (Médecins, Infirmiers, Laborantins, Moniteurs cliniques) soit un total de 550 ; La mise en place d'un réseau fonctionnel (outils de communications et des échanges), mais surtout des résultats concluants des études et à impacte visible qui sont immédiatement utilisés dans les pays.

## RAPPEL HISTORIQUE SUR LA PLATEFORME THA.

En date du 20 Septembre 2005, sous le haut patronage de son Excellence Monsieur le Ministre de la Santé de la République Démocratique du Congo, il s'est tenu à Kinshasa, une conférence scientifique sur les essais cliniques dans le domaine de la maladie du sommeil.

Le Programme National de Lutte contre la Trypanosomiase Humaine Africaine (PNLTHA) RDC avec ses partenaires (liste non exhaustive) : PNLTHA ANGOLA ; PNLTHA CONGO BRAZZAVILLE ; TMRI SOUDAN ; COCTU OUGANDA ; DNDI SUISSE ; SWISS TROPICAL INSTITUT (actuellement Swiss TPH) ; MSF ; FIND ; OMS ; IMT.A…ont créé la PLATEFORME REGIONALE DE RECHERCHES CLINIQUE EN THA



L'état des lieux fait à cette occasion a relevé deux faits majeurs qui entravent le contrôle /élimination de la maladie du sommeil :

- Le manque de nouveaux outils diagnostics, rendant le diagnostic de la THA lourd et parfois complexe ;
- Le choix thérapeutique très limité : seulement trois molécules pour traiter la THA et parmi elles un dérivé arsenical très toxique pour les malades (encephalopathie chez environ 20% des malades soumis à ce produit)

La résolution de ces problèmes passe par la recherche clinique dont les constats suivants sont faits :

- L'environnement éthique et réglementaire est soit inexistant soit accusant un retard
- Le domaine de la THA ne présente pas d'intérêt pour les firmes pharmaceutiques par défaut de perspective de bénéfice
- L'inexistence dans les milieux où vivent les malades, d'infrastructure capable de mener des essais clinique
- Les ressources humaines avec expertise en recherche clinique sont plutôt rares
- Les essais cliniques ne se sont pas réalisés car ce domaine ne représente aucun marché pour les producteurs de médicaments, justifiant ainsi la classification de la maladie du sommeil parmi les maladies négligées.

Pour surmonter tous ces obstacles, un réseau composé des chercheurs, des chefs de programmes (chargés de la lutte dans les différents pays), et des Organisations Non Gouvernementales s'est mis en place avec comme mission de créer un pool de compétences régionales hautement qualifiées ; de faciliter la réalisation des essais cliniques pour soutenir le développement de nouveaux outils de lutte contre cette maladie (moyens de diagnostic et de traitement)

**Organisation et fonctionnement**

Le comité directeur est l'organe qui dirige la Plateforme, il est composé de : deux membres de chaque institution partenaire (DNDi, Swiss TPH, MSF, OMS, FIND) et de deux points focaux venant de chaque pays membre de la Plateforme THA. Ce comité se réunissait deux fois l'an pour évaluer les réalisations et planifier les activités à faire.

Dans chaque pays, nos points focaux issus des institutions de recherche et du programme national de lutte contre la THA (mise en œuvre) sont entourés de

plusieurs chercheurs dans le domaine de la maladie du sommeil (Médecins investigateurs, laborantins et infirmiers), ainsi que les autorités réglementaires (Membres des comités d'éthiques, la direction de la Pharmacie et Médicaments, la direction de laboratoire).

Du point de vue fonctionnement, l'exécutif est assuré par un coordinateur qui joue le rôle du secrétariat permanent : suivi des résolutions, appui technique et logistique aux équipes, rapportage et diffusion des informations scientifiques.

**Réalisations**

De 2006 à 2010, grâce au un financement de l'Union Européenne (FP6) de plus ou moins 305.203.

Euros, reçu à travers DNDi, , nous avons effectué les activités suivantes :

- formations des membres des comités d'éthique dans chaque pays membre (cfr tableau en annexe, pour le renforcement des capacités des ressources humaines,
- formations de base en bonnes pratiques cliniques et bonnes pratiques de laboratoire des Médecins, laborantins et infirmiers.

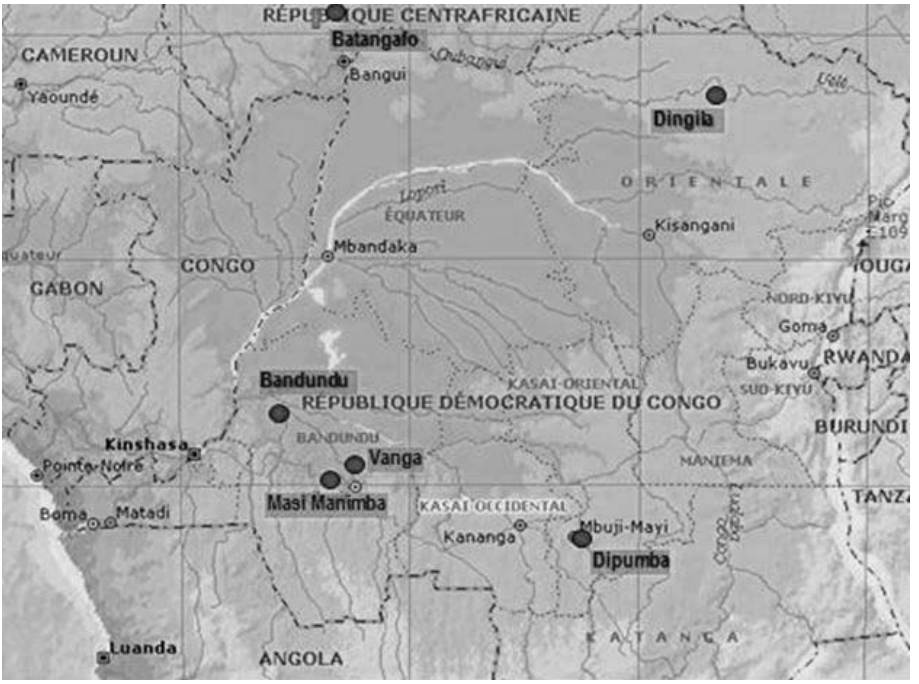
Dans la suite, DNDi a financé à hauteur de plus ou moins 250000 Euros chaque année

A travers la plateforme, des formations spécifiques et des réunions des investigateurs ont été organisées pour chaque protocole d'une étude menée.

Les formations étaient accompagnées d'autres activités telles que :

- Réhabilitations des infrastructures (Laboratoire et hospitalisation, latrines et incinérateurs),
- Approvisionnement en équipements (Microscopes, rotateurs, automates de laboratoire tels les PICCOLOS, les lits et matelas, les panneaux solaires…) et des fournitures.

En République Démocratique du Congo (RDC) , une dizaine des sites ont bénéficié de ces appuis des différents partenaires (DNDi, FIND, IMT.A ) notamment : Dipumba, Katanda, Tshibila et Ngandajika dans le Kasaï Oriental ; Bandundu ville, Masimanimba, Bangumi, Kwamouth, Vanga, Mosango et Bagata dans la province du Bandundu, Dingila et Isangi dans la province Orientale.




Au Congo Brazzaville, le centre de Nkaï.

En République Centre Africaine l'hôpital de Batangafo.



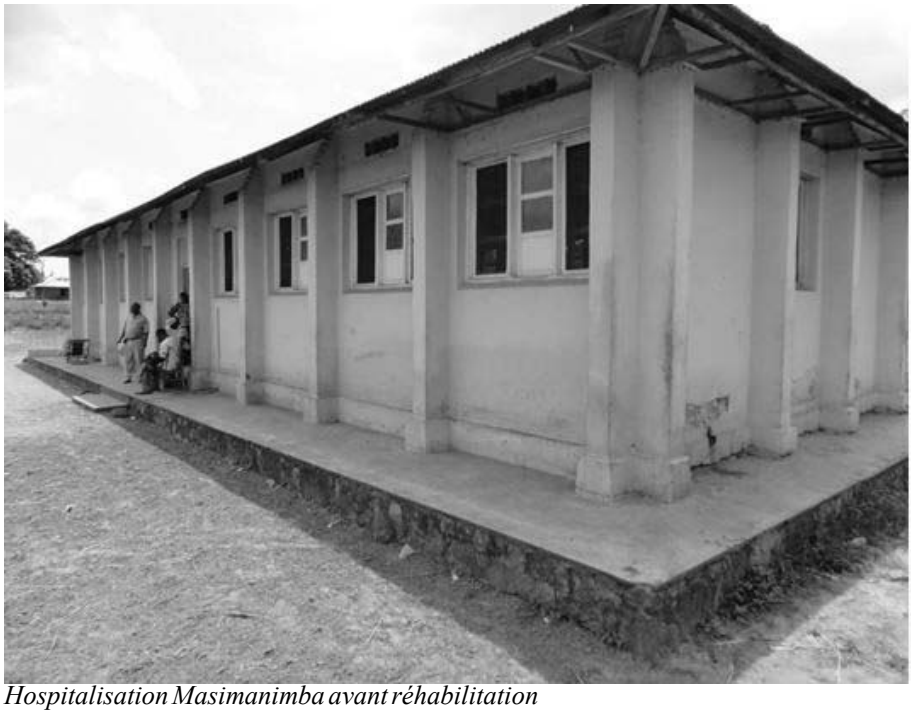
*Salle hospitalisation avant réhabilitation (Masimanimba)*



*Salle d'hospitalisation après réhabilitation et équipement (Masimanimba)*



*Laboratoire après réhabilitation et équipement*



*Hospitalisation Masimanimba avant réhabilitation*



*Hospitalisation Masimanimba après réhabilitation*

Trois grandes études ont été menées et publiées à savoir :

1. La combinaison Nifurtimox et Eflornithine connue sous le nom de NECT (phase II),
2. NECT-field (Phase IIb) par DNDi
3. L'étude RDT (Rapid Diagnostic Test) qui est un Test rapide pour le dépistage de la maladie du sommeil, Microscope à fluorescence (phase I) (FIND et Standard Diagnostic).

Plusieurs autres études ont été lancées et sont en cours notamment : LAMP, Féxinidazole, Nidiag, …. Notre plateforme a joué un rôle important dans la diffusion et les échanges d'informations scientifiques entre tous les pays membres de la plateforme THA et les scientifiques du monde entier dans ce domaine spécifique de la maladie du sommeil ainsi que des maladies tropicales négligées (MTN).

Nous avons publié et largement distribué chaque année deux bulletins d'information d'où un total de quatorze numéros sur sept ans (voir site DNDi : lien). Nous avons organisé des grandes réunions scientifiques de deux à trois jours toutes les deux années.

En plus, notre travail en réseau a permis que tous les pays membres puissent satisfaire aux exigences règlementaires pour changer la politique thérapeutique et être approvisionnés en cette combinaison pour usage au bénéfice des malades (passage de 56 perfusions à 14 pour le traitement d'un patient en comparaison du traitement à l'Eflornithine seul et celui au NECT).

**TABLEAU SYNTHESE DES FORMATIONS REALISEES DANS LA PLATEFORME**

**POUR LE RENFORCEMENT DES CAPACITES DANS LES ESSAIS CLINIQUES**

| **ACTIVITE** | **Lieu et date de réalisation** | **Nbre des personnes formées** |
|---|---|---|
| 1) Formation des membres des comités d'éthiques | Kinshasa (R.D.C); Mars 2007<br>Khartoum (Soudan); Juillet 2007<br>Kampala (Ouganda) ; Novembre 2007<br>Luanda (Angola) Mai 2008<br>Nairobi (Tous les pays Plateforme<br>THA) Mai 2009 | 15 Personnes<br>32 Personnes<br>30 Personnes<br>25 Personnes<br>8 Personnes |
| 2) Formations des médecins<br>Investigateurs | Kinshasa, Avril 2007<br>Mbujimayi Mars 2009 | 25 Médecins dont 3 du Congo<br>Brazza et 2 de l'Angola<br>RDC uniquement<br>19 infirmiers, médecins et laborantins |
| 3) Formation des moniteurs | Kampala, Mars 2008<br>Mbujimayi | 12 Personnes (2 Angola, 2<br>Soudan, 3 D.R.Congo, 2 Kenya,<br>2 Ouganda, 1 Congo Brazzaville)<br>8 moniteurs |

| ACTIVITE | Lieu et date de réalisation | Nbre des personnes formées |
|---|---|---|
| 4) Atelier sur la méthodologie des essais cliniques | Khartoum, Novembre 2007 | 30 Participants |
| 5) Atelier sur la<br>Pharmacovigilance et la Révisitation des stratégies de lutte contre la THA en RDC | Kinshasa, Juin 2010 | 58 Participants |
| 6) Formation GLP et GCP | Kampala, Novembre 2010<br>Kinshasa, Juin 2012 | ….Participants<br>7 Ougandais,…Sud Soudan,<br>…Soudan…Kenya 30 Participants |
| 7) Formation en<br>Pharmacovigilance | Kinshasa, Avril 2011 | 40 Participants (Angola 3 ;<br>Tchad 2 ; RCA 2 ; Congo Brazza 2, le reste RDC) |
| 8) Formation en Bonnes<br>Pratiques Cliniques | Kinshasa, Octobre 2011 | 23 Participants (2 RCA et le reste RDC)<br>4 infirmirs, 3 laborantins, 16 médecins |
| 9) Formations spécifique<br>personnel impliqué dans l'ètude Féxinidazole<br>GCP (nouveaux sites) | Kinshasa, Janvier 2012<br>Kinshasa, Août 2013 | 13 Médecins<br>12 Laborantins<br>20 Infirmiers<br>22 participants |
| 10) Réunion scientifique<br>(plusieurs sujets de recherches sur la THA) | Nairobi | 130 Participants |
| 11) Formation des Formateurs<br>GCP | Entebbe /OUGANDA | 4 Participants |
| 12) Plan stratégique (document<br>de politique nationale de lutte contre la THA) | Brazzaville /CONGO Mai 2013<br>Ndjamena /TCHAD Septembre 2013 | 30 Participants<br>35 Participants |

| ACTIVITE | Lieu et date de réalisation | Nbre des personnes formées |
|---|---|---|
| 13) Diplomes d'épidémiologie<br>(Bourse individuelle) | Bordeaux<br>Makerere | 1Participant<br>1 Participant |

**Conclusions et perspectives.**

De 2006 à fin 2013 soit huit années de fonctionnement, notre plateforme a fait du chemin et se positionne comme un des acteurs sur qui on peut compter comme contribution pour atteindre l'objectif de l'élimination de la maladie du sommeil.

A ce jour, une masse critique des compétences dans les essais clinique est disponible, ainsi que des infrastructures répondants aux normes standards internationaux pour les essais cliniques phase II et III.

Les résultats des recherches en cours vont changer radicalement le paradigme de la lutte contre la maladie du sommeil (Traitement oral pour les deux stades de la maladie, la non nécessité de faire la ponction lombaire, possibilité de traitement de masse, utilisation des bio-marqueurs de la guérison…), nous rêvons un monde sans maladie du sommeil.

La grande faiblesse est le manque de financement propre et le fait que les besoins réels ressentis par les acteurs de terrain sont de loin supérieurs aux ressources mises à la disposition par les différents partenaires.

Pour la pérennisation de ce réseau, nous invitons toutes les institutions intéressées par l'élimination de la maladie du sommeil (OMS, UA via le CSIRLT, …..) à mobiliser les ressources et à soutenir cette plateforme à l'instar de DNDi qui nous soutient depuis le début jusqu'à ce jour.

La plateforme reste ouverte et les autres pays comme la Guinée, le Cameroun, le Gabon peuvent y adhérer.

**Remerciements**

Nous remercions DNDi pour nous avoir fait confiance et nous avoir donné les moyens de réaliser ces activités. Tous les chefs de programme de lutte qui sont

nos points focaux dans leurs pays respectifs méritent notre reconnaissance. A L'OMS, FIND, MSF, IMT.A et tant d'autres partenaires qui nous accompagnent aussi bien par leur travail en laboratoire que celui sur terrain, nous leur témoignons notre gratitude.

**Les grands héros dans l'ombre restent nos unités mobiles, nos infirmiers et médecins qui sont engagés dans la lutte chaque jour dans les conditions très difficiles.**

# SOUTH SUDAN REPORT ON TSETSE AND TRYPANOSOMIASIS

# RAPPORT DU SUD SOUDAN SUR LA MOUCHE TSÉ-TSÉ ET LA TRYPANOSOMIASE

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## Résumé

La mouche tsé-tsé et la trypanosomose constituent un problème de santé de taille dans les États de l'Ouest et du Centre de l'Equatoria au Sud-Soudan. Glossina f. fuscipes est le seul vecteur de la trypanosomiase humaine africaine (THA) en raison de la présence de *T. brucei* dans les zones endémiques de Yei et Yambio, dans les régions de Tambura et Kajo-Keji. La résurgence actuelle de la THA à Yei et Kajo-Keji en raison de l'augmentation du taux d'infection du vecteur (10,5%) pourrait s'expliquer par l'incapacité des malades à accéder au centre de santé pour y recevoir le traitement des phases I et II au moyen de la NECT. Le dépistage actif à Yei en 2012 a révélé un nombre élevé de cas (14) dans le groupe d'âge de 16 à 45 ans, sur 38 personnes examinées. La population humaine à risque pour la THA dans les villes de Juba, Yei, Yambio, Lui et Nimulei était estimée à 1.344.898 en 2012 contre 1.305.726 en 2011.

La Nagana causée chez les bovins par T.congolense est encore problématique dans le Nord de l'État de Bahr El-Ghazal (NBGS), avec un taux de prévalence de 20%. Ceci peut être attribué à la résistance aux médicaments résultant principalement du sous-dosage du bromure d'éthidium. La sensibilisation et la mobilisation des communautés sont préconisées pour une campagne de contrôle. Le contrôle de la mouche tsé-tsé et de la trypanosomiase dans le Sud Soudan reste un défi en raison du manque de ressources. L'approche intégrée pour la lutte antivectorielle et le contrôle de la THA est prometteuse. Les partenaires au développement sont invités à solliciter des fonds pour atténuer le taux de prévalence de la Nagana dans le NBGS et de la THA dans les États de l'Ouest et du Centre de l'Equatoria.

**Mots-clés:** Mouche tsé-tsé, THA, Nagana, Bovin, Humain, Sud Soudan

## Sumarry

Tsetse and trypanosomiasis scourge constitute substantial health problem in Western and Central Equatoria States, South Sudan. Glossina f. fuscipes is the sole vector of human African trypanosomiasis (HAT) due to T.brucei in endemic areas of Yei , Yambio ,Tambura and Kajo-keji Counties .The current resurgence of HAT in Yei

and Kajo-keji due to increase infection rate of the vector(10.5%) might be due to inaccessibility to health facility for treatment in stage I and Stage II using NECT. Active screening in Yei in 2012 revealed high No of cases(14) in the age group from 16-45 out of 38 .Human population at risk due to HAT at Juba, Yei, Yambio, Lui and Nimulei towns estimated at 1,344,898 in 2012 as compared to 1,305,726 in 2011.

Nagana in cattle due to T.congolense is still problematic in Northern Bahr El-Ghazal State (NBGS) with a prevalence rate of 20%. This might be attributed to drug resistance resulting mainly from under-dosage of Ethidium bromide. Community sensitization and mobilization made as a clue for a control campaign. Control of tsetse and trypanosomiasis in South Sudan is still challengeable due to lack of resources. Integrated approach for vector and HAT control is promising. Development partners are urged to solicit fund for mitigating the prevalence rate of Nagana in NBGS and HAT in WES and CES.

**Keywords:** Tsetse, HAT, Nagana, Cattle, Human, South Sudan

## Introduction:

South Sudan is endowed with an estimated 35 million heads of livestock and human population of 8.2 million (Sudan Census ,2008).However, tsetse and trypanosomosis pose a threat to socio-economic development .Approximately , 38.5% of its territory(644,239 sq.km) of arable and agricultural potential land is tsetse-infested. Glossina m. submorsitans and G.f. fuscipes are among the seven species of tsetse incriminating livestock and humans. Gambian form of Human African trypanosomosis (HAT) or Sleeping sickness is one of the leading neglected tropical diseases in Western Equatoria State.HAT poses human health problems in the endemic foci of the three Equatoria States (figure 1),but the prevalence rate is relatively low compared to that of Democratic Republic of Congo(DRC),Central African Republic( CAR) and or Angola.

On the other hand, African animal trypanosomosis or Nagana constitutes a stumbling block to sustainable development of livestock. The impact of Nagana in cattle on the livelihoods of pastoralists and agro-pastoralists is enormous. 85% of the South Sudanese profess pastoralism and agro-pastoralism for cultural and socio-economic norms. Nilotic breeds and crossbred cattle are at risk of Nagana, particularly in Northern Bahr El-Ghazal State. Drug resistance to major trypanocides has challenged the prospects for animal health and production in the country. Although a couple of challenges faced on the ground, efforts have been made by the PATTEC South Sudan in collaboration with the National Sleeping Sickness Control Programme at the Ministry of Health(MOH) and Ministry of Animal Resources and Fisheries(MARF).This is intended to reduce and mitigate the prevalence rate of both HAT and AAT.

The purpose of this paper is to shed light on the situational analysis of tsetse and trypanosomosis (T&T) in South Sudan such that key stakeholders at the national, regional and international levels shall have opportunities to intervene. Such an intervention will eventually save human lives in the endemic areas and enhance livestock production all over the county.

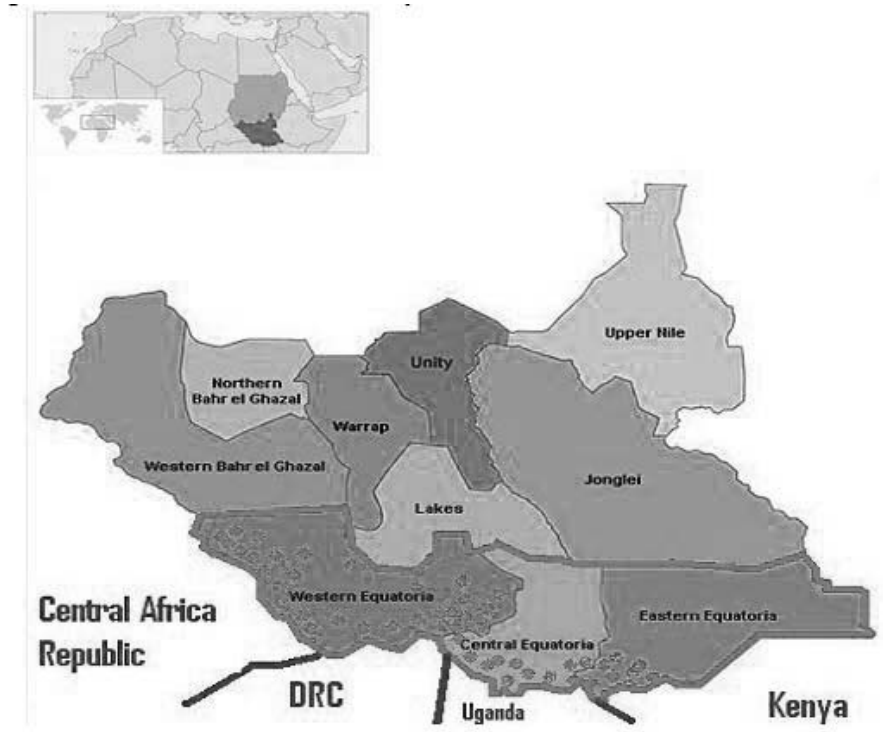



**Figure 1:** Map of South Sudan showing Endemic foci of Human African trypanosomosis in the three Equatoria States (Redden dots)

**Situation analysis:**

Human African trypanosomosis is confined in Central, Western and Eastern Equatoria States, South Sudan. Report showed that 327 of human cases were treated in 2012 compared to 52 cases in 2013. Moreover, Nifurtimox Eflornithine Combination Therapy (NECT) has been used for treatment of the second stage. Active screening carried out in Yei River County (CES) in 2012and 2013 revealed significant number of 14 cases (36.8%) out of 38 in the age group (16-45).This could explain such dynamic and energetic age in wood-fire collection, farming, fishing and water fetching as socio-economic related activities that contributed to flare up HAT. Table (2) shows the total number of individuals exposed to active and passive screening for human African trypanosomosis in Yei South Sudan, 20l2-2013 .Population at risk was recorded as 1.57 million in 2012 compared to 1.7 2 million in 2013. Yei

shows a high risk location with HAT compared to Lui with a low risk. Besides, seven hospitals including Juba ,Yei, Kajo-keji, (K.K) ,Yambio , Lui, Maridi and Nimule are assigned as treatment centers for HAT(table 1) .

**Table 1:** Population at risk of Human African trypanosomosis in the endemic States of South Sudan (2012 and 2013).

| **Location** | **State** | **2012** | **2013** |
|---|---|---|---|
| Juba | Central Equatoria(CE) | 395,093 | 406,946 |
| Yei | CE | 406,192 | 418,378 |
| KajoKeji | CE | 221,035 | 227,666 |
| Yambio | Western Equatoria(WE) | 267,628 | 275657 |
| Lui | WE | 84,762 | 87,307 |
| Maridi | WE | 92,811 | 95,595 |
| Nimule | Eastern Equatoria(EE) | 202,731 | 208,813 |
| **Total population at risk** | | **1,577,441** | **1,720,360** |

**Table 2:** Active and Passive Screening for human African trypanosomosis in Yei South Sudan, 2012-2013

| **Type of Screening** | **Number of individuals** |
|---|---|
| Active | 17,331 |
| Passive | 4,020 |
| **Total number of screened individuals** | **21,351** |

**Source:** *National Ministry of Health, Juba South Sudan*

AAT constitutes health problems in almost the ten states causing considerable economic impacts on the livelihoods of pastoralists and agro-pastoralists alike. This is exacerbated by the high incidence of drug resistance due to under-dosage of trypanocides including ethidium bromide. Thus, Nagana due to *T. congolense* poses a threat to cattle in Northern Bahr El-Ghazal State (NBGS) with a prevalence rate of 20%. Evidence shows that G.f.fuscipes is the sole tsetse vector for HAT in the endemic areas of Kajo-keji, Yambio and Tambura Counties. However, tsetse field survey and deployment of unbaited biconical traps showed that the average apparent density of the flies/trap / day had reduced to 1.1 and 3.0 during the dry season and the wet season, respectively.

**The outputs /Achievements:**

PATTEC coordination office in collaboration with the line Ministries plays a pivotal role in delivering services to vulnerable communities including the pastoral sector. This could be summarized as follows:

1. Preliminary notes and baseline data of the country profile on T&T established.
2. Cooperation and collaboration with AU/PATTEC and the partners through AU/PATTEC in information sharing.
3. Participating in HAT plat- form steering committee meeting held in Juba in September 2012.
4. Incorporation of T&T strategies , plans and actions into draft Policy Framework and Strategic Plans of the National Ministry of Animal Resources and Fisheries, (2012-2016).
5. Capacities on T&T control for target community leaders strengthened in the HAT endemic areas.

**Challenges and Constraints:**

1. Inadequate trained human resources at the level of the ten States of South Sudan.
2. Logistical impediments due to meager financial allocation for T&T control.
3. Limited livestock and human health facilities.
4. Inaccessibility to potential areas during the rainy season
5. Inadequate resources to operationalize regular tsetse field surveys to meet the minimum requirements for control campaigns.
6. Erratic surveillance, monitoring and evaluation system.

**Opportunities:**

1. Political will, peace and stability.
2. Technology transfers and innovations.
3. Experiences of Farming in Tsetse Controlled Areas (FITCA) programme for maximization of land use.
4. Development partners.
5. UN Agencies including FAO and WHO.

**Recommendations:**

1. Strengthening capacity of human resource in T&T control at the state level to mitigate a major challenge of unskilled staff.
2. Provision of logistical arrangements; vehicle to facilitate field activities,

control inputs and supplements.

3. Provision of livestock and human health facilities (wards, drugs storage, etc).
4. Maintenance of feeder roads to facilitate accessibility to some riverine tsetse potential areas during the rainy season.
5. Annual budgetary allocation of resources to operationalize regular tsetse field surveys and tsetse control.
6. Community dialogue, sensitization and mobilization of target communities in T&T control.
7. Coordination and harmonization in the T&T control with the neighbouring countries.

**Conclusion:**

HAT and AAT pose a threat to socioeconomic development .South Sudan is to strive for collaborative efforts to mitigate the impacts of AAT and HAT on the livelihoods of the poor rural people. Development partners and key stakeholders are urged to intervene for enhancement of healthy people, healthy livestock and food and nutrition security.

**Acknowledgements:**

We would like to acknowledge all of the AU/PATTEC, AU/IBAR, MARF, South Sudan, National Sleeping Sickness Control Programme, MOH-South Sudan, WHO, FIND, SMARF/SMOH, WE and CE Community opinion leaders and the Government of Sudan.

# COUNTRY REPORT: MAJOR TSETSE AND TRYPANOSOMIASIS CONTROL ACTIVITIES IN ZAMBIA FROM 2011 TO 2013

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## Summary

Tsetse flies affect about 60% of the country, with occurrence of both animal and human trypanosomiasis. Greater importance and attention is on the disease in livestock particularly in cattle – and the prevalence ranges from less than 1% to as high as 90%. The relatively lower attention given to human trypanosomiasis could be attributed to limited active surveillance and hence poor availability of information. The most affected areas are in the Eastern, Southern and Western provinces. Since 2011, the major activities were/are (1) Baseline surveys/surveillance in some 7000 km2 in the Western province, (2) investigative surveys/surveillance in parts of Lusaka, Southern and Western provinces (survey area ~10,000 km2), and (3) Tsetse control operations with application of odour-baited Targets: (i) two artificial tsetse barriers, one on border with Angola and Namibia (600 km2) the other on border with Malawi (300 km2); (ii) 500 km2 area in the Western province, and (iii) a privately funded operation (by a tour operator) in the Eastern province (area ~400 km2). Under the PATTEC facilitated Kwando-Zambezi Regional Project, an aerial spraying operation was funded and scheduled for 2013 (area~6000 km2), but the activity had to be rescheduled to 2014 due to challenges with tender process. The focus of future plans is based largely on the PATTEC oriented concept note and draft project proposal for tsetse eradication in the Luangwa-Zambezi tsetse belt that extends into Malawi, Mozambique and Zimbabwe. The major constraint remains inadequate and inconsistent funding in relation to the strategy and plans in place.

Tsetse flies affect about 60% of the country, with occurrence of both animal and human trypanosomiasis. The disease in livestock, particularly in cattle, is of relatively greater importance. The relatively lower attention given to human trypanosomiasis could be attributed to limited active surveillance and hence poor availability of information. The most affected areas are in the Eastern, Southern and Western provinces. The major T&T control activities since 2011 have been, (1) Baseline surveys and surveillance in some 7000 km2 in the Western province, (2) investigative surveys/surveillance in parts of Lusaka, Muchinga, Southern and Western provinces (survey area ~10,000 km2), and (3) Tsetse control operations with application of odour-baited Targets in form of (i) two artificial tsetse barriers, one on border with Angola and Namibia, the other on border with Malawi; (ii) a 400 km2 area in the Western province, and (iii) a privately funded operation (by a Wildlife Safari Company) in the Eastern province (area ~400 km2). Depending on location, these may be categorised as being within or outside the

PATTEC facilitated Kwando-Zambezi Tsetse Eradication Regional Project. In terms of current plans, an aerial spraying operation was funded and scheduled for 2013 (area~6,000 km2), but the activity was rescheduled to 2014 due to challenges with tender process. Future plans focus largely on the 2007 PATTEC oriented concept note and draft project proposal for tsetse eradication in the Luangwa-Zambezi tsetse belt that extends into Malawi, Mozambique and Zimbabwe. Among the major constraints is inadequate and inconsistent funding in relation to the strategy and plans in place, and lack of a clear process to practically domesticate the PATTEC agenda.

**Introdution**

Tsetse flies affect about 60% of the country, with occurrence of both animal and human trypanosomiasis. The disease in livestock, particularly in cattle, is of relatively greater importance. The relatively lower attention given to human trypanosomiasis could be attributed to limited active surveillance and hence poor availability of information. The most affected areas are in the Eastern, Southern and Western provinces.

During the period 2011 to 2013, the major activities in Zambia aimed at combating tsetse and trypanosomiasis could be categorised as follows;

1. Baseline Tsetse and Trypanosomiasis Surveys and Surveillance,
2. Investigative Tsetse and Trypanosomiasis surveys,
3. Tsetse control operations with application of Odour-baited Targets (OBTs).
4. Environmental Impact Assessment (EIA) relative to the 2009 SAT operation

Baseline surveys and surveillance were implemented in the area under the Kwando-Zambezi Regional Tsetse Eradication Project in the Western Province (survey area ~ 7000 km2), in line with plans for aerial spraying operations in the respective area. Investigative surveys on the other hand were executed in parts of Lusaka, Muchinga, Southern and Western provinces of the country, largely based on reports that suggested an increase in the prevalence and/or unexpected levels of occurrence of trypanosomiasis in particular areas.

Tsetse control operations with OBTs were implemented in form of two artificial tsetse barriers, one in the area that borders Angola and Namibia (2010-2012), and the other in an area that borders Malawi's Vwaza Game Reserve in the north-east of the country. A third operation was initiated in January 2013, in some 400km2 that falls within the proposed 2014 spray block.

With regard to EIA, assignments undertaken in 2011 constituted the final phase of the respective work associated with the SAT operation of 2009.

Under the African Union Pan-African Tsetse and Trypanosomiasis Eradication Campaign (AU-PATTEC) facilitated Kwando-Zambezi Regional Project, the 2013 budget provided for an aerial spraying operation (area~6500 km2) but challenges with the tender processes led to rescheduling of the activity to 2014. In terms of plans under the PATTEC agenda, a concept note and draft project document are in place for a tsetse eradication project in the Luangwa-Zambezi tsetse belt that extends into parts of Malawi, Mozambique and Zimbabwe. The major challenges remain inadequate and inconsistent availability of funding in relation to adopted policy, strategy and plans in relation to the Tsetse control and eradication agenda.

**Tsetse and Trypanosomiasis Policy and Strategy**

Since the colonial era, Zambia has invested substantially in the control of tsetse and trypanosomiasis (T&T). In this regard, the country has tried out and implemented almost all kinds of approaches or methods aimed at preventing/ control of the disease – which has included vegetation clearing and game elimination of the 1950s through to 1970s, intensive and extensive use of trypanocides in the late 1970s to early 1980s, and application of high tech based aerial spraying in recent times. The country had learnt so much in that regard such that it did not take long for the country to realise the clear advantages offered by the approach advocated through the AU-PATTEC.

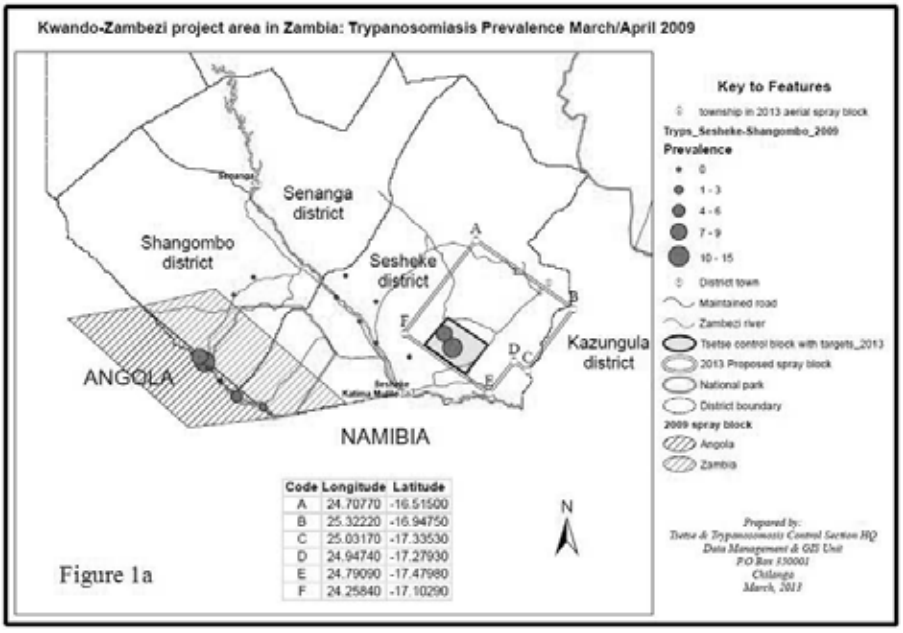
By about 2003, Zambia had formally started realigning its policy and strategy on Tsetse and Trypanosomiasis control towards the PATTEC approach. This process was greatly enhanced by the facilitation provided by the PATTEC Coordination Office in the eventual establishment of the Kwando-Zambezi Regional Tsetse Eradication Project involving Angola, Botswana, Namibia and Zambia. As at 2013, it may be stated that the country's policy, and hence strategy, with regard to control of tsetse and trypanosomiasis, is generally well in line with the approach as advocated through the AU-PATTEC's Vision, Strategy and Plan of Action.

**Major Activities**

*Baseline Tsetse and Trypanosomiasis Surveys and Surveillance*

The baseline surveys/surveillance work was associated with plans (as at 2010) for aerial spraying operations under Kwando-Zambezi Regional tsetse Eradication Project (Figure 1a).

In 2010, it was planned to undertake aerial spraying operations in the based on pre-determined spray blocks so as to systematically cover the respective tsetse belt one block after another – with the first block having been dealt with in 2009. For this reason, baseline Tsetse and Trypanosomiasis Surveys and Surveillance were a necessity in the section of the belt that was yet to be subjected to the planned tsetse control operations. The results are as given in Figure 2, and indicate that no case of trypanosomiasis was detected in blocks 2 and 3 of the respective area, with such cases only detected in block 3. The findings (Figure 1) suggest that it may be a worst of resources (considering the cost of such operations) to go ahead and subject subsequent spray blocks eastwards to aerial spraying operations - and consequently it was decided to take the block labelled ABCDE (Figure 1) as the most appropriate area under the circumstances – i.e. with regard to the subsequent aerial spraying operation.




*Investigative Tsetse and Trypanosomiasis Surveys*

These were largely based on particular reports from field personnel, farmers, etc. on suspected presence of tsetse flies and/or cases of AAT under circumstances that necessitate a follow up on the same. The assignments focussed on Sample/data collection to detect and quantify tsetse presence/ apparent density and, trypanosomiasis prevalence, and also to deduce the nature of factors that may be associated with occurrence of trypanosomiasis in respective locations. Findings through such surveys assist to guide decision making.

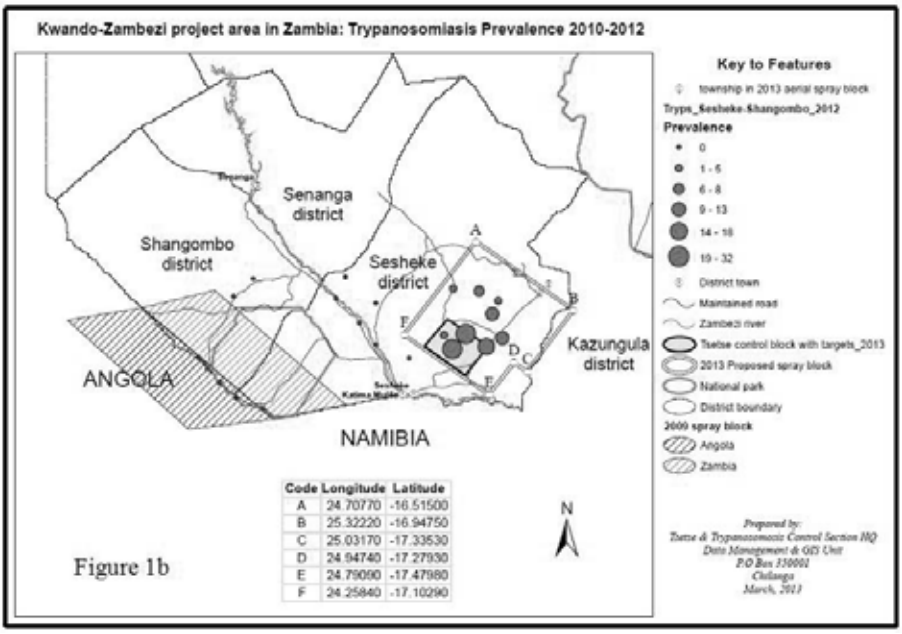



**Figure 1:** Tsetse Control Operations and Trypansomiasis Prevalence in area under the Kwando-Zambezi Project in Zambia, 2009-2012

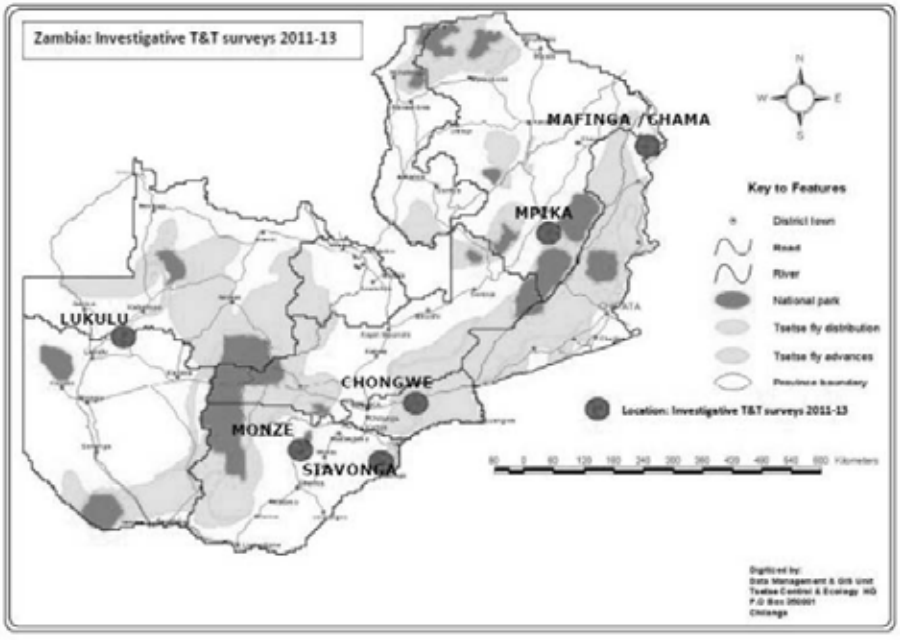



***Figure 2:*** *Location of Areas subjected to Investigative T&T Surveys, 2011-13*

Major surveys of the kind have been undertaken in the following locations (figure 2);

1. Lukulu district - Western province (Basis, AAT)
2. Sesheke district – Western Province (Basis, AAT)
3. Chongwe district – Lusaka Province (Basis, AAT)
4. Monze district – Southern Province (Basis, AAT)
5. Siavonga district - Southern Province (Basis, HAT)
6. Mpika district – Muchinga Province (Basis, AAT/HAT)

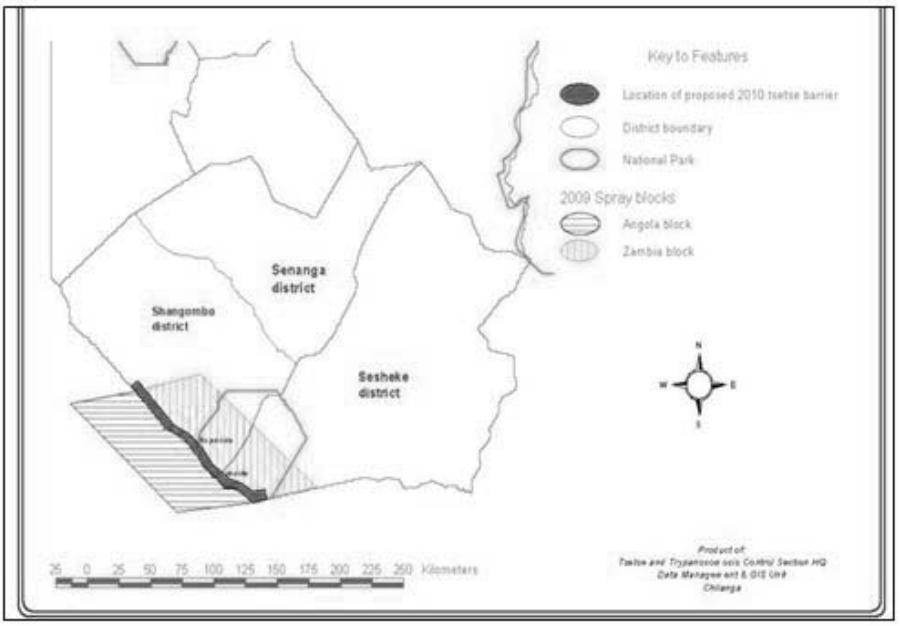



***Figure3:*** *Location of Tsetse barrier on border with Angola and Namibia (2010-2012)*

*Tsetse Barrier in Mafinga-Chama districts in North-eastern Zambia*

The tsetse barrier (with OBTs) was established in 2007, located in with the objective of diminishing the risk of exposure to infection with HAT in the human population living close border with Malawi's Vwaza Game Reserve. The decision was undertaken on an instruction from parliament to the ministry, based on persistent reports of concern raised by the community in the area, particularly through the area councillor and eventually through the member of Parliament for the area, that (over the years) suspected cases of HAT (from the respective area in Zambia) had been referred to a health institution in Malawi and that the trend had continued – and hence that call for an intervention. The barrier (~250km2) has remained in place since its establishment, and is

subjected to maintenance work every 6-8 months on average. Trypanosomiais prevalence/Incidence in a sentinel herd of 20 goats located within the barrier area, together with routine sampling for tsetse flies (Traps and Black-screen Fly rounds) are used to indirectly assess the performance of the barrier – and the results to date (including baseline) suggest that the barrier may have served the purpose well within expectation under the prevailing circumstances.

*Tsetse control with Odour-baited Targets in Sesheke in Western Zambia*

Among the sites that recorded prevalence of trypanosomiasis, through baseline survey/surveillance, in the area earmarked for aerial spraying operations under

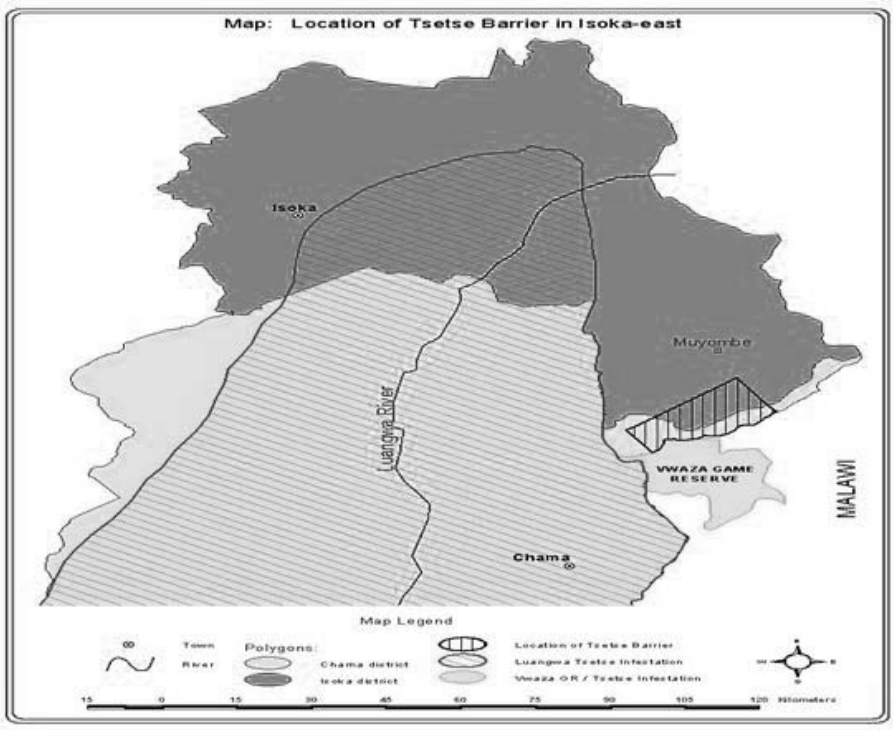



***Figure 4:*** Location of tsetse barrier (with OBTs) in North-east Zambia

the Kwando-Zambezi project (Figure 1), the community in one particular location had persistently submitted complaints and requests for support from government with regard to an intervention against the trypanosomiasis problem in the area, and by 2012 the community had become considerably aggressive in their approach to presenting their case. Even although the area was within that earmarked for an aerial spraying operation, the circumstances were such that it became a matter of urgency to have a short term measure put in place in the area. In this vein, a control operation with OBTs was put in place in January 2013, covering about 400km2 (Figure 2). Tsetse and

Trypanosomiasis surveillance work in the respective area did not detect any cases of trypanosmiasis in cattle, and there has been no catch of tsetse flies recorded since – and this could be taken to indicate that the barrier did perform accordingly.

*Tsetse control in a wildlife conservation area in Eastern Zambia*

In Mfuwe area in eastern Zambia, a Wildlife Safari Company funded a tsetse control operation with OBTs in an area covering some 400km2 that hosts several wildlife safari camps, with the objective of diminishing chances of occurrence of tsetse bites and hence risk of infection with HAT, among tourists visiting the respective wildlife safari camps. The company wholly funded the operation, and government personnel implemented the deployment of OBTs and their subsequent maintenance (once per year on average) – since 2010. Reports indicate that the Safari Company appears satisfied with the outcome (results) to date.

*Environmetal Impact Assessment (EIA)*

The activity was part of the 2009 aerial spraying operation under the Kwando-Zambezi project, with sample/data collection started in 2008 and continued until mid-2011. The activity was concluded at the end of 2011 and the final report has since been produced – with the key conclusion in the report being that the operation did not find evidence of any significant negative impact or disruption to the biological systems in the area, particularly with regard to the long-term.

*Other Activities*

In the existing organisation/management setup under the 'Kwando-Zambezi Regional Tsetse Eradication Project', Zambia takes responsibility for the overall coordination of the project – through the position of Regional Project Coordinator. In this regard, the Regional Project Coordinator made several visits to the Project's Offices in Katima Mulilo (Namibia) between 2011 and 2013, for respective project coordination assignments.

**Major Challenges**

With regard to Zambia's quest to implement plans based on the vision and approach to combating the trypanosomiasis problem, as adopted under the PATTEC, the country no doubt faces many challenges. The major challenges in this regard are as follows;

a. Inadequate and inconsistent funding.

b. Excessive bureaucracy with regard to procedures such as tender processes – with huge negative consequences with regard to implementation of work plans.

c. Poor levels of awareness relative to the problem of tsetse and trypanosomiasis among key decision makers.

d. Lack of clarity on practical steps to practically domesticate the PATTEC agenda and implement activities in the context of the PATTEC Plan of Action.

e. The Kwando-Zambezi Project is in practice NOT implemented based on the concept of 'a Project', and this has naturally made it very difficult for the existing 'Project implementation arrangements' to yield the desired outcomes.

**Way Forward: Plans for the Period 2014-15**

a. Under the African Union Pan-African Tsetse and Trypanosomiasis Eradication Campaign (AU-PATTEC) facilitated Kwando-Zambezi Regional Tsetse Eradication Project, the 2013 government budget provided USD2.5m towards an aerial spraying operation – and it was envisaged that the funds would facilitate SAT operation in a 6,000 km2 spray block. However, challenges with the tender processes led to rescheduling of the activity to 2014 – based on indications as at July 2013 that the tender process was likely to be concluded before the end of 2013 – and this could facilitate implementation of such an operation starting May 2014.

b. In the event that the government's budget in 2014 provides a similar allocation (funding) to the project in 2014 (i.e. as in 2013), it could allow for coverage of a much larger area in the aerial spraying operation scheduled for 2014 – and this could greatly assist to have the project progress quicker towards completion.

c. With regard to plans under the PATTEC agenda, a concept note and draft project document were in place for a tsetse eradication project in the Luangwa-Zambezi tsetse belt that extends into parts of Malawi, Mozambique and Zimbabwe.

d. The outcome of the recent meeting among the African Union, the Arab Bank for Economic Development in Africa (BADEA) and Ministers from countries affected by the tsetse and trypanosomiasis problem, offers a glimmer of hope as a prospect for external financial support towards implementation of the country's plans in line with the PATTEC strategy and Plan of Action.

e. Under the circumstances (with due reference to the major challenges indicated) it is vital that those that are directly charged with the responsibility to spearhead the fight against the trypanosomiasis problem

in the country, particularly under the respective ministries and departments, should endeavour to effectively;

1. Undertake awareness creation/advocacy aimed at resource mobilisation from both within and outside the country, particularly among key policy and decision makers, and other stakeholders, to facilitate implementation of Tsetse and Trypanosomiasis control/ eradication programmes and activities.
2. Utilise available resources (financial, material etc.) in such a way that programmes and activities implemented add as much value as possible towards realisation of the (ultimate) long-term vision/goal as spearheaded under the AU-PATTEC.

# GHANA COUNTRY REPORT
# TSETSE CONTROL PROGRAMME

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*GHANA*

**Summary**

The Pan African Tsetse and Trypanosomiasis Eradication Campaign(PATTEC) is being executed in Ghana within the context of sustainable agricultural and rural development. The Government of Ghana supports PATTEC through the Tsetse Control Programme which seeks to control and/or eradicate tsetse in priority areas. The Programme is supported by regular Government budget as well as with Loans and Grants obtained from development partners. This report is a summary account of activities carried out with the support of key development partners within the framework of PATTEC.

The goal of the Tsetse Control Programme of Ghana is to promote Sustainable Agricultural and Rural Development(SARD) through the progressive reduction of tsetse-transmitted trypanosomiasis. The Programme complements the New Medium Term Agricultural Sector Investment Plan (METASIP: 2009-2015) which seeks to improve livestock production through various strategies and interventions including disease control.

This report is a succinct account of T&T activities undertaken with funding and technical support from Government and development partners, notably the African Development Bank, the Food and Agricultural Organisation(FAO) of the United Nations and the International Fund for Agricultural Development(IFAD) of the United Nations.

## Integrated Tsetse and Trypanosomiasis Interventions

It is estimated that over 70% of Ghana is infested with various species of tsetse flies belonging to the Palpalis, Morsitans and Fusca groups. A review by Mahama et al; 2003 discusses tsetse distribution according to the different agro-ecological zones and the prevalence of bovine trypanosomiasis across the country.

The diffuse nature of tsetse infestation makes it imperative that control interventions are undertaken in a manner which takes into consideration not only the presence of tsetse but also on the agro-ecological setting of the areas concerned. Resource mobilization and utilization are currently focused on helping rural farmers improve their incomes through the use of cost-effective Tsetse and Trypanosomiasis (T&T) control technologies.

*Tsetse Control in the Upper West Region.*

During the period between 2008 and 2013 a combination of tsetse control methods were used in the Upper West Region of Ghana to suppress tsetse populations to levels that would promote viable livestock production. The operations were carried out under the "Multinational Project for the Creation of Sustainable Tsetse and Trypanosomiasis Free Areas in East and West Africa" funded by the African Development Bank. Adam et al: 2012 discuss pre-control surveys that preceded the operations associated with an integrated tsetse control operation in the Upper West Region. The use of the Sequential Aerosol Technique (SAT) as a major component forms the subject of a publication in press.

As a result of these interventions, tsetse fly population in the Upper West Region was reduced by 99.6% in an area of 8,900sqkm thus creating an enabling environment for viable livestock production and sustainable agricultural and rural development. The following impact parameters were estimated for the period 2006 to 2011

- Mortality in ruminant and pig production systems arising from trypanosomiasis decreased by 80% and is expected to reach 100% by 2015. Estimated income per square kilometer for beef production has increased from US$4,000 to US$ 12,000 .

- Production of major crops, especially cereals increased from 1,188,000 tonnes in 2006 when the intervention started to 1,872,000.00 by December, 2010. There was also a considerable increase in the number of livestock slaughtered for meat during the period. Cattle increased from 180,035 heads in 2008 to 231,779 in 2010 while slaughtered sheep rose from 60,468 to 67,359 in 2008 and 2010 respectively.

- Due to the near absence of the disease treatment costs estimated for the region has decreased from US$500,000.00 per annum to US$100,000.00 leading to savings that could be used to satisfy other needs.

- The opportunity for the introduction of artificial insemination for the production of improved breeds of livestock has been created by the clearing of tsetse flies. Government as a next step is going to establish a number of Artificial Insemination centres in the Upper West Region(the project region) to the objective of introducing improved livestock breeds.

- Fodder crop production was introduced by the project to improve animal nutrition and to mitigate any adverse effects that may be created by increased livestock numbers. There are now about 11 demonstration fodder crop farms that currently serve selected communities in the region.

- Knowledge on tsetse and trypanosomiasis control and/or management has increased from 2 communities before the project to about 621 communities by the end of project. This is important from the point of view of project sustainability.

- Due to increased incomes, the numbers of people from the project region that are now able care for child education has increased by about 30%.

- As a result of the decrease in nuisance bites of tsetse flies fishermen along the major rivers attest to an increase in the fish harvests because they are able to fish for longer periods

- The risk of sleeping sickness has been eliminated in the Upper West Region. Government can now re-direct the use of resources to investigate and manage other disease of public health importance.

*Supporting pig farmers in the Eastern Region.*

The project entitled "Development of innovative site-specific integrated animal health packages for the rural poor (GCP/RAF/444/IFA) is funded by IFAD and implemented by FAO in collaboration with three institutional partners: International Centre for Insect Physiology and Ecology (ICIPE, Kenya), Centre International de Recherche-Développement sur l'Elevage en zone Subhumide (CIRDES, Burkina Faso) and the Ghana component of the Panafrican Tsetse and Trypanosomosis Eradication Campaign (PATTEC-Ghana).

The project is implemented in the New Juaben District in the Eastern Region of Ghana, in small-scale intensive pig production farms. It was supposed to

be implemented in the northern part of Ghana to complement ongoing IFAD projects. But a different choice was made, motivated by the following reasons:

a. New Juaben District has a high tsetse challenge and at one time small-scale farmers lost all their pigs through trypanosomosis
b. the poverty level among the rural population is very high, with a very little land available for crop farming and grazing of livestock.(dense forest and marshy lands)
c. local populations have identified pig rearing as a rapid income generating venture which can help to alleviate their poverty.
d. Favorable climatic conditions for pig rearing.

Pigs are confined in pigsties, where they are fed and watered (zero-grazing). They are fed with different fresh farm products like pawpaw, cassava leaves and tubers, and agricultural by-products e.g. coco paste, wheat bran, plantain peels and corn chaff.

Pigs are raised just as a source of cash income and not for domestic consumption. The price is around 70 USD for an animal of 25-30 kg weight.

The various outputs and associated work packages are discussed below:

**Output 1.** Holistic site-specific animal health package developed and evaluated in a participatory approach

**Work Package 1:** Two sites, Jumapo and Oyoko villages were selected for the intervention, on the basis of collected data on the socio-economic situation, but also the willingness of the farmers from those two villages. In the selected villages, 27 sties were netted; 10 sties, 5 from each village were randomly selected and monitored as intervention farms and five sties not netted are also monitored as controls.

**Work Package 2:** Through surveys, farmer's constraints were identified to be tsetse and trypanosomosis, lack of improved feed, and lack of financial support to feed and increase the size of pig farms. The previously used solution to avoid tsetse bites was the use of dirty engine oil as tsetse repellent which proved not effective

**Work Package 3:** The proposed solution to manage tsetse and trypanosomosis constraint was the use Livestock Protective Fence(LPF) to fence pig sties along with record keeping by farmers on pig parameters for assessment of the socio-economic impact of this solution. Pig farmers have been convinced of its usefulness; their only reservation is on the price of the net which is presently 2.2 USD per meter. Despite this complaint, nine persons have bought a total of 268 meters of the net.

**Work package 6:** Three-hundred pig farmers benefitting from 1000 pigs distributed by the Government of Ghana and 14 technical officers were sensitized to the use of the LPNF. These farmers will enroll in the use of the LPNF in 2013.

**Output 3.** Capacity of primary beneficiaries and NARES strengthened

**Work Package 5:**

- 42 farmers have been trained on the deployment and maintenance of LPNF
- Eight Technicians of the Ministry of Agriculture have been trained on extension methods for a wider dissemination of the Animal Health package
- An international workshop was carried out in February 2013, with 12 participants from Eritrea, Ghana, Nigeria and Sierra Leone. The participants visited the project sites, discussed with pig farmers and appreciated the project results; the topics delivered at the workshop embraced all the six work packages planned in the project. In this way, participants received the necessary information to be able to replicate this experience in their respective countries and regions.
- One MSc student benefitted from training through participation in implementation of the project activities

**Output 4.** Complementary with IFAD loan projects effective

Under the WP5 the training workshop was attended by two participants from Northern Ghana where there are two IFAD-funded projects. Their acquired knowledge will benefit the communities involved in the IFAD loan projects

**Output 5.** Animal health and production improved, stakeholders networked and empowered in policy decision making and technology skills

Farmers using the LPF have been linked with private agents selling the net to ease the access to the net

**Output 6.** Exchange and dissemination of information among stakeholders improved and sustained and involvement of private sector enhanced

**Work Package 6:** A manual for technical staff and a leaflet for farmers use are in process of production or finalization to support the extension of project activities in other regions and countries for the benefit of small-scale pig farmers in Forest areas of West Africa

**Conclusion**

The Government of Ghana continues to support the Tsetse Programme because of the high priority accorded to Sustainable Agricultural and Rural Development.

Although the African Development Bank support ended in 2011, Government continues to provide a regular budget for the implementation of core activities of the Programme.

Capacity building at all levels for the control of tsetse and trypanosomiasis is key for the realization of the programme goal. The massive infrastructural development being undertaken by Government provides more justification for the control of tsetse and trypanosomiasis.

Strategies for tsetse control will continue to take into account the agro-ecological and farming systems prevalent in the country. Resource mobilization and utilization will also take into consideration the priorities of Government and the decentralized system of development.

The overall approach to tsetse eradication will be a progressive suppression of tsetse populations using simple and appropriate technologies with emphasis on community participation.

The importance of sub-regional cooperation cannot be overemphasized bearing in mind the trans-boundary nature of tsetse infestation. This underscores the significance of the Pan African Tsetse and Trypanosomiasis Eradication Campaign(PATTEC).

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# COUNTRY REPORT FOR SENEGAL

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**Summary**

The Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes targets a total area of 7,350 km2, from which 1,375 km2 are infested by Glossina palpalis gambiensis, which still transmits trypanosomoses (AAT). This area is isolated from the main tsetse belt in the remaining of the country, which prompted the option of eradication of the vector and the disease. Activities conducted from 2011 to 2013 included vector control (suppression and eradication using SIT), monitoring of AAT incidence, environmental monitoring, a socio-economical study and the management and publication of the data collected.

The suppression phase included impregnated traps (~2000), insecticide treated cattle (~10,000 heads) and insecticide screen around pig pens (~300m). Regarding competitiveness studies and the initiation of the eradication phase, more than 300,000 sterile flies were ground or air released, coming as chilled irradiated pupae mainly from CIRDES and secondarily from Slovakia. An entomological monitoring system allows assessing the impact of control.

Sentinel herds located inside and outside the tsetse infested area are used to assess the impact of control on incidence of AAT. Beside, thousands of infected animals were treated using trypanocides. Environmental monitoring demonstrated a very low impact of the project. Finally, the socio-economical study proved a high cost-effectiveness of the project.

**Résumé**

La zone du Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes couvre une superficie totale de 7,350 km2 dont 1,375 km2 infestés par Glossina palpalis gambiensis, qui y transmet la trypanosomose (TAA). Elle est isolée par rapport aux autres zones infestées du pays, ce qui a motivé l'option d'y éliminer le vecteur et la maladie. Les activités menées entre 2011 et 2013 ont concerné la lutte antivectorielle (suppression et éradication par TIS), le suivi d'incidence parasitologique, le suivi environnemental, l'étude socioéconomique, la gestion et la valorisation des données collectées.

Pour la suppression, les pièges imprégnés (~2000), le traitement insecticide du bétail (~10,000 bovins traités) et les filets imprégnés (~300 m déployés dans des porcheries) ont été utilisés. Pour les études de compétitivité et l'initiation de l'éradication dans le premier bloc, près de 300,000 mouches issues des pupes mâles irradiées en provenance du CIRDES principalement et de Slovaquie secondairement, ont été lâchées au sol ou par air. Le système de suivi entomologique mis en place permet de suivre l'impact de la lutte.

Des troupeaux sentinelles situés en zone infestée et en zone indemne permettent de suivre l'impact de la lutte sur l'incidence des TAA. Parallèlement, un millier d'animaux malades ont été traités aux trypanocides. Le dispositif de suivi environnemental mis en place a permis de démontre un faible impact négatif du projet. L'étude socio-économique a montré une forte rentabilité.

The Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes targets a total area of 7,350 km2, from which 1,375 km2 are infested by Glossina palpalis gambiensis, which still transmits trypanosomoses (AAT). This area is isolated from the main tsetse belt in the remaining of the country, which prompted the option of eradication of the vector and the disease. Activities conducted from 2011 to 2013 included vector control (suppression and eradication using SIT), monitoring of AAT incidence, environmental monitoring, a socio-economical study and the management and publication of the data collected.

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Sentinel herds located inside and outside the tsetse infested area are used to assess the impact of control on incidence of AAT. Beside, thousands of infected animals were treated using trypanocides. Environmental monitoring demonstrated a very low impact of the project. Finally, the socio-economical study proved a high cost-effectiveness of the project.

# HUMAN AFRICAN TRYPANOSOMOSIS/TRYPANOSOMOSE HUMAINE AFRICAINE

# IDENTIFICATION OF TRYPANOSOMA BRUCEI RHODESIENSE IN WILD TSETSE FLIES NKHOTAKOTA WILD LIFE RESERVE IN MALAWI BY POLYMERASE CHAIN REACTION (PCR)

# IDENTIFICATION DE TRYPANOSOMA BRUCEI RHODESIENSE CHEZ LES ESPECES SAUVAGES DE MOUCHES TSE-TSE DANS LA RESERVE FAUNIQUE DE NKHOTAKOTA AU MALAWI PAR LA REACTION EN CHAINE DE LA POLYMERASE (PCR)

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**Résumé**

**Contexte :** Trypanosoma brucei rhodesiense est l'agent responsable de la trypanosomiase humaine africaine aiguë. L'identification de Trypanosoma brucei rhodesiense dans les populations de glossines est essentielle pour la compréhension de la dynamique de transmission, l'évaluation du risque de maladie chez l'homme et le suivi des tendances spatio-temporelles et de l'impact des interventions de lutte. La détection précise et la caractérisation des trypanosomes chez les vecteurs s'appuient fortement sur les techniques moléculaires (amplification en chaîne par polymérase - PCR). Pour la première fois au Malawi, la technique moléculaire a été utilisée pour identifier les trypanosomes infectieux chez les glossines dans la réserve faunique de Nkhotakota.

**Méthodologie / principales conclusions :** La TB-PCR a été utilisée pour identifier le gène associé à la résistance au sérum (SRA) de *T. brucei* rhodesiense chez les mouches tsé-tsé capturées dans la réserve faunique de

Nkhotakota au Malawi. 206 mouches tsé-tsé ont été capturées de manière aléatoire et disséquées, et chaque milieu d'intestin placé dans des tubes Eppendorf contenant du tampon PBS pour l'extraction d'ADN. Les amorces de *T. brucei* ont d'abord été utilisées pour isoler le groupe *Trypanozoon*. Les échantillons positifs de *T. brucei* ont encore été évalués par TB-PCR pour rechercher la présence du gène associé à la résistance au sérum (SRA), associé à l'infectiosité chez l'homme de *T. b. rhodesiense*.

Sur les 206 mouches tsé-tsé, 107 (51,9%) étaient positives à *T. brucei*. Des 107 échantillons positifs à *T. brucei*, 4 (3,7%) avaient le gène SRA.

Conclusion : Ces résultats semblent indiquer que les espèces sauvages de mouches tsé-tsé au Malawi sont infectées par des trypanosomes infectieux pour l'homme, qui exposent les communautés vivant autour des réserves fauniques au risque d'apparition de foyers de THA. Cependant, des études supplémentaires doivent être menées pour 1) identifier les sources de repas sanguins des mouches tsé-tsé ; 2) évaluer si les animaux domestiques dans ces zones abritent des trypanosomes infectieux pour l'homme ; et 3) mener des études de surveillance sur les communautés vivant autour des réserves fauniques.

**Summary**

**Background:** Trypanosoma brucei rhodesiense is the causative agent of acute Human African Trypanosomiasis. Identification of Trypanosoma brucei rhodesiense in tsetse populations is essential for understanding transmission dynamics, assessing human disease risk and monitoring spatio-temporal trends and the impact of control interventions. Accurate detection and characterization of trypanosomes in vectors relies heavily on molecular techniques (polymerase chain reaction, PCR). For the first in Malawi molecular technique has been used to identify infective trypanosomes in tsetse flies in Nkhotakota Wildlife Reserve.

**Methodology/Principal Findings:** TB-PCR was used to identify the serum resistance associated (SRA) gene of T.brucei rhodesiense in Tsetse flies caught in Nkhotakota Wild life Reserve, Malawi. 206 Tsetse flies were randomly caught, dissected and each mid-gut pooled in ependorf tubes containing PBS buffer for DNA extraction. *T. brucei* primers were first used to isolate the *Trypanozoon* group. The *T. brucei* positive samples were further evaluated by TB-PCR for the presence of the Serum Resistance Associated (SRA) gene, which has been linked to human infectivity in *T. b. rhodesiense*. Of the 206 Tsetse flies, 107 (51.9%) were *T. brucei* positive. Of the 107 *T. brucei* positives samples, 4 (3.7%) were found to have the SRA gene.

**Conclusion:** These results suggest that wild Tsetse flies in Malawi are infected with human-infective trypanosomes that put communities around Wild Life Reserves at risk of HAT outbreak. However, further studies need to be done to 1) identify sources of blood meals for the tsetse flies, 2) assess if domestic animals around these areas are harboring human infective trypanosomes and 3) Do surveillance studies on communities around Wild Life Reserves

**Abstract:**

**Background:** Trypanosoma brucei rhodesiense is the causative agent of acute Human African Trypanosomiasis. Identification of Trypanosoma brucei rhodesiense in tsetse populations is essential for understanding transmission dynamics, assessing human disease risk and monitoring spatio-temporal trends and the impact of control interventions. Accurate detection and characterization of trypanosomes in vectors relies heavily on molecular techniques (polymerase chain reaction, (PCR). For the first time in Malawi molecular technique has been used to identify infective trypanosomes in tsetse flies in Nkhotakota Wildlife Reserve.

**Methodology/Principal Findings:** TBR-PCR was used to identify the serum resistance associated (SRA) gene of *T. brucei* rhodesiense in Tsetse flies caught in Nkhotakota Wildlife Reserve, Malawi. 206 Tsetse flies were randomly caught, dissected and each mid-gut pooled in ependorf tubes containing PBS buffer for DNA extraction. *T. brucei* primers were first used to isolate the *Trypanozoon* group. The *T. brucei* positive samples were further evaluated by TBR-PCR for the presence of the Serum Resistance Associated (SRA) gene, which has been linked to human infectivity in *T. b. rhodesiense*. Of the 206 Tsetse flies, 109 were ITS-rDNA (51.9%) *T. brucei* positive. Of the 109 ITS-rDNA PCR positive samples, 75 were T. brucei positives samples using TBR-PCR. Of the 75 sample, 4 (3.7%) were found to have the SRA gene.

**Conclusion:**

These results suggest that wild Tsetse flies in Malawi are infected with human-infective trypanosomes that put communities around Wildlife Reserves at risk of HAT outbreak. However, further studies need to be done to 1) identify sources of blood meals for the tsetse flies, 2) assess if domestic animals around these areas are harboring human infective trypanosomes and 3) Do surveillance studies on communities around Wildlife Reserves

**Key words:** PCR, TBR-PCR, ITS-rDNA PCR, Tsetse flies, Glossina morsitans morsitans, Glossina pallidipes

## Introduction

Tsetse flies (Glossina sps) are the vectors for the transmission of both human and animal African trypanosomiasis. Animal trypanosomiasis is called Nagana and it affects domestic animals. The reservoir hosts for both human and animal trypanosomiasis are wild animals in particular antelopes (Duke, 1912) with domestic animals contributing to a lesser extent (van den Bossche, 1997). The human disease is caused by two species of Trypanosoma brucei. These are Trypanosoma brucei rhodesiense which is confined to Southern Western Africa with Uganda, Malawi and Tanzania mainly reporting the disease. This species of Trypanosme is commonly associated with an acute infection. The other disease is caused by Trypanosoma brucei gambiense, and is currently confined to West Africa in particular DR Congo, Angola, Guinea, Cote d'lvoire and other countries in Western Africa (WHO, 2015). This particular infection is associated with a chronic disease.

There are several species of tsetse flies (Glossinidae: Diptera) that feed on both humans and animals. There are specific foci for these flies. The flies that are good vectors for Trypanosoma brucei rhodesiense are mainly confined to the South Western countries of Africa which are associated with the acute disease while the flies that are good vectors for Trypanosoma brucei gambiense are mainly confined o the Western part of Sub-saharan Africa mainly associated with the chronic disease. However, there is an overlap of these flies mainly in North West and South East Uganda (Aksoy, 2015). The flies that are good vectors for transmission of Trypanosoma brucei rhodesiense belong to Glossina morsistans morsistans, Glossina swynnertinii, Glossina auteni, Glossina longipenis, Glossina pallidipes, Glossina bravepalpis, Glossina fuscipes fuscipes (Mahama *et al.,* 2004; van den Bossche *et al.,* 2000a; Sigauque *et al.,* 2000) The ones associated with the transmission of Trypanosoma brucie gambiense mainly belong to the Glossina fuscipes fuscipes Glossina tachinoides and Glossina morsistans (Saunders 1962; Woolhouse *et al.,* 1994; Wamwiri *et al.,* 2007;). It is clear that Glossina fuscipes and Glossina morsistans are ubiquitous in their locations making these species of tsetse flies good vectors for both acute and chronic human African trypanosomiasis.

There are three subspecies of Trypanosoma brucei, namely, Trypanosoma brucei rhodesiense, Trypansoma brucei gambiense and Trypanosoma brucei brucei and the latter is associated with animal trypanosomiasis and has no effect on human hosts. These species cannot be distinguished morphologically using microscope. There are molecular techniques that utilize the genetic differences between these parasites that are in use to distinguish them. The commonly used one is the Serum Resistant Antigen (SRA-Gene) which distinguishes Trypanosoma brucei rhodesience from the other two sub-species. While the other two sub-species of Trypanosoma brucei get lysed in the presence of human serum, Trypanosoma brucei rhodesiense is resistant to the

lysis factors that are found in human serum (Gibson *et al.,* 2002; Radwanska *et al.,* 2002). This molecular method is carried out by the Polymerase Chain Reaction (PCR) technique (Kyambadde *et al.,* 2000; Katakura *et al.,* 1997). There is also an Internal Transcribed Spenser 1 (ITS 1) PCR technique that is used to identify almost all species of Trypanosomes in body fluids (Njiru *et al.,* 2005). There are also other molecular techniques that involve the Loop Mediated isothermal Amplification of DNA (LAMP) (Lisulo *et al.,* 2014) The Repetitive Insertion Mobile Element (RIME) LAMP is used to distinguish all the subspecies of Trypanosome brucei from others that mainly affect animals (Njiru *et al.,* 2007). The PanTryp LAMP technique is used to identify almost all species of trypanosomes that are associated with human and animal disease in African trypanosomiasis in fluids.

The current study was designed to identify the species of tsetse flies that inhabit Nkhotakota wildlife reserve and the types of Trypanosomes that they transmit. This was done by trapping tsetse flies and isolating them according to age and sex. The tsetse fly mid-guts were dissected and microscopy examination performed on them to identify infection rates followed by performance of molecular techniques on the mid-guts to identify the species of trypanosomes in them.

## Materials and Methods

*Trapping of Tsetse flies*

After getting clearance from the Nkhotakota wildlife reserve officials and in collaboration with Ministry of Agriculture, Biconical and Mzi traps were deployed in five locations in Nkhotakota wildlife reserve. They were deployed at a distance of 100 meters a part alternatively. A total of 100 traps were deployed 30 for Biconical and 70 for Mzi-Epison Traps (see Fig 1 & 2) and they were baited with phenols and acetone before being deployed. Tsetse flies were harvested every 24 hours for 2 weeks and there was a break of three months during the year. All flies were sorted according to sex and maturity using an ordinary microscope. All tenerals and dead flies were recorded but were not included in the investigation. Tsetse flies were dissected each mid-gut was examined parasitologicaly using Olympus dissecting and biological microscopes respectively. Each mid-gut was then pooled in eppendorf tubes containing 200µl PBS buffer and frozen at -200C for DNA extraction. DNA was extracted from these mid-guts using the Qiagen DNeasy Blood and tissue kit (Qiagen USA).

*1. ITS1 (Internal transcribed spacer) rDNA PCR*

ITS1 rDNA primers used were: ITS1 CF, 5'CCGGAAGTTCACCGATATTG and ITS1 BR, 5'TTGCTGCGTTCTTCAACGAA (Njiru *et al.,* 2005). PCR was carried out in 25-ul reaction mixtures containing 5 X phusion HF buffer with 1.5 mM MgCl2 final reaction concentration (FINNZYMES), 10 mM of each of the four deoxynucleoside triphosphates (dNTPs), primers at 1 µM, 0.25µl of Taq DNA polymerase (FINNZYMES) and 3µl of DNA template. PCR cycles for ITS1 CF and BR primers were: initial step at 98 0C for 10 s, followed by 35 cycles of 98 0C for 30 s, 65 0C for 30 s, 72 0C for 30 s, and final extension at 72 0C for 10 min using the Techne Genius thermocycler. Amplification products were visualized in 2 % molecular grade agarose (Fisher Biotech) stained with ethidium bromide on UV transluminator (Syngene, USA).

*PCR size products with ITS1 CF and BR*

All members of the subgenus *Trypanozoon* gave an approximate band size of 480 bp; Nannomonas: T.congolense savannah 700 bp; *T. congolense* kilifi 620; *T. congolense* forest 700; T. simiae 400; T. simiae tsavo 370; T. godfreyi 300 and Duttonella; *T. vivax* 250 bp.

*2. TBR 1 & 2 (T. brucei) PCR*

Primers used were: TBR1 (CGAATGAATATTAAACAATGCGCAG) and TBR2 (AGAACCATTTATTAGCTTTGTTGC). PCR was carried out in 25-ul reaction mixtures containing 5 X phusion HF buffer with 1.5 mM MgCl2 final reaction concentration (FINNZYMES), 10 mM of each of the four deoxynucleoside triphosphates (dNTPs), primers at 1 µM, 0.2µl of Taq DNA polymerase (FINNZYMES) 7µl DNA template for initial PCR and 5µl template for nested PCR. PCR cycles for TBR 1 & 2 primers were: initial step at 98 0C for 10 s, followed by 35 cycles of 98 0C for 30 s, 66 0C for 30 s, 72 0C for 30 s, and final extension at 72 0C for 10 min using the Techne Genius thermocycler. Amplification products were visualized in 2 % molecular grade agarose (Fisher Biotech) stained with ethidium bromide on UV transluminator (Syngene, USA). The size of the PCR product was 173 bp.

*3. SRA PCR.*

Primers used were: The forward 5'-ATAGTGACAAGATGCGTACTCAACGC-3') and reverse (5' -AATGTGTTCGAGTACTTCGGTCACGCT-3'). PCR was carried out in 20 µl reaction mixtures containing 5 X phusion high fidelity buffer with 1.5 mM MgCl2 final reaction concentration (FINNZYMES), 10 mM of each of the four deoxynucleoside triphosphates (dNTPs), primers at 1 µM, 0.2µl of Taq

DNA polymerase (FINNZYMES) 5µl DNA template for initial PCR and 2µl template for nested PCR. PCR cycles for TBR 1 & 2 primers were: initial step at 98 0C for 10s, followed by 35 cycles of 98 0C for 30 s, 66 0C for 30 s, 72 0C for 30s, and final extension at 72 0C for 10 min using the Techne Genius thermocycler. Amplification products were visualized in 2 % molecular grade agarose (Fisher Biotech) stained with ethidium bromide on UV transluminator (Syngene, USA). The size of the PCR product was 284 bp.

*4. RIME LAMP*

Primers were those described by Njiru *et al.,* 2007, briefly RIME-F3 5'CTGTCCGGTGATGTGGAAC, RIME-B3 5' CGTGCCTTCGTGAGAGTTTC, RIME-FIP 5'GGAATACAGCAGATGGGGCGAGGCCAATTGGCATCTTTGGGA, RIME-BIP 5'AAGGGAGACTCTGCCACAGTCGTCAGCCATCACCG TAGAGC,RIME-LF 5' GCCTCCCACCCTGGACTC and RIME-LB 5' AGACCGATAGCATCTCAG. LAMP was carried out in 25 µl reactions mixtures that contained 2.0 µM for each FIP and BIP primer, 0.8 µM for each loop primer (LF and LB), 0.2 µM for each of the F3 and B3 outer primers, 200 µM for each deoxynucleoside triphosphate, 0.8 M betaine (Sigma, St. Louis, Mo, USA), 20 mM Tris–HCl (pH8.8), 10 mM KCl, 10 mM (NH4)2SO4, 2 mM MgSO4, 0.1% Triton X-100 and 8 U of BstDNA polymerase large fragment (New England Biolabs, MA, USA). The template was 1-3 µl. The LAMP test was carried out for 1 h at 62 0C and terminated by increasing the temperature to 80 0C for 5 min using the Techne Genius thermocycler.

Amplification of DNA in the LAMP reaction was monitored through electrophoresis in 2.0% agarose gels stained with ethidium bromide on UV transluminator (Syngene, USA) and direct visual inspection after addition of 2 µl of 1/10 dilution of SYBR Green I (Invitrogen, Australia).

**Results**

As can be observed from Table 1, 257 flies were caught. Out of these 185 (72%) flies were Glossina morsistan morsitans and 72 (28%) were Glossina pallidipes. 140 (54.5%) were females and 117 (45.5%) were males regardless of the species. 3 (1.2%) were tenerals and 12 (4.7%) were dead on the day of sampling regardless of the species. The overall population of female flies infected was 116 (45.0%) regardless of the species however when the subset of only female flies studied, 116 flies out of 140 were carrying trypanosomes in their mid-guts representing 82.9% of females carrying infection. On the other hand 90 of the 117 male flies caught regardless of the species were carrying trypanosomes in their mid-guts representing 76.9% of the male population. In total 206 flies in total out of 257 flies were identified with trypanosomes in

their mid-gut representing a total population of 80.2% infection rates.

Fig. 4 is a sample of the gel electrophoresis of TBR-PCR. The 206 flies were crashed and their DNA extracted and subjected to TBR-PCR process. 116 (56.3%) samples of extracted DNA from 206 infected flies revealed that they were infected by the Trypanosome brucei subspecies of trypanosomes. This observation showed that tsetse flies in this reserve are highly infected with parasites that could be a risk to human disease. This species could either be Trypansoma brucei brucei or Trypanosome brucei rhodesience and there was a need to perform a definitive procedure to isolate Trypanosoma brucei rhodesience from Trypanosome brucei brucei .

Fig. 5 is a sample of the gel electrophoresis of ITS-rDNA PCR. Following the identification of 56.3% of DNA of infected flies to carry trypanosome genes of Trypanosome brucie subspecies, the same DNA was subjected to ITS-rDNA PCR to identify other species of Trypanosomes that might be harbored in the flies. 109 (52.9%) of the 206 infected flies were positive with ITS-rDNA PCR. This shows that some of the flies had infections that ITS-PCR has no primers for. Moreover, some flies had mixed infections, the same flies containing more than one species of Trypanosomes. The 109 flies were again subjected to the TBR-PCR technique to identify the ones that harbored only Trypanosome brucei subspecies. Out of the 109 infected DNA samples 75 (68.8%) were isolated to be infected by Trypanosome brucei species.

As shown in Fig. 6, the 75 DNA samples that were positive for Trypanosome brucei subspecies form ITS-rDNA PCR followed by TBR-PCR were subjected to the SRA-Gene PCR. SRA-PCR which distinguishes Trypanosome brucie rhodesiense from the other Trypanosome brucei species was positive in 4 (5.3%) of the 75 samples. This was a definitive observation that flies in Nkhotakota wildlife reserve carry trypanosomes that are infective to humans.

**Discussion**

Previous studies have also shown that Glossina morsitans morsitans and Glossina pallidipes are the most prevalent species of tsetse flies in the wildlife reserves in Malawi (Mthepheya *et al.,* 1989). The present study is in agreement with this observation. However, the prevalence of Glossina morsitans morsitans was higher than that of Glossina pallidipes. It was also noted that the infection rates of both species of flies was not sex dependent as there was no difference between the proportion of the male (76.9%) and females (82.9%) flies that had mid-gut infections. This shows that feeding habits of these flies are similar and they are not dependent on the egg maturity of the female flies. One would have expected a difference in infection rates if blood meal was directly related to egg maturity. There would also be a difference if

the preferred host for feeding were different. The proportion of flies infected was also higher than has been observed in other tsetse flies both in the region and other areas (unpublished result, BMGF-Xenomonitoring Project). This could partly be explained by a common host animal which is preferred for feeding by the flies in Nkhotakota game wildlife reserve. It is well established that Glossina morsitans morsitans are very good vectors for trypanosomiasis as they easily establish infections in their mid-guts after a blood meal (Mihok *et al.,* 1999.). These flies might be feeding on antelopes which are widely spread in the nature reserve and these animals are known be one of the major reservoir hosts for trypanosomes (Moloo *et al.,* 1991; Duke, 1912)

The present study has also established that Trypanosoma brucei species are the most prevalent parasites circulating in the tsetse flies implying that they are also prevalent in the reservoir hosts. The direct TBR-PCR showed that of all infected flies, 116 out of 206 (56.3%) were harboring Trypanosoma brucei infection. The proportion of DNA samples from the same infected flies showed that 109 out of 206 (52.9%) were positive with ITS- rDNA PCR. ITS-rDNA PCR does not segregate between species of trypanosomes. However when the positive samples were further analyzed to find the actual proportion of DNA that had Trypanosome brucei species the proportion rose to 68.8% (75 out of 109) by using TBR-PCR. The difference between ITS-rDNA PCR and TBR-PCR can partly be explained by mixed infections in some of the tsetse flies. If every fly was infected by a single parasite the proportions between TBR-PCR and ITS-rDNA PCR would have been the same. Due this finding, it became necessary to distinguish the species of Trypanosoma brucie in the DNA of 75 tsetse flies that were identified after ITS-rDNA PCR and TBR-PCR. This was done by nested PCR for SRA-Gene. From the 75 samples, 4 were found positive for SRA-Gene (see fig.6). SRA-Gene identification confirmed the existence of Trypanosoma brucie rhodesiense, the causative agent of the human acute trypanosomiasis found in Malawi and other countries in the Southern African region.

From these molecular studies, it shows that both animal infections and possible human trypanosomiasis disease can be transmitted in this nature reserve. Indeed, over the years, high levels of human infections of trypanosomiasis have been reported at Nkhotakota District hospitals since records of cases began. The level of human infections has been on the decline while the data for domestic animal infections is scanty (Chisi et. al., 2003, 2004, 2007, 2011). The present study has also confirmed that both human and animal infections are likely to be caused by the Trypanosoma brucei subspecies in and around Nkhotakota wildlife reserve. Reported cases of trypanosomiasis have been reported in tourists and soldiers that have visited some of Malawi's wildlife reserves (Croft *et al.,* 2006, 2007; Darby *et al.,* 2008 ) Moreover, the cases of trypanosomiasis have also been shown to be sub-acute in some studies

showing a genetic susceptibility in some people (Macleod *et al.,* 2004; 2010). Indeed the high infection rates that have been shown in the present study have not translated in a trypanosomiasis epidemic in Malawi. The possible explanation of this is lack of human and tsetse interface (Gondwe *et al.,* 2009).

All in all, the present study has shown that tsetse flies in Nkhotakota wildlife reserve have a high infection rate at 80.2% and more than half of these infections are attributed to Trypanosoma brucie species causative agents of both human and animal infections. There is a need to sample blood from both animals and human to establish whether the risk translates in infections in the human beings and in cattle, pigs, goats and wildlife in and around the reserves. In addition, there is a strong need to intensify tsetse trapping to reduce the number of flies in the park. The blood meal analysis would assist in identifying the common source of infection between flies. This will clarify the observation that tsetse flies seem to prefer a common source of host feeding as shown by the same infection rate differences between species and sexes. Detection of trypanosomes in the vector indicates the presence of potentially infective human trypanosomes as well as Nagana in the surrounding areas. It is sensible to suggest that resources have to be mobilized to mitigate the potential trypanosomiasis epidemic both in humans and animals

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# A MULTI-AGENT MODEL FOR SIMULATING SLEEPING SICKNESS

# UN MODELE MULTI-AGENT POUR SIMULER LA MALADIE DU SOMMEIL

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## Résumé

Le modèle multi-agent LAVHAT, développé avec le système CORMAS ©, permet de simuler l'évènement endémique et l'évolution de la maladie dans un foyer de Trypanosomose Humaine Africaine, afin d'en évaluer les probabilités d'apparition.

Les agents « Hôte-Vecteur-Parasite » ont la possibilité d'entrer en interaction à chaque pas de temps (2h) sur une scène de transmission caractérisée par un biotope et une fréquentation. Les simulations présentées ici portent sur cinq ans. Par ailleurs, la possibilité d'un réservoir animal temporaire a été prise en compte. Les informations utilisées pour réaliser ce modèle sont celles observées dans le foyer de THA de Bipindi (Cameroun).

L'intérêt du modèle réside dans la possibilité de s'adapter à n'importe quel terroir villageois et ainsi qu'aux changements environnementaux ou démographiques auxquels il pourrait être soumis. Des comparaisons ont été réalisées qui prennent en compte les actions des programmes nationaux, qu'il s'agisse de dépistage ou de lutte antivectorielle. Ce simulateur est un outil qui peut être très utile pour l'aide à la décision dans le cadre de l'élimination de la maladie du sommeil.

**Mots-clés :** Modélisation – Trypanosomose – Multi-agent – Simulation – Glossine – Aide à la décision.

**Summary**

The multi-agent model LAVHAT developed with © CORMAS system simulates the endemic event and disease progression in a focus of Human African Trypanosomiasis, to assess the likelihood of occurrence.

Agents "Host-Vector-Parasite" have the opportunity to interact with each time step (2h) on a stage transmission characterized by a biotope and attendance. The simulations presented here are over five years. Furthermore, the possibility of a temporary animal reservoir has been taken into account. Information used to develop the model is those observed in the HAT focus Bipindi (Cameroon).

The interest of the model is the ability to adapt to any villagers and local as well as environmental and demographic changes which it may be subjected. Comparisons were made taking into account the actions of the national programs, whether for screening or vector control. This simulator is a tool that can be very useful for decision support in the elimination of sleeping sickness.

**Keywords:** Modeling - Trypanosomiasis - Multi-agent - Simulation - Glossina - Decision Support.

Human African Trypanosomiasis is a parasitic disease whose agent (trypanosome) is transmitted by a vector (Glossina or tsetse fly) that feeds on the blood of humans or animals. Today the disease is considered to be in extinction, but the maintenance of reservoirs, in both humans and animals, along with maintenance of the vector, involves a laborious elimination process. In this context, modeling seems to be an appropriate tool for evaluating the strength of these interventions in controlling the disease. Modeling this disease began for the end of the 1980, using compartmental mathematical models with differential equations [4, 5, 6 & 7], new-generation matrix [11], and agent based model [9, 13]. A web site was created [8] for vector control simulations and Funk and al. evaluated the importance of the animal reservoir [12].

The model we present herein is based on the methodology used by Müller *et al.,* and was developed on the main HAT focus in Cameroon in the 2000s, the Bipindi focus. It differentiates itself from Muller's work by the incorporation of a spatial map corresponding to the occupation of space specific of this area. The distribution of the agents (humans, tsetse flies, wild and domestic animals) in this model was the distribution observed in the field during several studies [14, 15, 16, 17, 18 and 19]. The availability of epidemiological data in this area allowed us to validate the predictive quality of the model,

including the historical spread of the disease, the interventions of the National Control Program (NCP) by mass screening and treatment, and the numbers of humans in the first and second phases of the sickness, as well as the impact of vector control, testing different control devices. Furthermore, the inclusion of a potential animal reservoir of *T. b. gambiense* in the model allowed us to evaluate its importance.

## Methods

### *Epidemiological context*

Evidence for an active sleeping sickness focus in Bipindi was given at the end of the 1990s when 42 cases of the disease were identified in four villages and prevalence reached 3.5% in two villages, Lambi and Bidjouka, considered as the epicenter of the focus [14]. At that time, 80% of the diagnosed cases were in the first phase, indicating that the disease was still expanding. From 2000 to 2013, regular medical surveys were conducted by the NCP (Figure 1), and scientific studies were carried out that shed light on the transmission by tsetse flies [16, 20, 21] and suggested the circulation of *T. b. gambiense* in wild mammals [15, 17].

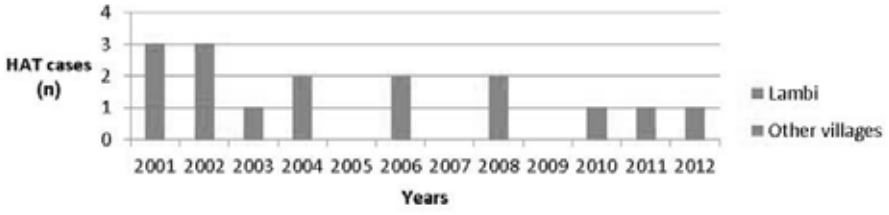



**Figure 1.** Sleeping sickness cases diagnosed by the NCP in the HAT focus of Bipindi (Ocean district, Cameroun) from 2001 to 2012.

From 2004 to 2012, nine cases in the second phase of disease were detected but were all diagnosed passively (Ebo'o E.V., personal communication), and except for the 2012 case diagnosed in Lambi, the other eight cases came from other villages.

### The cormas system

Cormas is a simulation system that relies on an agent-based model and was created in Smalltalk language, using VisualWorks software® [22]. This simulation tool is useful for better understanding the complex interactions between natural and social dynamics. Cormas comprises different sets of programs. The first one is used to model agents and interactions; these interactions are mediated by means of a simulation space, understood as a set

of cells, either via messages such as the times for blood meals or spawning for the tsetse. The second set of programs is used for controlling the dynamics of the simulation, and several probes can be registered for each time step, such as the total number of flies, the number of infected agents (flies, animals and humans), the number of infective flies and the first or second stage of disease for humans. The third set of programs is used to define the different viewpoints of the observer using two types of interfaces: graphs, a grid to display all the cells of the carrier space and the agents located, and where the number, size, and shape of the cells can be set.

Simulations were performed on a classical computer and data were recorded using MS Excel®. We initialized the simulations by introducing one sleeping sickness case at the first stage of the sickness in the model (T0), which facilitates the measurement of the basic reproduction number of the human-infective *T. brucei* gambiense R0. We defined a time' step (TS) of 2 h, which is the estimated meantime spent on an activity by villagers, and corresponds to 21,900 TS per 5 years. Each parameter was tested using at least 100 simulations that lasted for about 48 h. For the analysis, the 21,900 TS were reduced to weekly occurrences (every 84 TS) and we retained the steps corresponding to the time of the NCP interventions.

**Active agents**

All active agents (tsetse flies, humans and animals) were characterized by attributes that are presented in Table I.

Glossina palpalis palpalis is the main vector of sleeping sickness in the Bipindi area. Each fly is considered an individual agent, which is born, lives, feed, breeds, eventually transmits the disease and dies, while keeping the whole population in equilibrium and respecting seasonal population changes (four seasons in this area). The overall tsetse population that an environment could support was estimated with Glossina palpalis in the forest area of the Ivory Coast [23]. All was resumed in the following equation $N=a(ADT)b$, where N is the estimated population and a and b the constants defined by mark-recapture experiments . After conducting hundreds of simulations, we found that the natural mortality rate (NMR) that had to be defined to keep the vector's population in equilibrium in this area was 0.02936.

Massussi *et al.,* [18, 19] recorded the population of wild mammals in Lambi as 31 mammal species, among them six species known to be reservoir hosts of *T. b. gambiense*. Using the estimations of Massussi, who defined a density for each of these species, we estimated the animal populations as 770 wild mammals and 30 domestic animals (goat, pig, sheep, dog, etc.). Among them, potential

reservoirs of *T. b. gambiense* in wild mammal population represented 50% of the whole population and domestic animals were all considered as potential reservoirs too. Except for the studies conducted on domestic animals [29, 30,31], very few studies have been conducted on wild animals, consequently we choose a maximum duration of 4 months in all potential reservoirs.

**Table 1:** Agents with their programmed attributes and corresponding references.

| Agents | Attributes | Programming | References |
|---|---|---|---|
| Humans | Population | 500 | [14] |
| | Movements | - Randomly per TS by day<br>- One TS to water point every day<br>- Stay in the village by night | |
| | First stage | - Randomly from 2 to 4 years<br>- Reservoir | [25] |
| | Second stage | - From 2 to 6 months<br>- Non reservoir | |
| | Infection | When bitten by a fly with vector competence | |
| Tsetse flies | Population max | 5000 | [9, 23] |
| | Population at equilibrium | 3500 | |
| | Mortality rate | 0.02936 | [24] |
| | Life span | - 2 months in dry season<br>- 3 months in rainy season | |
| | Fertilization | Randomly, from day1 to day 5 after merging | |
| | First nesting | 15 days after fertilization | |
| | Larvae laying | Every 10 days | |
| | Blood meal | - Every 3 days when host is present<br>- Maximum fasting period = 6 days<br>- 20% on humans | [16] |

| Agents | Attributes | Programming | References |
|---|---|---|---|
| | Infection | When a teneral fly picks blood on an infected host | [26, 27] |
| | Movements | One cell max per TS | |
| | Vector competence | 2% of infected flies | [28] |
| | Tbg cycle | 25 days | |
| Animal | Nature | Domestic or wild | |
| | Population | - 30 domestic<br>- 770 wild | [18, 19] |
| | Movements | - Domestic ones: no more than 2 cells outside the village<br>- Wild ones: do not penetrate the village<br>- Day and night<br>- 1 cell by TS | |
| | Reservoir | - 30 domestic + 370 wild<br>- Duration = 4 months | [15, 17, 29] |

**Passive agents**

*Scenes of transmission*

The simulation space was defined as a 30×30 square grid covering an area of 36 km2. Each square is 200 m long; such fine spatial resolution enabled us to take into account the small size of the cultivated land and forest trails. An attribute characterized each cell, and the cells were distributed according to observations made in the field [8, 15]: village (4%), crop field (10.5%), cocoa plantations (22.5%), encampments (2%), forest (40%), shallows (5.5%), water (11%), footpaths and tracks (4.5%). Each attribute is associated with a specific color on the map.

*The seasons*

The Bipindi region is characterized by four seasons: a long dry season from December to March, a short rainy season in April, a short dry season from June to July, and a long rainy season from August to November. These seasons greatly influence the fly population.

*The National Control Program (NCP)*

Mass screening generally occurs in the short dry season (June and July), which corresponds to five medical surveys in 5 years from the introduction of one sleeping sickness case in the model at T0. To model the NCP interventions, we performed the simulations with an average 70% of the population covered, the same coverage as performed in the field by the Cameroonian NCP.

*Vector control*

Vector control was tested with different trapping devices (2.5 and 5 traps / km2), principally at water points, in fields, cocoa plantations, encampments, footpaths, and around the village. Decrease of the vector population that was programmed was the one (90% in 2 months) observed in the field by Laveissière *et al.,* [24].

*Epidemiological profiles*

The endemic levels that were observed during the simulations were gathered in four groups, taking into account the low prevalence levels observed in Lambi:

**Group 1**, this group comprises all situations where disease extinction was observed (number of HAT cases = 0);

**Group 2**, takes into account the situations where there was only one HAT case (0.2% prevalence);

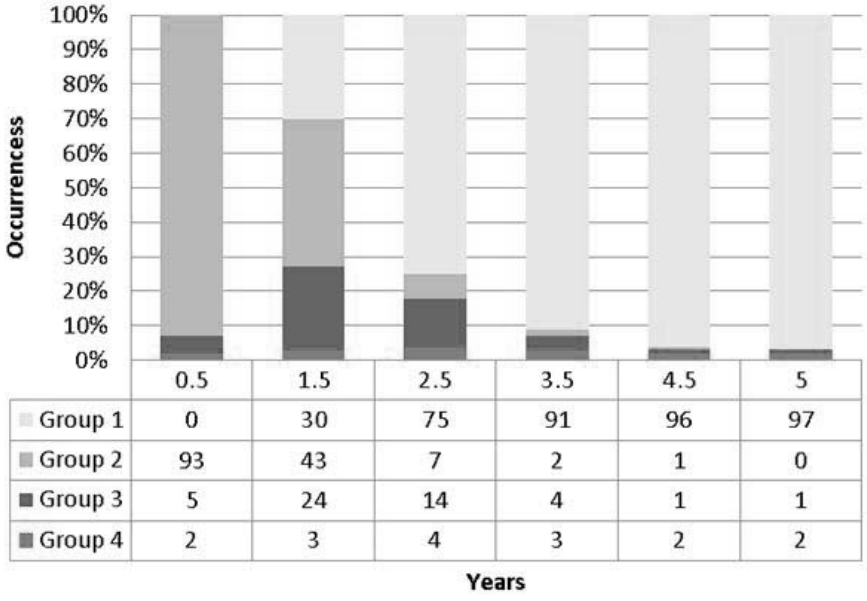
**Group 3**, corresponds to all endemic expansions where R0>1 and the prevalence was 0.2%<≤1%;

**Group 4**, comprises endemic situations where prevalence was >1%.

## Results

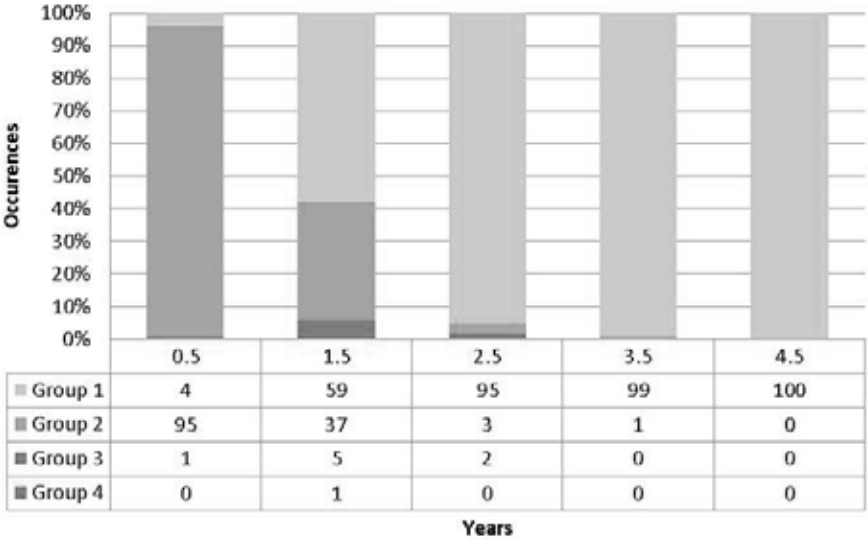
*Natural evolution of the disease*

First, we evaluated the natural expansion of the disease over 5 years without any public health intervention, in order to verify that the model was able to propose an endemic situation corresponding to the one actually observed at the end of the twentieth century by the first mass screening campaign carried out in the Bipindi focus. Figure 2 shows the probabilities of distribution of the four endemic groups introduced for each year of the 5-year simulations. R0>1 (groups 3 and 4) was observed in 7% of the simulations, 6 months after T0 (year 0.5), but the highest number of occurrences (27%) was observed in year 1.5; among them, 3% had a prevalence of >1%. The 3.5% prevalence rate that was observed in 1998–1999 in Lambi was obtained in only 2% of the simulations at years 2.5 and 3.5. Self-extinction of the disease occurred at 4.5 and 5 years in 96% and 97% of the simulations, respectively. Five years




| | 0.5 | 1.5 | 2.5 | 3.5 | 4.5 | 5 |
|---|---|---|---|---|---|---|
| Group 1 | 0 | 30 | 75 | 91 | 96 | 97 |
| Group 2 | 93 | 43 | 7 | 2 | 1 | 0 |
| Group 3 | 5 | 24 | 14 | 4 | 1 | 1 |
| Group 4 | 2 | 3 | 4 | 3 | 2 | 2 |

**Figure 2:** *Natural endemic evolutions proposed by the LAVHAT model during five years.*




| | 0.5 | 1.5 | 2.5 | 3.5 | 4.5 |
|---|---|---|---|---|---|
| Group 1 | 4 | 59 | 95 | 99 | 100 |
| Group 2 | 95 | 37 | 3 | 1 | 0 |
| Group 3 | 1 | 5 | 2 | 0 | 0 |
| Group 4 | 0 | 1 | 0 | 0 | 0 |

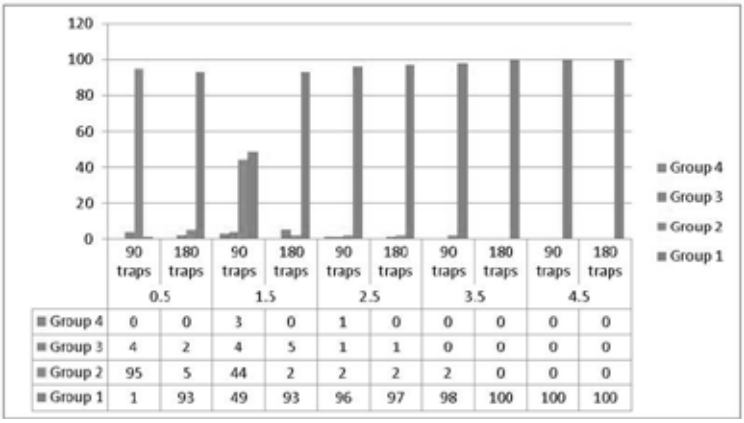
**Figure 3:** *Endemic evolutions proposed by the LAVHAT model during five years, including 5 medical surveys at 0,5 - 1,5 - 2,5 - 3,5 - 4,5 years with a 70% average cover of the population.*

after the arrival of one case in the village, there was still a 3% probability of R0 being >1.

**Impact of the NCP**

We evaluated the impact of the Cameroonian NCP that carried out yearly mass screening for the beginning of the decade (2000). We considered only the population's coverage (70%) to evaluate these public health interventions, retaining the endemic level that prevailed after each field survey (Figure 3). The highest level of endemic evolution in 5 years was observed after the 1.5-year screening in 6% of the simulations. The probability of elimination of the disease reached 95% at year 2.5 and almost (99%) reached full extinction at year 3.5.

When comparing all the occurrences of endemic events (R0>1) with and without NCP interventions in 5 years, it is clear that NCP induces a significant difference ($\chi 2=0.013 < \alpha$, DF2) in the number of endemic events, showing a relevant decrease after the second medical campaign, at year 1.5.




| | 90 traps | 180 traps | 90 traps | 180 traps | 90 traps | 180 traps | 90 traps | 180 traps | 90 traps | 180 traps |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 | | 1.5 | | 2.5 | | 3.5 | | 4.5 | |
| Group 4 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Group 3 | 4 | 2 | 4 | 5 | 1 | 1 | 0 | 0 | 0 | 0 |
| Group 2 | 95 | 5 | 44 | 2 | 2 | 2 | 2 | 0 | 0 | 0 |
| Group 1 | 1 | 93 | 49 | 93 | 96 | 97 | 98 | 100 | 100 | 100 |

***Figure 5.*** *Endemic evolutions proposed by the LAVHAT model during five years, including 5 medical surveys at 0.5, 1.5, 2.5, 3.5, 4.5 years with a 70% average cover of the population and a vector control device of 90 traps and 180 traps.*

In figure 4, the prevalence observed in the field is included in the confidence intervals of the average prevalence of MC70 at 1.5 (CI 95%: 0.2–0.8) and 2.5 (CI 95%: 0.1–0.6) years. In absence of any NCP's monitoring, the modeled prevalence increases principally at year 3.5, despite the small number of endemic events. Inversely, it falls under medical pressure and becomes null during the fourth year, showing good agreement between the model and the results observed in the field between 2001 and 2005.

*The animal reservoir*

The capacity of animals to constitute a reservoir of *T. b. gambiense* was evaluated in all the situations tested. Without any public health intervention, animals were infected in 31% of the simulations; among them, 77.4% occurred during the spreading of the disease in groups 3 and 4, contributing to the expansion of the disease. The number of endemic occurrences in animals dropped to 14 with the intervention of an NCP, with 10 of them (71.4%) occurring during epidemic events.

## *Discussion*

Modeling HAT in the village of Lambi provides more information on the natural endemic evolution in this area, the capacity of public health programs to eliminate the disease, and the actual effect of vector control on the disease. These results also show that this tool could easily be adapted to other sleeping sickness foci, but needs to be developed on a wider scale.

The results of the simulations are in agreement with those obtained by the NCP in Lambi between 2001 and 2011. The endemic situation (3.5% prevalence) that was found in the village at the end of the last century by OCEAC was proposed by the model in only 2% of occurrences in years 2.5 and 3.5; which means that this endemic profile would have been observed once in the last 50 years. The four cases diagnosed between 2001 and 2004 are also in agreement with the endemic levels observed in the simulations including medical surveys with 70% of the population covered. The absence of HAT cases in Lambi from 2004 to 2011 proves that after 4.5 years of surveillance the disease was eliminated in Lambi, as observed in the model. In contrast, the passive diagnosis of one case in the second stage of disease in 2012 in Lambi raises the hypothesis of the maintenance of a reservoir in another village of the Bipindi focus.

In the simulations, the main limitation of the animal reservoir is related to its duration (4 months); we did not observe any autonomous cycle from one animal to another lasting more than 2 weeks. Therefore, we focused on a human reservoir instead. The epicenter of this HAT focus is principally composed of two villages, Lambi and Bidjouka, which present similar demographical, geographical, and social characteristics, and are regularly screened by the NCP. Nevertheless, more cases were diagnosed between 2004 and 2012 in other villages such as Ebimimbang (five cases), located 5 km south of Lambi with which it shares a forest that had already been identified as a potential transmission area [14].

Another outcome of this model is challenging: Vector control has not proven its effectiveness in eliminating the disease. This observation supports the conclusion of Gouteux [6], who noted that when there is a long first stage characteristic of an endemic situation, the detection of sick individuals is more efficient than vector control. Inversely, this greater efficiency of detection decreases in an epidemic situation. Nevertheless, a higher density of traps should also be tested, to evaluate the quantity necessary to impact the disease, but it would need to take into account the costs of vector control implementation. At this point, we do not conclude that vector control must not be applied in Bipindi: Vector control reduces the nuisance caused by the tsetse bites and can protect small livestock from other trypanosomes than *T. b. gambiense*. We would also like to point out the extreme sensitivity of the mortality rate of the vector population, which needs to be adjusted to the 1/10,000 precision mark.

All these epidemiological hypotheses give evidence of the difficulty of programming a model closer to reality. There are still many points that need to be clarified about the vector, the humans and the animals. The fly's transmission competence remains unknown and as does its refractoriness to infection, as Davis *et al.,* reported [10]. Ecological studies on wild mammals living in a tropical forest are difficult to realize, but are important in a system where animals are considered as a potential reservoir. In the same way, a better understanding of the human population's movements outside and inside the area, from one village to another, is a prerequisite for a change in the scale of the model, which can then simultaneously integrate all the villages of the focus in the simulations.

### *Conclusions*

This ABM prototype for simulating the endemic evolution of sleeping sickness proves to be efficient, close to reality, and offers a good predicting capacity. It shows that the NCP of Cameroon reached elimination of the sickness in heart of the Bipindi focus, but that the maintenance of a reservoir in the villages besides favored the merging of new HAT cases. That means that particular attention must be paid to the perimeter of medical surveillance. The change of scale will be the next step and will need to program new communities of agents linked to several villages. In this way, modeling HAT will be a precious tool for predicting the elimination of the disease, which first needs to focus on the active reservoir before it spreads.

### *Author's contributions*

PG collected part of field datas, initiated the modeling concept with Cormas, realized simulations and their analysis, and drafted the manuscript. VF

programmed the model and realized simulations. FB conducted the conception and the programming of the model.

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## NECT FIELD TRIAL: FINAL EFFECTIVENESS AND SAFETY RESULTS

## ESSAI DE LA NECT SUR TERRAIN : RESULTATS FINALS EN MATIERE D'EFFICACITE ET DE SECURITE

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**Résumé**

La trypanosomiase humaine africaine (THA : maladie du sommeil) causée par Trypanosoma brucei (Tb) gambiense est une maladie mortelle lorsqu'elle n'est pas traitée. La polythérapie au nifurtimox-éflornithine (NECT) a montré une tolérance acceptable et une bonne efficacité dans un essai contrôlé randomisé (RCT) et a été ajoutée à la liste des médicaments essentiels (LME) de l'Organisation mondiale de la santé (OMS) pour les adultes en 2009. Les résultats en matière d'innocuité et d'efficacité en situation réelle sont destinés à encourager l'utilisation de la NECT.

**Matériel et méthodes**

Une étude multicentrique, ouverte, sur groupe unique, de phase IIIb portant sur l'utilisation de la NECT pour le traitement de la THA à Tb gambiense au 2ème stade. Des visites de suivi ont été effectuées tous les 6 mois jusqu'à 24 mois. Le résultat principal en matière d'efficacité était le taux de guérison à 24 mois. Tous les patients capables de prendre les médicaments par voie orale ont été inclus.

Les indicateurs d'innocuité étaient les effets indésirables graves et les décès. La population de l'étude comprenait des patients ITT qui n'ont pas été complètement perdus au suivi.

**Résultats**

L'étude a porté sur 630 patients, dont 100 enfants de moins de 12 ans, 14 femmes enceintes et 33 femmes allaitantes. 15 patients ont été complètement perdus au suivi. A 24 mois, le taux global de guérison était de 94% (577/613).

Le taux de guérison et le taux de survie globale étaient similaires pour les adultes et les enfants de moins de 12 ans. Les femmes enceintes et allaitantes ont montré à la fois le taux de guérison le plus élevé et un taux de survie globale de 97,9% (46/47).

Les données sur l'innocuité ont révélé 28 décès (11 connexes) et un total de 65 effets indésirables graves (EIG).

**Conclusion**

La NECT pour le traitement de la THA au deuxième stade est sûre et efficace en milieu de terrain. Les sous-groupes spécifiques (enfants, femmes enceintes et femmes allaitantes) n'ont pas montré de différences marquées.

**Summary**

Trypanosoma brucei (T.b.) gambiense Human African trypanosomiasis (HAT; sleeping sickness) is a fatal disease if untreated. Nifurtimox-eflornithine combination therapy (NECT) showed acceptable tolerability and good efficacy in a randomised controlled trial (RCT) and was added to the World Health Organisation (WHO) List of Essential Medicines (EML) for adults in 2009. Effectiveness and real-world safety findings are intended to encourage the use of NECT.

A multicentre, open label, single arm, phase IIIb study of the use of NECT for 2nd stage T.b. gambiense HAT. Follow-up visits were done every 6 months until 24 months. The main effectiveness outcome was the cure rate at 24 months. All patients able to take oral drugs were included.

Safety indicators were serious adverse events and deaths. Analysis population included ITT patients who were not completely lost to follow-up.

630 patients were included; 100 of them were children below 12 years of age, 14 pregnant women and 33 breastfeeding women. 15 patients were completely lost to follow-up. At 24 months, the overall cure rate was 94% (577/613).

Cure rate and overall survival were similar for both adults and children below 12 years. Pregnant and breastfeeding woman showed both the highest cure rate and overall survival 97.9 % (46/47). Safety data brought 28 deaths (11 related) and a total of 65 serious adverse events (SAE). NECT for treatment of second stage HAT is safe and effective in field settings. Special subgroups (children, pregnant and breastfeeding woman) did not show marked differences.

## BACKGROUND

*Improved treatment for T.b. gambiense*

Human African trypanosomiasis is letal without treatment. In 2012, over 7000 cases of HAT have been diagnosed in Sub-Saharan Africa, more than 85% in Democratic Republic of Congo. Until 2009, only toxic (Melarsoprol) or complex treatments (Eflornithine) were available for neurological infection, 2nd stage T.b.gambiense. This led to research and develop a combination treatment, easier to use: Nifurtimox + Eflornithine. NECT was introduced in the WHO Essential Medicines List for Adults in 2009 and for Children in 2013

*NECT: Nifurtimox-Eflornithine Combined Therapy*

Clinical trial showed non inferiority to eflornithine treatment (Priotto, Lancet 2009). Clear improvement in treatment schedule by adding 10 days oral nifurtimox. 14 vs 56 IV infusions; 10 vs 14 days. Ease of logistics: 4 treatments in 110 $dm^3$ vs 2 in 170 $dm^3$. Cost cut by half (554 to 288 Euros per treatment including transport)

## NECT

*NECT Field: Trial objectives*

Primary objective : Assess the **clinical response** of NECT under field conditions (discharged alive from the hospital*)

*Secondary objectives:*

Assess the incidence and type of **adverse events** (AE), and the capacity of the treatment centers to deal with these; Assess the **feasibility** of the implementation of NECT by the health center; Assess the **effectiveness** of NECT at 24 months after treatment

**NECT Field: Study design**

*Multicentre, open-labeled, non-controlled*

Open inclusion criteria : All stage 2 HAT patients (diagnosed according local rules), including Pregnant/breastfeeding women, children, patients with other underlying disease, poor health, old age, as a general principle, at the decision of investigator or national rules

Target sample size: 620 patients (final sample 630), the trial set up a data safety Monitoring Board (DSMB) and precise stopping rule. The inclusions were done during 12 months (enrolment May 2009 -June 2010), and the follow up visits for each patient during 24 months (6, 12, 18, 24 months). Ethical clearance was provided by Basel and Kinshasa Ethics Committees.

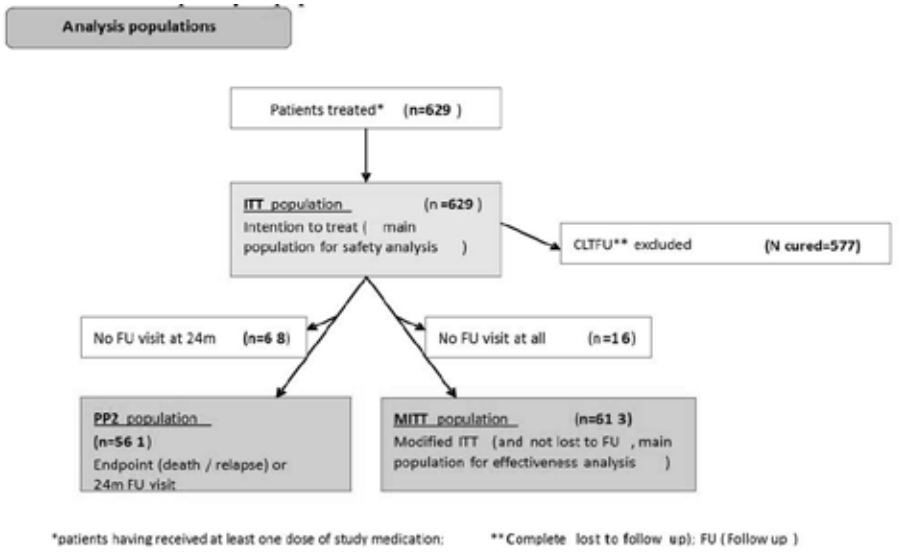
*Final Effectiveness analysis*

The main population analysis (Follow-Up) was based on the modified intention to treat (ITT) population, which was defined as ITT patients who were not completely lost to follow-up. (i.e. main effectiveness criterion available). Main effectiveness criterion was the clinical cure rate, defined as survival without clinical and/or parasitological signs of HAT under real-life conditions were assessed at 24 months (22-26 months).Safety criteria considered serious adverse events and deaths

**Results**

| **Patients Characteristics** | **n** | **%** |
|---|---|---|
| **Patients treated (ITT)** | **629** | **100** |
| Completely lost to follow up | 16 | 2.5 |
| **Modified ITT population*** | **613** | **97.5** |
| Children 0 to 4 years | 35 | 5 |
| Children 5 to >12 years | 65 | 11 |
| Pregnant women | 14 | 2 |
| Breastfeeding women | 33 | 5 |
| *mITT population excludes those without an endpoint (death or relapse) and who missed all follow up visits | | |

Flow Chart of follow up analysis population




*Effectiveness Results*

Cure rate at 24 months - mITT population

Whole population : 94.13 % (577/613), 95% CI = [91.96; 95.85]

Sub-populations:

Adults: 93.8 % (438/467); 95% CI = [91,2 ; 95,8]

Children: 93.9% (93/99); 95% CI = [87,3 ; 97,7]

Breastfeeding and pregnant women. 97.9 % (46/47); 95% CI = [88,71 ; 99,95]

Similar for adults and children below 12 years, without variation shown after sensitivity analysis

*Relapses:*

| **Type of Relapse** | **Patients age at NECT treatment** | **Time of detection after treatment** |
|---|---|---|
| Confirmed | 3 | 1y 6m 12d |
| Confirmed | 8 | 2y 0m 11d |
| Confirmed | 9 | 6m 14d |
| Probable | 12 | 8m 18d |
| Confirmed | 36 | 2y 4m 18d |

| Type of Relapse | Patients age at NECT treatment | Time of detection after treatment |
|---|---|---|
| Probable | 41 | 1y 0m 7d |
| Confirmed | 56 | 6m 22d |

*Confirmed: parasite found; Probable: WBC raised in CSF, no parasite found.*

*Safety Comparison with RCT (Priotto 2009)*

| Adverse Events | NECT FIELD | NECT | DFMO |
|---|---|---|---|
| N | 629 | 143 | 143 |
| Average events per patient | 5 | 5 | 5 |
| Patients with at least one event | 597 (95%) | 95% | 96% |
| Severe adverse events* | 77 (12%) | 14% | 29% |
| Serious adverse events | 61 (10%) | 0.7% | 4% |
| Fatalities** | 28 (3.5%) | 0.6% | 2.1% |

*Notes: * Severity was not monitored during follow up, just passive reports.*

***Fatalities include all deaths even unrelated to the treatment or disease.*

*Prediction of Final Outcome at 6 & 12 months*

Mumba algorithm in two steps at 6 and 12 months [5-50-20]. At 6 months, patients with <=5 WBC count in CSF: cured and those with >=50 WBC count in CSF: relapsed; all remaining patients at 12 months (patients with 5 < WBC in CSF < 50) are discriminated with a cut-off at 20 WBC count in CSF

| Algorithm | N | Sensitivity (%) | 95% CI | Specificity (%) | 95% CI |
|---|---|---|---|---|---|
| 5-50-20 [A] | 213 | 94.4 | 86-98 | 97.8 | 94-100 |
| 5-50-20 [B] | 2190 | 87.4 | 85-90 | 97.7 | 97-98 |
| 5-50-20 [C] | 437 | 66.7 | 22-96 | 100 | 99-100 |

*[A]: reported by Mumba (2010) JID. Algorithm C": includes deaths as treatment failures and patients with incomplete follow-up*

*[B]: reported by Priotto* et al., *(2012) PLoS NTD*

*[C]: same algorithm tested in NECT-FIELD cohort*

**Conclusions**

NECT is useful for treatment of second stage HAT; safe, effective and easy to use in field referral hospital settings. It can be used in special subgroups (children…) as it did not show marked differences for both safety and effectiveness. The field trial showed similar results with NECT Randomised Control Trial (2009), and supported inclusion in EML for Children 2013

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# ANIMAL AFRICAN TRYPANOSOMOSIS
# TRYPANOSOMOSE ANIMALE AFRICAINE

# ANIMAL AFRICAN TRYPANOSOMOSIS: AN EMERGED CRISIS IN KARAMOJA PASTORAL ECOSYSTEM.

# TRYPANOSOMOSE ANIMALE AFRICAINE : APPARITION D'UNE CRISE DANS L'ECOSYSTEME PASTORAL DE KARAMOJA

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## Résumé

Nous présentons les premières informations factuelles sur les espèces et les sous-espèces de trypanosomes qui circulent parmi les bovins indigènes de Karamoja. Située dans le nord-est de l'Ouganda, cette terre semi-aride était généralement considérée comme étant indemne de mouche tsé-tsé et de trypanosomiase en raison de conditions climatiques défavorables. Nous avons réalisé une étude transversale en 2011/2012 pour étudier l'apparition soupçonnée de la trypanosomose bovine et identifier les espèces et sous-espèces de trypanosomes dans la zone d'étude. Au départ, nous avons examiné 706 têtes de bovins en utilisant une combinaison de techniques : micro-hématocrite, buffy coat, goutte épaisse et frottis. Nous avons constaté que la prévalence globale de la trypanosomose bovine été de 5,2% (37/706), 11,5% (9/78) dans le kraal de Lokona, 11,0% (15/137) à Lotanyet et 5,9% (13/220) à Natuket, tandis que les quatre autres kraals communaux étaient aparasitémiques. Dans la deuxième de phase de prélèvement, nous avons recueilli 199 échantillons de sang pour le typage moléculaire. *Trypanosoma vivax* était dominant avec une prévalence de 21,1% par ITS-PCR. Il était suivi respectivement par *Trypanozoon* avec une prévalence de 15,6% par ITS / TBR-PCR, *T. congolense* Savannah avec 1,5% et T. simiae 0,5%. Un échantillon avait une triple infection à T. vivax, *T. congolense* Savannah et *Trypanozoon*, tandis que le taux de double infection était de 3,5%. La conférence du CSRILT offre la meilleure opportunité de partager cette découverte récente sur la trypanosomiase, maladie qui constitue une menace majeure pour la production animale, la sécurité alimentaire et les moyens de subsistance des pasteurs karamojong. En outre, la maladie risque d'aggraver les conflits sous-ethniques en raison de l'accès restreint aux pâturages. En conclusion, nous avons confirmé la présence de plusieurs espèces / sous-espèces de trypanosomes dans les terres pastorales semi-arides de Karamoja. Nous recommandons d'entreprendre d'urgence des études supplémentaires et des

mesures de contrôle appropriées pour faire face à cette catastrophe émergente.


## Summary

We present the first evidence on trypanosome species/subspecies circulating in indigenous cattle from Karamoja. Situated in northeast corner of Uganda, this semi-arid land was generally believed to be free from tsetse-trypanosomosis due to unfavorable climatic conditions. We conducted a cross-sectional study in 2011/2012 to investigate suspected occurrence of bovine trypanosomosis, and to identify trypanosome species and subspecies in the study area. Initially, we tested 706 heads of cattle using a combination of micro-haematocrit buffy coat, thick film and thin smear film techniques. We found the overall prevalence of bovine trypanosomosis to be 5.2% (37/706); 11.5% (9/78) in Lokona kraal, 11.0% (15/137) in Lotanyet and 5.9% (13/220) in Natuket, while the other four communal kraals were aparasitaemic. In second phase sampling, we collected 199 blood samples for molecular typing. *Trypanosoma vivax* dominated with a prevalence of 21.1% by ITS-PCR. It was followed by *Trypanozoon*, with a prevalence of 15.6% by ITS/TBR-PCRs, *T. congolense* Savannah 1.5% and T. simiae 0.5% respectively. One sample had triple infection with T. vivax, *T. congolense* Savannah and *Trypanozoon*, while double infection rate was 3.5%. The ISCTRC conference presents best opportunity for sharing this recent finding, which poses a major threat to livestock production, food security and livelihoods of Karimojong pastoralists. Besides, it's anticipated to aggravate sub-ethnic conflicts due to restricted access to range lands. Conclusively, we confirmed presence of multiple species/subspecies of trypanosomes in the semi-arid Karamoja pastoral land. We recommend urgent further studies and appropriate control measures to address this emerging catastrophe.


## Introduction

Bovine trypanosomosis 'nagana' is an infectious tsetse-borne disease of cattle (OIE, 2010) caused by Trypanosoma vivax, *T. congolense* and *T. brucei* s.l. Several studies carried out within Uganda revealed prevalence of 8.9% (by Micro-haematocrit Centrifugation) and 45.3% (by ELISA) in Butaleja district (Jing *et al.,* 2009), 11.9% and 25% in intensive diary and communal grazing systems respectively (Magona *et al.,* 2002), 12.2% in Tororo district (Magona *et al.,* 2008) and 18.6% in Buvuma Islands (Magona *et al.,* 1999). These studies implicated T. congolense, T. vivax, *T. brucei* or mixed infections. Whereas *T. b. brucei* is known to be non-infective to humans, *T. b. rhodesiense* and *T. b. gambiense* cause the acute and chronic fatal forms of human African trypanosomosis (HAT) 'sleeping sickness' respectively (Brun *et al.,* 2010).

Uganda is unfortunate to be the only country in the world where both Rhodesian and Gambian forms of human sleeping sickness exist (Welburn and Odiit, 2002, Picozzi *et al.,* 2005). These two diseases have existed for several

years as distinct foci until recently when the Rhodesian sleeping sickness foci was confirmed to be expanding northeast words from its traditional Busoga region at the shores of lake Victoria. Studies have attributed this expansion to movement of animal reservoirs. According to Picozzi *et al.,* (2005), the distance between these two diseases foci has reduced to only about 150 km. Animal and Rhodesian human trypanosomosis have been confirmed as far as Teso and Lango sub-regions (Picozzi *et al.,* 2005). These areas share porous borders from Karamoja region, where the present epidemiologic investigation was conducted with the objectives of determining the prevalence and characterizing trypanosome species and subspecies incriminated in the Kotido district outbreak of bovine trypanosomosis. The present study was prompted by Between April and May 2011, a public outcry over suspected outbreak of bovine trypanosomosis in Kotido district between April and May 2011.

**Methods and Materials**

The study was conducted in Kotido district, which is situated in the northern part of the semi-arid Karamoja region of Uganda. The later comprises seven districts (Kotido, Kaabong, Abim, Moroto, Napak, Amudat & Nakapiripirit districts) in the far northeast corner of Uganda. Kotido district consists of Jie county, which encompasses one town council (Kotido) and five sub counties (Kotido, Kacheri, Nakapelimoru, Panyangara & Rengen), with approximately 22,927 households at averagely 7.5 persons per household (MAAIF and UBOS, 2009). Accordingly, about 85.6% of these households derive their livelihoods from rearing livestock. The Jie pastoralists in Kotido district exhibit high frequency of short nomadic transhumance due to shortage of pastures and water. Their district is largely semi-arid and highly prone to cyclical droughts that may last 5-15 months. The district has bi-modal variable rainfall pattern with an average annual rainfall of 500-600 ml. The rainy season may last for four months, starting from late March or early April until late September or early October. The terrain is flat grassland with a few scattered thorn bushes and trees, except along seasonal rivers, where thickets and patches of gallery forest are found. About 30% of Karamoja's 2.3 million cattle (MAAIF and UBOS, 2009) are owned by the Jie sub-ethnic group in Kotido district. Due to prevailing insecurity stemming from cattle rustling, over 95% of the livestock are communally grazed in large communal kraals guarded by the Uganda Peoples' Defence Forces (UPDF). In Kotido district, herds are economic, social and cultural asset, and their sizes are critical for household welfare; as source of meat, milk and blood, social safety net and performing religious and cultural ceremonies/rituals including payment of bride price, among other values.

This cross-sectional epidemiological survey was conducted in two phases. The initial phase randomly sampled 706 cattle from seven protected communal kraals in Rengen, Kacheri, Panyangara and Kotido sub-counties to determine

prevalence and spatial distribution of trypanosomes, using microscopy techniques. During the preliminary survey, about 2.0 ml of jugular blood was collected into heparinized and plain vacutainers and preserved at 4o C in a car fridge. These samples were processed and analyzed immediately at the temporary field laboratory set up at the office of the District Veterinary Officer (DVO). This was done from the 20th -28th May, 2011. All samples were collected in the morning hours between 7-10 am, east African time. The preliminary survey results informed planning for the second phase study that was conducted in July 2011; in which whole blood was collected from 199 cattle, which belonged to Lokona, Lotanyet and Natuket communal kraals. These samples were preserved on FTA® cards until required for DNA extraction at the University of Edinburgh, where PCR analyses were conducted to identify the species and subspecies of the incriminated trypanosomes.

A combination of micro-hematocrit centrifugation buffy coat (MHC) and field's thick and thin films parasitological techniques were used to estimate prevalence of bovine trypanosomosis in the study area.The PCV values were measured as described previously by Marcotty *et al.,* (2008), whilst the body condition of sampled animals were scored following criteria developed by Dierenfeld and Lukuyu (2010) for scoring native cattle in Uganda.

For molecular analyses, DNA extraction was executed according to the technique by Ahmed *et al.,* (2011). All the 199 FTA blood samples were screened initially by ribosomal intergenic transcribed spacer (ITS)-PCR (Njiru *et al.,* 2005), and then re-subjected to Trypanosoma brucei (TBR)-PCR (Moser *et al.,* 1989). All samples that amplified for *Trypanozoon* (480 bp) were then ran on SRA/PLC multiplex PCR (Picozzi *et al.,* 2008).

The raw data was initially entered on Microsoft Excel spread sheets and then exported to SPSS version 16.0 for analysis. Univariable analysis was done to summarize the data into proportions. The proportions of disease status, the mean PCV values and body condition score of cattle among different kraals were compared using the chi-square test, at 5% level of significance.

**Results**

Approximately 92% (652/706) of all sampled cattle had BCS below 3.0, 3.7% (26/706) had BSC of 3.0, while only 3.1% (22/706) had BSC above 3.0. The overall mean BCS in the study area was (2.1± 0.9), while the mean BCS of trypanosomosis positive and negative cattle were 1.9 and 2.1 respectively.

The overall mean PCV of all sampled cattle was 28.5 ± 5.8%. All kraals had

mean PCV above 24% but less than 30%, ranging from 26.8% to 29.9% as depicted by the box plot below.

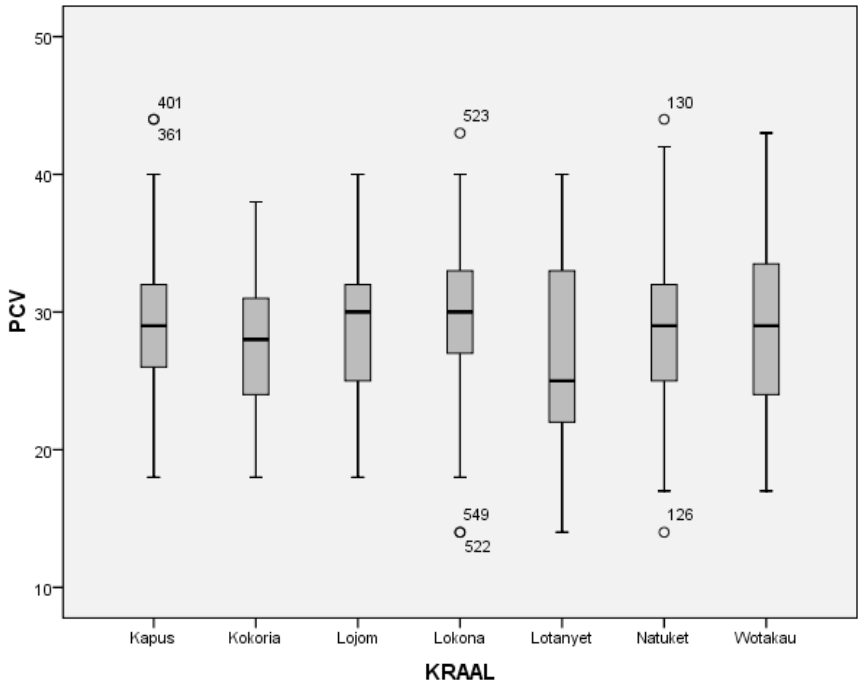



***Figure 1:*** *Box plot showing the median, quartiles and extreme PCV values of seven communal kraals in Kotido district.*

However, the mean PCV of samples that tested positive to trypanosomosis (23.7%) by microscopy was significantly lower than that of microscopy test negative samples (29.0%) (Two-sample Student's t-test, P=0.0001). Five samples recorded the lowest PCV value of 14%, while 3 samples had the highest PCV of 44%.

Based on microscopy, the sample estimate of overall prevalence of trypanosomosis in Kotido district was 5.2% (37/706); Lokona communal kraal 11.5% (9/78), Lotanyet 11.0% (15/137) and Natuket 5.9% (13/220), while the remaining four communal kraals (Kapus, Kokoria, Lojom and Wotakau) were test negative for trypanosomosis (Table 1).

These results were interpreted according to Ian Dohoo *et al.,* (2003), where animals that test positive to one test, the other test or both were considered test positive.

**Table 1:** *Prevalence of trypanosomosis in seven communal kraals; based on parallel interpretation of buffy coat, thin film and thick film microscopy results*

| **KRAAL** | **Geographic position points** | | | **No. of samples tested (n1)** | **Trypanosome-test positivity (%)** | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Thin film | Thick film | MHC Buffy coat | Kraal prevalence |
| Kapus | 36 N 328227 | 603415 | UTM | 101 | 0 | 0 | 0 | 0 |
| Kokoria | 36 N 345448 | 611022 | UTM | 32 | 0 | 0 | 0 | 0 |
| Lojom | 36 N 326285 | 625360 | UTM | 47 | 0 | 0 | 0 | 0 |
| Lokona | 36 N 349734 | 603490 | UTM | 78 | 3(3.9%) | 9(11.5%) | 7(9.0%) | 9(11.5%) |
| Lotanyet | 36 N 354155 | 590043 | UTM | 137 | 5(3.7%) | 5(3.7%) | 14(10.2%) | 15(11.0%) |
| Natuket | 36 N 340058 | 620278 | UTM | 220 | 4(1.8%) | 10(4.5%) | 11(5.0%) | 13(5.9%) |
| Wotakau | 36 N 340769 | 622048 | UTM | 91 | 0 | 0 | 0 | 0 |
| **Total** | | | | **706** | **12(1.7%)** | **24(3.4%)** | **32(4.5%)** | **37(5.2%)** |

***Table 2:*** *ITS and TBR-PCRs detected trypanosome species and subspecies in Kotido district*

| **Kraal** | **Number of samples tested (n2)** | Trypanosome test positivity (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *T. vivax* | *T. simae* | *T. congolense Savannah* | *T. congolense Forest* | *T. congolense Kilifi* | *Trypanozoon* | Total |
| Natuket | 89 | 25 (12.6%) | 0 | 3 (1.5%) | 0 | 0 | 9 (4.15) | 18.6% |
| Lotanyet | 84 | 12 (6.0%) | 0 | 0 | 0 | 0 | 14 (10.2%) | 13.1% |
| Lokona | 26 | 5 (2.5%) | 1 (0.5%) | 0 | 0 | 0 | 8 (10.3%) | 7.0% |
| **sub-total** | **199** | **42 (21.1%)** | **1 (0.5%)** | **3 (1.5%)** | **0** | **0** | **31 (15.6%)** | **38.7%** |
| **% of positive** | | **87.6%** | **2.1%** | **6.2%** | **0.0%** | **0.0%** | **4.1%** | **100.0%** |

**Discussion**

Whilst the recorded history of trypanosomosis in Uganda dates back to late 1890's (Duke, 1916, Cook, 1901), it was generally believed that trypanosomes were absent in the semi-arid Karamoja region due to harsh climatic conditions. Although Deshler (1960) was able to reveal that tsetse flies first appeared to Karamoja in the early 1920's, a nationwide survey conducted in the late 1960's declared Karamoja region free from tsetse flies and trypanosomes. The bushes of Dodoth county (currently Kaabong district) were cleared off the tsetse flies by the by the British Colonial Government (Deshler, 1960). The documented evidence of presence of trypanosomes in domestic animals from Karamoja region remained largely lacking until the present study.

The Kotido district outbreak of bovine trypanosomosis occurred shortly after return of rain in late March 2011, following a dry spell between late October 2010 and early March 2011. During this dry season, which lasted for about five months, pastoralists from southern parts of Kotido district migrated with their herds towards Abim district whilst pastoralists from northern Kotido grazed their livestock along Kapeta valley at Kotido/Kaabong border, close to Kidepo valley national Game Park. While on their migratory quest for pastures and water, pastoralists from Kacheri and Rengen sub-counties allegedly came across tsetse flies at Longorikipi dam, Lokorikipi-Kapeta valley and Lolelia sub-county in Kaabong district. Some pastoralists lamented being bitten by the flies. Also they reported that their herds interfaced with buffalos, wild pigs, antelopes and other wild animals.

The results in this study confirmed an outbreak of bovine trypanosomosis in Lokona, Lotanyet and Natuket protected communal kraals in Kacheri and Rengen sub counties, Kotido district, Northern Karamoja. Unlike the other four protected communal kraals that tested negative for trypanosomosis, Lokona, Lotanyet and Natuket had a history of recent interface with wildlife at Kapeta valley, along Kotido/Kaabong border. Kapeta valley is a dry season favorable grazing area for Karamojong pastoralists. It is also a favorable destination point for buffalos and elephants from Kidepo National Game Park in the neighboring Kaabong district. The African buffalo is particularly known to be a very important reservoir of various species and subspecies of trypanosomes (Anderson *et al.,* 2011). It is therefore possible that the Kotido district outbreak of bovine trypanosomosis may have originated from livestock-wildlife interactions.

The overall prevalence of trypanosomosis in the three kraals (Lokona, Lotanyet & Natuket) was 33.7% (67/199) and 8.5% (37/435) by PCR and microscopy respectively. The microscopy prevalence results of trypanosomosis reported in this study was similar to the 7.1% previously recorded in Tororo and Soroti

districts (Magona *et al.,* 2002) and the 8.9% in Butaleja district (Jing et al., 2009), eastern Uganda. The interpretation of microscopy results was based on parallel hypothesis, where animals that tested positive to one test, the other test or both tests; were considered test positive (Ian Dohoo *et al.,* 2003). A higher percentage 86.5% (32/37) of the 37 trypanosome positive samples were recorded by micro-hematocrit buffy coat (MHC), compared to 64.9% (24/37) by thick film and 32.4% (12/37) by thin film techniques. These results were in agreement with previous study (Brown, 1990), where sensitivity of microscopic methods decreased in the order of; MHC> thick film > thin film.

Among 199 samples typed by PCRs, *T. vivax* amplified in most 21.1% (42/199) followed by *Trypanozoon* 15.6% (31/199), *T. congolense* Savannah 1.5% (3/199) and *T. simae* 0.5% (1/199). None of the samples tested positive for T. godfreyi, *T. congolense* Kilifi and Forest subtypes. Whereas 3.5% (7/199) of the samples had double trypanosome infections, only 0.5% (1/199) had triple infection with T. vivax, *T. congolense* Savannah and *Trypanozoon*. Previous studies in Uganda reported trypanosome mixed infections in cattle, yet triple infections remain a rare occurrence (Njiru *et al.,* 2004). The detection of multiple infections further substantiates the fact that cattle are indeed potential reservoirs of various species and subspecies of trypanosomes, including the human infective *T. b. rhodesiense*.

The relatively high prevalence of *T. vivax* detected in this study may probably explain the high mortality reported by Kotido pastoralists. The clinical signs were typical as those reported by Magona *et al.,* (2008), which included enlarged superficial lymph nodes, pale mucous membranes, rough hair coat, photophobia, excessive lacrimination, diarrhoea, wasting and sometimes bleeding from the ears.

Only 1.0% (2/199) was positive for *Trypanozoon* by internal transcribed spacer (ITS)-1, compared to 14.6% (29/199) by Trypanosoma brucei (TBR) primers. However, TBR primers produced faint PCR amplification products, suggesting chronic low grade infections in the local cattle population. Consequently, the wide discrepancy between ITS-1 and TBR detected prevalence of *Trypanozoon* could be attributed to very low parasitaemia levels that often occur in animal reservoirs (Katunguka-Rwakishaya, 1996). Besides, TBR primers are specific for *T. brucei* subspecies (Moser *et al.,* 1989), making them could be more sensitive in detecting *T. brucei* infections than ITS-1 primers.

The human serum resistance-associated (SRA) gene was not detected in any of the *Trypanozoon* ITS-PCR positive samples. This, however, does not rule out possibility of presence of *T. b. brucei* and/or the human infective *T. b.*

*rhodesiense* subspecies in the local cattle population since even the PLC gene was not detected, indicating that the amount of *T. brucei* genomic material in the samples was possibly too little to be amplified. Alternatively, being single copy genes, the SRA and PLC are likely to be vulnerable targets for antigenic variation, a phenomenon that would result in different variants that could not be amplified by the current target primers (Enyaru *et al.,* 2006). Previous studies have so far identified three different variants of the SRA gene.

The PCR results in this study concur with previous reports of *T. congolense* Savannah being most widely prevalent in East Africa (Malele *et al.,* 2003, Adams *et al.,* 2006) including Uganda (Magona *et al.,* 2008, Jing *et al.,* 2009) than the other two subtypes. These studies however, show clear variations in spatial prevalence of *T. congolense* subtypes. The 1.5% PCR detected prevalence of *T. congolense* Savannah was half that reported by Magona *et al.,* (2008) but higher than the 0.9% observed by Jing *et al.,* (2009) in Butaleja district in Uganda. None of these studies detected *T. congolense* Kilifi and Forest subtypes. Besides being more prevalent, *T. congolense* Savannah is also thought to be more pathogenic than the other two subtypes (Bengaly *et al.,* 2000).

The recent increasing detection of *T. simae* in domestic cattle could be linked to interaction with wild boars during grazing. It still remains uncertain whether cattle could indeed act as a natural reservoir of *T. simae*, a trypanosome species known to cause acute fatal disease in pigs.

Despite the fact that, the mean PCV of trypanosome test positive samples (23.7%) was significantly lower than that for negative samples (29.0%) (Two-sample Student's t-test, P=0.0001), this study demonstrated that PCV was not a good indicator of trypanosome infection as there was more significant association between PCV and trypanosome test negativity than positivity (Table 6). This observation suggests presence of other PCV determinants that were more general across the study population. These could include among others; poor nutrition (since outbreak occurred shortly after drought), high temperature (Jing *et al.,* 2009) and concurrent infections with tick borne diseases (TBDs) and helminthosis.

Like the PCV, the mean BCS (1.9) of trypanosomosis positive cattle was significantly lower than mean BCS (2.1) of trypanosomosis negative cattle, indicating that the disease had real impact on body condition of infected cattle. However, the overall mean BCS (2.1) of cattle in the study area was lower than the recommended ideal mean BCS (2.8), which suggests the influence of other factors.

**Conclusions.**

This study confirmed the outbreak of bovine trypanosomosis in Kacheri and Rengen sub-counties, Kotido district, more specifically in Lokona, Lotanyet and Natuket protected communal kraals, which registered prevalence of 11.5%, 11.0% and 6.0% respectively by microscopy, as compared to 7.0%, 13.1% and 18.6% respectively by PCRs. The other four communal kraals (Watakau, Lojom, Kapus and Kokoria) were free from trypanosomosis. PCR typing identified multiple trypanosomes with *T. vivax* being most prevalent, amplifying 21.1% (42/199), followed by *Trypanozoon* 15.6% (31/199), *T. congolense* Savannah 1.5% (3/199) and *T. simae* 0.5% (1/199). Only one sample (lane 28 in Figure 11), a female adult cow from Natuket communal kraal, had a triple infection whilst 3.5% (7/199) had double trypanosome infections. There was a wide discrepancy between ITS-1 and TBR detected prevalence of *Trypanozoon*. This could have arisen from very low parasitaemia levels that often occur in indigenous cattle reservoirs. The SRA and PLC single copy genes were not detected in any of the samples subjected to SRA multiplex PCR, indicating that the amount of genomic material was possibly too little to be amplified or there were different variants of the SRA gene that could not be detected by the present target primers.

Although this study did not complete typing of *Trypanozoon* to subspecies level, the presence of *T. b. brucei* and the human infective *T. b. rhodesiense* circulating in the cattle population might not be ruled out. *T. b. gambiense* is generally thought to be non-infective to cattle. While *T. b. brucei* and *T. congolense* are considered non-infective and non-pathogenic to humans, sporadic infections with these animal pathogens have been reported in man (Deborggraeve *et al.,* 2008, Truc *et al.,* 1998). The fact that *Trypanozoon* and *T. congolense* were detected in the March/April 2011 outbreak of bovine trypanosomosis in Kotido district, northern Karamoja, meant that the epidemic tentatively had zoonotic potential to infect humans. Hence, further studies should be undertaken to strain type, map and track origins and movements of animal and human infective trypanosomes in all the seven districts in Karamoja region. The outcome of this study informs stakeholders engaged in pastoral and agro-pastoral livelihoods programming that trypanosomes are present in Karamoja and control efforts should be undertaken. This is particularly important since the government of Uganda expressed interest in promoting commercial beef production in Karamoja region.

**Recommendations**

1. Undertaking further studies to strain type, map and track origins of trypanosomes in all surrounding districts in Karamoja region.
2. Investigating the pathogencity of *T. simae* in cattle and the role played by cattle in the epidemiology of *T. simae* infections in pigs in Karamoja

region.

3. Instituting active trypanosomosis surveillance and monitoring in Karamoja region so that any overlap in distribution of the human-infective trypanosomes can be detected as early as possible.
4. Undertaking socio-economic impact assessment of incursion of trypanosomosis into pastoral and agro-pastoral livelihoods of the Karamojongs.
5. Developing a complete understanding of trypanosomosis situation in Karamoja region requires one health approach should investigate the situation in humans, livestock and wildlife populations, putting into consideration the indigenous knowledge of the pastoralists so as to generate concrete evidence data for advocacy and awareness creation and develop a sustainable control strategy. This is particularly important because trypanosomosis usually receives minimal attention from local authorities, since the disease mostly affects the rural low economic class (Brun *et al.,* 2009).

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# MOLECULAR DETECTION OF SOME BOVINE TRYPANOSOME ISOLATES FROM DIFFERENT AREAS OF SUDAN

# DETECTION MOLECULAIRE DE CERTAINS ISOLATS DE TRYPANOSOME BOVIN DE DIFFERENTES REGIONS DU SOUDAN

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## Résumé

La réaction en chaîne de la polymérase (PCR) a été utilisée pour la détection des trypanosomes sur les cartes FTA de sang. Au total, 97 échantillons de sang prélevés chez des bovins infectés dans différentes régions du Soudan ont été testés. La PCR a été effectuée après l'extraction de l'ADN, conformément à un protocole de purification des kits d'ADN génomique Invitrogen Purelink, au moyen de trois ensembles d'amorces. Le premier ensemble était constitué d'amorces spécifiques aux espèces de Trypanosoma (Nannomonas) congolense des types de savane et de Kilifi, T. (*Trypanozoon*) brucei et T. (Dunonella) vivax. Le deuxième ensemble était composé d'amorces SES utilisées comme test unique ; et le troisième ensemble était constitué d'amorces ITS utilisées dans une PCR nichée. Les résultats du PCR ont indiqué que, en plus de la présence de *T. vivax* et *T. brucei*, les seuls groupes taxonomiques de *T. congolense* identifiés au Soudan appartenaient au type de savane. Aucune infection attribuable à *T. congolense* Kilifi n'a été détectée. Ces travaux ont confirmé l'existence d'infections mixtes, qui ne peuvent pas être détectées par les méthodes parasitologiques classiques.

**Mots-clés :** Trypanosoma congolense, T. vivax, Bétail

## Summary

Polymerase chain reaction (PCR) was used for detection of trypanosomes on blood of FTA cards. A total of 97 blood samples isolated from infected cattle in different areas of Sudan were tested. The PCR was carried out after DNA extraction according to a protocol of purification of invitrogen Purelink genomic DNA kits, using three sets of primers. The first set was species specific primers to Trypanosoma (Nannomonas) congolense of Savannah and Kilifi types, T. (*Trypanozoon*) brucei and T. (Dunonella) vivax. The second set was ITS primers used as a single test and the third set of primers

was ITS primers used in a nested PCR. The results of the PCR indicated that in addition to the presence of *T. vivax* and *T. brucei*, the only *T. congolense* taxonomic groups identified in Sudan belonged to the Savannah type. No infection attributable to *T. congolense* Kilifi was detected. This work confirmed the existence of mixed infections in the field, which cannot be detected by the classical parasitological methods.

**Keywords:** Trypanosoma congolense,T. vivax, cattle

## Introduction

Parasitological diagnosis of animal trypanosomosis with low parasitaemia is hampered by low diagnostic sensitivity of traditional detection methods, so many serological and molecular tests had been developed to improve the disease diagnosis (Uilenberg, 1998; Eisler *et al.,* 2004). Several molecular tools have been developed and widely used for detection and characterization of different trypanosomes species (Adams and Hamilton, 2008). In addition to trypanosome species specific primers, Research is now focusing on diagnosis based on the amplification of the internal transcribed spacer-1 (ITS-1) of ribosomal DNA which may lead to the development of a multi-species-specific diagnostic protocol using a single PCR. Recently a new PCR method, ITS-PCR has enabled differentiation to the species level of some or all trypanosomes circulating in an animal host by means of a single and nested PCR reaction based on identification of Internal transcribed (ITS) regions of the parasite genome (Desquesnes et al, 2001, Njuri, *et al.,* 2005 and Cox et al, 2005).

## The Objectives of the following study:

Molecular detection of trypanosomes isolated from cattle in different areas of Sudan, in order to identify the parasites accurately

## Materials and Methods

Samples: 97 blood samples on FTA cards were collected from cattle from several areas of Sudan. One hundred and twenty microlitres of whole blood were applied directly onto FTA® Cards (Whatman®) DNA extraction from FTA blood samples was performed using invitrogen kits.

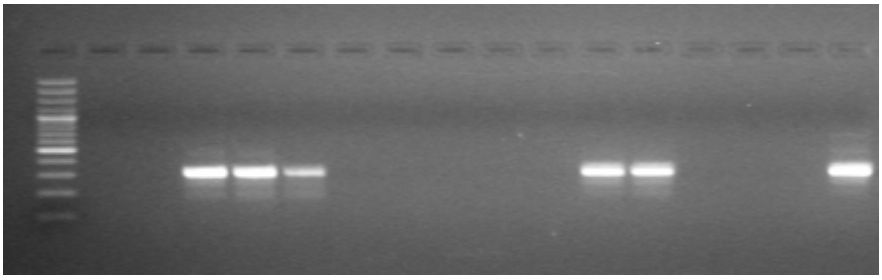
Primers: Species specific primers ( Masiga *et al.,* 1992), ITS CF and ITS BR primers (Njuri, *et al.,* 2005) and nested ITS primers (Cox et al, 2005), were purchased from Bioneer Company (USA).

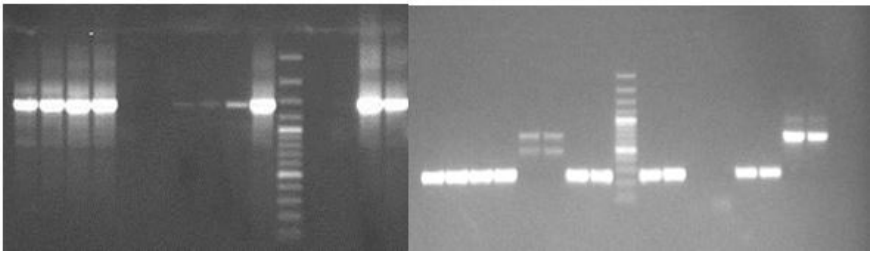
Statistical analysis was performed using SPSS 14. Results obtained using the

different sets of primers were compared. The level of significance was P£ 0.05




*Results*





Species specific PCR

Nested ITS PCR ITS CF and ITS BR PCR

***Table 1:*** *Molecular Detection of trypanosome species from different areas of Sudan*

| | Species specific PCR | | | | | | | | Nested ITS PCR | | | | | | | ITS CF and ITS BR PCR | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area** | **No of samples** | ***T. v*** | ***T. c* S** | ***T. c* K** | ***T. b*** | ***T. v* + *T. c* S** | ***T. b* + *T. c* S** | **Total Positive** | ***T. v*** | ***T. c* S** | ***T. c* K** | ***T. b*** | ***T. v* + *T. c* S** | ***T. b* + *T. c* S** | **Total Positive** | ***T. v*** | ***T. c* S** | ***T. c* K** | ***T. b*** | ***T. v* + *T. c* S** | ***T. b* + *T. c* S** | **Total Positive** |
| **Blue Nile** | 47 | 1 | 35 | 0 | 0 | 1 | 0 | 37 | 4 | 30 | 0 | 0 | 3 | 0 | 37 | 4 | 33 | 0 | 0 | 5 | 0 | 42 |
| **South Darfur** | 15 | 1 | 11 | 0 | 0 | 0 | 1 | 13 | 1 | 10 | 0 | 0 | 0 | 1 | 12 | 1 | 8 | 0 | 0 | 0 | 2 | 11 |
| **Gedaref** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| **Gazira** | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 4 |
| **Sennar** | 7 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| **Khartoum** | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **North Kordofan** | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Unity** | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 97 | 12 | 46 | 0 | 0 | 1 | 1 | 60 | 12 | 40 | 0 | 0 | 3 | 1 | 56 | 14 | 41 | 0 | 0 | 5 | 2 | 62 |

*T. v, T. c S, T. c K and T. b represent T. vivax,* T. congolense *Savannah,* T. congolense *kilifi and T. brucei, respectively*

**Conclusions/Recommendations**

The present study ascertained the suitability of using ITS based PCR assays for large-scale epidemiological studies in Sudan. The three PCR primer sets allowing diagnosis of trypanosome infections with reasonable sensitivity and high specificity. By using PCR in this study, the different species of trypanosomes present in different areas of Sudan were determined. Trypanosoma congolense was by far the most abundant species of trypanosomes in the samples, only Savannah-type *T. congolense* was detected.

Improving sample preparing and preserving strategy will improve the sensitivity of PCR. Preparing FTA cards from buffy coats is by far better in improving the sensitivity of the PCR test as well as repeating DNA extraction from the same FTA cards several times using cheap DNA extraction methods to reduce the costs.

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# VIRULENCE OF TRYPANOSOMA CONGOLENSE STRAINS FROM KWAZULU-NATAL, SOUTH AFRICA

# VIRULENCE DES SOUCHES TRYPANOSOMACONGOLENSE DU KWAZULU-NATAL EN AFRIQUE DU SUD

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## Résumé

Trypanosoma congolense et *Trypanosoma vivax* infectent le bétail dans le nord-est du KwaZulu-Natal, en Afrique du Sud. Parmi les deux types génétiquement distincts de *T. congolense* – à savoir les sous-groupes savane et Kilifi- le premier est plus répandu et considéré comme responsable de la trypanosomose animale africaine (nagana) dans le KZN. L'objectif de la présente étude été de comparer la virulence des souches de *T. congolense* à l'intérieur du parc de Hluhluwe-Umfolozi ou des fermes près du parc (± 5 km) à celle des isolats éloignés (> 10 km) de ces parcs. Pour obtenir les isolats de T. congolense, le sang d'animaux connus parasitologiquement positifs ou de bovins symptomatiquement suspectés d'être atteints de nagana et de buffles du parc de Hluhluwe-Umfolozi a été passé en souris Balb/c. Sur les 26 isolats de *T. congolense* obtenus, 18 étaient de l'intérieur du parc ou à proximité tandis que 8 provenaient de bovins éloignés du parc. Environ 80% et 20% des isolats appartenaient respectivement à T.congolense savane et Kilifi. Pour définir la virulence, chaque isolat a été inoculé dans des groupes de six souris. Aucune différence statistique n'a été observée au niveau de la période pré-patente moyenne, la parasitémie maximale et la baisse de l'hématocrite. Des différences significatives ont été observées des jours après l'infection par une chute de l'hématocrite, la période patente et la durée de survie médiane. Ces différences ont été utilisées pour classer les isolats comme étant de virulence élevée, modérée ou faible. En tout, 46% étaient très virulents ; 27% étaient soit modérés ou faibles. Alors que 11 des 12 souches très virulentes provenaient d'animaux à l'intérieur ou à proximité des parcs, une seule des sept souches de faible virulence provenait d'animaux à proximité du parc. Ces résultats révèlent que la

prévalence de souches très virulentes est plus importante à l'intérieur et à proximité du parc par rapport aux fermes éloignées. La répartition géographique de ces souches par rapport au parc dans la zone a été discutée.

## Summary

Trypanosona congolense and Trypanosonavivax infect cattle in north-eastern KwaZulu-Natal, South Africa. Of the two genetically distinct types of T. congolense, Savannah and Kilifi sub-groups, the former is more prevalent and thought to be responsible for African animal trypanosomosis (nagana) in KZN. The objective of the present study was to compare the virulence of *T. congolense* strains from inside Hluhluwe-Umfolozi Game Park or farms near the game parks (± 5 km) to that of isolates away (>10km) from these parks. To obtain T. congolenseisolates, blood of known parasitologically positive or cattle symptomatically suspected to be suffering from nagana and buffaloes from inside Hluhluwe-Umfolozi Game Park were passaged in inbred Balb/c mice. Of the 26 T. congolenseisolates obtained, 18 were from inside or cattle near the game parks and eight were from cattle away. About 80% and 20% of isolates to belonged to T.congolenseSavannah and Kilifi respectively. To define virulence, each isolate was inoculated into groups of six mice. No statistical differences were observed in the mean pre-patent period, maximum parasitaemia and drop in PCV. Significant differences were found in days after infection for a drop in PCV, patent period and median survival time. These differences were used to categorize the isolates as being high, moderate or low virulent. In all, 46% were highly virulent; 27% either moderate or low virulent. While 11 of the 12 high virulent strains were from animals either inside or near the game parks, only one of seven low virulence strains was from near the park. These results indicate the prevalence of high virulent strains to be higher inside and near the parks than on farms further away. The geographical distribution of these strains in relation to the game parks in the area is discussed.

## Introduction

African animal trypanosomosis or nagana is a wasting disease of livestock caused by unicellular blood parasites of the genus Trypanosoma commonly known as trypanosomes (Minnaar 1989). Pathogenic trypanosomes infecting livestock are primarily transmitted cyclically by various species of Glossina, tsetse flies (Diptera: Glossinidae). However, mechanical transmission of certain trypanosome species, such as *Trypanosoma vivax* and Trypanosoma evansi, by biting flies of the family Tabanidae does occur (Allsopp & Newton 1985; Gardiner 1989; Hoare 1972). In South Africa, animal trypanosomosis is restricted to the north-eastern parts of KwaZulu-Natal (KZN) Province. Pathogenic trypanosomes infecting cattle in KZN are Trypanosoma congolense and *T. vivax* (Gillingwater, Mamabolo & Majiwa 2010; Mamabolo *et al.,* 2009; Van den Bossche *et al.,* 2006). Trypanosoma congolense is considered the most pathogenic trypanosome species infecting livestock with great variation in its virulence (Bengaly *et al.,* 2002). Recently, two genetically

distinct types of T. congolense, Savannah and Kilifi, have been isolated from cattle and tsetse flies in KZN (Mamabolo *et al.,* 2009). The main vector for *T. congolense* in this region is Glossina austeni (Motloang *et al.,* 2012). Variation in pathogenicity of *T. congolense* Savannah sub-group is ascribed to strain differences (Masumu *et al.,* 2006; Van den Bossche *et al.,* 2011). In South Africa, Savannah sub-group is more prevalent and thought to be responsible for occasional disease outbreaks in north-eastern KZN (Gillingwater *et al.,* 2010; Mamabolo *et al.,* 2009).

African trypanosomes exhibit a wide range of virulence in vertebrate hosts (Joshua 1990). Nonetheless, the range and severity of pathological effects are influenced by a range of variables that involves the parasite, geographic regions and the host (Murray & Morrison 1978; Taylor & Authié 2004). Substantial variations in pathogenicity between strains of Savannah sub-group exist, with some strains producing more severe disease outcomes than others (Masumu *et al.,* 2006; Van den Bossche *et al.,* 2011). This variation has been associated with the type of transmission occurring either inside wildlife reserves or in communal areas where large wild animals are rare or absent. Sylvatic transmission associated with large wild animals is responsible for acute disease in livestock kept at the wildlife– livestock interface. In contrast, infection in cattle kept where large wild animals are rare or absent is mild, as a result of the domestication of trypanosome strains (Van den Bossche 2001). In a recent study, transmissibility of *T. congolense* to tsetse flies was shown to be influenced by its pathogenicity within the cycle type (Chitanga *et al.,* 2013). Both sylvatic and domestic strains were significantly better transmitted if they are more pathogenic to mice.

**This study was carried out to investigate the virulence of**

*T. congolense* strains isolated from African buffaloes (Syncerus caffer) kept inside Hluhluwe-iMfolozi Park (HiP) and from cattle kept by communal farmers near and farther away from wildlife parks in north-eastern KZN, South Africa. The study not only expands on the findings of Van den Bossche (2001) but is also the first to determine the geographical location of virulent *T. congolense* strains in KZN, South Africa.

## Research method and design

*Sampling*

Blood samples were collected from cattle at eight communal diptanks and one commercial farm in north-eastern KZN. Five of the eight diptanks were located less than 5 km from wildlife parks. None of the blood samples taken at diptank 1, 3, 5 and 6 (Ekuhlehleni, Khume, Ntabayengwe and Ekuphindisweni, respectively), were parasitologically positive. As a result, only four diptanks:

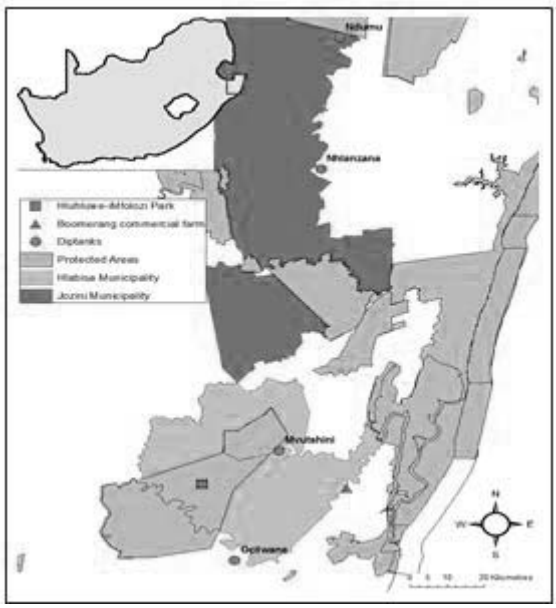
2, 4, 7 and 8 circled in black (Figure 1) are referred to in the present study. Of these, Mvutshini (28.124369 S; 32.134825 E) and Ocilwane (28.412914 S; 32.992797 E) are situated 2.6 km and 3.7 km from HiP, respectively, whilst Ndumo (26.933675 S; 32.281539E) lies 2.8 km south of Ndumo Game Reserve. The fourth diptank, Nhlanzana (27.312822 S; 32.237039 E) is located 47.9 km south of Ndumo Game Reserve (Figure 1). Additional sampling was undertaken at Boomerang commercial farm (28.23285 S; 32.298717 E) situated about 10 km away from Charters Creek, the closest protected area harbouring large wild animals. Buffalo blood samples originating from HiP (28.219592 S; 31.947886 E) were obtained in the form of stabilate from the reference collection at the Department of Veterinary Tropical Diseases, Faculty of Veterinary Sciences of the University of Pretoria.

*Stabilate preparation*

Blood from individual cattle was screened to determine the packed cell volume (PCV) and the presence of trypanosome parasites using the buffy coat dark ground/phase contrast technique (Murray, Murray & McIntyre 1977). Blood samples from infected cattle or cattle symptomatically suspected to be suffering from nagana as determined by low PCV values (Marcotty *et al.,* 2008) were inoculated intraperitoneally in inbred BALB/c mice (Masumu *et al.,* 2006). The inoculated mice were monitored three times a week for the development of parasitaemia by examination of wet blood films prepared from tail-derived blood drops (Herbert & Lumsden 1976). Blood of parasitologically positive mice was used to prepare buffy coat on FTA® elute micro-cards for DNA analysis. The micro-cards were allowed to air-dry and stored in sealed plastic bags at room temperature until use. The remaining blood was stored as stabilate at -180 °C until required. In total, 26 stabilates were prepared, amongst which 5 originated from buffaloes, 13 from cattle near wildlife parks and 8 from cattle kept away from parks.

Molecular characterisation of trypanosomes Trypanosoma DNA was characterised using universal primer pairs targeting the segment of the 18S ribosomal RNA gene of all trypanosomes described by Geysen, Delespaux and Geerts (2003). Species characterisation was performed with the application of oligonucleotide primers amplifying the satellite DNA monomers of Trypanosoma brucei (Sloof *et al.,* 1983), *T. congolense* Kilifi type, (Masiga *et al.,* 1992), *T. congolense* Savannah type (Majiwa & Otieno 1990) and T. vivax

(Masake *et al.,* 1997). Known Kilifi (OVIKZNTT/7098/07) and Savannah (IL1180) *T. congolense* strains were used as positive controls. In addition, TVIL 2160, TBA4 and OVI1 were used as positive controls for T. vivax, *T. brucei* and Trypanosoma equiperdum, respectively, whilst pure grade water was added as a negative control.




*Source: Map drawn by Chantel de Beer*

***Figure 1:*** *Map showing the location of the six sampling sites in KwaZulu-Natal Province: Ndumo, Nhlanzana, Mvutshini, Ocilwane, Hhluhluwe-iMfolozi Park and Boomerang commercial farm.*

Following DNA extraction, amplification for both the 18S rRNA gene and species-specific polymerase chain reaction (PCR) was carried out in an automated Eppendorf Mastercycler gradient cycler (Eppendorf, Hamburg, Germany). PCR conditions for the 18S rRNA gene included denaturation for 4 min at 94 °C, followed by 35 cycles of 30 s denaturation at 94 °C, 30 s annealing at 58 °C and 2 min extension at 72 °C, whereas conditions for species-specific amplification included denaturation at 94 °C for 3 min, followed by 30 cycles of 1 min each at 94 °C, 60 °C and 72 °C. Amplified products were resolved by electrophoresis through 1.5% agarose gel containing 0.5 μg/mL of ethidium bromide. Products were run against a 100 bp molecular marker, O'GeneRuler (Fermentas, Waltham, USA). Separated PCR products were analysed using a gel documenting system (Quantity One 4.6.3; BioRad, Berkeley, USA) and species identified according to their molecular band sizes.

*Assessment of virulence*

The virulence of each *T. congolense* isolate was determined in a group of six BALB/c mice. Each isolate was first resuscitated in two mice to prepare the infective doses. The mice were monitored every second day for the development of parasitaemia as described above. When parasitaemia in infected mice was

estimated to be 107.8 trypanosomes per mL or higher, a drop of tail blood was diluted in phosphate buffer saline glucose (PSG) to make a final concentration of 105 trypanosomes in a total volume of 0.2 mL (Masumu *et al.,* 2006). The resultant mix was used immediately as an infection dose (0.2 mL). An additional group of six mice injected with 0.2 mL PSG was used as a negative control.

Parasitaemia was recorded daily for the first 2 weeks and every second day for the remainder of the experiment, up to 90 days post infection, as described by Masumu *et al.,* (2006). Mice were considered parasitologically negative when no trypanosomes were detected in at least 50 microscopic fields. Mice were declared uninfected when parasites could not be detected for 30 successive days, that is, for 15 successive samplings. A baseline PCV was recorded for each mouse in all the groups by microhaematocrit centrifugation methods before infection. Subsequent PCV was measured three times a week for the first 2 weeks following infection and once a week for the duration of the experimental period. Death was recorded every day for all experimental and control groups. Virulence categories were determined according to the criteria described by Bengaly *et al.,* (2002) and Masumu *et al.,* (2006), with some modification. This included days to percentage drop in PCV, whilst the pre-patent period (PPP), the patent period (PP) and the survival time (ST) of each group of mice were retained. Based on these parameters, the field isolates were subsequently classified as high, moderate and low virulence strains (high virulence strain [HVS], moderate virulence strain [MVS] and low virulence strain [LVS], respectively).

All experimental mice were kept under standard animal housing facilities in an air conditioned room (22 °C – 23 °C) with a relative humidity of 60% – 70%. Mice were fed mouse pellets and supplied with clean water ad libitum.

*Statistical analysis*

For the purpose of this study, a generalised linear model was used firstly to compare strain variability irrespective of origin and secondly with respect to origin. The number of days measured for the PPP, PP, ST and percentage PCV were used as continuous explanatory variables, whilst trypanosome strains were used as categorical explanatory variables. For the first three continuous explanatory variables, no measurement was made for the controls. The data were subjected to a one- way analysis of variance (ANOVA) excluding the controls to test for a significant strain effect. In the case where the strain effect was significant, the Student's t-LSD (least significant difference) was calculated at a 5% level of significance to compare and group strain means. Controls were included for the PCV variable, therefore the first ANOVA was performed to test whether the controls differ significantly followed by the final

ANOVA performed to compare the different strains with the pooled controls.

## Results

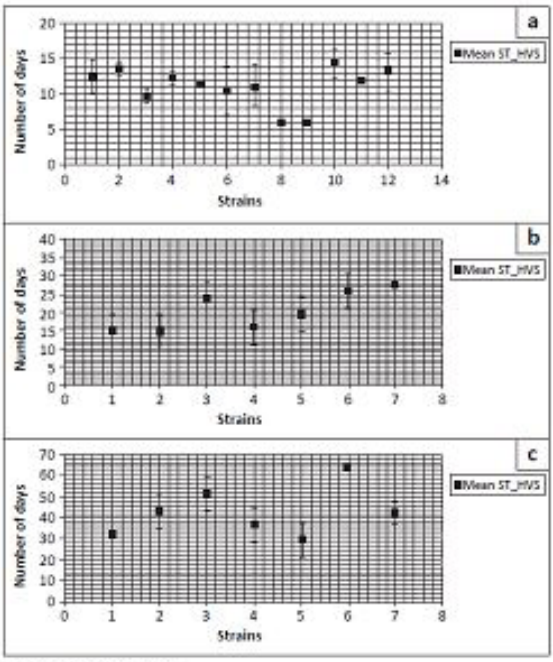
*Molecular identification of trypanosomes*

Using genotype-specific primers, amplification products for Savannah and Kilifi revealed 26 *T. congolense* isolates, of which 24 (92.3%) belonged to the Savannah and 2 (7.7%) were Kilifi sub-groups. All the strains gave a single molecular band profile following amplification with species-specific primer, confirming that there were no mixed infections. DNA of samples amplified with Savannah-specific primers could not be amplified when Kilifi, *T. brucei* and *T. vivax* specific primers were used. Moreover, when the primer sets for *T. vivax* and *T. brucei* were used, none of the samples were amplified except for the controls. Of the 24 *T. congolense* Savannah isolates, 5 were isolated from buffalo, 13 from cattle at the HiP interface and 6 from cattle kept further away from parks. All of the *T. congolense* Kilifi were obtained from areas away from the parks.

*Classification of virulent strains*

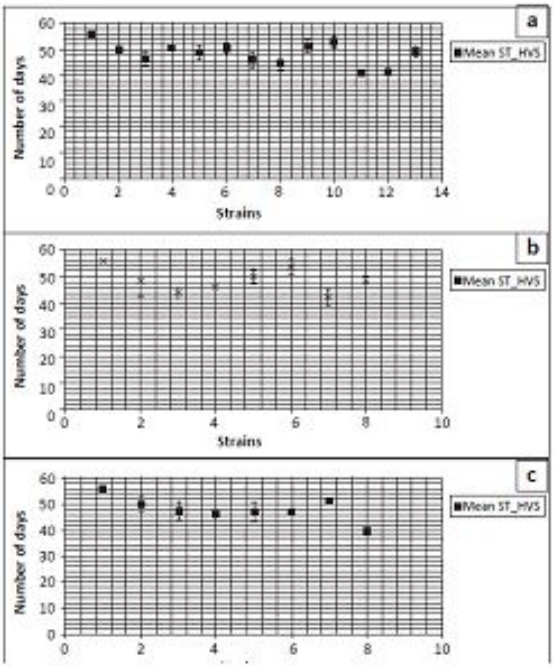
Isolates that killed mice within 2 weeks post infection were classified as HVS ($6 \pm 0.0 - 14 \pm 2.1$). Those that killed mice after 2 weeks up to a month were MVS ($16 \pm 2.1 - 27 \pm 7.3$) and where mice survived for longer than a month, the strains were categorised as LVS ($31 \pm 6.4 - 64 \pm 0.0$). Graphical representation of the results is shown in Figure 2. Mortality in the HVS, MVS and LVS groups was 100%, 100% and 82.0%, respectively. Only 8.3% of mice injected with the Kilifi strain died.

Variability between individual strains was highly significant for all explanatory variables ($p < 0.0001$). Grouping of strains




Source: Authors' own creation
ST, survival time; HVS, high virulence strain; MVS, moderate virulence strain; LVS, low virulence strain.

**FIGURE 2:** Trends in the mean survival time for the (a) high virulence strain (n = 12), (b) moderate virulence strain (n = 7) and (c) low virulence strain (n = 7).



*Source: Authors' own creation*

PCV, packed cell volume; HVS, high virulence strain; MVS, moderate virulence strain; LVS, low virulence strain.

***FIGURE 3:*** *Development of packed cell volume represented as mean for (a) high virulence strain, (b) moderate virulence strain and (c) low virulence strain. Mean control values are represented as the first point for the three categories.*

using the LSD value revealed that 46.2% were HVS, whilst 26.9% were either MVS or LVS (Table 1). The PPP and the PCV mean differences between the HVS, MVS and LVS categories were not significant ($p = 0.2739$ and $p = 0.7738$, respectively). In Figure 3, the first point in the three graphs represents the mean control PCV values.

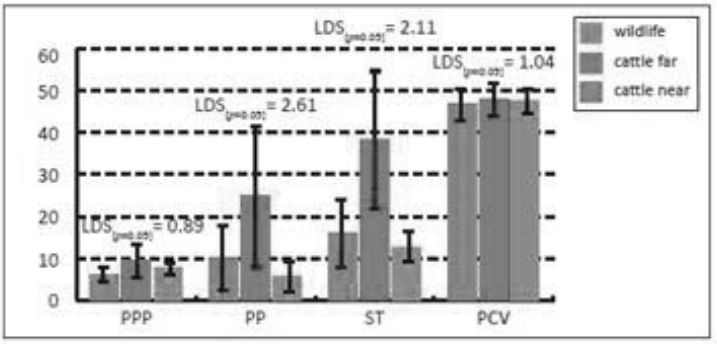
The mean differences for PP and the ST, on the other hand, were highly significant ($p < 0.0001$) between the three categories (Table 2).

Comparison and geographical distribution of virulent strain A summary of the prevalence and distribution of *T. congolense* strains is presented in Table 3. In all, 26 strains were collected and analysed. Of these, 5 (19.2%), 13 (50.0%) and 8 (30.8%) were collected inside the Park, near to, and away from the parks, respectively. The difference in PPP between strains collected from the buffaloes inside HiP, cattle near the parks and cattle far from the parks was highly significant (LSD[p =0.05] = 0.89). The PPP was recorded earlier in strains collected near the parks and strains collected inside HiP (mean 6.2 ± 2.3 and 7.9 ± 2.0, respectively), compared to strains collected far from the parks (mean 9.7 ± 4.3). Similarly, the PP (LSD[p = 0.05] = 2.67) and ST (LSD[p = 0.05] = 2.11), although significant between strains collected from the bufalloes inside HiP (mean 5.9 ± 4.1 and 12.8 ± 4.1, respectively) and from cattle near the parks (mean 10.4 ± 8.2 and 16.0 ± 8.6, respectively). Longer PP and ST were observed in strains collected far from the parks (mean 25.0 ± 17.3 and 38.3 ± 16.9, respectively). When the PCV variable was considered, the difference was not significant (LSD[p = 0.05] = 1.04). The means were 46.8 ± 4.3, 48.0 ± 4.5 and 47.6 ± 3.5 for strains collected from cattle close to and far from parks and buffaloes inside HiP, respectively (Figure 4).

*Ethical considerations*

Animal ethics approval for the experiments was obtained from the Animal

Ethics Committee of the Agricultural Research Council – Onderstepoort Veterinary Institute (ARC-OVI) (ref. 07/20/C174) and the Animal Use and Care Committee of the University of Pretoria, Faculty of Veterinary Science (ref. VO56-09).




*Source:* Authors' own creation
PPP, pre-patent period; PP, patent period; ST, survival time; PCV, packed cell volume; LSD, least significant difference.

**FIGURE 4:** Significance in the pre-patent period, patent period, survival time and packed cell volume between strains collected from Hluhluwe-iMfolozi Park, cattle near (< 5 km) and far (> 10 km) from game parks, with least significant difference calculated at $p = 0.05$.

**TABLE 1:** Means with standard deviations to compare and group strains into high, moderate and low virulence categories using the least significant difference.

| *N* | % | Strain | Origin | Virulence category | Mean | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | PPP ± s.d. | PP ± s.d. | ST ± s.d. | PCV ± s.d. |
| 12 | 46.2 | Bmrng_A1 | Far | High | 10 ± 0.0 | 3 ± 1.3 | 12 ± 1.0 | 49 ± 2.4 |
| | | MVUKZN_10 | Close | High | 6 ± 2.1 | 8 ± 0.5 | 12 ± 0.0 | 41 ± 1.6 |
| | | MVUKZN_5 | Close | High | 5 ± 0.8 | 7 ± 2.5 | 11 ± 2.9 | 45 ± 2.8 |
| | | MVUKZN_6 | Close | High | 6 ± 1.6 | 2 ± 1.6 | 6 ± 0.0 | 51 ± 2.3 |
| | | MVUKZN_7 | Close | High | 3 ± 0.6 | 4 ± 0.5 | 6 ± 0.0 | 53 ± 2.0 |
| | | MVUKZN_9 | Close | High | 5 ± 2.1 | 10 ± 3.3 | 14 ± 2.1 | 41 ± 1.6 |
| | | MVUZN_2 | Close | High | 8 ± 0.0 | 5 ± 0.5 | 12 ± 0.5 | 50 ± 2.5 |
| | | OCIKZN_1 | Close | High | 7 ± 0.1 | 6 ± 2.7 | 13 ± 2.6 | 49 ± 2.1 |
| | | TC-UP-KZNBT/1/06 | Wild | High | 9 ± 0.1 | 5 ± 1.8 | 13 ± 2.3 | 50 ± 1.5 |
| | | TC-UP-KZNBT/3/06 | Wild | High | 10 ± 1.6 | 5 ± 0.9 | 14 ± 0.8 | 46 ± 2.7 |
| | | TC-UP-KZNBT/4/06 | Wild | High | 7 ± 0.8 | 4 ± 1.7 | 10 ± 1.0 | 50 ± 0.8 |
| | | ndmT_1 | Close | High | 5 ± 1.2 | 7 ± 3.6 | 11 ± 3.3 | 46 ± 2.9 |
| 7 | 26.9 | MVUKZN_1 | Close | Moderate | 7 ± 0.0 | 17 ± 2.6 | 24 ± 3.7 | 46 ± 1.6 |
| | | MVUKZN_3 | Close | Moderate | 6 ± 0.0 | 22 ± 7.1 | 27 ± 7.3 | 48 ± 2.6 |
| | | MVUKZN_8 | Close | Moderate | 10 ± 4.2 | 7 ± 3.6 | 16 ± 2.1 | 50 ± 2.4 |
| | | NdmH_2 | Close | Moderate | 5 ± 0.8 | 17 ± 9.2 | 26 ± 3.1 | 42 ± 3.1 |
| | | TC-UP-KZNBT/2/06 | Wild | Moderate | 9 ± 3.0 | 7 ± 5.2 | 15 ± 6.4 | 48 ± 5.5 |
| | | TC-UP-KZNBT/5/06 | Wild | Moderate | 6 ± 1.3 | 9 ± 6.6 | 15 ± 6.5 | 44 ± 2.1 |
| | | bmrngK_1 | Far | Moderate | 16 ± 4.0 | 5 ± 2.0 | 20 ± 5.4 | 54 ± 2.3 |
| 7 | 26.9 | BMRNGK_5* | Far | Low | 12 ± 5.6 | 10 ± 11.0 | 64 ± 0.0 | 51 ± 1.2 |
| | | BmrngK_2 | Far | Low | 9 ± 0.0 | 23 ± 6.4 | 31 ± 6.4 | 50 ± 2.8 |
| | | MVUKZN_4 | Close | Low | 8 ± 2.3 | 23 ± 10.6 | 30 ± 8.6 | 47 ± 1.6 |
| | | bmrngK_3 | Far | Low | 14 ± 3.8 | 39 ± 15.0 | 51 ± 12.8 | 46 ± 1.8 |
| | | njB_1 | Far | Low | 8 ± 1.2 | 38 ± 8.7 | 43 ± 6.4 | 48 ± 3.4 |
| | | njT_1 | Far | Low | 7 ± 0.0 | 31 ± 7.3 | 37 ± 6.9 | 47 ± 3.3 |
| | | njT_2* | Far | Low | 4 ± 0.0 | 46 ± 5.7 | 43 ± 5.7 | 40 ± 1.8 |
| Control | - | - | - | - | - | - | - | 56 ± 1.1 |
| LSD ($p = 0.05$) | - | - | - | - | 2.43 | 7.11 | 5.75 | 3.07 |

*, *Trypanosoma congolense* Kilifi.

**TABLE 2:** Mean pre-patent period, patent period, survival time and the packed cell volume progression of South African *Trypanosoma congolense* strains belonging to high, moderate and low virulence strains.

| Parameters | Virulence categories | | | *p*-value |
|---|---|---|---|---|
| | HVS ± s.d. | MVS ± s.d. | LVS ± s.d. | |
| PPP (days) | 6.8 ± 2.3 | 7.8 ± 3.8 | 8.8 ± 4.0 | 0.2739 |
| PP (days) | 5.5 ± 3.0 | 12.7 ± 8.0 | 29.9 ± 14.0 | 0.0001 |
| ST (days) | 11.1 ± 3.0 | 20.5 ± 7.0 | 42.8 ± 13.0 | 0.0001 |
| PCV (%) | 47.5 ± 4.0 | 47.4 ± 4.0 | 46.9 ± 4.0 | 0.7738 |

PPP, pre-patent period; PP, patent period; ST, survival time; PCV, packed cell volume; HVS, high virulence strain; MVS, moderate virulence strain; LVS, low virulence strain; s.d., standard deviation.

**TABLE 3:** Prevalence and distribution of high, moderate and low virulence strains in the study areas.

| Category | Hluhluwe-iMfolozi Park | | Near game parks (< 5 km) | | Far from game parks (> 10 km) | |
|---|---|---|---|---|---|---|
| | *N* | % | *N* | % | *N* | % |
| HVS | 3 | 60.0 | 8 | 61.5 | 1 | 12.5 |
| MVS | 2 | 40.0 | 61.5 | 30.7 | 1 | 12.5 |
| LVS | 0 | 0.0 | 4 | 7.6 | 6 | 75.0 |
| **Total** | **5** | **100** | **13** | **100** | **8** | **100** |

## Discussion

Three pathogenic species of Trypanosoma have been identified in South Africa. Trypanosoma brucei was identified in the 19th century by Sir David Bruce (Bruce 1895) and *T. congolense* and *T. vivax* have been isolated on several occasions from tsetse flies, buffalo and cattle blood but no isolates of *T. brucei* have been found for a long time (Gillingwater *et al.,* 2010; Mamabolo *et al.,* 2009; Van den Bossche *et al.,* 2006). It is therefore possible that *T. brucei* disappeared from South Africa when Glossina pallidipes was eradicated between 1945 In the present study, *T. congolense* was selected as the species of interest because of its prevalence in KZN. *Trypanosoma vivax* infections may have been eliminated by the isolation method used which involved sub-inoculation of mice. There is evidence that wild isolates of *T. vivax* fail to develop and establish in mice (Eisler *et al.,* 2004), whilst the Nannomonas subgenus, to which *T. congolense* belongs, has been shown to grow readily in laboratory rodents (Joshua 1990; Morrison *et al.,* 2010). In the present study, molecular analysis has confirmed the identity of 26 isolates belonging to T. congolense. This confirmation excludes the possibility of contamination with any other trypanosome species. In addition, genotype-specific PCR unequivocally distinguished between *T. congolense* Savannah and Kilifi sub-groups based on specific band products observed for each. and 1952 (Du Toit 1954).

Both *T. congolense* and *T. vivax* and tsetse fly vectors are present in the study area (Gillingwater *et al.,* 2010; Mamabolo *et al.,* 2009; Motloang *et al.,* 2012; Van den Bossche *et al.,* 2006).

Although the presence of *T. congolense* virulent strains is reported in other studies (Masumu *et al.,* 2006; Van den Bossche *et al.,* 2011), this is the first attempt to determine the geographical distribution of virulent strains in KZN. Notwithstanding the limited number of samples used, it is evident from the results obtained that Savannah type *T. congolense* is more prevalent (92.3%) with severe infections than Kilifi (7.7%). Although sampling was random, preference was occasionally given to symptomatically sick animals to increase the chances of obtaining parasitologically positive blood samples and to confirm that trypanosomosis does contribute to disease burden in these animals. The possibility therefore exists that some LVS, including Kilifi infections, may have been missed. The current results indicating low prevalence of Kilifi strains are in agreement with recent reports by Mamabolo *et al.,* (2009) and Gillingwater *et al.,* (2010). In both studies, 0.8% and 16.0% of mixed infections with Savannah and Kilifi were reported. In endemic areas cattle are continuously challenged with infected tsetse. As a result, a large proportion of cattle harbourinfections with more than one trypanosome species or sub- species (Masumu *et al.,* 2009), thus explaining mixed infections in the two former studies. In the present study, however, mixed infections were eliminated by selecting strains that gave a single molecular band profile when amplified with genotype-specific primers to fulfil the objective of this study.

The *T. congolense* Savannah strains characterised in this study suggested a range of clinical outcomes ranging from high, moderate to low virulence. On the other hand, neither of the two Kilifi strains was highly or moderately virulent as they both fell into the low virulence category. These findings confirm the observations made by Bengaly *et al.,* (2002) that Kilifi is non-pathogenic. There was no remission or self-cure following the infection in mice infected with the Savannah types, but where infections were caused by the Kilifi type, the course of the disease was brief and the infection cleared within 2 weeks and remained so throughout the experimental observation. This indicates that the strains were very mild or of non-virulent nature.

Long PPPs and the height of parasitaemia peaks observed in the present study did not influence the outcome of the disease. Thus, HVS killed mice rapidly once the parasitaemia was detectable in the blood compared to the MVS and LVS categories. These results are comparable to those of Bengaly *et al.,* (2002) and Masumu *et al.,* (2006) in that there was a shift in the survival time in the present study as a result of longer PPP. Their short PPP was accountable for shorter survival time, whilst, in our case, long PPP resulted in longer survival

times. However, the behaviour was similar in that the rise in parasitaemia in HVS correlated with a steep drop in PCV, as reported earlier by Masumu *et al.,* (2006). The difference between the PPP in the former studies and the present study may be attributed to either the mice used or the trypanosome strains themselves. Extensive work undertaken to unravel susceptibility versus resistance in inbred strains of mice shows that the development of infection and the pathological events involved differ between laboratory models (D'Leteren, Authié & Murray 1998). On the other hand, genetic variation in trypanosomes of the same species from distinct geographic origin may influence the outcome of infection (Taylor & Authié 2004).

In animals infected with trypanosomes, anaemia plays a key role in determining severity of the infection (Noyes *et al.,* 2009). The change in red blood cell count was apparent in infected individual mice. However, the mean PCV values were not significant when compared to those of the uninfected control groups. In mice infected with the HVS, MVS and, to a lesser extent, LVS Savannah, the drop in PCV was not an indication that death in these groups correlated with anaemia. Similarly, mice infected with the LVS Kilifi were also able to control anaemia and parasitaemia. However, very limited numbers of this strain were used and further research is necessary to confirm these observations.

Of the above 26 strains characterised in mice, HVS and MVS categories were found to be prevalent inside HiP and in the wildlife–livestock interface (Mvutshini, Ocilwane and Ndumo). All of the LVS, with the exception of one (MVU4), originated from locations considered far from any wildlife reserve, as in Nhlanzana and Boomerang commercial farm. High prevalence of HVS inside HiP and areas in the vicinity of parks has been reported (Masumu *et al.,* 2009; Van den Bossche 2001). The results of this study confirm the finding in 2006, when 60.5% of animals at Mvutshini were found to be infected withv *T. congolense* Savannah sub-group by PCR restriction fragment length polymorphsm (Van den Bossche *et al.,* 2006). According to these authors and Ntantiso (2012), high proportions of animals considered to be in poor condition were indeed infected with trypanosomes. The virulence profile obtained in the present study supports these findings and indicates that high disease impact occurring near wildlife areas is indeed caused by extremely virulent

*T. congolense* strains. The strain obtained from Ocilwane,

located at the southern part of HiP, was also allocated to the HVS category. Although a single strain was used in the present study, evidence exists that nagana was acute in affected cattle at Ocilwane and that 100% of positive

cattle were anaemic (Ntantiso 2012). On Boomerang commercial farm, 20.0% of the strains were highly virulent, whilst 80.0% were either of moderate or low virulence. Given the fact that this farm is situated > 10 km away from Charters Creek, the closest wildlife reserve, cattle on this farm may constitute the main host of tsetse, thus limiting the transmission cycle of trypanosomes (Van den Bossche 2001). According to Masumu *et al.,* (2006), this is attributed to the fact that strains most likely to survive in susceptible host populations have low virulence, producing mild disease. To support the latter statement, more studies conducted at Boomerang showed that cattle had a very high trypanosome infection rate, although the level of anaemia in the herd did not exceed 27.0%, compared to percentage of anaemic cattle at Mvutshini diptank (Ntantiso 2012). Taking this into account, our findings reveal that the low disease impact in cattle at Boomerang, as in most endemic areas located far away from parks, is possibly indicative of high prevalence of low virulent trypanosome strains in circulation as compared to cattle around parks. Our results further indicate that there is correlation between virulence and geographic distribution.

## Conclusion

In the present study, HVS produced shorter PPP, PP and ST, followed by MVS and, lastly, LVS. Comparative observations were made when the same parameters were considered for strains collected from cattle near to and far from parks, and buffaloes inside HiP. Only strains collected from cattle away from parks exhibited longer periods compared to the other two areas. This study confirms that *T. congolense* occurring in South Africa has similar pathogenicity to other strains reported from other countries with severe infections occurring near the wildlife reserves.

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## Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

## Authors' contributions

M.Y.M. (ARC-OVI) was the project leader, performed most of the experiments and wrote the manuscript. J.M. (Institute of Tropical Medicine) was a student mentor who assisted with the laboratory experiments and the edition of the manuscript.

B.J.M. (ARC-OVI) was the co-supervisor of the study and contributed to revision and editing of the manuscript. A.A.L. (ARC-OVI) was the project supervisor and also contributed to revision and editing of the manuscript.

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# BOVINE TRYPANOSOMOSIS AND HORSEFLIES, PREVALENCE AND DIVERSITY IN THE BLUE NILE STATE, SUDAN

# TRYPANOSOMOSE BOVINE ET TABANIDES, PREVALENCE ET DIVERSITE DANS L'ÉTAT DU NIL BLEU AU SOUDAN

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## Résumé

La présente étude a été réalisée dans l'État du Nil Bleu, au Soudan, au cours de la période d'août 2005 à juillet 2006. La prévalence de la trypanosomose bovine a été déterminée parmi les troupeaux de bovins sédentaires et migrateurs par l'utilisation des techniques de buffy coat et de frottis sanguins.

L'étude a constaté que les bovins sédentaires de la localité d'Ed Damazine étaient infectés seulement avec T. vivax, alors que dans les autres localités de cet État des infections à *T. congolense* ont également été relevées. Le taux global de prévalence était de (4%), (6,7%), (9,3%), (13,3%) et (16%) respectivement dans les localités d'Ed Damazine, d'Er Rosaris, de Baw, de Qissan et de Kurmuk.

Les bovins migrateurs examinés au cours de la saison des pluies, autour des comtés d'Ed Damazine et d'Er Rosaris, étaient infectés par des trypanosomes avec un taux de prévalence de 7%. Cependant, les infections à *T. congolense* étaient plus fréquentes que celles de *T. vivax* et *T. brucei*.

Des tabanidés, Stomoxys et d'autres mouches muscidae ont été recueillis au moyen de de pièges biconiques et Epsilon. Atylotus agrestis était l'espèce dominante chez les tabanidés dans les captures des pièges (29,8%), suivie de Tabanus taeniola (0,9%), A. fuscipes (0,2%), T. soufis (0,1%) et T. bigutattus (0,1%). De grands nombres d'espèces de Stomoxys et de muscidae ont été collectés, respectivement (56%) et (12,9%). Les tabanus taeniola ont commencé à apparaître en mars et leur nombre a augmenté pour atteindre un pic en juillet, puis il a baissé progressivement et a disparu complètement de décembre à février. Atylottus fuscipes et Tabanus soufis sont apparues pendant la saison des pluies (juillet à octobre) et ont complètement disparu pendant la saison sèche (décembre à juin). Atylottus agrestis, les espèces de Stomoxys et de Muscidae ont été notées tout au long de l'année et ont atteint un pic au cours de la saison des pluies.

## Summary

This study was carried out in the Blue Nile State, Sudan during the period, August 2005 to July 2006. The prevalence of bovine trypanosomosis was determined in resident and migratory cattle herds by means of using the buffy coat and thin smear techniques.

The resident cattle in Ed Damazine locality were found infected only with T. vivax, while in the other localities of the state the *T. congolense* infections were also encountered. The overall prevalence rate was (4%), (6.7%), (9.3%), (13.3%) and (16%) in Ed Damazine, Er Rosaris, Baw, Qissan and Kurmuk localities, respectively.

The migratory cattle examined during the rainy season, around Ed Damazine and Er Rosaris county, were found infected with trypanosomes with prevalence rate of 7%. However, frequencies of *T. congolense* infection were more than those of *T. vivax* and *T. brucei*.

Tabanids, Stomoxys and other Muscidae flies were collected by both Biconical and Epsilon traps. Atylotus agrestis was the dominant tabanid species in the catches of traps (29.8%) followed by Tabanus taeniola (0.9%), A. fuscipes (0.2%), T. sufis (0.1%) and T. bigutattus (0.1%). Large numbers of Stomoxys and muscidae species were collected (56%) and (12.9%), respectively. Tabanus taeniola started to appear in March and their numbers rose to reach a peak in July then it dropped gradually and disappeared completely during December to February. Atylottus fuscipes and Tabanus sufis appeared in the rainy season (July to October) and disappeared completely in the dry season (December to June), Atylottus agrestis, Stomoxys and Muscidae species were found throughout the year and peaked during the rainy season.

## Introduction

Blue Nile State is one of the major animals producing States in Sudan. The animal population in the State per head is estimated at 2,977,600 cattle, 3,965,000 sheep, 222,600 goats, 130,000 camels, 15,000 donkeys and a few numbers of horses and mules. Mainly the livestock owners are migratory tribes (Fulani groups, Kenana and Ruffaa tribes) who spend the dry season in the tsetse belts around Khor Yabus and the Ethiopian border in the southern part of the State. The parasitic diseases are major constraints for sustainable development of livestock. Biting flies in the Blue Nile State are enormous constituting the major cause of migration in the rainy-season. Trypanosomosis is among the major parasitic disease in the State, causing debility, loss of weight, infertility, abortion and death. Therefore, losses due to the disease are substantial and its impact on the economy and livelihood of the animal owners is great. Despite the fact that Kurmuk is the only tsetse infested Province

among the four Provinces of the State, trypanosomosis is enzootic throughout the State.

The disease surveys in the Sudan indicated high prevalence of bovine trypanosomosis outside the tsetse belt, it was attributed to mechanical transmission by other biting flies (Kheir *et al.,* 1995 and A/Rahman, 2005).

## Materials and Methods

*Geographical location:*

The study was conducted in Blue Nile State on the Southeast Sudan. It covers an area estimated at 38.500 km2 extending between latitudes 9° 30' - 12° 35' N and longitude 53° 80' - 35° 80' E, Map (1). The State borders Sinnar State to the North, and its shares international borders with Ethiopia to the East and South Sudan in the South and West,. The Blue Nile River transects the State in the North eastern parts for a length of 200 km.

The State is divided in to five provinces, Ad-Damazin, Al-Rosayris, Al-Kurmuk, Qissan and Baw, Map (2).

*Parasitological methods:*

*Wet smear:*

A drop of fresh blood placed in clean slide and covered with cover slip was examined under light microscope using medium magnification (objective 40X). Diagnosis of the trypanosomosis was based on motility of trypanosomes between the blood cells.

*Thin blood smears:*

A drop of fresh blood taken on clean slide spreaded by a corner of another slide at 45° angle then air dried and fixed with absolute methanol for 4 min., stained with 10% Giemsa stain for 45 min. Excess stain was removed with phosphate buffer saline or distilled water, the slide was dried by air and examined under light microscope (objective 100x with oil immersion). This method was used for the identification of different species of trypanosomes depending on their morphology.

*Haematocrit Centrifugation Technique (HCT):*

Blood was drawn into heparinized microhaematocrit tube (capillary tube) by capillary attraction up to ¾ of its length. The tube sealed at one side with cristaseal, and placed on a microhaematocrit centrifuge and spun at 12,000 RPM (Hawksley and sons Ltd.) for 5 minutes. The tube was placed on McMaster slide with a drop of clean water in to the chamber of McMaster and the Buffy coat (plasma function) examined under a light microscope at 10x10 objective magnifications. The positive capillary tube was broken to make a thin smear fixed in absolute methanol for two minutes and stained with Giemsa stain washed in distilled water dried and examined (100x oil lens) to identify trypanosome species.

*Sentinel cattle herd:*

A total of one hundred head of cattle of different age groups resident in Al-Damazine town were named and ear tagged. Those animals were examined monthly for trypanosomosis starting from August 2005 until July 2006.

*Trapping:*

Biting flies were caught around the sentinel herd and their grazing areas, using Biconical and Epsilon traps.

Biconical trap, is however, still one of the most widely used traps for sampling tsetse flies especially for Palpalis species group. The trap consists of two cones, each 80 cm wide, the upper cone 73 cm high and the lower cone 60 cm high. Joined at their widest point, the trap body is kept open by a metal or plastic hoop sewn into the seam, where the two cones join. The blue lower cone has four entrances, approximately 30 cm high and 20 cm wide, the upper netting cone has 12 mm hole to allow flies to enter (but not exit) the cage, the cage is large wire gauze to prevent overcrowding, later replaced by an arrangement of chambers made from plastic bottles and collecting bag. Vertically dividing the inside of the trap is a black cruciform, which acts as a target; the trap supported by central pole (FAO manual, 1992).

The Epsilon trap, is about one meter height and three walled triangular shape equilateral triangle of the cotton cloth, with the lower half of the front folded back into the trap to give a horizontal shelf. The target is a vertical piece of black cloth sewn into the rear of the trap. All other inside surfaces are blue, and the cone is recessed, with its apex level with the top and forward of centre, uses the seam plastic cage design but lacks a groundsheet. It is supported internally by iron ropes (FAO manual, 1992).

For a period of one year, the biting flies were collected by two traps, Epsilon and Biconical. The traps were deployed for a period of three days at the beginning, mid, and end of each month starting by August (nine days each month). The total catches of the two traps were pooled and recorded for each month.

**Results**

Incidence of bovine trypanosomosis in the sentinel herd:

Within 1161 cattle examined for trypanosomosis during the period Aug. 2005 to Jul. 2006, only four animals revealed infector with T, vivax (0.3%) 4/1161. Generally, the incidence among the sentinel herd is very low. No trypanosomosis were found in the dry season. The general condition of the herd as indicated by PCV was good during the rainy season where the PCV varied between 21.5 to 25%. During the dry season, the general condition was poor and the mean herd PCV varied between 18 to 20%. The mean PCV in the infected animals is 21.6, as compared to non-infected animals which 22.5. There was no significant difference between mean PCV of infected and non-infected animals. The results are shown in table (1).

The Prevalence of Bovine trypanosomosis among the resident cattle in the different localities of the State:

Three hundred seventy five resident cattle for different localities of the State were examined for trypanosomosis (seventy five each province). Damazin localities were found only infected with T. vivax, while in the other localities the *T. congolense* infections were found. The prevalence rate in Damazin localities was 3/75 (4%), and 5/75 (6.7%), 7/75 (9.3%), 10/75 (13.3%), 12/75 (16%) in Rosayris, Baw, Qissan and Kurmuk localities respectively. The results are shown in table (2).

Tabanids, Stomoxyes and other Muscidae were collected by both Biconical and Epsilon traps. Atylottus agrestis was the dominant tabanid species in the whole catches of traps (29.9%), followed by Tabanus taeniola (0.9%), Atylottus fuscipes (0.2%), Tabanus sufis (0.1%) and Tabanus bigutattus (0.1%). Large numbers of Stomoxyes species were collected (56%). The traps also caught many species of Muscidae (12.9%). Tabanus taeniola started to appear in March and their numbers raised to reach a peak in July then it dropped gradually and disappeared completely during December to February.

**Table 1:** *Incidence of Bovine trypanosomosis in Damazin sentinel herd during the period Aug. 2005 to Jul. 2006*

| Months | No. of animals examined | No. of positive cases | Tryps spp. | | | PCV average |
|---|---|---|---|---|---|---|
| | | | *T.v* | *T.c* | *T.br* | |
| Aug. 2005 | 100 | 00 | 00 | 00 | 00 | 25.1 |
| Sep. 2005 | 100 | 00 | 00 | 00 | 00 | 24.9 |
| Oct. 2005 | 100 | 00 | 00 | 00 | 00 | 25.5 |
| Nov. 2005 | 100 | 00 | 00 | 00 | 00 | 20.8 |
| Dec.2005 | 100 | 00 | 00 | 00 | 00 | 22.5 |
| Jan. 2006 | 99 | 00 | 00 | 00 | 00 | 21.5 |
| Feb. 2006 | 96 | 00 | 00 | 00 | 00 | 20.5 |
| Mar. 2006 | 96 | 00 | 00 | 00 | 00 | 19.8 |
| Apr. 2006 | 96 | 00 | 00 | 00 | 00 | 19.5 |
| May. 2006 | 94 | 01 | 01 | 00 | 00 | 18.3 |
| Jun. 2006 | 90 | 01 | 01 | 00 | 00 | 19.3 |
| Jul. 2006 | 90 | 02 | 02 | 00 | 00 | 21 |
| **Total** | **1161** | **04** | **4 (0.3%)** | **00** | **00** | **21.6** |

*T.v = T. vivax; T.c = T. congolense; T.br* = T. brucei

***Table 2:*** *The prevalence of bovine trypanosomosis among resident cattle in the different localities of Blue Nile state*

| Localities | Animals examined | T.vivax | T.congolense | Mixed infection | Prevalence rate |
|---|---|---|---|---|---|
| Damazin | 75 | 03 | 00 | 00 | 4% |
| Rosayris | 75 | 03 | 02 | 00 | 6.7% |
| Baw | 75 | 03 | 04 | 00 | 9.3% |
| Qissan | 75 | 06 | 04 | 00 | 13.3% |
| Kurmuk | 75 | 06 | 04 | 02 | 16% |

Trapping:

| | *A.agrs.* | *A.fus.* | *T.taen.* | *T.suf.* | *T.big.* | *Stom.* | *Mus.* | Total |
|---|---|---|---|---|---|---|---|---|
| Aug. | 387(27.9%) | 00 | 01 | 00 | 01 | 710 | 287 | 1386 |

Atylottus fuscipes and Tabanus sufis appeared in the rainy season (July to October) and disappeared completely in the dry-season (December to June), Atylottus agrestis, Stomoxyes species and Muscidae species were found through out the year and peaked during the rainy season. The results were shown in table (3).

***Table 3:*** *Total collections of flies caught by Epsilon and Biconical traps during (August 2005 to July 2006) in Damazin town*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sep. | 253(28.5%) | 00 | 03 | 00 | 02 | 533 | 97 | 888 |
| Oct. | 334(49.7%) | 07 | 04 | 05 | 00 | 284 | 38 | 672 |
| Nov. | 422(49.5%) | 05 | 05 | 05 | 02 | 252 | 162 | 853 |
| Dec. | 240(57.2%) | 00 | 00 | 00 | 00 | 127 | 53 | 420 |
| Jan. | 421(50.4%) | 00 | 00 | 00 | 01 | 252 | 162 | 836 |
| Feb. | 86(31.2%) | 00 | 00 | 00 | 02 | 152 | 36 | 276 |
| Mar. | 426(27.4%) | 00 | 17 | 00 | 00 | 1088 | 27 | 1558 |
| Apr. | 103(5.1%) | 00 | 02 | 00 | 00 | 1837 | 64 | 2006 |
| May | 93(7.9%) | 00 | 11 | 00 | 00 | 668 | 405 | 1177 |
| Jun. | 243(33.1%) | 00 | 34 | 00 | 02 | 415 | 41 | 735 |
| Jul. | 974(38.7%) | 14 | 40 | 03 | 01 | 1135 | 347 | 2514 |
| **Total** | **3982(29.9%)** | **26** | **117** | **13** | **11** | **7463** | **1719** | **13326** |

*A. agrs. = Atylottus agrestis. A. fus = Atylottus fuscipes T. taen. = Tabanus taeniola. T.suf. = Tabanus Sufis. T.big.= Tabanus bigutattus Stom. = Stomoxyes specie. Mus. = Muscidae species*

## Discussion

The low disease prevalence in this study in the sentinel herd may be due to intensive use of trypanocidals by the owners. The diagnostic method used in this study is the microhaematocrit centrifugation method which is not very sensitive in detecting low transient parasiteamia (Murray and Dexter, 1988).

T. vivax was the only trypanosomes species found to infect cattle resident in tsetse free areas including cattle of the sentinel herd. The existence of *T. vivax* outside tsetse fly area indicates mechanical transmission (Stephan, 1986). In Nigeria, Folkers and Jones Davis (1966), Davies (1967) and later Leaflang (1975), emphasized the predominance of *T. vivax* where no tsetse flies were found. The similar results were obtained by Ford (1964) in Rhodesia, Daniel et al, (1993) in Ethiopia.

The Tabanidae collected and identified using traps Biconical and Epsilon in Damazin town. Epsilon trap was more efficient in catching Atylotus agrestis, while Biconical trap was more efficient in catching Stomoxys. All flies caught in the traps were females, which feed on animal blood as traps are designed to simulate animal figure.

In this study the high incidence of *T. vivax* among cattle correlated with

the high abundance of biting fly particularly. Atylotus .agrestis is a well distributed tabanid species from Senegal to South Africa (Oldroyid, 1954) and it is considered as the most abundant tabanids in several African countries (Goodwin, 1982). It is thought to be a highly efficient mechanical vector of *T. vivax* (Desquesnes and Dia, 2003).

During this study Tabanus bigutatus catches were very low as they don't enter traps and they were only captured by hand-nets from resting sites and moving animals (Abdel Karim and Benjamin, 1989 and A\Rahman *et al.,* 1991b).

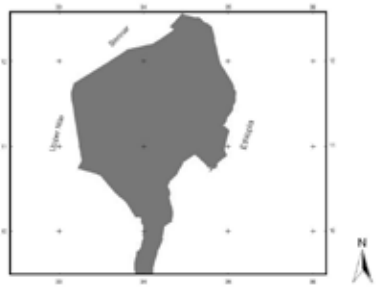
The high peak abundance of Stomoxys spp. during the rainy season is probably due to the suitability of the environment for the fly to breed, Elnaeim (2001), which gives more indication to the wide range spread of the trypanosomosis during this season, as reported by Musa *et al.,* (1991), Homeida (1993) and Abdel Salam (1996).

**Recommendation**

Trypanocidal drugs resistance preset a threat to chemotherapy. Studies on trypanocidal drugs efficacy among trypanosomes species in the State are needed for the control of the disease.

Given that appreciating the sensitivity and specificity of PCR as molecular diagnostic technique. Therefore, introduction of PCR for further epidemiological studies in the State is needed.

Noting that eradication of the vectors (Tsetse, Tabanidae, Stomoxys, etc…) and control of animal trypanosomosis requires collaboration work. Therefore, formulation of trypanosomosis strategic plan in the Blue Nile state is highly recommended



***Map 1:*** *Blue Nile State*



***Map 2:*** *Blue Nile State Provinces*

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# PREVALENCE AND RISK FACTORS OF BOVINE TRYPANOSOMIASIS IN KHARTOUM STATE, SUDAN

# PREVALENCE ET FACTEURS DE RISQUE DE LA TRYPANOSOMIASE BOVINE DANS L'ÉTAT DE KHARTOUM AU SOUDAN

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## Résumé

Une étude transversale a été réalisée d'avril 2012 à juillet 2012 dans l'État de Khartoum au Soudan, dans le but d'estimer la prévalence de la trypanosomiase bovine, d'identifier les espèces prédominantes de trypanosomes et d'étudier les facteurs de risque connexes de la maladie. Des échantillons de sang ont été prélevés sur 271 bovins sélectionnés de manière aléatoire dans les huit régions étudiées, et évalués en utilisant des méthodes d'examen parasitologique standard (Technique de centrifugation à hématocrite – HCT- et frottis sanguin). La valeur d'hématocrite PCV de chaque animal a également été déterminée en utilisant les techniques de mesure de l'hématocrite pour l'estimation de l'anémie.

Les résultats ont indiqué que la prévalence globale de la trypanosomiase chez les bovins était de 4,8% (13/271). Tous les trypanosomes identifiés chez les bovins appartiennent à une seule espèce de *Trypanosoma vivax*. La répartition de la trypanosomiase selon les localités se présentait comme suit : Ombeda (13,6%), Est du Nil (5,2%), Omdurman et Jabal Awlia (0%). En outre, la prévalence selon les régions se présentait comme suit : Alkeriab (17,8%), Felstine (13,6%), Alozozab (2,4%), les fermes Eidbabeker (1,5%), et Almoilh, Aldkhinate, la ferme de l'université du Soudan et Soba (0%). La prévalence selon les races d'animaux était de (5,1%) pour la race croisée et de (2,8%) pour la race locale. La prévalence de la trypanosomiase chez les femelles était plus forte (5,3%) que chez les mâles (0%). Le taux d'infection des animaux en mauvais état corporel était plus élevé (9,2%) que ceux en bon état (1,6%), et aucune infection n'a été identifiée chez les animaux en très bon état corporel. La prévalence de la maladie dans une population de moins de 30 animaux était plus élevée (6,2%) par rapport à une population de ≥ 30 animaux (1,3%). Dans les fermes comportant d'autres espèces d'animaux la prévalence était de 16,4%, et elle était nulle dans les fermes n'abritant pas d'autres espèces animales (1%). Dans les fermes pratiquant une mauvaise hygiène, la prévalence de la trypanosomiase était significativement plus

élevée (6,4%) par rapport aux exploitations pratiquant une bonne hygiène (2,6%). Dans les élevages où les soins vétérinaires n'existaient pas, le taux d'infection était plus élevé (9,9%) que dans les exploitations où les soins vétérinaires (0,7%) étaient disponibles. Les opérations chirurgicales ou les blessures sur le corps des animaux montraient un taux d'infection plus élevé (20,0%) que (4,5%) chez les animaux où il n'y avait aucune opération chirurgicale ou blessure. Les fermes situées à proximité du marché d'animaux vivants avaient un taux d'infection plus élevé (11,9%) par rapport aux fermes éloignées (2,5%). Dans les régions où Tabanus spp était présent, le taux d'infection était de 6,6% par rapport à celui de Stomoxys qui était de 11,8%. Quant à la présence de tiques dans les fermes, le taux d'infection était de 5,8% dans les fermes avec une grande infestation de tiques. En ce qui concerne la sensibilisation des éleveurs à la maladie, le taux d'infection était plus élevé (6,0%) dans les exploitations des éleveurs non sensibilisés.

L'analyse univariée utilisant le Chi-carré pour chacun des facteurs de risque suivants se présentait comme suit : la localité (valeur p = 0,084), la région (valeur p = 0,000), le sexe (p = 0,219), l'état corporel (p = 0,009), la taille du troupeau (valeur p = 0,094), le traitement des animaux malades (p = 0,003), la présence d'autres espèces animales dans la ferme (valeur p = 0,000), l'hygiène de la ferme (valeur p = 0,148), les soins vétérinaires (valeur p = 0,000), les opérations chirurgicales ou plaies sur le corps de l'animal (valeur p = 0,108), l'emplacement du marché des animaux vivants (valeur p = 0,002), la présence d'insectes dans la ferme (valeur p = 0,108) , les espèces d'insectes trouvées dans la ferme (valeur p = 0,106), la présence de tiques dans la ferme (valeur p = 0,099) et la sensibilisation des éleveurs sur la maladie (p = 0,065) avaient un lien significatif avec la trypanosomiase (valeur $p \leq 0,25$). D'autre part, la race (valeur p = 0,543), l'âge (p = 0,427), le type de production (valeur p = 0,272), l'utilisation d'un traitement prophylactique pour la maladie (p = 0,355), la présence d'autres maladies (valeur p = 0,912), le système de pâturage (valeur p = 0,272), la source des animaux (valeur p = 0,272), la densité des insectes (valeur p = 0,893), l'utilisation d'insecticides pour le contrôle (valeur p = 0,371), la vie sauvage autour de la ferme (valeur p = 0,954), le corps de l'eau et le canal d'irrigation (valeur p = 0,355), la végétation (valeur p = 0,534) et l'hématocrite (p = 0,972) n'avaient aucune association significative avec la trypanosomiase.

L'analyse multivariée utilisant la régression logistique a identifié quatre facteurs de risque potentiels qui avaient un lien significatif avec la trypanosomiase (valeur $p \leq 0,05$) : le traitement des animaux malades (p = 0,012), la présence d'autres espèces animales dans la ferme (valeur p = 0,003), les soins vétérinaires (valeur p = 0,023) et l'emplacement du marché des animaux vivants (valeur p = 0, 004).


## Summary

A cross-sectional study was conducted from April 2012 up to July 2012 in Khartoum state, Sudan to estimate the prevalence of bovine Trypanosomiasis, to identify the

prevailing species of Trypanosomes and to investigate the related risk factors of the disease. Blood samples were collected from 271 randomly selected cattle of the eight study areas and evaluated through standard parasitological methods (Haematocrit Centrifugation Technique (HCT) and thin blood smear). Also packed cell volume PCV of each animal was measured using haematocrit techniques for anemia estimation.

The results indicated that the overall prevalence of Trypanosomiasis in cattle was 4.8% (13/271). All the Trypanosomes encountered in cattle belong to a single species of *Trypanosoma vivax*. The distribution of the Trypanosomiasis according to locality: Ombeda (13.6%), East Nile (5.2%) and Omdurman and Jabal Awlia were (0%). Also, the prevalence's regarding areas were Alkeriab (17.8%), Felstine (13.6%), Alozozab (2.4%), Eidbabeker farms (1.5%) and Almoilh, Aldkhinate, Sudan university farm and Soba were (0%). As in breeds of animals the prevalence's were (5.1%) in cross breed and (2.8%) in local breed. Females had higher prevalence of Trypanosomiasis (5.3%) than males (0%). Infection rate in poor body condition animals were higher (9.2%) than good (1.6%) and no infection in very good body condition animals. Less than 30 animals in herd size had higher prevalence of the disease (6.2%) than ≥ 30 animals (1.3%). Regarding presence of other animal species in the farm, the prevalence was 16.4% compared to no presence of other animal species in the farm (1%). Poor farm hygiene had a significantly higher prevalence of Trypanosomiasis (6.4%) than good farm hygiene (2.6%). In farms where the veterinary care was not available infection rate was higher (9.9%) than farms which had veterinary care (0.7%). Surgical operation or wounds in animal's body had higher infection rate (20.0%) than (4.5%) in no surgical operation or wounds in animal's body. Farms located close to the live animals market had a higher infection rate (11.9%) compared to distant farms (2.5%). In area where Tabanus spp found the infection rate was 6.6% compared to Stomoxys spp which was 11.8%. As for presence of ticks in the farm, the infection rate was 5.8% in farm with high ticks infestation. In farmer awareness about the disease the not aware farmer had higher infection rate (6.0%).

The univariate analysis using Chi-square for each following risk factors was: locality (p-value = 0.084), area (p-value = 0.000), sex (p-value = 0.219), body condition (p-value = 0.009), herd size (p-value = 0.094), treatment of sick animals (p-value = 0.003), presence of other animal species in the farm (p-value = 0.000), farm hygiene (p-value = 0.148), veterinary care (p-value = 0.000), surgical operation or wounds in animal's body (p-value = 0.108), location of live animals market (p-value = 0.002), presence of insects in the farm (p-value = 0.108), insects species found in the farm (p-value = 0.106), presence of ticks in the farm (p-value = 0.099) and farmer awareness about the disease (p-value = 0.065) had a significant association with Trypanosomiasis (p-value ≤ 0.25). On the other hand, breed (p-value = 0.543), age (p-value = 0.427), production type (p-value =0.272), using prophylactic treatment for the disease (p-value =0.355), presence of other diseases (p-value = 0.912), grazing system (p-value = 0.272), source of animals (p-value = 0.272), density of insects (p-value = 0.893), use of insecticide for control (p-value = 0.371), wild- life around the farm (p-value = 0.954), water body

and irrigation canal (p-value = 0.355), vegetation (p-value = 0.534) and packed cell volume (p-value = 0.972), had no significant association with Trypanosomiasis.

In multivariate analysis using the Logistic Regression there were four potential risk factors had a significant association with Trypanosomiasis (p-value $\leq$ 0.05), these were treatment of sick animals (p-value = 0.012), presence of other animal species in the farm (p-value = 0.003), veterinary care (p-value = 0.023) and location of live animals market (p-value = 0 .004).

## Introduction

African animal trypanosomiasis is indisputably a great problem on the African scene, but the perspective alters when it is examined against a global background, even when taking into account mechanically and venereally transmitted African trypanosomes which have spread to other continents (Trypanosoma evansi causing surra, mechanically transmitted *T. vivax* and T. equiperdum the causal agent of the venereal disease dourine) (Uilenberg, 1998). Trypanosomiasis is a parasitic disease caused by species of flagellated protozoa belonging to the genus Trypanosoma which inhabit the blood plasma, various body tissues and fluids of vertebrate host. The disease is transmitted cyclically by tsetse flies (Glossina species), and non cyclically by other biting flies (Tadesse *et al.,* 2011). Trypanosomiasis induces loss of body condition in pregnant animals leading to birth of offspring with low birth weights, fetal and neonatal losses, besides production losses in lactating animals. The consequences of trypanosomiasis are less severe in better-nourished animals but good nutrition does not by itself provide protection. Adequate energy, protein and vitamin nutrition enhances the ability of trypanosome-infected animals to withstand the adverse effects of infection (Pathak, 2009). *T. vivax* is enzootic in wide areas of Sudan more than 2,000 km away from the known tsetse belt of the country. Previous outbreaks of bovine trypanosomiasis reported to be due to *T. congolense* were reported as far north as Kosti area along the White Nile, more than 1,000 km north of the Tsetse belts. The transmission of the disease is due to the enormous populations of Tabanidae and biting flies (Abdelrahman, 2005). Trypanosoma infection restricts the animal production and causes economic losses by the clinical signs of the infection such as restricted growth, abortion, anaemia, treatment cost, and death of the affected animals. So the objectives of this study were to estimate the prevalence of the disease in Khartoum State, to identify the prevailing species of trypanosomes and to investigate the related risk factors associated with the disease.

## Materials and Methods

*Study area:*

Khartoum is the political capital of the Sudan. The state lies between longitudes 31.5□ -34□ east and latitude 15□-16□ north in an area about 28.165 km2. Geographically, Khartoum is divided into three governorates (first governorate Khartoum (Jabal Awlia and Khartoum localities), second governorate Khartoum North (East Nile and Baharri localities) and third governorate Omdurman (Omdurman, Ombeda and Karari localities)) (www. krt.gov.sd.2012).

The population of animals in Khartoum state is 6300000 for birds, 513000 for sheep ,19000 of goat, 6585 camel and 240003 cattle .The number of cattle distributed in Khartoum state is 138067 in East Nile, 28016 in Baharri , 13578 in Ombeda, 13901 in Karari, 20455 in Omdurman, 20360 in Jabal Awlia and 5626 in Khartoum localities (Khartoum census, 2008).



***Figure1:*** *Maps of Sudan and Khartoum state showing the study areas of bovine trypanosomiasis*

*Study design:*

A cross sectional survey was conducted from April up to July 2012 to estimate the prevalence of bovine trypanosomiasis and to investigate risk factors associated with the trypanosomiasis.

*Sampling Method:*

A multistage simple random sampling method was followed to select the study animals based on state, governorates (Khartoum, Khartoum North, and Omdurman), Localities (Jabal Awlia, East Nile, Omdurman and Ombeda), areas (Ombeda (Felstine), Omdurman (Almoilh), Jabal Awlia (Aldkhinat) and East Nile (Edbabeker farms, Eidbabeker alozozab, Alkeriab, Sudan University of Science and Technology farm and Soba) then farms and animals.

*Animals sample size determination:*

Using the following formula of Thrusfeild (2005) the sample size was determined:

$n = (1.96)2 \times P\square \times Q\square / L2$

n ≡ the sample size

(1.96)2≡ constant

P^ ≡ expected prevalence (4.4%) (Abdalla et al; 2008)

Q^ ≡ 1- P^

L2 ≡ allowable error (5%)

$n= (1.96)2 \times 0.044 \times 0.956 /0.0025= 64.6$ samples

The samples were not enough to represent the population, and to increase the precision of the study; the sample size was multiplied by 4 so the number of samples became 258 samples (Thrusfeild, 2005) and there was 13 samples collected and added to the sample numbers so there was 271 animals were examined in these study.

*Blood sample collection:*

Blood samples were collected from each animal by puncture of the jugular vein using a sterile needle (Abenga *et al.,* 2004, Adam *et al.,* 2011, Magona *et al.,* 2011, Batista *et al.,* 2012). Blood was obtained in dry clean sterile heparinised tube 5 milliliters (containing EDTA (ethylene diamine tetra acetic acid) as anticoagulant) and was put in cold box with ice and transported to the laboratory (Central Veterinary Research Institute Laboratories, Soba,

Khartoum) as soon as possible for diagnosis.

*Diagnostic techniques:*

For diagnosis, parasitological methods (Haematocrit Centrifugation Technique (HCT) and thin blood smear stained with Giemsa stain) was used to identify the parasite, also packed cell volume (PCV) of each animal was measured for anemia estimation.

*Investigation of risk factors associated with the disease:*

A questionnaire was completed in an interview with the farms owner and workers to collect information data about selected potential risk factors on the occurrence of trypanosomiasis.

*Data analysis:*

The overall prevalence was calculated based on the positive results divided by the total number of animals examined. The collected data and the laboratory examination outcome were analysed using SPSS (version 16.0). The Chi-square test ($\chi 2$) was used for univariate analysis. Risk factors found significant at P-value$\leq$ 0.25 were entered to the multivariate analysis using Logistic Regression the significant level of association was set at P- value$\leq$ 0.05.

**Results**

Out of the total of 271 animals examined 13 were positive. The overall prevalence of trypanosomiasis in Khartoum state, Sudan was (4.8%). The prevalent trypanosome species in the study was *Trypanosoma vivax*.

*Univariate analysis:-*

The Chi- square test showed that there were 15 out of 33 risk factors statistically significantly associated with bovine trypanosomiasis (P-value $\leq$ 0.25). These were locality (p- value = 0.084), area (p- value = 0.000), sex (P- value = 0.219), body condition (P- value = 0.009), herd size (P- value = 0.094), treatment of sick animal (P- value = 0.003), presence of other species of animals in the farm (P- value = 0.000), farm hygiene (P- value = 0.148), veterinary care (P- value = 0.000), surgical operation or wound in the animal's body (P- value = 0.108), location of live stock market (P- value = 0.002), presence of insects in the farm (P- value = 0.108), species of insect found in the farm (P- value = 0.106), presence of ticks in the farm (P- value = 0.099) and farmer awareness about the disease (P- value = 0.065) (Table1).

***Table 1:*** *Univariate analysis of risk factors significantly associated with trypanosomiasis in Khartoum state (P-value ≤ 0.25)*

| **Risk factors** | **No. tested** | **No. positive (%)** | **df** | **$X^2$** | **P-value** |
|---|---|---|---|---|---|
| **1. Locality** | | | 3 | 6.648 | 0.084 |
| Ombeda | 22 | 3 (13.6) | | | |
| Omdurman | 22 | 0 | | | |
| Jabal Awlia | 34 | 0 | | | |
| East Nile | 193 | 10 (5.2) | | | |
| 2. Area | | | 7 | 27.293 | 0.000 |
| Felstine | 22 | 3 (13.6) | | | |
| Almoilh | 22 | 0 | | | |
| Aldkhinate | 34 | 0 | | | |
| Alozozab | 42 | 1 (2.4) | | | |
| Eidbabeker farms | 67 | 1 (1.5) | | | |
| Sudan university farm | 8 | 0 | | | |
| Alkeriab | 45 | 8 (17.8) | | | |
| Soba | 31 | 0 | | | |
| 3. Sex | | | 1 | 1.511 | 0.219 |
| male | 27 | 0 | | | |
| female | 244 | 13 (5.3) | | | |
| 4. Body condition | | | 2 | 9.327 | 0.009 |
| poor | 119 | 11 (9.2) | | | |
| good | 122 | 2 (1.6) | | | |
| very good | 30 | 0 | | | |
| 5. Herd size (animal) | | | 1 | 2.803 | 0.094 |
| <30 | 195 | 12(6.2) | | | |
| ≥30 | 76 | 1(1.3) | | | |
| 6. Treatment of sick animals | | | 1 | 8.559 | 0.003 |
| not treated | 72 | 8 (11.1) | | | |
| treated | 199 | 5 (2.5) | | | |

| Risk factors | No. tested | No. positive (%) | df | $X^2$ | P-value |
|---|---|---|---|---|---|
| 7. Presence of other animal species in the farm | | | 1 | 26.319 | 0.000 |
| present | 67 | 11 (16.4) | | | |
| not present | 204 | 2 (1.0) | | | |
| 8. Farm hygiene | | | 1 | 2.095 | 0.148 |
| good | 115 | 3 (2.6) | | | |
| poor | 156 | 10 (6.4) | | | |
| 9. Veterinary care | | | 1 | 12.550 | 0.000 |
| not available | 121 | 12 (9.9) | | | |
| available | 150 | 1 (0.7) | | | |
| 10. Surgical operation or wound in animal's body | | | 1 | 2.578 | 0.108 |
| yes | 5 | 1 (20.0) | | | |
| no | 266 | 12 (4.5) | | | |
| 11. location of livestock market | | | 1 | 9.944 | 0.002 |
| close to the farm | 67 | 8 (11.9) | | | |
| away from the farm | 204 | 5 (2.5) | | | |
| 12. Presence of insects in the farm | | | 1 | 2.578 | 0.108 |
| present | 5 | 1 (20.0) | | | |
| not present | 266 | 12 (4.5) | | | |
| 13. Insects species found in the farm | | | 3 | 6.122 | 0.106 |
| Tabanus | 136 | 9 (6.6) | | | |
| Tabanus+ Stomoxys | 16 | 1 (6.2) | | | |
| Stomoxys | 17 | 2 (11.8) | | | |
| Other species of insects | 102 | 1 (1.0) | | | |

| Risk factors | No. tested | No. positive (%) | df | $X^2$ | P-value |
|---|---|---|---|---|---|
| 14. Presence of ticks in the farm | | | 1 | 2.79 | 0.099 |
| not present | 45 | 0 | | | |
| present | 226 | 13 (5.8) | | | |
| 15. Farmer awareness about the disease | | | 1 | 3.398 | 0.065 |
| not aware | 217 | 13 (6.0) | | | |
| aware | 54 | 0 | | | |

**Multivariate analysis**

The multivariate analysis using the Logistic Regression showed that there were four potential risk factors significantly associated with trypanosomiasis (P-value ≤ 0.05). These were treatment of the sick animals (P-value = 0.012), Presence of other animal species in the farm (P-value = 0.003), veterinary care (P-value = 0.023) and location of live stock market (P-value = 0.004).

**Table 2:** *Multivariate analysis for association between trypanosomiasis and risk factors in 271 cattle tested in Khartoum state, Sudan (P-value ≤ 0.05)*

| Risk factors | No tested (%) | No positive (%) | OR | CI 95% | P-value |
|---|---|---|---|---|---|
| 1.Treatment of sick animals | | | | | |
| Treated | 199 | 5 (2.5) | ref | | |
| not treated | 72 | 8 (11.1) | 5.536 | 1.4-21.06 | 0.012 |
| 2. Presence of other animal species in the farm | 271 | 13 (4.8) | | | |
| not present | 204 | 2 (1.0) | ref | | |
| present | 67 | 11(16.4) | .076 | 0.014-0.418 | 0.003 |

| Risk factors | No tested (%) | No positive (%) | OR | CI 95% | P-value |
|---|---|---|---|---|---|
| 3. Veterinary care | | | | 1.4-21.06 | |
| available | 150 | 1 (0.7) | ref | | |
| not available | 121 | 12 (9.9) | .092 | | 0.003 |
| 4. location of livestock market | | | | | |
| away from the farm | 204 | 5 (2.5) | ref | | |
| close to the farm | 67 | 8 (11.9) | .118 | 0.028-0.497 | 0.004 |

**Discussion**

Trypanosomiasis is a major constraint that affects the health and productivity of livestock. The major consequences of infection include mortality, loss of body condition, abortion (Delafosse *et al.,* 2006).

Trypanosomiasis among all species has, since the beginning of the 20th Century, been regarded as the most serious animal disease problem in Sudan. *Trypanosoma vivax* occurs in most parts of the country (Abdelrahman, 2005).

In our study prevalence and risk factors of bovine trypanosomiasis in Khartoum state, Sudan was investigated. T.vivax was the only trypanosome species found during the study period. This is in agreement with Abdelrahman (2005), Abdalla *et al.,* (2005), Delafosse *et al.,* (2006), Gonzales *et al.,* (2007), Abdalla *et al.,* (2008), Tadesse *et al.,* (2011) and Batista *et al.,* (2012) who reported that T.vivax constituted the majority of infection in the tsetse free zone.

The prevalence in our study was 4.8%. This result is not different from other studies carried out in Blue Nile area between Admazien and Khartoum where the prevalence in Khartoum was 1% in the dry season and 6% in the rainy season (Abdelrahman, 2005), in Sinnar, Sudan the prevalence was 4.4% (Abdalla *et al.,* 2008). Another study carried out in Lake Chad showed a prevalence of 1.6% (Delafosse *et al.,* 2006). Also, in another study in South Western Ethiopia the prevalence was 4.4% (Tadesse *et al.,* 2010). However, the prevalence in our study was very low compared with other studies in Sudan and different countries which was 50.3% in Sinnar, Sudan where there is no tsetse fly in the area (Abdalla *et al.,* 2005), 43% in Blue Nile State, Sudan (Salim *et al.,* 2011), and 70% in Western Kenya (Thumi *et al.,* 2010).The difference in trypanosomiasis prevalence between our study and different studies may be

due to different factors associated with the disease like: Khartoum state is out of the tsetse belt and the disease is transmitted mechanically, environmental factors which affect the vector, control strategy applied in the areas, variation on climatic conditions and dry season which affects the vectors breeding and low parasitaemia.

In this study the univariate analysis showed that 15 risk factors were statistically significantly associated with the disease (P-value $\leq$ 0.25). In multivariate analysis using logistic regression there were four potential risk factors significantly associated with trypanosomiasis (P-value $\leq$ 0.05).

Distribution of the prevalence of trypanosomiasis in the localities showed significant association (P- value = 0.084). The higher infection rate in Ombeda may be due to the proximity of the area to livestock market.

With a significant association between the disease and areas (P-value = 0.000). The highest prevalence could be due to the presence of irrigation canals which extended in the area and good vegetation making a suitable environment for vector breeding.

The study showed an infection rate of 5.3% in females. There was a significant association in the univariate analysis between trypanosomiasis and sex (P-value = 0.219). This result is in agreement with Magona *et al.,* (2011) who found that female at risk two times higher than male. Females have a high rate of infection than males, may be because females remain longer in farms for reproductive purposes and physiological stress like estrous cycle, pregnancy and milk production may affect female body condition and immunity.

The body condition was statistically significant (P-value = 0.009). These results agree with Tadesse *et al.,* (2010) who found that difference (P<0.05) between poor and animals with good to medium body condition was statistically significant, Begna *et al.,* (2011) who reported that animals of various body conditions showed statistically significant difference (P<0.05) in the prevalence of trypanosomiasis , Bitew *et al.,* (2011) who say that Infection rate in poor body condition animals were significantly higher than good body condition animals (P < 0.05) and Mulaw *et al.,* (2011) who reported that the prevalence was significantly higher (P<0.05) in poor body condition animals. This could be due to the chronic nature of the disease that resulted in anaemia and poor body condition and emaciation of the animals.

There was a significant association between the disease and small herd size (P-value = 0.094). These could be attributed to the fact that most of < 30 groups are located in areas with high density of insects, thus more fly attacks to the small herd size than large one.

The current study investigated the use of drugs for treatment of animals. There was significant association between the disease and treatment of sick animals (P-value = 0.003). This risk factor was also significant in multivariate analysis (P-value = 0.012). The results agree with Kidanemariam *et al.,* (2002) who reported that chemotherapy and chemoprophylaxis is important against trypanosomiasis. Logically, treatment of sick animals restricts spread of the disease.

There was significant association between trypanosomiasis and the presence of other species in the farm (P-value = 0.000). The risk factor was also significant in multivariate analysis (P-value = 0.003). This result agrees with Mustafa, (2004) who reported that sheep can act as a potential reservoir in mixed herd. So presence of other species of animals in the farm may act as a source of the disease in the farm.

Also, the study investigated the farm hygiene as risk factor possibly associated with the disease and there was a significant association between the disease and farm hygiene (P-value = 0.148). This could be attributed to the fact that poor farm hygiene prepares a suitable environment for breeding of insects.

For veterinary care the study showed a significant association between the Trypanosomiasis and the availability of veterinary care in the univariate analysis (P-value = 0.000). Also, veterinary care had a significant association with Trypanosomiasis (p-value = 0.000) in the multivariate analysis with protective odds ratio. Logically, veterinary care plays a role in restricting the disease by intervention if any clinical sings appear.

Surgical operation and wounds in the animal's body were investigated and a significant association between Trypanosomiasis and surgical operation or wounds in the animal's body was observed (P-value = 0.108). That is logical because surgical operation or wounds in the animal's body invites the insects to have their blood meal.

There was a significant association between the disease and location of live animals market (P-value = 0.002). Also, location of livestock market had a

significant association with the disease (p-value = 0.004) in the multivariate analysis. These results agree with Abdelkarim, (1991) who reported that Trypanosoma infected animals can act as a source of infection to the neighboring farms. Logically, if there is one animal with the disease in the market all the area around may be at risk when the vector is present.

Also, the study investigated presence of insects in the farms. There was a significant association between the disease and presence of insects in the farm (P-value = 0.108). However, the most species of insects in the farms was house fly which is not one of the hematophagous insects.

Another risk factor investigated was insects species found in the farm. There was a significant association between the disease and insects species found in the farm (p-value = 0.106). This result agrees with Abdelrahman (2005). These insect's species act as a mechanical vector for the disease.

Also, presence of ticks in the farm was investigated in our study. There was a significant association between the disease and presence of ticks in the farm (P-value = 0.099). Tick may predispose animals to infection by bothering the animal leading to restlessness and other diseases and all of these may reduce the animal immunity.

Farmer awareness about the disease was investigated as a risk factor possibly associated with the disease. There was a significant association between the disease and farmer awareness about the disease (P-value = 0.065). Logically, aware farmer could apply control methods to control the disease and vectors.

Most probably, there is confounding between the risk factors in the multivariate analysis which affects the odds ratio of presence of other animal species in the farm and location of livestock market.

**Conclusion**

The current study confirms that bovine trypanosomiasis is one of the parasitic diseases which are distributed in Khartoum state farms with 4.8% prevalence. In general, the present study indicated that trypanosomiasis due to *T. vivax* is an important disease limiting cattle productivity and the body condition of the animals.

The presence of various biting flies and the absence of tsetse flies in this

investigation indicate that *T. vivax* infection in the study area is caused by mechanical transmission mediated by biting flies.

According to the study results in the multivariate analysis there were four potential risk factors that had a significant association with trypanosomiasis (P-value < 0.05). These risk factors are: treatment of sick animals (P-value = 0.012), presence of other species of animals in the farm (P- value = 0.003), veterinary care (P-value = 0.023), location of livestock market (P-value = 0.004).

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# GLOSSINA, BIOLOGY AND CONTROL/ BIOLOGIE, CONTROLE ET ERADICATION DES GLOSSINES

# WOLBACHIA, SODALIS AND TRYPANOSOME CO-INFECTIONS IN NATURAL POPULATIONS OF GLOSSINA AUSTENI AND GLOSSINA PALLIDIPES FROM THE KENYAN COAST

# WOLBACHIA, SODALIS ET LES CO-INFECTIONS DE TRYPANOSOME DANS LES POPULATIONS NATURELLES DE GLOSSINA AUSTENI ET GLOSSINA PALLIDIPES DE LA CÔTE KENYANE

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## Résumé

La manipulation génétique des symbiotes naturellement présents dans Glossina a été reconue comme un moyen de lutte contre la maladie. Cependant, il ya peu d'information sur la prévalence du symbiote dans les populations naturelles, ce qui est une considération importante dans l'évaluation de la faisabilité du contrôle base des symbiotes. Cette étude a été menée afin de déterminer la prévalence du symbiote naturel des tsé-tsé de la côte kenyane et pour détecter les infections simultanées de trypanosomes. G. austeni (n = 298) et *G. pallidipes* (n = 302) pris au piège dans les collines du Shimba et dans la forêt d'Arabuko-Sokoke étaient ages, classés et analysés pour Wolbachia, Sodalis et l'infection des trypanosomes en utilisant des tests PCR. Les mâles de ces espèces ont montré des profils similaires de distribution d'âge, mais les femelles de *G. pallidipes* ont une durée de vie (70 d) de la sympatric G. austeni (54 d). Les infections à Wolbachia étaient présentes dans toutes les mouches de G. austeni analysées, mais apparemment absentes de *G. pallidipes*. La prévalence totale de Sodalis était de 3,7% et 16%, tandis que les amorces ITS1 ont détecté des trypanosomes dans respectivement 13% et 10% de G. austeni et *G. pallidipes*. *T. congolense* était le parasite le plus commun à infecter à la fois *G. pallidipes* (37,9%, n = 29) et G.austeni (26,3%, n = 38). La co-infection par les trois organismes est de 1% et de 3,3% dans G. austeni et *G. pallidipes*, respectivement. 85% des mouches co-infectées portaient les parasites *T. congolense* et T. simiae. L'association entre l'infection trypanosome et

Sodalis était statistiquement significative dans *G. pallidipes* (P = 0,0127). Cette étude a conclu que les deux espèces sympatriques différaient grandement de la prévalence des symbiotes, malgré l'exposition à des facteurs environnementaux similaires. Les résultats suggèrent des inter-relations limitées entre Sodalis et l'infection des trypanosomes. Ces résultats sont discutés dans le cadre des interventions de contrôle à médiation symbiote possible pour réduire les infections parasitaires et / ou des populations de mouches.

## Summary

Genetic manipulation of symbionts naturally present in Glossina has been promoted as an avenue for disease control. However, there is limited information regarding symbiont prevalence in natural populations, which is an important consideration in assessing feasibility of symbiont-based control. This study was conducted to determine natural symbiont prevalence in tsetse from the Kenyan coast and to detect concurrent trypanosome infections. G. austeni (n=298) and *G. pallidipes* (n= 302) trapped in Shimba Hills and Arabuko-Sokoke forest were aged-graded and analyzed for Wolbachia, Sodalis and trypanosome infection using PCR assays. Male flies of these species displayed similar age distribution profiles, but *G. pallidipes* females had a longer lifespan (70 d) than the sympatric G. austeni (54 d). Wolbachia infections were present in all G. austeni flies analysed, but apparently absent from *G. pallidipes*. Total Sodalis prevalence was 3.7% and 16% while ITS1 primers detected trypanosomes in 13% and 10% of G. austeni and *G. pallidipes* respectively. *T. congolense* was the most common parasite infecting both *G. pallidipes* (37.9%, n=29) and G.austeni (26.3%, n=38). Co-infection with all three organisms was 1% and 3.3% in G. austeni and *G. pallidipes*, respectively. 85% of co-infected flies harboured *T. congolense* and T. simiae parasites. Association between trypanosome and Sodalis infection was statistically significant in *G. pallidipes* (P=0.0127). This study concluded that the two sympatric species differed greatly in the prevalence of symbionts, despite exposure to similar environmental factors. The results suggest limited inter-relations between Sodalis and trypanosomes infection. These findings are discussed in the context of potential symbiont-mediated control interventions to reduce parasite infections and/ or fly populations.

## Background

The tsetse fly Glossina (Diptera: Glossinidae) is the key vector for trypanosomes which cause trypanosomiasis is both man and his livestock. This disease continues to be a constraint to livestock-based rural livelihoods and a potentially fatal human disease (Allsopp 2001). Earlier research was based mainly on tsetse ecological studies and concentrated on ways to reduce the numbers of tsetse flies using bait-based methods such as use of traps, insecticide-treated targets and spraying, which have been seen to be effective over small operational areas (Willemse 1991). As more advanced scientific techniques become more available, current research is

directed more towards tsetse biology and in particular, methods to stop or reduce trypanosome acquisition, development and transmission. This line of research has led to the discovery of symbiotic microbes that live within the tsetse gut and which may influence tsetse and trypanosome interactions. Three of these symbiotic microbes (also referred to as gut endosymbionts) have been identified: Wigglesworthia glossinidia, Wolbachia pipientis and Sodalis glossinidius (Aksoy 2000). The endosymbionts inhabit the tsetse gut which is also the site of trypanosome maturation. The interactions between symbionts and trypanosomes in nature may provide an avenue for disease control. Not all tsetse individuals carry these symbionts and indeed some carry none except the primary symbiont Wigglesworthia glossinidia. This then raises the question as to whether the presence of one, or all or none of these symbionts affects the fly's vectorial capacity. Therefore, the objective of the present study was to determine the prevalence of endosymbiont infections in natural populations of G. austeni and *G. pallidipes*, and to assess the degree of concurrent trypanosome infections in these populations.

## Materials and Methods

*Study Area*

Glossina austeni and *G. pallidipes* flies were trapped in the Shimba Hills National Reserve (SHNR) in Kwale County and the Arabuko-Sokoke National Reserve (ASNR) in Malindi County (Figure 1). These two areas are national reserves which the government has protected in order to preserve their natural flora and fauna. The Shimba Hills Reserve lies between

latitude 4°20′S and longitude 39°31′E, at an altitude of 120-450m above sea level in the coastal lowlands agro-ecological zones 2-4 and covers an area of about 250km2. Temperatures range between 24-36oC. Rainfall averages 900-1200mm per annum, with the short rains falling in the months of October-December and the long rains during March-June. A wide range of wild animals can be found in SHNR including elephants, buffalo, antelope and waterbuck. The Arabuko-Sokoke National Reserve is located at latitude 3°16′S and longitude 39°49′E. The

park itself covers an area of about 6km² and is part of the larger Arabuko-Sokoke forest, which is the largest remaining fragment of coastal forest in East Africa. The forest contains three forest types namely mixed forest, Brachystegia and Cynometra, each of which protects different communities of plants and animals. Animals found here include a variety of birdlife, mongoose, duikers, forest elephants, African civets, baboons and vervet monkeys. There are three species of tsetse found in the study area namely *G. pallidipes*, G. austeni and G. brevipalpis.

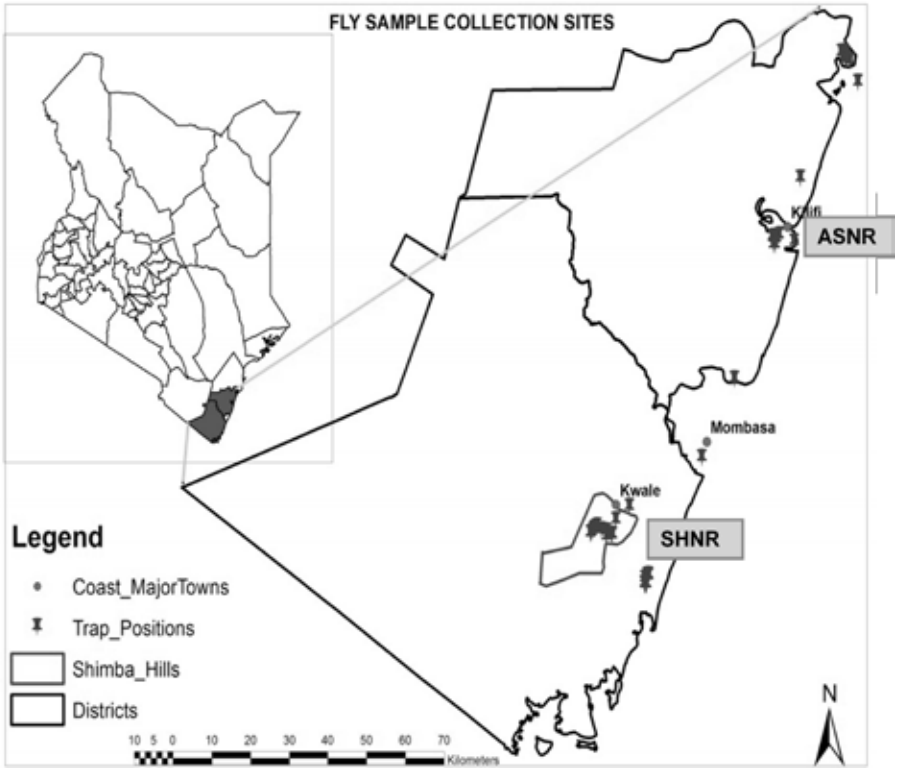



***Figure 1:*** *Fly sample collection sites Arabuko-Sokoke National Reserve (ASNR) and Shimba Hills National Reserve (SHNR)*

*Fly Sample Collection*

Flies were trapped using either standard biconical trap or theNGU2G trap (Brightwell, Dransfield *et al.,* 1987). The traps were baited with acetone and synthetic phenols and left in position for between 6 - 24 hours depending on the tsetse density in the particular area. All trap sites were geo-referenced using Garmin GPSmap76 (Garmin Corporation, Olathe, KS, USA). Flies were collected in the period 2009-2011, during the months of October-November, coinciding with the short rainy season. On collection, catches from each trap were sorted by species and a proportion of them preserved in 50ml Falcon tubes containing absolute ethanol. The remaining proportion of flies was reserved for dissection. Records of total catches, sex, date and area of collection were maintained for cross-referencing purposes.

*DNA extraction and diagnostic PCR for symbionts and trypanosomes*

Upon removal from ethanol storage, individual flies were blotted dry on a paper towel and air- dried overnight at room temperature. Total genomic

DNA was prepared from individual whole fly samples (minus legs and wings) using the DNeasy® Blood and Tissue Kit (Qiagen GmbH, Hilden, Germany) according to the manufacturer's instructions. The DNA was then stored at -20°C until further processing.

*Determination of the prevalence of symbionts and trypanosomes*

General screening for the presence of Wolbachia was determined by PCR amplification of the wsp gene using the primers 81F/691R (Zhou, Rousset *et al.,* 1998) which amplifies a 600bp product. The presence of Sodalis was determined using the primers GPO13/GPO15 (Dale and Maudlin 1999). For both symbionts, cycling conditions were as detailed previously (Alam, Hyseni *et al.,* 2012). The quality of template DNA was assured by amplification of insect- specific 12S rRNA (Simon, Frati *et al.,* 1994). The frequency and identity of trypanosome infection was investigated using an ITS1 assay (Njiru, Constantine *et al.,* 2005 ) whereby identification of the infecting trypanosome(s) species was based on the DNA product size.

## Results

*Prevalence of symbiont infection in G. austeni and G. pallidipes*

The incidence of Sodalis infections in G. austeni was 2% (n=100) and 4.6% (n=196) in ASNR and SHNR, respectively (Table 1). The difference in infection incidence between the two sampling areas was not significant (p=0.3443) and therefore the data were pooled to give a total infection rate of 3.7%. The Sodalis infection rate in *G. pallidipes* was significantly higher at 15.9% (p< 0.0001) Fisher's exact test. In both fly species, Sodalis was found to infect significantly more females than males (p=0.0249). All G. austeni samples analyzed were positive for Wolbachia, whereas all the *G. pallidipes* samples were negative.

| | | | **Symbiont Infection prevalence** | | | |
|---|---|---|---|---|---|---|
| **Species** | **Location** | **n** | *Sodalis* | | | *Wolbachia* |
| | | | **Females** | **Males** | **Total** | |
| *G. austeni* | ASNR | 100 | 2/50 (4) | 0/50 (0) | 2% | 100% |
| | SHNR | 196 | 6/103 (5.8) | 3/93 (3.2) | 4.6% | 100% |
| | Total | 296 | 8/153 (5.3) | 3/143 (2.1) | 3.7% | 100% |
| *G. pallidipes* | SHNR | 302 | 32/161 (19.9) | 16/141 (11.3) | 15.9% | 0% |

*ASNR-Arabuko-Sokoke National Reserve, SHNR-Shimba Hills National Reserve*

*Trypanosome infection in G. austeni and G. pallidipes*

The incidence of trypanosome infection was 12.8% and 9.6% for G. austeni and *G. pallidipes*, respectively (Table 2). The average infection rate realized in the three years of the study (2009- 2011) was 14±6.4% and 9.6±3.2% for G. austeni and *G. pallidipes* respectively, with the highest infection rate observed in 2010. However, chi-square test showed that the differences in prevalence rates for the three years between the two species was not significantly different. Proportionately more females than males were infected in both species, however the infection prevalence was significantly higher in *G. pallidipes* ($p<0.0001$) (Table 2).

***Table 2:*** *Prevalence of trypanosome infection in G. austeni and G. pallidipes*

| **Species** | **n** | **Trypanosome infection** | | | **Statistics** |
|---|---|---|---|---|---|
| | | **Total** | **Males[a]** | **Females[a]** | |
| *G. austeni* | 296 | 38 (12.8) | 16 (42.1) | 22 (57.9) | p=0.0505 |
| *G. pallidipes* | 302 | 29 (9.6) | 1(3.4) | 28 (96.6) | p<0.0001* |

*n-sample number. a numbers in brackets represent % of infected flies only. *significantly different infection between males and females*

The most common species of trypanosomes found infecting wild flies (n=598) were *T. congolense* (5.2%) and *T. vivax* (4.2%). Two sub-types of *T. congolense* were identified, namely *T. congolense* Kilifi and *T. congolense* savannah. Other trypanosome species found infecting flies were *T. brucei* (in mixed infections) and T. simiae. The distribution of infecting trypanosome species among the two tsetse fly species is presented in Table 3. Statistical analysis of the total trypanosome infection prevalence indicted that observed values were not significantly different between the two tsetse species (p=0.2435). Considering both fly species, trypanosome infection patterns that were observed include (a) *T. congolense* was the most common trypanosome at every sampling point (b) mixed infections were identified in only the 2009 sample set and (c) T. simiae was absent in the 2011 sample set.

***Table 3:*** *Species of trypanosomes found infecting Kenyan G. pallidipes and G. austeni.*

| | **Area** | ***n*** | ***T. c.*** | ***T. v.*** | ***T. sm*** | ***Tbb/Tc*** | ***Total*** |
|---|---|---|---|---|---|---|---|
| G. austeni | SHNR | 196 | 12 (6.1) | 11(5.6) | 2 (1.0) | 0 (0) | 25 (12.7) |
| G. pallidipes | ASNR | 100 | 8 (8) | 3 (3) | 1 (1) | 1 (1) | 13 (13) |
| | SHNR | 302 | 11 (3.6) | 11 (3.6) | 7 (2.3) | 1 (0.3) | 29 (9.6%) |
| **TOTAL** | | **598** | **31 (5.2)** | **25 (4.2)** | **10 (1.7)** | **2 (0.3)** | |

*The % infection is presented in brackets. T. c. - T. congolense, T. v. - T. vivax, T. sm - T. simiae, mixed - T. b. brucei / T. congolense*

*Sodalis and trypanosome co-infection*

Majority of the flies sampled were found to carry neither Sodalis nor trypanosomes and only a small proportion (13/598) harbored both trypanosomes and Sodalis bacteria. Of these 10 (3.3%) were *G. pallidipes* and 3 (1%) were G. austeni. In flies that carried the symbiont, 20.8% and 27.3% had a concurrent trypanosome infection in *G. pallidipes* and G. austeni respectively. The occurrence of co-infection was most commonly associated with T. simiae parasites whereby, out of 7 flies found infected with T. simiae, 6 (85.7%) contained the bacteria as well. Correspondingly, 5/31 (8%) T. vivax-infected flies and 2/25 (16%) T. congolense-infected flies also had Sodalis infection. The association between trypanosomes and Sodalis infection was statistically significant in *G. pallidipes* but not so in G. austeni (Table 4).

***Table 4:*** *Sodalis and trypanosome co-infection in wild G. pallidipes and G. austeni*

| | *G. pallidipes (n=302)* | | *G. austeni (n=2 96)* | |
|---|---|---|---|---|
| S+ | 10 (3.3%) [20.8] | 38 (12.6%) [79.2] | 3 (1.0%) [27.3] | 8 (2.7%) [72.7] |
| S- | 19 (6.3%) | 235 (77.8%) | 35 (11.8%) | 250 (84.5%) |
| p – value | p = 0.0127 * | | p = 0.1554 (NS) | |

** significant, NS-not significant. Bold values in square brackets indicates % of Sodalis-positive flies that were either parasite positive or negative*

## Discussion and Conclusion

*Symbiont Infections*

This study presents data on Wolbachia and Sodalis prevalence in two tsetse species from the Kenyan coast. The results show an increase in the G. austeni Wolbachia infection rate from that of 48% obtained in a 1996 sample (Cheng, Ruel *et al.,* 2000). This indicates an increase towards fixation of the Wolbachia infection in this population. This increase is attributed to the characteristic of Wolbachia to perpetuate its own spread via infected females; an asymmetry which results in the number of Wolbachia-infected individuals in a given population gradually increasing from low levels to complete fixation (Turelli and Hoffmann 1991 ).

Wolbachia infection was not detected in the *G. pallidipes* populations sampled. This result is consistent with previously reported zero infection rates for this species in Kenya and Uganda (Cheng *et al.,* 2000). However, recent work has reported a prevalence of 1.2% in 1,823 samples originating from eastern Africa (Doudoumis, Tsiamis *et al.,* 2012). Another factor that may have influenced the results obtained in this study with regard to Wolbachia prevalence in *G. pallidipes* could be the sensitivity of the diagnostic test

used. The wsp assay has been used successfully to amplify Wolbachia DNA in several tsetse species (Cheng, Ruel *et al.,* 2000; Doudoumis, Tsiamis *et al.,* 2012). However, the application of more sensitive and discriminative tools may serve to enhance detection of low-titre infections, as are suspected to be in this species (Arthofer, Riegler *et al.,* 2009). This would bring out a clearer picture of actual Wolbachia prevalence in *G. pallidipes*. Wolbachia based control strategies, principally Wolbachia-mediated cytoplasmic incompatibility (CI) are dependent upon the density of Wolbachia infection in the target species, which plays are role in expression of CI (Ikeda, Ishikawa *et al.,* 2003). Therefore, it would be of further interest to determine if, in the presence of low titre infections, CI is expressed in *G. pallidipes*.

Secondary symbionts such as Sodalis are generally found at intermediate frequencies within host populations (Russel and Moran 2006) and such infections show great variation in prevalence between populations and species. Variation in symbiont infection frequencies may be influenced by environmental factors, such as geographical location and climatic conditions, as well as by biological factors, such as parasitism pressure, the arthropod's host and population genetics, competition between symbionts, increased virulence and bottlenecks experienced by symbionts during vertical transmission (Mira and Moran 2002; Hansen, Jeong *et al.,* 2007; Toju and Fukatsu 2011). Given the fact that the species in this report were sympatric, it may be presumed that the variation in infection frequencies would moistly be related to biological species-specific factors.

*Trypanosome Infection*

The present results are consistent with those reported by Tarimo *et al.,* (1984) who found *G. pallidipes* infection prevalence in the same area to average 8.7% and the order of abundance of infecting trypanosome species to be *T. congolense* (62.5%), *T. vivax* (35.5%) and *T. brucei* (2%). It was found that the level of trypanosome infection in G. austeni was consistently higher than that found in *G. pallidipes*. This result concurs with previous findings that in areas of mixed tsetse infestation, despite lower abundance of G. austeni relative to other sympatric species, G. austeni is often found with higher levels of trypanosome infection (Motloang, Masumu *et al.,* 2012).While this may signify a higher vectorial capacity in G. austeni than in its sympatric species, account has to be taken of the multiple undefined factors affecting field situations. A controlled experimental study comparing the ability of G. austeni and *G. pallidipes* to pick up and establish trypanosomes infections would suffice to increase our understanding of transmission dynamics in these two species.

It was also notable that very few multiple trypanosome infections were found

in both fly species. This is in contrast to results obtained from Rufiji district along the Tanzanian coast whereby more than half of all *G. pallidipes* and G. austeni flies analyzed were infected with between two and five different species of trypanosomes (Malele, Magwisha *et al.,* 2011). It is inferred that the presence of a wide spectrum of potential tsetse hosts, both domestic and wild animals as well as frequent feeding upon these hosts may contribute to an abundance of mixed trypanosome infections (Simo, Silatsa *et al.,* 2012). However, in both countries, samples were collected in or around wildlife game reserves having a wide variety of wild animals. Therefore the difference in prevalence of mixed infections cannot be wholly attributed to host variety and may be a factor of the relative abundance of trypanosomes circulating in each given area.

*Sodalis and Trypanosome Co-infection in field-collected flies*

The presence of Sodalis has been postulated to increase the susceptibility of tsetse fly to trypanosomes infection (Geiger, Ravel *et al.,* 2007). However, in the present study, the proportion of Sodalis-infected flies with a concurrent trypanosome infection was lower than the proportion without the trypanosome infection. In part, this can be attributed to the relatively small number of co-infections detected. The low co-infection rate obtained in this study is in contrast with the rates of 32.2% reported in G. p. palpalis (Farikou, Njiokou *et al.,* 2010). It is however worth noting that in both the present study and the G. p. palpalis study, the trypanosomes species infecting Sodalis-positive flies belong to the sub-groups *Trypanozoon* and Nannomonas. These two sub-groups have a similar development cycle whereby maturation takes place in the midgut (Leak 1999). The synergistic effect of Sodalis on trypanosome establishment and maturation applies to trypanosomes species that pass through a midgut stage in fly and therefore includes T. congolense, *T. brucei* and T. simiae but excludes *T. vivax* (Welburn, Arnold *et al.,* 1993). The positive co-relation between the presence of Sodalis and trypanosome infection evident in *G. pallidipes* is consistent with previously reported findings which postulate that the presence of Sodalis supports the infection of the fly with various trypanosomes (Farikou, Njiokou *et al.,* 2010). It would therefore seem that in nature, co- infection is dependent upon the specific identity of both fly and trypanosome. However, the low level of symbiont infection in the two populations studied would imply the absence of any significant interplay between Sodalis and trypanosome infection in this area.

In conclusion, the correlation between symbiont status and trypanosome infection may be dependent upon the vectorial capacity of the tsetse species involved. In order to fully unravel this relationship, it is recommended that laboratory-based studies be conducted to confirm the observed differences in vectorial capacity of G. austeni and *G. pallidipes* in mixed populations.

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# MORPHOMETRIC ANALYSIS AS A TOOL FOR DETECTING DIFFERENCES AMONG TSETSE POPULATIONS: A CASE STUDY OF TSETSE SAMPLES FROM FOUR SITES IN ZAMBIA.

# ANALYSE MORPHOMETRIQUE : UN OUTIL DE DISCRIMINATION DES MOUCHES TSE-TSE, LE CAS DE LA ZAMBIE.

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## Résumé

L'objectif de l'étude était d'utiliser une analyse morphométrique des ailes fondée sur des repères pour établir une distinction entre les mouches tsé-tsé de différentes régions géographiques en Zambie. Des échantillons de l'aile gauche des mouches tsé-tsé de Mpulungu (Glossina fuscipes. martini n1 = 8), de Kakumbi – divisés en deux (G. morsitans morsitans n2=11 et n3=10), de Chinyunyu (G.m. morsitans n4 = 10) et de Muyombe (G. m. morsitans n5 = 9) ont été numérisés en recueillant 11 repères de nature de type de chaque aile, formatés et analysés. L'identité et l'origine des mouches tsé-tsé ont été cachées à l'enquêteur et seulement révélées après l'analyse discriminante. La présentation graphique des rapports ont montré que l'échantillon de Mpulungu (G.Fuscapes. martini n1 = 8) était significativement différent des autres échantillons (G. morsitans) de Kakumbi, Chinyunyu et Muyombe. Les échantillons fragmentés de Kakumbi étaient plus apparentés l'un à l'autre que les échantillons provenant de Chinyunyu et Muyombe. L'échantillon de Muyombe était sensiblement différent de celui de Chinyunyu même si les duex appartenaient à la même espèce. Les résultats ont révélé une technique abordable susceptible d'étudier les populations de glossines de différentes zones afin de les stratifier en zones d'affinité. La stratification de la population de mouches tsé-tsé en fonction de leur affinité est vitale dans les approches de lutte contre les glossines à l'échelle d'une région, en particulier dans l'édification de barrières pour bloquer les sources potentielles de ré-invasion. L'analyse morphométrique des ailes a différencié significativement les mouches tsé-tsé des diverses espèces. Elle a également établi une distinction entre les mouches tsé-tsé de la même espèce, même si la différence n'était pas significative dans certains cas.

## Summary

Wing Morphometric Analysis was used to check for any differences among tsetse samples from four geo-locations in Zambia - i.e. Mpulungu in the Northern Province

(Glossina fuscipes martini, n1=8), Kakumbi in the Eastern Province (G. morsitans morsitans split into two sub-samples: n2=11 and n3=10), Chinyunyu in Lusaka Province (G.m. morsitans, n4=10), and Muyombe in Muchinga Province (G. m. morsitans, n5=9). Left wings were digitized by collecting 11 landmarks of type I nature from each wing and, formatted and analysed. The identity and source of the tsetse flies were concealed from the investigator and were only revealed after completion of the analysis and presentation of the results. The results showed that the sample from Mpulungu (G.Fuscipes. Martini n1=8) was significantly different from the other samples from Kakumbi, Chinyunyu and Muyombe. The sub-samples from Kakumbi were more related to each other than they were to samples from Chinyunyu and Muyombe. The sample from Muyombe was significantly different from that from Chinyunyu even though the two belonged to the same species. The technique discriminated tsetse flies of different species, and also did detect some difference among tsetse flies of the same species - even though the difference was found not to be significant. The results indicate the potential of the technique as an effective and relatively low cost technique for identifying difference among tsetse populations in different belts so as to stratify them into areas of relatedness. Such stratification is helpful in the area-wide approach to tsetse control, e.g. with regard to the most appropriate location of artificial tsetse barriers.

## Introduction

Morphometrics may be defined as a more or less interwoven set of largely statistical procedures for analysing variability in size and shape of organs and organisms (Elewa, 2010). Morphometrics focuses on variation, its parameterization and relation to extrinsic factors of organs or organisms under study. Morphometric variation is under the influence of the physiological status, adaptive changes and genetic differences. The characters provided by morphometric analyses, either distance between landmarks or their coordinates contain information of both size and shape (Dujardin and Slice, 2007). Whereas traditional morphometrics focused on measurement of dimensions (size), modern or geometric morphometrics focuses on measurement of both dimensions and forms. Geometric Morphometrics that uses landmarks is referred to as Landmark Based Morphometrics. Landmarks are anatomical points that can easily be recognisable from one individual to the other made on an organ or organism. There are three types of landmarks; type I, type II and type III. Type I landmarks are those that are at the junction of two different tissue; Type II landmarks are those that are at the top of a curve; and type III are those at an abstract construction. Landmark based morphometrics consists of data collection, formatting and storage and analyses. Thanks to specialized software, some freely available at http://life.bio.sunysb.edu/morph/ and http://www.mpl.ird.fr/morphometrics, data collection, formatting and storage and analyses can be done (Dujardin and Slice, 2007).

Effective and efficient management and control of Tsetse flies is dependent

on knowledge of the tsetse subpopulations' relatedness and structure. This study's objective was to check for differences in wing morphology among 5groups of tsetse samples using morphometric analysis in order to explore its potential to stratify subpopulations. Stratification is helpful in the area-wide approach to tsetse control especially in identifying appropriate locations for placement of artificial tsetse barriers to prevent reinvasion.

In this particular exercise landmark based morphometric analysis has been used to discriminate known but concealed samples of tsetse flies from four geo-locations in Zambia. In Zambia circumstances occur where existence of subpopulations may be suspected – and Morphometrics could be a useful tool to establish the true status in such cases.

**Materials and Methods**

Permission was sought from the tsetse and trypanosomiasis control unit to use preserved tsetse samples caught during their routine tsetse surveys. Five known but concealed samples of tsetse flies from four concealed geo locations in Zambia were used in the study, figure 1. The objective was to apply wing Morphometric Analysis to check for differences among these groups of tsetse flies.

Forty eight (48) microscope slides each with a left wing covered with a cover slip and pasted with cello tape were given to the analyst to carry out the analysis. Some studies have shown that there are subtle but statistically highly significant differences between the mean shapes of left and right wing (Palmer and Strobeck, 1986; Sokal & Rohlf, 1995; klingenberg, Mclntyre and Zaklan, 1998). Slides were numbered 1 to 48. Slides 1 to 8 had wings of flies from one sample, 9-19, 20-29, 30-39 and 40-48 for flies from other samples. Samples were correspondingly number 1 to 5.

The mounted wings were then photographed using Dino lite digital microscope which was connected to a lap top computer via a USB port. Eleven (11) landmarks of type I nature, figure 2, were made on each of the 48 wings. Digitization was done using the COO module of CLIC software (http://www.mpl.ird.fr/morphometrics). The data was then formatted using the TET module of CLIC. Lastly the formatted data was analysed using the MOG module of CLIC and Discriminant Analysis, DA, or Canonical Variates analysis , CVA.

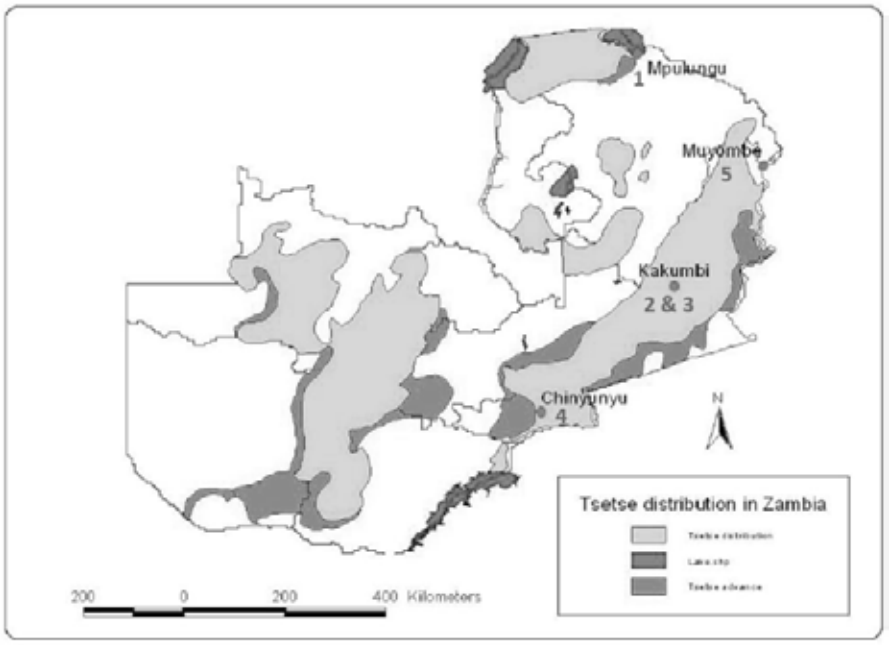



***Figure 1:*** *Geo-locations of sample sources*

DA is used to estimate the linear combination of characters that best discriminate groups. It is explicitly a multiple group procedure, and assumes that the groups are known correctly before analysis on the basis of extrinsic criteria and that all individuals are members of one of the known groups. It optimizes discrimination between groups by one or more axes, the discriminant functions (Elewa, 2010).

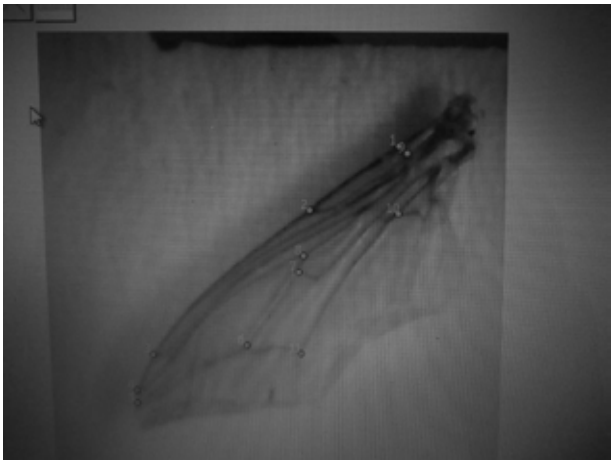


***Figure 2:*** *Sequence of the 11 landmarks followed on each of the 48 left wing.*

## Results

Results were presented in graphically as canonical factor against dimension (size) according to geo location, figure 4. There was indication of a clear difference between sample 1 and the other four samples. Among samples 2 to 5, the results showed a marked difference between sample 4 and 5, and also between sample 2 and 4. Samples 2, 3 and 5 appeared to be considerably similar.

It was then revealed that sample 1 comprised of Glossina fuscipes martini from Mpulungu of the Northern tsetse belt. Sample 2 and 3 were split from one sample of Glossina morsitans morsitans collected from Kakumbi of the Eastern tsetse belt. Samples 4 and 5 comprised Glossina morsitans morsitans collected from Chinyunyu and Muyombe, respectively, also of the Eastern tsetse belt. After revelation of existence of two species among the samples, discriminant analysis was carried on the basis of species and results graphically presented in figure 5.

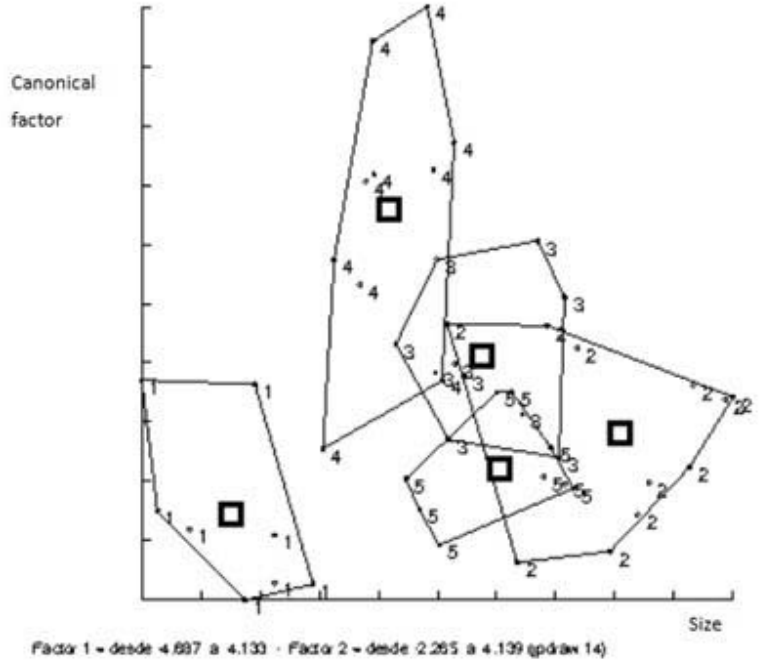



Figure 4: Graphic presentation of sample according to geo location that is 1=*Gfm* from Mpulungu, 2 and 3=*Gmm* from Kakumbi, 4=Gmm from Chinyunyu, 5=*Gmm* from Muyombe.

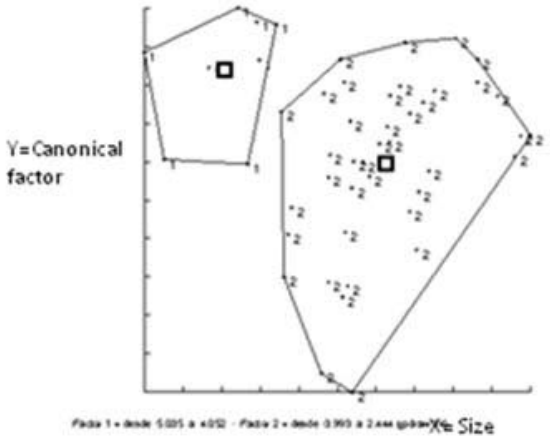



Figure 5: Graphic presentation of sample according to species that 1=*Gfm* from Mpulungu, 2=*Gmm* from Kakumbi, *Gmm* from Chinyunyu, Gmm from Muyombe.

**Discussion and Conclusion**

Land mark based wing morphometric analysis can be a helpful tool for Biologists working with organisms that can be characterized by a few landmarks (Periago *et al.,* 2008). It has been used in species detection and re-infestation studies. The taxonomic power of morphometrics has also been used to question species boundaries (Dujardin *et al.,* 2004), or to synonymize controversial taxa (Gumiel *et al.,* 2003). Cryptic species, when examined for morphometric differences, have been accurately distinguished in Triatominae (Villegas *et al.,* 2002), sandflies (Lane and Ready, 1985; De la Riva *et al.,* 2001.) and mosquitoes (Kitthawee *et al.,* 1992).

Results in this study indicate that wing morphometric analysis is as an effective and relatively low cost technique for detecting differences among tsetse populations i.e. between species and within same belts demonstrating the potential of the technique to stratify tsetse populations according to geo location of relatedness and identification of subpopulations. Such stratification is helpful in the area-wide approach to tsetse control especially in identify appropriate locations for placement of artificial tsetse barriers to prevent reinvasion. To substantiate, upon revelation of sources of samples and their identities, it was noted that the clear difference between sample 1 and other four samples (1-5) denoted ability of the technique to discriminate samples on the basis of species as sample 1 comprised Glossina fuscipes martini flies and samples 2 to 5 comprised Glossina morsitans morsitans flies. Further the technique was able to show that flies of sub samples (2 and 3) from Kakumbi were not markedly different in wing morphology from each other

than they were to those of samples from Chinyunyu and Muyombe (4 and 5, respectively). In addition flies of the sample from Muyombe were markedly different in wing morphology from those from Chinyunyu even though the two belong to the same species.

Wing morphometric analysis categorically discriminated tsetse flies of different species in terms of morphology. It also discriminated tsetse flies from the same species even though differences were not substantial morphologically in some cases.

**Acknowledgement**

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# FLIGHT SEASON AND ABUNDANCE OF TABANIDS (DIPTERA: TABANIDAE) AND MUSCIDS (DIPTERA: MUSCIDAE) IN KHARTOUM STATE-THE SUDAN

# PÉRIODE DE VOL ET ABONDANCE DES TABANIDÉS (DIPTERA: TABANIDAE) ET MUSCIDÉS (DIPTÈRES: MUSCIDAE) DANS L'ETAT DE KHARTOUM AU SOUDAN

*Faiza F. A. and Mohammed, M. Mohammed-Ahmed*

**Résumé**

Cette expérience avait pour objectif d'étudier l'abondance relative et la saisonnalité des tabanidés et muscidés à Hillat Kuku, dans le Nord de Khartoum au Soudan. Des mouches ont été capturées au moyens de pièges Nzi et interceptées en vol par un filet électrique. Les espèces capturées comprenaient Atylotus agrestis Weidmann (28,8%), Tabanus soufis Jennike (48,9%), T. taeniola Palisot (22,3%) et Musca SPP, avec Stomoxys calcitrans (Linnaeus), cette dernière espèce étant constatée seulement au cours de la saison sèche et chaude. De l'ensemble des tabanidés pris dans les pièges Nzi sur une période d'un an (N = 2595), 806 (31,1%), 1041 (41,1%) et 748 (28,8%) ont été capturés respectivement pendant les saisons chaude et sèche, froide et sèche, et pluvieuse, par rapport aux 239 (21,6%), 492 (44,4%) et 377 (34,0%) tabanidés femelles capturées au filet électrique (N = 1 108) durant les mêmes saisons. La capture par le filet électrique pour les mâles était de 54 (14,5%), 190 (50,9%) et 129 (34,6%) respectivement pendant les saisons chaude et sèche, froide et sèche, et pluvieuse. Deux pics de vol pour les taons à Khartoum étaient apparents : un niveau plus élevé en mars et avril signalant la fin de la saison froide et le début de la saison sèche et chaude, et un niveau moins prononcé à la fin de la saison des pluies et au début de la saison sèche et froide de septembre à novembre. On a pu capturer plus de muscidés avec le filet électrique par rapport au piège Nzi (16.8-234.3/piège/jour pour le filet électrique contre 3,0 à 70,8 pour le piège Nzi). La capture de muscidés au moyen du filet électrique a révélé cinq pics (janvier, mars, juin, septembre et octobre), tandis que les captures au piège Nzi ont révélé un seul pic prolongé pendant les mois les plus frais de l'année, de décembre à mars.

**Summary**

This experiment aimed to study relative abundance and seasonality of tabanids and muscids at Hillat Kuku, Khartoum North, the Sudan. Flies were caught by Nzi trap and intercepted in flight by an electric net. The species caught included Atylotus agrestis Weidmann (28.8%), Tabanus sufis Jennike

(48.9%), T. taeniola Palisot (22.3%) and Musca SPP, together with Stomoxys calcitrans (Linnaeus), the latter being found during the hot dry season only. Of the total tabanids caught in Nzi trap over one year period (N = 2595), 806 (31.1%), 1041 (41.1%) and 748 (28.8%) were in the hot dry, cool dry and rainy seasons, respectively, compared with 239 (21.6%), 492 (44.4%) and 377(34.0%) female tabanids caught at the electric net (N = 1108) in the same seasons. The catch of the electric net for male was 54 (14.5%), 190 (50.9%) and 129 (34.6%) in the hot dry, cool dry and rainy seasons, respectively. two flight peaks for horse flies in Khartoum were apparent: a higher one in March and April signaling the end of the cool and the beginning of the hot dry season and a smaller one at the end of the rainy season and the beginning of cool dry season from September to November. more muscids were obtained from the electric net compared with Nzi trap (16.8—234.3/trap/day for electric net versus 3.0-70.8 for Nzi trap). Muscids catch at the electric net indicated five peaks (in January, March, June, September and October) while the trap catches signified a single extended peak over the coolest months of the year from December to March.

**Introduction**

Lewis (1953) made the first comprehensive study of the species of Tabanidae in the Sudan; he stated that some species were widely distributed in different types of country and had received great attention, probably because of their role in seasonal movements of pastoral groups in disease transmission. These species are Atylotus agrestis, A. fuscipes, T. gratus, T. taeniola, T. sufis, Haematopota brumescens and H.tenusis. So for the distribution of the various types of tabanids species seems to have the same distribution described by Lewis (1953). The genera Philoliche and Atylotus included species, which exist in the relatively dry central Sudan.

Abdel Razig and Yagi (1975) observed that at El Rahad Turda T. teaniola was very much related to the wet season. In South Darfur, the first catch of the latter species started about April, reaching a maximum during the rains in July-August (Yagi and Abdel Razig, 1972).

In Khartoum state Mohamed- Ahmed *et al.,* (2007) found that A. agrestis was most available to Nzi trap in, May, July, September and October while T. sufis had higher prevalence during the hot dry season between March-May, and at the end of the rains between September and October. Sawsan, 1997 found that A. agrestis and T. sufis to be the most available to traps in May, September and October.

## Materials and methods

*Study sites*

The study was conducted over one year in the Teaching and Experimental Farm Unit (26ha) of the College of Veterinary Medicine and Animal Production, Sudan University of Science and Technology, Hillat Kuku, Khartoum North (15.5oN-32.5oE), Khartoum State, the Sudan. About 25 ha of the farm are utilized for cultivation of fodder. Fodder crops are irrigated by a system of canals originating from the River Nile. These canals constitute permanent suitable breeding sites for Dipteran insects including horse flies (Tabanidae) and mosquitoes (Culicidae). Some 150 experimental animals in the farm comprising cattle, goats, equines and camels guarantee a permanent source of blood meals for haematophagous flies. The main college building to the south of the farm is well furnished with exotic evergreen shade trees as well as flower and grass beds that also provide floral nectar, resting sites and refuge for insects during extreme climatic conditions in this largely desert environment. Khartoum and its environs have an arid desert climate with three distinct seasons. The cool dry season (November to March), the hot dry season (April to June) and a short rainy season (July to October).

*Trapping of flies:*

Flies were caught in Nzi trap (Mihok, 2002) and intercepted in flight by an electric net (Vale, 1974). The Nzi trap and electric net were installed for four consecutive days each month in permanent sites 50m apart and were separated from each other by a thick hedge of trees which were entwined with grass and climbers.

## Results

*Flight season of tabanids*

Catches of tabanids by any one device showed that all species of tabanids were present the year around from November 2007 to October 2008. Subsequent plots of mean catches of each species of tabanids on their respective months produced roughly similar profiles for the electric and Nzi trap. Thus, a peak of flight in any season could be identified from plots of any or both catching methods which suggest a direct association between trap and electric net catches. This was subsequently proved by the regression of the mean pooled trap catches as well as those of each species on the corresponding values of the electric net (Table 1).

Since plots of mean catches on their respective months revealed negligible

differences among species of tabanids, peak flight seasons of these flies were deduced from plots of monthly pooled tabanids caught in Nzi trap (Fig. 2, A). Figure 2 shows that relatively high numbers of tabanids (> 71/trap/day) were caught by Nzi trap in November 2007, the start of the cool dry season. In the following coolest months of the year (December 2007 and January 2008), mean catches of flies dropped to < 10/trap/day. In February catches picked up to above 34 and continued to do so until they attained a peak (100-123 flies/trap/day) in March and April. In the succeeding hottest months of the year (May and June) mean catches dropped and fluctuated about 41-45 flies/ trap/day. In July catches increased to above 50 flies only to decline again in August (< 20 flies). From September onwards trapped horse flies increased progressively to reach a peak in November. From the above account two flight peaks for horse flies in Khartoum were apparent: a higher one in March and April signaling the end of the cool and the beginning of the hot dry season and a smaller one at the end of the rainy season and the beginning of cool dry season from September to November (Fig 1 A, B).

*Flight season of muscids*

The mean catches of muscids in Nzi trap and at the electric net are shown in figure 2B. Many more muscids were obtained from the electric net compared with Nzi trap (16.8—234.3/trap/day for electric net versus 3.0-70.8 for Nzi trap) However, unlike tabanids, mean catches of muscids by the two methods were apparently not correlated in any one season.

Thus, catches at the electric net indicated five peaks (in January, March, June, September and October) while the trap catches signified a single extended peak over the coolest months of the year from December to March. Thereafter, muscids remained low at roughly equal densities until the end of the year in December. Additionally catches by both techniques included a few stable flies, Stomoxys calcitrans, caught only during the hot dry season.

*Flight season of male tabanids*

The electric net male catch from November 2007 to October 2008, was 54 (14.5%), 190 (50.9%) and 129 (34.6%) in the hot dry, cool dry and rainy seasons, respectively. Thus, Flight season shown in Figure 3, reflex seasonal fluctuations in catch indicating two flight seasons in November and August.

***Table 1:*** *Correlation between mean catches of tabanids and muscids caught in Nzi trap (Y) and at electric net (X) from November 2007 to October 2008*

| Species | Regression equation | Correlation coefficient(R) | Probability (P) |
|---|---|---|---|
| *A. agrestis* | Y= 3.01 +7.01X | 0.921 | 0.000 |
| *T. sufis* | Y= -0.64+0.65X | 0.961 | 0.000 |
| *T. taeniola* | Y= -0.24+1.00X | 0.994 | 0.000 |
| Total tabanids | Y= 1.73+0.49X | 0.555 | 0.049 |
| Muscids | Y=21.64+0.89X | 0.347 | 0.245 |

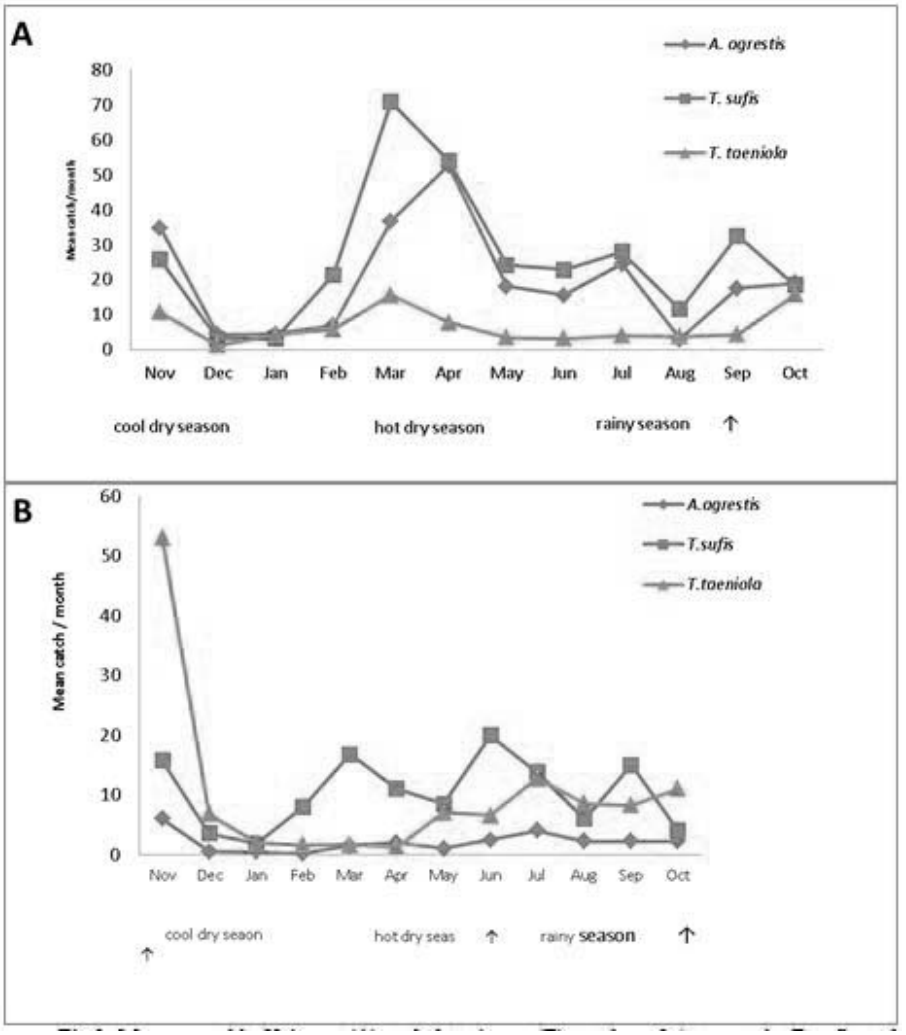



***Figure 1:*** *Mean monthly Nzi trap (A) and electric net (B) catches of A. agrestis, T. sufis and T. taeniola (November2007-October2008)*

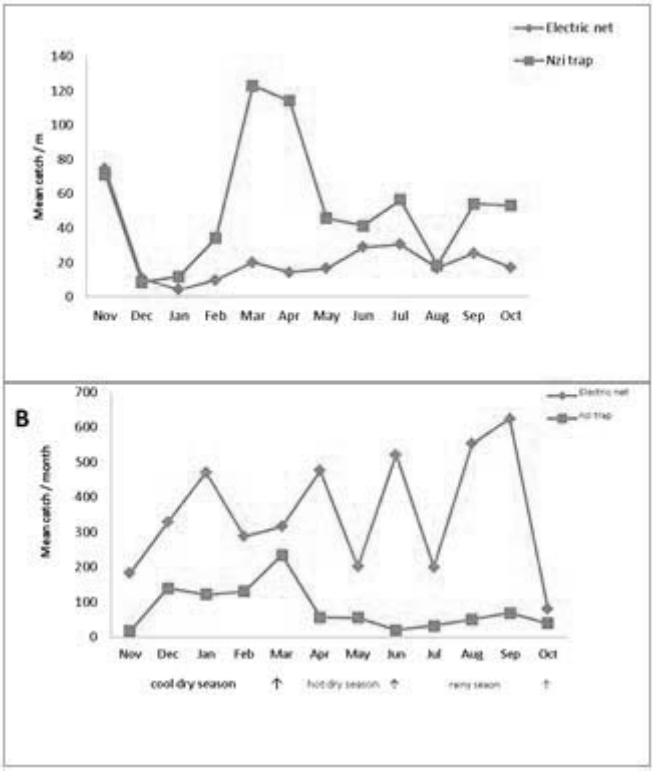



***Figure 2:*** *Mean monthly Nzi trap and electric net catches of total tabanids (A) and muscids (B) (November 2007-October 2008)*

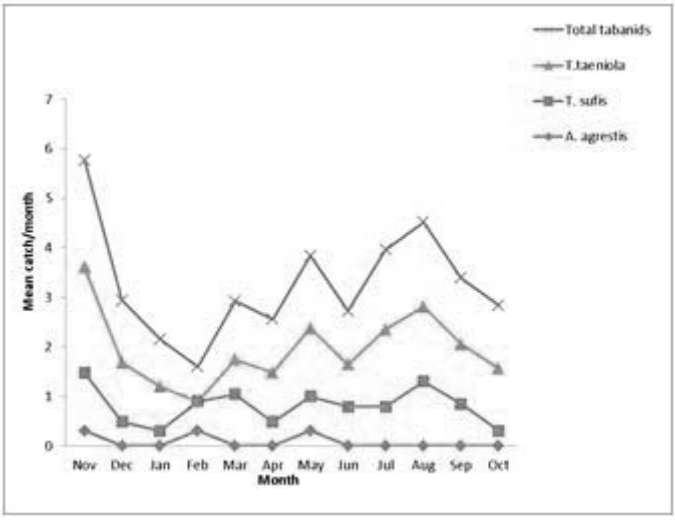



***Figure 3:*** *Mean monthly electric net catches of male tabanids (November 2007-October 2008)*

## Discussion

*Flight season of tabanids*

In temperate zones, Tabanidae increase in abundance in the summer, while in the tropics, they do so in the wet or rainy season (Lehane, 1991). In this study it was found that tabanids population in Khartoum had biannual peaks of abundance: one in at the end of the cool dry and the beginning of the hot dry season, and another during the late rainy season up to the beginning of the cool dry season. Such peaks could obviously be explained on the basis of the ecology and biology of tabanids in the area. Tabanids larvae and pupae are aquatic or semi-aquatic. Therefore, high abundance of these flies is to be expected during and immediately after the rains due to the high availability of breeding sites. Conversely, shortly after the rains have ceased and the cool dry season ushered in late November, the tabanids population declines as the pools of water have dried up and larvae have started to hibernate with no more replenishment for the natural mortality in adult flies from the quiescent immature stages. The data also imply that hibernating larvae probably start to moult into pupae in February. By early March most of these pupae hatch into adults thus leading to a population flight peak in March and April the end of the cool dry season. The latter scenario seems to apply to all tabanids communities in central Sudan if not the entire country. Thus, similar biannual flight peaks were reported for tabanids in South Darfur State (Yagi and Abedel Razig, 1972; Hall *et al.,* 1983), in Kordofan State (Yagi, 1968), in Khartoum State (Sawsan,1997; Mohamed-Ahmed *et al.,* 2007; Rahman, 2005) and in about 1000 km along the Blue Nile banks from Khartoum southward to Damazin (Suliman, 1992; Rahman, 2005). Association of flight peaks of tabanids with the rains was reported in several regions in Africa: in West Africa (Ahmed2005), in southern Africa (Phelps and Vale, 1976) and in east Africa (Sinshaw and Abebe 2006)

*Flight season of muscids*

In contrast to tabanids, monthly mean trap catches of muscids did not correlate significantly with those of the electric net . This implies that the flight season of any one extant species of muscids could vary with the catching method of flies. As there is no immediate explanation for the latter discrepancy, we have speculated that the trap and electric net sample were physiologically different segments of the muscids population. Thus, while the trap may catch host-oriented muscids, the electric net intercepts ranging muscids flying spontaneously.

The electric net caught both male and female tabanids while the trap caught only female horse flies. The males of tabanids had two flight seasons in November and August. However, this is probably the first documentation of flight seasons of male tabanids in the Sudan or elsewhere.

**Acknowledgements**

I dedicate this work to my late supervisor Prof Mohamed Musa Mohamed-Ahmed

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# CONTRÔLE DES GLOSSINES EN CONDITIONS RÉELLES PAR ZEROFLY® LIVESTOCK AU SÉNÉGAL

# A FIELD TRIAL WITH ZEROFLY® LIVESTOCK SCREEN TO CONTROL TSETSE IN SENEGAL

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## Summary

A field trial with ZeroFly® Livestock was conducted in the Niayes area of Senegal in order to evaluate its impact on tsetse in two farms located in Pout, from which one was traditional and the other modern. The objectives were to determinate the sensitivity of tsetse to deltamethrin and its persistency using contact tests and to evaluate the impact of protecting cattle pens primarily on the apparent densities of the tsetse Glossina palpalis gambiensis, main vector of trypanosomoses in the area, and secondarily on those of other mechanical vectors of trypanosomoses and domestic flies. The apparent densities were monitored from May to Dec 2012 using three types of traps, including biconical traps for tsetse, Olson traps for haematobia and domestic flies, and Nzi traps for stomoxes and tabanides.

The sensitivity of tsetse was confirmed and the persistency of deltamethrin exceeded the trial period. Moreover, ZeroFly® Livestock screen allowed a significant protection of cattle against tsetse within a distance range of 50m in both farms ($p=0.003$). Against other dipteran families, no significant impact was recorded.

It must be noted that ZeroFly® Livestock was primarily set to protect cattle against tsetse, i.e. ~100% of their flying corridor was concerned, whereas only 80 and 58% of the cattle pens perimeter was protected in the traditional and modern farms respectively. The results of this trial confirmed the efficacy of ZeroFly® Livestock to provide individual protection against tsetse under the conditions of use preconized by the manufacturer.

## Résumé

Un essai de terrain de ZeroFly® Livestock a été mené dans deux fermes (moderne et traditionnelle) de la localité de Pout dans la zone des Niayes au Sénégal. Les objectifs de cette étude étaient de déterminer la sensibilité des tsé-tsé à la deltaméthrine et sa persistance à l'aide de tests de contact, et d'évaluer l'impact de la protection des enclos de bovins, principalement sur les densités apparentes de Glossina palpalis gambiensis, et secondairement sur les vecteurs mécaniques de la trypanosomose et les mouches domestiques. Un suivi entomologique a été réalisé de Mai à décembre, avec trois types de pièges dont des pièges biconiques pour les tsé-tsé, des pièges Olson pour les Haematobia et les mouches domestiques et des pièges NZI pour les stomoxes et les tabanidés.

La sensibilité des tsé-tsé a été confirmée et la persistance de la deltaméthrine a excédé la période d'essai. De plus, ZeroFly® Livestock a permis une protection des bovins contre les tsé-tsé dans un rayon de 50m dans les deux fermes (p=0,003). Pour les autres familles de diptères, aucun impact significatif n'a été noté.

Il faut noter que ZeroFly® Livestock a été posé dans le but de protéger les bovins contre les tsé-tsé, c'est-à-dire que pratiquement 100% de leur couloir de vol était concerné, alors que seulement 80 et 58% du périmètre des enclos de bovins a été protégé dans la ferme traditionnelle et moderne respectivement. Les résultats ont confirmé l'efficacité de ZeroFly® Livestock à fournir une protection individuelle contre les tsé-tsé dans les conditions d'utilisation préconisées par le fabriquant.

## Introduction

Les glossines ou mouches « tsé-tsé » sont des diptères brachycères hématophages, qui transmettent plusieurs espèces de protozoaires flagellés du genre Trypanosoma responsable de la trypanosomose animale ou nagana et de celle humaine ou maladie du sommeil ; occasionnant des pertes énormes (FAO, 1998). En plus des glossines, d'autres insectes transmettent la trypanosomose animale africaine (TAA), ce sont entre autres : les tabanidés, les stomoxes, les Haematobia…

Dans les années 1970 et 1980, un projet d'élimination des tsé-tsé, par diverses méthodes dans la zone des Niayes, avait été entrepris par le gouvernement sénégalais (Touré, 1972). Il s'en est suivi un silence glossinien de courte durée, car moins d'une décennie après, des investigations de terrains ont montré une reconstitution de la population de Glossina palpalis gambiensis (Bouyer *et al.,* 2010). Le gouvernement sénégalais a alors initié à nouveau une campagne d'élimination des glossines qui comporte deux volets : une première phase de « suppression » et une deuxième phase « d'éradication ».

Vestergaard Frandsen développe des produits innovants pour la lutte anti-vectorielle. ZeroFly® Livestock est un écran de protection fait d'un mono filament de polyéthylène, avec incorporation d'un insecticide pyréthrinoïdes, la Deltaméthrine. Ceci est une version améliorée, assurant une prolongation de la vie du produit pour usage à l'extérieur, et plusieurs études ont déjà été réalisées confirmant l'efficacité de ce produit (Bauer *et al.,* 2007, Maia *et al.,* 2010, Kagbadouno *et al.,* 2011, Maia *et al.,* 2012).

C'est dans ce cadre général qu'un test d'efficacité entomologique sur le terrain a été réalisé pour Vestergaard Frandsen utilisant ZeroFly® Livestock., écran protecteur incorporé de Deltaméthrine. Le test d'efficacité du produit visait trois objectifs : i) la détermination et le décompte des différentes espèces de mouches (en rapport avec la trypanosomose animale africaine) inféodées à la zone d'étude avant et après la pose de ZeroFly® Livestock écrans protecteurs, ii) la détermination de la sensibilité des tsé-tsé à la deltaméthrine (DM) par des tests de contact et iii) le contrôle de la rémanence de l'insecticide sur l'écran entourant les sites ciblés, suite à l'exposition aux conditions environnementales locales, par envoi régulier d'échantillons dans des laboratoires affiliés à la société Vestergaard Frandsen au Vietnam et au Ghana.

## Méthodologie

*Sites D'études et Périodes*

Dans la zone des Niayes, la localité de Pout a été choisie pour la mise en œuvre de cette activité, du fait que c'est la zone qui présente la densité la plus élevée de tsé-tsé, de l'espèce Glossina palpalis gambiensis, Vanderplank (Bouyer *et al.,* 2010, Seck *et al.,* 2010). Deux types de fermes y ont été ciblés pour l'étude : une ferme traditionnelle (FT) et une ferme moderne (FM), (figure 1).

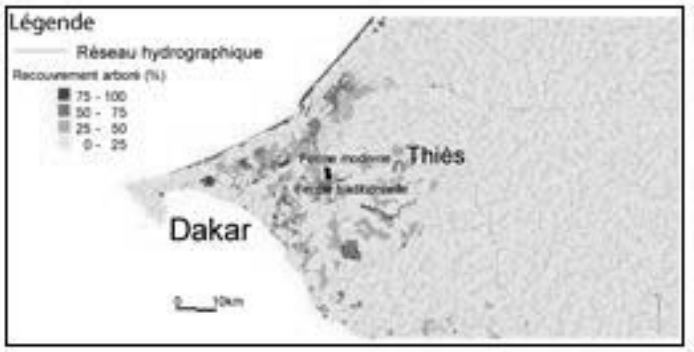



***Figure 1 :*** *Localisation des sites d'étude (carte Bouyer J.)*

Le programme d'exécution de cette activité comprenait deux phases :

- Une première phase de suivi entomologique avant installation du ZeroFly® Livestock. Cette phase consistait à déterminer les différentes espèces de mouches (surtout celles impliquées dans la transmission de la TAA) présentes sur les deux sites, ainsi que leur densité apparente moyenne (nombre de mouches/piège/jour). Cette étape s'est effectuée durant les mois de mai et de juin 2012 (période chaude et sèche de l'année dans la zone).
- Une deuxième phase de suivi entomologique, après l'installation du produit dans les deux sites. Ce suivi consistait en des séries de mesures de DAP (Densité Apparente par Piège et par jour) effectuées du mois de juillet au mois d'octobre 2012 (saison pluvieuse) et de novembre à décembre 2012 (saison sèche-froide). Cette étape permettra de voir si l'intervention a eu une influence sur la dynamique de la densité apparente des mouches.

*Suivi Entomologique*

Trois types de pièges ont été utilisés : des pièges biconiques (pour capturer les tsé-tsé), des pièges NZI (pour les stomoxes et les tabanidés) et des pièges OLSON ou « sticky trap » (pour les mouches domestiques, les Haematobia et les stomoxes) (figures 2, 3, 4).

Dans chaque site, 4 pièges géo-référencés de chaque type ont été posés pendant trois nuits successives, soit au total 12 pièges par site, chaque mois. Les pièges ont été posés aux mêmes points durant toute la durée de l'expérimentation. Une distance d'environ 50 à 100 m séparait les différents pièges de façon à couvrir une grande superficie de la zone.

Une fois les pièges posés le premier jour, une première lecture a été faite environ 24 heures après pour tous les pièges biconiques et NZI. La lecture a ainsi été faite durant trois jours successifs de piégeage pour les pièges NZI et biconiques. Les pièges OLSON ont été laissés en place pendant les 3 jours de piégeage et n'ont été collectés que le dernier jour de la série de DAP.

*Installation de Zerofly® Livestock*

Le produit a été livré sous forme de rouleaux de 100m enveloppés dans du papier plastique, le tout recouvert de scotch (figure 5). La veille de l'installation, le produit, dégagé de son enveloppe, a été disposé à l'air libre pour être aéré.



***Figure 5:*** *Rouleau de ZeroFly® Livestock (Cliché Bassène M.)*



***Figure 6 :*** *Installation de ZeroFly® Livestock (à gauche ferme moderne, à droite ferme traditionnelle) (Clichés J. Bouyer)*

Dans les deux sites, l'écran protecteur a été disposé autour des enclos (80% de l'enclos dans la ferme traditionnelle et 58% dans la ferme moderne, correspondant à 100% du couloir de vol des glossines, le reste étant constitué de bâtiments infranchissables par ces dernières) pour un maximum de protection des animaux (figure 6).

ZeroFly® Livestock est constitué de 98,55% de polyéthylène, de 1,05% de stabilisateurs de rayons UV, et de 0,4% de deltaméthrine (insecticide de contact)

*Tests au Laboratoire*

Pour juger de l'efficacité et de la rémanence de l'insecticide à la surface de l'écran protecteur au cours du temps et suite à l'action des conditions climatiques, un test en cage sur les glossines a été effectué le premier jour de pose du ZeroFly®, et par la suite tous les trois mois. Pour réaliser ce test en cage, des pièges biconiques et monoconiques ont été posés dans différents vergers avoisinant les deux sites en vue de capturer beaucoup de glossines. Ensuite, un échantillon du ZeroFly® Livestock, prélevé dans l'une des fermes a été accroché à la surface d'un côté de la cage. Avant de démarrer le test, les glossines capturées ont été séparées en lot de 10 mouches en moyenne dans de petites cages. Après isolement du lot témoin pour éviter toute contamination, le test a démarré. Les glossines ont été introduites à l'aide d'un tube dans l'espace principal de la cage-test, où elles étaient séparées de l'écran par une plaque. Ensuite la plaque était retirée pour que les mouches puissent être en contact direct avec la surface recouverte de ZeroFly® Livestock, orientée vers la lumière du jour (figure 7).

Les mouches ont ainsi été exposées pendant une minute. Après cela, elles ont été recapturées et remises dans leur cage en y mettant une petite étiquette indiquant le numéro du lot. Le même protocole a été répété pour tous les lots, excepté le lot témoin. Après les 60 secondes d'exposition, des observations étaient faites pour voir l'état des mouches. Elles étaient classées en 4 catégories : knock down (paralysées), volantes, mortes ou échappées. Au bout d'une minute, une demi-heure, une heure, et 24 heures, les observations faites pour chaque lot, y compris le lot témoin, ont été notées.

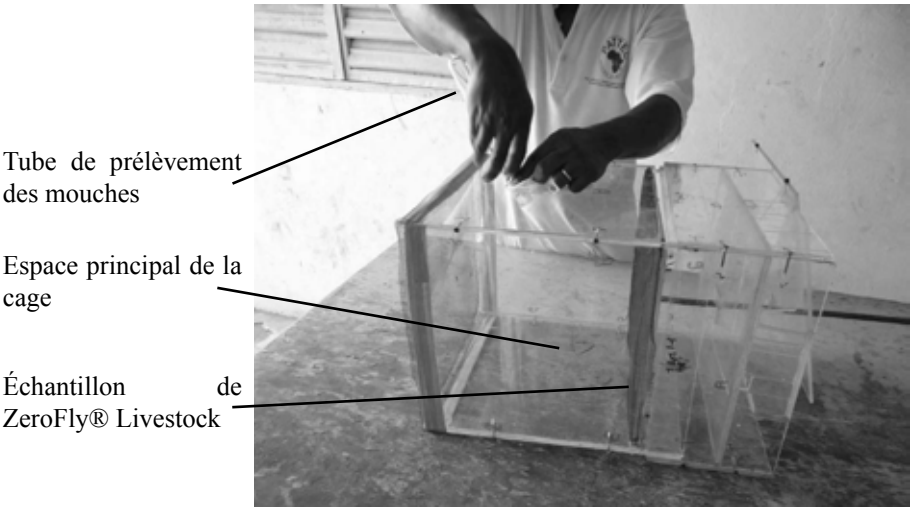



***Figure 7 :*** *Test du ZeroFly® Livestock à l'aide d'une cage-test (Cliché Bouyer J.)*

Des échantillons de ZeroFly® Livestock ont été prélevés le premier jour de son installation et chaque mois après, dans les deux fermes (moderne et traditionnelle), pour des analyses de laboratoire. Un premier échantillon de 1,20 m a été prélevé dans les deux fermes, et envoyé au laboratoire de la société Vestergaard Frandsen au Vietnam pour déterminer les propriétés physiques et chimiques. Ensuite, un deuxième échantillon, constitué de deux coupons de 20 cm de produit, était prélevé dans les deux fermes et envoyé à un autre laboratoire de Vestergaard Frandsen basé à Accra au Ghana pour des bio-essais utilisant des mouches piqueuses (Stomoxys calcitrans). Des échantillons ont été encore envoyés pendant trois mois après la fin de l'étude.

*Analyses Statistiques*

Les analyses statistiques ont été faites avec les logiciels « R » et Excel 2007. Pour l'analyse statistique des données, un modèle linéaire généralisé à effets mixtes a été utilisé avec le temps après traitement, le site (ferme traditionnelle ou moderne) et la distance à l'écran protecteur (discrétisé en deux classes, inférieure ou supérieure à 50 m) et leurs interactions comme effets fixes, et le site de piégeage comme effet aléatoire. La variable «date» a été recodée en plaçant l'origine au jour de fixation des moustiquaires (2012-06-29) et en l'exprimant en mois. Les logiciels Excel 2007 et « R » ont également été utilisés pour le tracé des figures.

**Résultats**

*Caractérisation des Sites de Piégeage*

Deux sites sont choisis pour cette étude : une ferme traditionnelle et une ferme moderne.

- La ferme traditionnelle (FT), à une surface de 0,008 km² (figure 8). L'élevage y est semi-sédentaire, c'est à dire que les adultes pâturent librement en dehors de la ferme pendant la journée alors que les veaux sont gardés à l'intérieur de la ferme, mais hors de l'enclos. De plus, la plupart des animaux (adultes) ont effectué une transhumance d'août à novembre. Dans ce site, 99% des pièges (biconiques, NZI et OLSON) sont posés à moins de 50 m de l'intervention; 50% sont entourés partiellement d'euphorbes et 2% des pièges proches d'une petite mare permanente. Son périmètre total est de 370 m. L'enclos fait 100m de périmètre, dont 80m ont été entourés de ZeroFly® Livestock.
- La ferme moderne (FM), à une surface de 0,056 km² (figure 8). L'élevage y est intensif, principalement en zero-grazing, mais les animaux circulent parfois à l'intérieur de la ferme afin de consommer les résidus de culture, notamment en fin de saison des pluies (août-novembre). Dans ce site, 42% des pièges (biconiques, NZI et OLSON) sont posés à plus de 50 m de l'intervention et 58% des pièges entourés partiellement d'euphorbes et

de maraîchage. Son périmètre total est de 1,29 km. L'enclos fait 222m de périmètre, dont 129m (58%) ont été protégés par ZeroFly® Livestock.

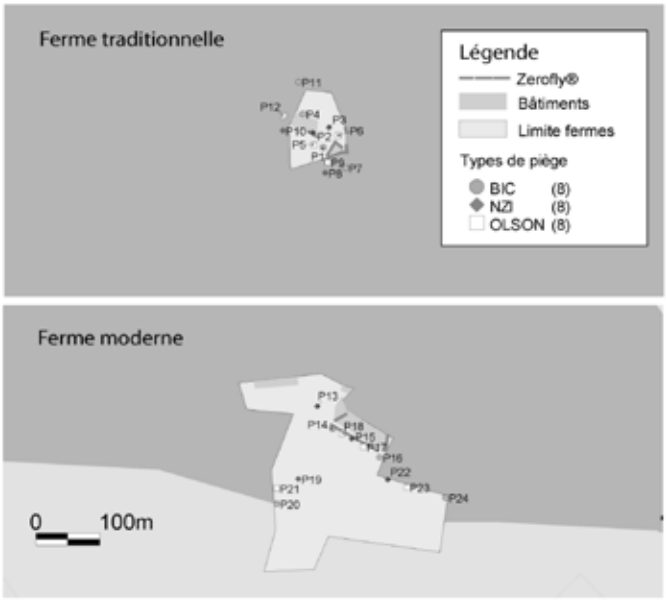



***Figure 8 :*** *Description géo-référencée des sites d'étude*

*Suivi Entomologique*

*1 : DAP des glossines*

La collecte et la lecture des différents pièges tout au long de l'étude, montrent que les différents types de pièges capturent certains insectes plus que d'autres. En effet, comme le montre la figure 9 pour le cas des glossines, les pièges biconiques sont ceux qui en capturent le plus. De ce fait, la variation de la densité des glossines, en fonction du temps, du site de piégeage et de la distance à ZeroFly® Livestock, est mieux observable sur les données des pièges biconiques (figures 10).

Avant l'intervention dans la ferme moderne (FM) et la ferme traditionnelle (FT), les DAP moyennes étaient respectivement de 0,57±0,99 et 0,37±0,79. Après l'intervention, la DAP moyenne a diminué de façon significative avec le temps dans la ferme moderne ($p=0,0465$), mais elle a augmenté significativement dans la ferme traditionnelle ($p=0,0223$). Cependant, les densités ont toujours été significativement plus élevées au-delà de 50 m qu'à proximité de l'écran protecteur dans les deux fermes ($p=0.003$), et en particulier dans la FT ($p<10\text{-}3$). L'effet de protection rapprochée de ZeroFly® Livestock était donc significatif dans les deux fermes.

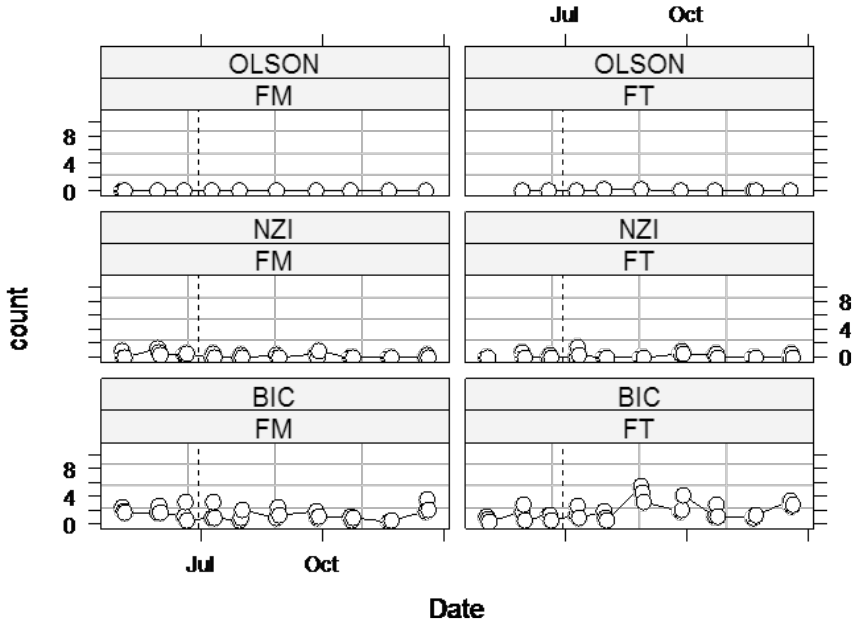



Figure 9 : *Evolution mensuelle de la densité des glossines, sur différents types de pièges, avant et après installation du ZeroFly® Livestock(----- : Date de 'intervention).*

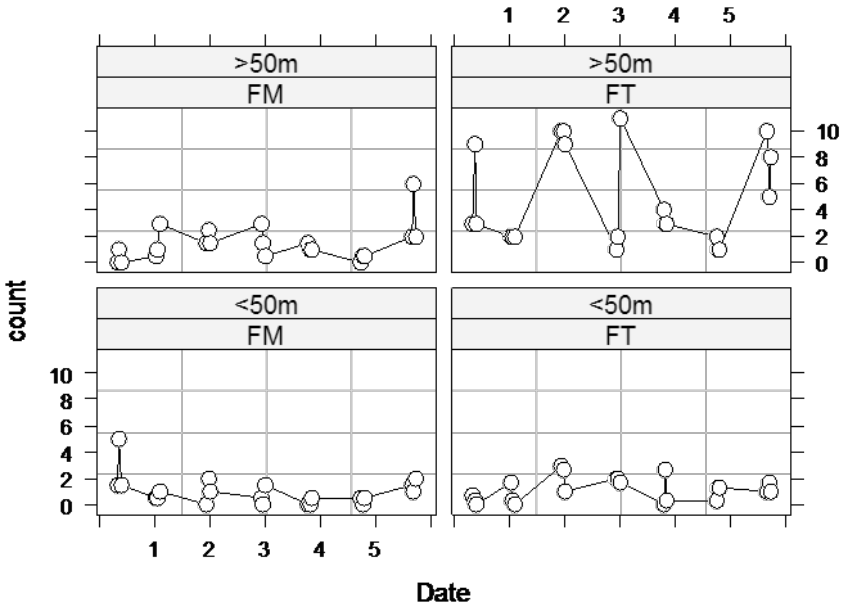



***Figure 10 :*** *Variation de la densité des glossines à moins et plus de 50 m de ZeroFly® Livestock en fonction de la date, exprimée en mois depuis l'intervention.*

*2 : DAP des Tabanidés*

Les données montrent que les pièges NZI capturent beaucoup plus de tabanidés que les autres (figure 11).

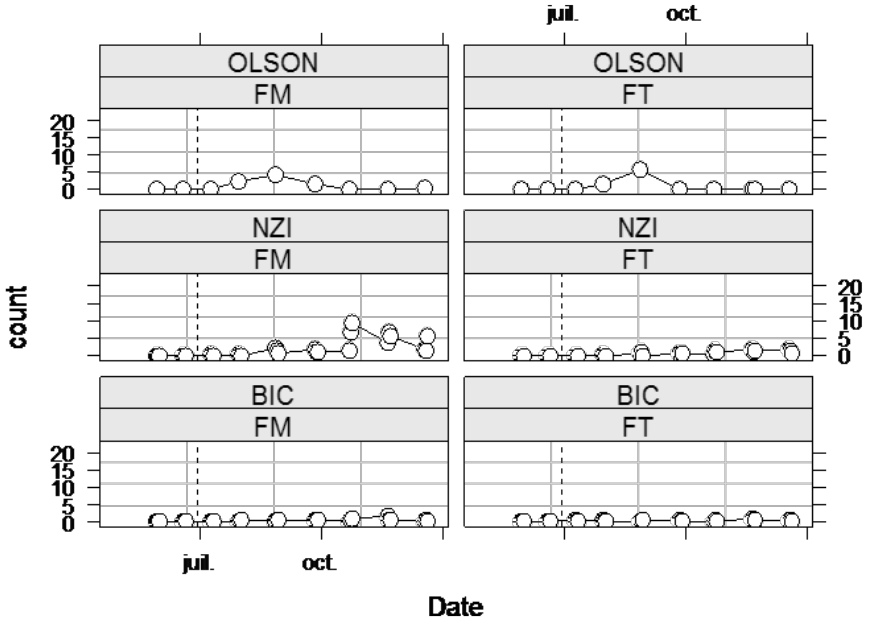



***Figure 11 :*** *Evolution mensuelle de la densité des tabanidés, sur différents types de pièges, avant et après intervention*

Au début de l'étude, aucun des pièges, NZI, biconiques et OLSON, n'ont capturé de tabanidés. Après la mise en place de l'intervention, les DAP moyennes sont de 2,74±4,19 et 0,68±1,2 à moins de 50 m de l'intervention de l'écran protecteur, respectivement pour la ferme moderne et traditionnelle. Au-delà de 50 m, il n'y a de pièges NZI que dans la ferme moderne avec une DAP moyenne de 1,68±2,28. Dans les deux sites, les DAP ont augmenté significativement avec le temps surtout dans la ferme moderne ($p<10\text{-}6$), ce qui est probablement un effet saisonnier, sans effet notable de protection de l'écran protecteur. En l'absence de pièges à moins et plus de 50 m de l'intervention, il était cependant impossible de mesurer un effet de protection rapprochée.

*3 : DAP des stomoxes*

Le même constat est fait pour les stomoxes, à savoir que ce sont les pièges NZI qui en capturent le plus (figure 12), mais les pièges biconiques en ont capturé également beaucoup, permettant ainsi de modéliser l'effet de protection rapprochée de ZeroFly® Livestock.

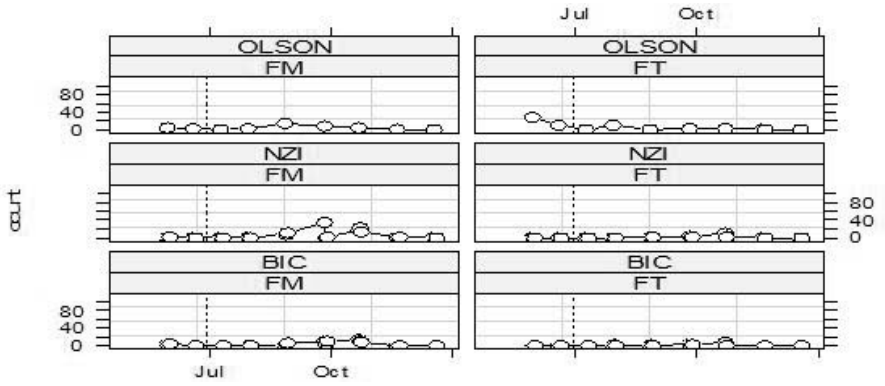



***Figure 12 :*** *Evolution mensuelle de la densité des stomoxes, dans différents types de pièges, avant et après intervention*

Les DAP moyennes des stomoxes étaient plus importantes dans la ferme moderne (0,39±1,36) que traditionnelle (0,15±0,41) avant l'installation. Après l'intervention, la densité des stomoxes a augmenté dans les deux fermes à moins de 50 m avec des DAP moyennes de 3,37±8,94 et 0,61±2,17 respectivement dans la ferme moderne et celle traditionnelle. Mais globalement les DAP moyennes sont restées plus faibles dans la ferme traditionnelle.

Avec les données des pièges biconiques, le même constat a été fait que pour les pièges NZI sur le plan qualitatif, à savoir une augmentation des densités avec le temps et des densités supérieures pour la ferme moderne (p=0,45), mais cela n'était pas significatif. Il n y a pas eu d'effet d'impact de l'écran protecteur ZeroFly® Livestock, même à proximité des animaux (rayon <50 m) dans les deux fermes (p=0.60).

*4 : DAP des Haematobia*

La collecte et la lecture des différents pièges montrent que seuls les pièges OLSON capturent les insectes de cette espèce (Haematobia sp.) (figure 13)

La Densité moyenne des Haematobia par piège et par jour était plus élevée dans la ferme moderne (4,25±4,76) que dans celle traditionnelle (1,52±1,27) avant ZeroFly® Livestock. Après l'installationde l'écran protecteur, la DAP a augmenté dans les deux fermes à moins de 50 m (4,45±3,97 pour la ferme moderne et 2,08±0,60 pour la ferme traditionnelle) ; mais elle a diminué au-delà pour la ferme moderne (2,63±2,55). Cependant, ces tendances n'ont pas été significatives (p=0,7). Il n'y avait pas de pièges OLSON au-delà de 50 m de l'écran protecteur dans la ferme traditionnelle, rendant impossible de mesurer l'effet de protection rapprochée éventuel de ZeroFly® Livestock.

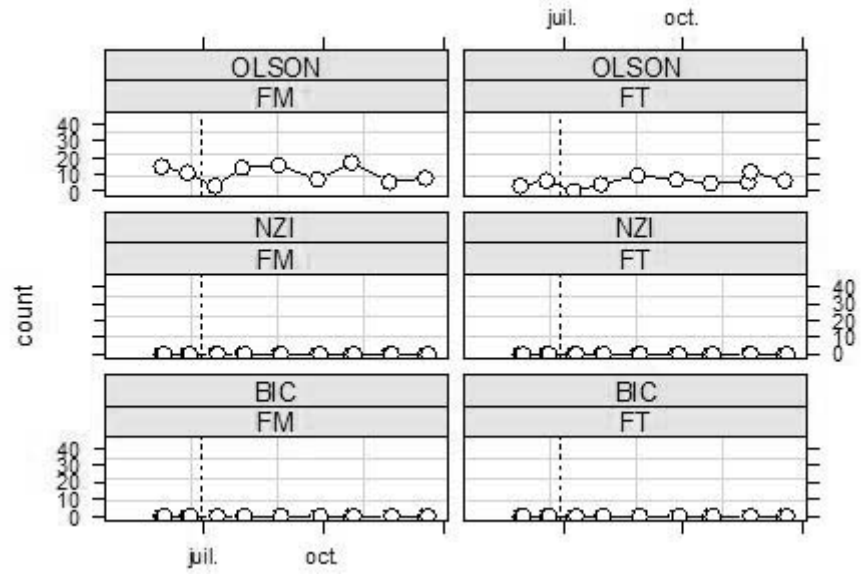



***Figure 13 :*** *Evolution mensuelle de la densité des Haematobia, sur différents types de pièges, avant et après intervention.*

*5 : DAP des mouches domestiques*

Les trois types de pièges sont efficaces pour les mouches domestiques (figure 14). Pour mieux apprécier l'effet de la distance à ZeroFly® Livestock, les données des pièges biconiques ont été utilisées pour les analyses.

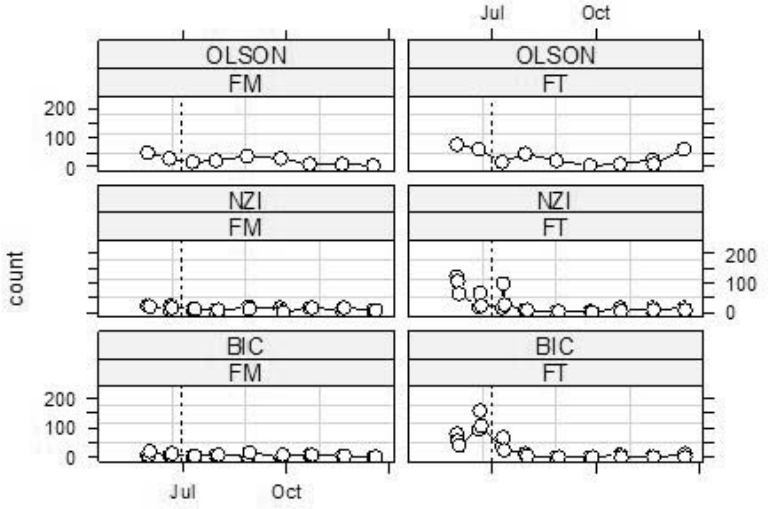



***Figure 14 :*** *Evolution mensuelle de la densité des mouches domestiques dans différents types de pièges, avant et après intervention.*

Les mouches domestiques présentaient les DAP moyennes les plus élevées avec 11,20±11,56 dans la FM et 88,86±72,70 dans la FT avant l'intervention. Les DAP ont ensuite diminué de façon significative dans les deux fermes surtout dans la FT (6,47±5,87 ; p=0,0001 pour la FM et 7,77±10,45 ; p=7,76e-06 pour la FT) après la pose des écrans protecteurs.

Cette diminution était observable et significative même au-delà de 50 m (p=2,71e-09). De plus, l'effet de protection rapprochée n'était pas significatif (p=0.10), ce qui montre que ces variations étaient saisonnières et non liées à l'intervention, comme également observée dans la zone au cours de l'année 2008 en l'absence d'intervention.

**Tests au Laboratoire**

*1 : Effet du ZeroFly® Livestock sur les glossines (cage-test)*

Dans le premier test, 100% des mouches testées ont été paralysées (Knock-down, ou Kd) au bout d'une minute pour les lots 1 et 2, et 90% pour le lot 3. Une heure après exposition, il y a eu 100% de mortalité dans les 3 lots testés. Trois mois après l'intervention, un autre test a été fait après une nuit de pluie intensive ; mais cette fois ci il n'y a eu 100% de Kd qu'au bout de 30 minutes. De plus, une heure après, aucune mortalité n'a été relevée. Les résultats à 24H n'étaient pas interprétables en raison d'une forte mortalité (40%) dans le lot témoin. Au troisième test (6 mois après l'intervention), environ 40% des mouches testées ont été Kd au bout d'une minute. Au bout d'une heure, comme pour le premier test, 100% des mouches testées étaient mortes contrairement au deuxième test où les mortalités n'étaient survenues qu'au bout de 24 heures (Tableau 1).

Il faut cependant signaler que ce test a été réalisé avec des mâles stériles

d'insectarium, un nombre insuffisant de glossines sauvages ayant été capturées pour faire le test à cette date.

*2 : Test physico-chimique et bio essai*

Les résultats des tests physico-chimiques et bio-essais réalisés respectivement au Vietnam et Accra sont illustrés dans le tableau 2.

Les résultats des bio-essais ont montré un effet Kd et une mortalité de 100% pour tous les essais. Pour les tests physico chimiques, le taux d'isomérie était inférieur à 0,5% et la concentration de la DM avait très faiblement varié par rapport à la dose initiale (0,4%).

***Tableau 1 :*** *Test de l'effet du ZeroFly® Livestock sur les glossines*

| | | **Nbre Gpg** | **Kd 1 min** | **Mort 1 min** | **Kd 30 min** | **Mort 30 min** | **Kd 1 heure** | **Mort 1 heure** | **Kd 24 heures** | **Mort 24 heures** |
|---|---|---|---|---|---|---|---|---|---|---|
| M-0 | **Lot témoin** | 7 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (14,3%) |
| | **Lot 1** | 8 (100%) | 8 (100%) | 0 (0%) | 8 (100%) | 0 (0%) | 0 (0%) | 8 (100%) | 0 (0%) | 8 (100%) |
| | **Lot 2** | 14(100%) | 14 (100%) | 0 (0%) | 14 (100%) | 0 (0%) | 0 (0%) | 14 (100%) | 0 (0%) | 14 (100%) |
| | **Lot 3** | 10 (100%) | 9 (100%) | 0 (0%) | 10 (100%) | 0 (0%) | 0 (0%) | 10 (100%) | 0 (0%) | 10 (100%) |
| M-3 mois | **Lot témoin** | 9 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | ND<br>ND | ND<br>ND |
| | **Lot 1** | 10 (100%) | 0 (0%) | 0 (0%) | 10 (100%) | 0 (0%) | 10 (100%) | 0 (0%) | ND<br>ND | ND<br>ND |
| | **Lot 2** | 8 (100%) | 6(75%) | 0 (0%) | 8 (100%) | 0 (0%) | 8 (100%) | 0 (0%) | ND (0%) | ND (50%) |
| M-6 mois | **Lot témoin** | 7(100%) | 0(0%) | 0 (0%) | 0 (0%) | 1 (14,3%) | 0 (0%) | 1 (14,3%) | 0 (0%) | 1 (14,3%) |
| | **Lot 1** | 20 (100%) | 8(40%) | 0 (0%) | 20 (100%) | 0 (0%) | 0 (0%) | 20(100%) | 0 (0%) | 20 (100%) |
| | **Lot 2** | 21 (100%) | 9 (42,8%) | 0 (0%) | 21 (100%) | 0 (0%) | 0 (0%) | 21 (100%) | 0 (0%) | 21 (100%) |

*Kd = Knock down ; Mort = Mortalité ; min = minute ; Nbre = Nombre ; ND = Non déterminé*

***Tableau 2 :*** *Résultats des analyses physico-chimiques et des bio-essais du ZeroFly® Livestock*

| | **Bio-essais** | | | | | | **Test physico-chimique** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE CODE | %KD15 | SD KD15 | %KD30 | SD KD30 | %TD24 | SD TD24 | Weight (g/m2) | BS (kPa) | Tensile in Warp (N) | Tensile in Weft (N) | R-isomer % | DM (‰) |
| SE_0/12_C(T) | 100 | 0 | 100 | 0 | 100 | 0 | 64,1 | 441 | 212 | 151 | <0.5 | 3,9 |
| SE_0/12_C(M) | 100 | 0 | 100 | 0 | 100 | 0 | 69,7 | 450 | 206 | 156 | <0.5 | 4,1 |
| SE_1/12_C(T) | 100 | 0 | 100 | 0 | 100 | 0 | 64,6 | 449 | | | <0.5 | 3,46 |
| SE_1/12_C(M) | 100 | 0 | 100 | 0 | 100 | 0 | 62,9 | 472 | | | <0.5 | 3,78 |
| SE_2/12_C (T) | 100 | 0 | 100 | 0 | 100 | 0 | 66,8 | 457 | | | <0.5 | 3,49 |
| SE_2/12_C(M) | 100 | 0 | 100 | 0 | 100 | 0 | 63,1 | 464 | | | <0.5 | 4,09 |
| SE_3/12_C(T) | 100 | 0 | 100 | 0 | 100 | 0 | 67,7 | 451 | 243 | 151 | <0.5 | 3,28 |
| SE_3/12_C(M) | 100 | 0 | 100 | 0 | 100 | 0 | 64,1 | 478 | 226 | 144 | <0.5 | 3,44 |
| SE_4/12_C(T) | 100 | 0 | 100 | 0 | 100 | 0 | 64 | 444 | 235 | 149 | <0.5 | 3,67 |
| SE_4/12_C(M) | 100 | 0 | 100 | 0 | 100 | 0 | 64,7 | 462 | 214 | 150 | <0.5 | 3,11 |
| Pos. control | 100 | 0 | 100 | 0 | 100 | 0 | | | | | | |
| Neg. control | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |

## Discussion

*Suivi Entomologique*

Un regard sur l'ensemble des données de capture, toutes espèces confondues, montre une forte dispersion de ces dernières. En effet, l'importance des écart-types montre que les densités des captures par piège et par jour ne sont pas homogènes autour des moyennes de capture, comme c'est toujours le cas pour des données de densité apparente.

Pour le cas des tsé-tsé, avant l'intervention, il y avait en moyenne plus de mouches dans la ferme moderne que dans la ferme traditionnelle ; et les plus fortes captures étaient notées au niveau des pièges situés non loin des haies d'euphorbes (pièges 7, 16, 20, 24), et de la mare permanente (pièges 4, 11). Or ces sites, selon certains auteurs (Touré, 1972), sont des habitats favorables aux glossines, ou au moins favorisent leur dispersion. Cela expliquerait donc ce résultat.

Après l'intervention, la densité moyenne des glossines a baissé dans la ferme moderne et a augmenté dans la ferme traditionnelle. Une des explications à ce fait, provient du système d'élevage des deux fermes. En effet, dans la ferme moderne, les animaux sont en stabulation presque permanente, alors que dans la ferme traditionnelle, les animaux sont laissés libres à l'extérieur de la ferme et ne rentrent dans leur enclos que le soir. Or, étant donné que les glossines sont des insectes essentiellement diurnes (Bentaleb *et al.,* 2008), elles ont probablement été moins attirées vers l'enclos (protégé par l'écran protecteur) dans la ferme traditionnelle car les animaux n'y étaient pas une grande partie de la journée et par conséquent elles ont de faibles chances d'être en contact direct avec l'insecticide incorporé dans l'écran protecteur. De ce fait, l'effet attractif des pièges posés en plus de la saison des pluies et de la présence de conditions favorables (point d'eau, euphorbes,…) à l'habitat des glossines tout autour des sites de piégeage, ont été à l'origine de l'augmentation des DAP dans l'environnement autour de la ferme traditionnelle malgré l'intervention. Cependant, l'effet de protection de proximité (<50 m) a été net et significatif, avec des densités toujours inférieures à moins de 50 m qu'au-delà de cette distance après intervention, et une baisse significative des DAP à cette distance.

En revanche, dans la ferme moderne, les animaux sont presque en permanence dans leur enclos (protégé par l'écran protecteur) ; de ce fait les tsé-tsé qui se dirigent vers eux pour se nourrir, ont plus de risque de buter contre le produit et d'en mourir ; ce qui explique les faibles densités observées dans cette ferme, en particulier à moins de 50 m.

L'augmentation des DAP dans l'environnement de la ferme traditionnelle à partir d'octobre est saisonnière et apparente (retour de la saison sèche et concentration dans les gîtes favorables comme la mare permanente située à proximité), comme le montre un suivi réalisé dans le cadre du projet d'éradication dans la zone. Cette évolution naturelle ne s'est pas observée à proximité de l'écran ZeroFly® Livestock, confirmant l'effet de protection rapprochée de ce dernier.

Les vecteurs mécaniques (tabanidés, stomoxes et haematobia) sont connus pour être des insectes qui pondent et se développent pour la plupart dans la matière organique en décomposition (Desquesnes *et al.,* 2005, Mocquet *et al.,* 2007) avec des pics marqués de densité de leurs populations en fonction des saisons. Ce fait explique en partie la dynamique des DAP observée dans cette étude pour ces espèces, indépendamment de l'intervention.

En effet, pour le cas des tabanidés par exemple, les résultats montrent des DAP de 0 avant l'intervention dans les deux sites de l'étude.

Le même constat a été fait en 2011 lors d'un suivi entomologique dans la même localité (Pout) et pendant la même période (saison sèche-chaude) (ISRA/LNERV, 2011). La période avant l'intervention coïncide donc avec la période défavorable pour le développement des tabanidés. En revanche, après l'intervention, les DAP ont augmenté à plus et moins 50 m dans les deux fermes, avec des densités supérieures dans la ferme moderne (2,73 tabanidés/piège/jour en moyenne). Le même constat a été fait pour les stomoxes et les haematobia dans les deux fermes, à savoir l'augmentation des DAP moyennes après intervention. Cette période (fin juin à novembre) correspond à la période favorable à l'émergence de ces trois groupes, ce qui pourrait expliquer l'augmentation des DAP. Le mode de conduite des animaux dans chacune des fermes pourrait également contribuer à cette évolution croissante des DAP au niveau des pièges. Dans la ferme moderne, après l'installation de l'écran (saison des pluies), les animaux étaient de temps en temps laissés libres dans la ferme (car il y avait beaucoup d'herbes pour qu'ils puissent brouter) et ils pâturaient à proximité des pièges. Étant donné que les vecteurs mécaniques sont des insectes réputés pour leur caractère harceleur, c'est-à-dire qu'ils font des repas sanguins répétés et de courtes durées (Finelle, 1983), ils sont la majeure partie du temps en contact avec les animaux. Ce qui réduit le risque de contact avec l'écran protecteur. Durant cette même période des pluies, au niveau de la ferme traditionnelle, les animaux ont transhumé vers une autre zone de pâturage, réduisant leur attraction sur les vecteurs mécaniques à l'intérieur de la ferme. Ce changement de mode de conduite des animaux fait que ZeroFly® Livestock n'a pas eu un impact important sur les densités de ces vecteurs.

Pour ce qui concerne les mouches domestiques, leur densité a diminué de façon significative dans les deux fermes mais plus dans la FT. Cette réduction de leur DAP est encore plus importante à plus de 50 m. Ce fait suggère donc que la diminution de la densité de ces mouches domestiques est liée non pas au filet mais à un processus saisonnier observé également lors des suivis de densité ayant eu lieu dans la zone d'étude lors de l'étude de faisabilité du projet d'éradication des glossines dans les Niayes.

Il faut signaler ici que ZeroFly® Livestock a été posé initialement pour lutter contre les glossines uniquement, en les interceptant entre leurs sites de repos et d'attaque, et qu'il aurait été possible de cibler ces autres groupes d'insectes en tenant compte de leur écologie. L'objet de ce projet était cependant d'évaluer l'impact du ZeroFly® Livestock sur les glossines en priorité, et secondairement sur les autres vecteurs mécaniques.

*Tests Au Laboratoire*

Des études faites par Nitchman (1988) ont montré une forte sensibilité des glossines face à la deltaméthrine. Nos résultats confirment cette sensibilité.

Toutefois, le deuxième test (3 mois après la pose) n'a pas donné les mêmes résultats car non seulement le taux de mortalité était plus faible (50%) par rapport au premier test, mais aussi 50% des glossines se sont réveillées après être restées paralysées pendant plus de 30 minutes. Ce fait suggère que la concentration de la DM a diminué à cause des conditions environnementales. Or les résultats des analyses physico-chimiques faites dans les laboratoires de Vestergaard Frandsen, montrent que la concentration de DM était toujours à une dose létale pour les glossines, ce que confirment les essais biologiques (100% de mortalité des mouches piqueuses) faits à leur niveau. La veille du deuxième test en cage, il avait plu à Pout, or, d'après les caractéristiques physico-chimiques du ZeroFly® Livestock, l'eau estomperait momentanément l'effet de la DM. Ainsi, le temps que les échantillons prélevés dans les différents sites (ferme moderne et ferme traditionnelle) arrivent dans les laboratoires d'analyses au Vietnam et à Accra, la DM a eu le temps nécessaire pour se régénérer en diffusant dans le tissu. Ce qui pourrait expliquer la différence des résultats que nous avons obtenus lors du deuxième test et ceux du laboratoire d'Accra. Le troisième test a confirmé ce dernier fait car toutes les mouches testées étaient mortes au bout d'une heure comme lors du premier test et il n'avait pas plu dans la localité. Ce qui veut donc dire que la DM était toujours à une dose létale après 6 mois d'exposition aux conditions environnementales.

Cependant, dans ce dernier cas, des mouches physiologiquement plus sensibles ont été utilisées (mâles stériles de la souche élevée au CIRDES)

faute de captures suffisantes de glossines sauvages. Une hypothèse alternative serait donc une résistance partielle des glossines de Pout à la DM. Il serait donc intéressant de reprendre quelques essais à partir d'expositions en tube OMS, où les conditions sont mieux contrôlées (temps de contact) que dans l'expérience réalisée ici. Cependant, nous l'avions sélectionné afin de comparer nos résultats avec un essai similaire réalisé sur du tissu bleu pour les écrans fournis par Vestergaard au CIRDES, qui avait permis d'obtenir un taux de KD de 100% pendant plus de 250 jours (réalisé avec des mâles de la même souche de glossines, de l'insectarium du CIRDES, fig. 17).

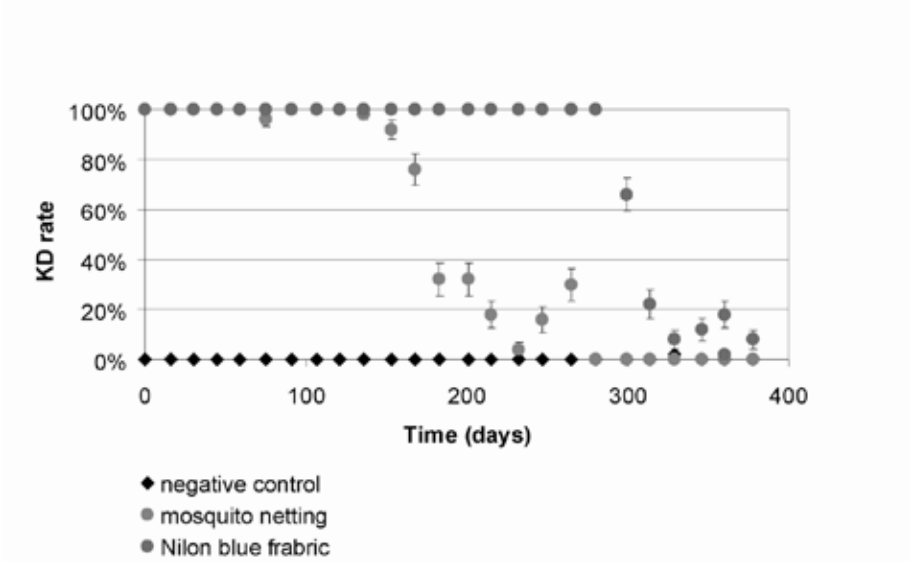



***Figure 17 :*** *Persistance de l'effet KD de filet moustiquaire et de tissu bleu réalisé pour Vestergaard au CIRDES (source : (Kagbadouno et al., 2011)).*

L'ensemble des résultats obtenus pourrait être meilleur et plus précis en l'absence de quelques aléas survenus lors de l'expérimentation. Ce sont entre autres : la perte de données de capture due à la destruction de certains pièges par le vent ou les animaux (bovins, ânes, etc.) ; la désertion des animaux de la ferme traditionnelle pendant deux mois durant la saison des pluies ; l'utilisation réduite des pièges OLSON lors des séries de DAP, du fait qu'ils ne sont pas remplacés à chaque jour de collecte (mais laissés pendant trois jours consécutifs) ; et enfin l'utilisation, pour les tests en cage, de glossines de laboratoire pour le dernier test.

## Conclusion

Les résultats obtenus lors de cette expérimentation, ne mettent pas en doute l'efficacité du ZeroFly® Livestock sur les glossines pour une protection des

animaux dans l'enclos, sans toutefois fournir la preuve d'un effet distant (communautaire) de cette technique. Son efficacité contre les glossines est bien prouvée sur le terrain et au laboratoire et les animaux sont bien protégés dans le cas où ils restent enfermés dans leur enclos. En revanche, l'effet du ZeroFly® Livestock sur les vecteurs mécaniques, dont la dynamique est très difficile à cerner, nécessite un éclaircissement par des tests en cage et au laboratoire (les mêmes que pour les glossines) pour ainsi adopter la meilleur stratégie d'utilisation de l'écran protecteur contre eux. L'analyse de l'ensemble des résultats montre que pour une bonne efficacité du ZeroFly® Livestock, quelques conditions sont requises à savoir qu'il faut d'abord que le bétail reste en permanence dans les enclos entourés du filet, ce qui est bien recommandé par Vestergaard Frandsen. Cette condition est difficile à respecter pour les systèmes d'élevage semi-intensifs (comme c'est le cas de la ferme traditionnelle) qui ne représentent pas la cible principale de Vestergaard Frandsen. En plus, le produit nécessite de temps en temps un nettoyage à l'eau pour enlever la poussière et du raccommodage s'il est troué par endroit, conformément aux instructions d'utilisation et entretien de la compagnie. En cas de destruction complète, un écran neuf est à acheter or il est très cher (105 000f cfa/ rouleau de 100 m à Dakar).

ZeroFly® Livestock semble en revanche bien adapté au cas des fermes modernes pour une protection efficace des enclos, même si seulement 58% de l'enclos était entouré dans cette étude, représentant en revanche 100% du couloir de vol des glossines. Il resterait à déterminer quelles sections de la ferme protéger pour atteindre les glossines, sans avoir à en mettre autour de tous les enclos, ce qui représenterait un budget trop élevé pour les éleveurs. Il faut noter qu'il n'a pas été possible ici d'entourer 100% de l'enclos en raison de sa structure, mais que les filets ont été posés partout où c'était possible, contrairement à ce qui est recommandé par Vestergaard Frandsen. Il s'agit donc d'un essai en conditions réelles d'utilisation au Sénégal, où les fermes ne présentent pas une structure idéale pour un entourage complet. De plus, les déplacements du troupeau traditionnels, qui n'avaient pas été mentionnés à l'avance par l'éleveur, ont clairement diminué l'impact de l'écran dans la ferme traditionnelle, qui est toutefois resté important contre les glossines.

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# A NOVEL INSECTICIDE IMPREGNATED SCREEN FOR TSETSE CONTROL.

# UN ECRAN INEDIT IMPREGNE D'INSECTICIDE POUR LE CONTROLE DES GLOSSINES

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## Résumé

Les écrans de filet érigés autour des unités de zéro-pâturage minimisent le contact entre les mouches tsé-tsé et le bétail, réduisant ainsi l'incidence de la trypanosomiase animale. Les filets sont également utilisés pour flanquer les appâts visuels utilisés dans la lutte contre les glossines. Ces filets résistent difficilement aux intempéries et sont généralement d'une courte durée de vie. L'efficacité biologique et la longévité du filet anti- mouches - VF ZeroFlyLivestock Fence ®, utilisée dans la lutte contre les mouches tsé-tsé, ont été évaluées sur la côte Kenyane. ZFLF et un filet équivalent non imprégné d'insecticide ont été érigés comme temoin chacun sur un côté d'une unité de zéro-pâturage. La disposition a été reproduite deux fois par espace. À des intervalles d'une semaine, des échantillons de filet ont été coupés à la fois du ZFLF et de son filet témoin équivalent et soumis à des essais biologiques en utilisant des mâles de *G. pallidipes* élevés en laboratoire âgés de 30 jours et placés dans des tubes individuels. Le temps de choc (ou la mort) et le sort des mouches tsé-tsé après 24 heures ont été enregistrés. L'analyse des tendances a été effectuée. Aucune différence n'a été observée au niveau des résultats obtenus dans les 2 champs. 100% des glossines exposées au filet VFZFL étaient moribondes dans les 5 minutes suivant l'exposition, et mortes après 24 heures. Après six mois, un choc de 100% est survenu dans les 10 minutes et la mortalité dans les deux heures. Ceci a persisté pendant 24 heures. Il n'y a eu aucun effet de choc chez les mouches tsé-tsé exposées aux échantillons non traités aux insecticides, même après 24 heures. Après neuf mois d'essai, le filet n'a pas subi de dommages causés par les intempéries. Le filet ZFLF n'a pas eu besoin de nouvelle imprégnation d'insecticide et montre une résistance aux intempéries. Il semble prometteur pour une utilisation dans des unités de zéro - pâturage, et par extension, il pourrait être utilisé pour flanquer les appâts visuels dans le cadre du contrôle des glossines.

## Summary

Screens of netting erected around zero – grazing units minimize contact between tsetse flies and livestock, thereby reducing incidences of livestock trypanosomiasis. Netting are also used to flank visual baits used for tsetse control. Such nets easily succumb to weather and are usually short – lived. The biological efficacy and longevity of VF ZeroFly Livestock Fence® against tsetse flies was evaluated at the Kenya Coast. ZFLF and an equivalent non-insecticide laced netting were erected each on one face of a zero-grazing unit. The layout was replicated by space twice. At weekly intervals, samples of netting were clipped from both the ZFLF and its equivalent control netting and subjected to bio-assays using thirty day old laboratory reared male Glossina pallidipes placed in individual tubes. Time to knockdown (or death) and the fate of tsetse flies after 24 hours were recorded. Trend analysis was carried out. No differences were observed on results obtained at both field. 100% of tsetse flies exposed to VFZFL were moribund within 5 minutes after exposure, and remained dead after 24 hours. After six months, 100% knockdown occurred within 10 minutes and mortality within two hours. This persisted for 24 hours. There was no knockdown in the tsetse flies exposed to non – insecticide treated samples even after 24 hours. After nine months of trial, the netting has suffered no damage from weather. ZFLF has not required recharging with insecticide and shows resistance to weather. It show promise for use in zero – grazing units, and by extension it could be used to flank stationary visual baits used for tsetse control.

## Introduction

Tsetse transmitted trypanosomiasis continues to constrain livestock production in Kenya. Disease incidence could be reduced by breaking down transmission through preventing access of tsetse flies to cattle. Cattle raised in zero – grazing units are kept away from tsetse flies in the field, yet they remain attractive. Insecticide treated netting surrounding the zero – grazing units are shown to reduce trypanosomiasis incidence by 90 – 95% in pigs (Bauer et. al., 2011) within two months of installation. Increased production of milk by cattle and their improved health while protected against tsetse and trypanosomiasis is also reported in western Kenya (Bauer et. al., 2006). Through a Food and Agriculture Organisation initiative, the impacts of use of insecticide treated nets on vectors of humans and livestock outside tsetse and trypanosomiasis were studied. Cases of mastitis were reduced, in addition to freedom from biting flies and mosquitoes and malaria incidence are reported (Saini et al 2011, FAO-2014). Use of insecticide-treated nets as an effective tool for vector control to protect livestock is reviewed by Maia (2009) among others. One of the disadvantages of the method is that the netting is fragile and lasts for only two months under strong winds and animal movements (Bauer et. al., 2006). There is need therefore to identify stronger netting that is also insecticidal, efficacious and durable while for use in the field for tsetse and trypanosomiasis management. These parameters were studied for 'Zero Fly Livestock (ZFL)' manufactured by Vestergaard Frandsen. The product is a UV

stable knitted insecticide – incorporated polyethylene monofilament screen that contains 4 gm of deltamethrin per kilogram of netting.

## Materials and Methods

This study was carried out at two sites in Kwale County: Gathua farm in Msambweni and the Archdiocese of Mombasa Seminary Farm next to Kwale town. The farms are adjacent to Shimba Hills National Park that is historically known to be infested by Glossina pallidipes Austen and G.brevipalpis Newstead. About 20 metres of the ZFL together with an equivalent non-insecticide treated screen were installed on opposite faces of zero grazing units in each of the field sites.

Clips measuring about 8 x 15 cm were obtained weekly from each of the screens at both sites.

Clipped samples of the screens were wrapped in aluminium foil, and appropriately labelled with date, site, side of clipping were delivered to the laboratory at KARI TRC in Muguga for bioassays. Duration of insecticidal activity after onset of exposure of the screens was determined through weekly bioassays. Life experimental Glossina pallidipes were obtained from the KARI-TRC insectary. Thus thirty 30-day old male tsetse flies held in individually in new and cleaned plunger tubes were allowed contact with each of the clipped samples of netting for 20 minutes. The fate of flies was observed after 0, 5 and 10 minutes post-exposure to determine the impact / efficacy of tsetse flies that just touch the screen and immediately fly off. Beyond this period, their fate were recorded after 1, 2, 4, 6 and 24 hours post - exposure For each sample, the percentage kill and / or knockdown action of the flies was calculated for the different times. Efficacy of the insecticide was determined when at least 80% of the exposed tsetse flies were knocked down or dead within 6 hours. Under field conditions, such flies are usually preyed on by ants.

## Results

This trial was conducted for fourteen months between July 2012 and August 2013. A behavioural change was observed of the tsetse flies that made contact with the ZFL. Initial restlessness was followed by cessation of buzzing and finally the fly laid prostrate. For the first three months of trial, 100% of tsetse flies exposed to ZFL were moribund within 5 minutes. From the forth to the end of trial in month 14, 100% of exposed tsetse flies to ZFL were moribund within 10 minutes post – exposure. Complete loss of activity, here considered as mortality, was recorded within two hours in 100% of these tsetse flies. No recovery was observed even after 24 hours post – exposure to ZFL. On

the contrary, 100% of flies exposed to the equivalent netting remained alive throughout all the observation times and study period. Bioassay data between the two field sites and within the experimental treatments were similar

**Discussion**

The study sites of Gathua Farm in Msambweni and ArchDiocese of Mombasa farm in Kwale Town have the Shimba Hills National Reserve in their immediate neighbourhood. The latter is historically known to be home to Glossina pallidipes, G.brevipalpis and G.austeni. It is within the Kenyan Coastal fly belt. The study was therefore conducted under natural conditions of tsetse fly habitation characterized by challenging and extreme conditions of moisture, heat and UV radiation. Dairy cattle kept in these farms and in similar farms are managed in complete zero grazing units, and netting surrounding all windows. Keeping away tsetse flies is given as the principal reason for the netting. Studies on insecticidal properties previously used to assess impacts on field populations of tsetse flies (e,g Bauer et. al., 2011). Because of variations in the intensities of infestation by tsetse flies in the different areas, a properly controlled study is difficult to achieve. The alternative has been to carry out bioassays where tsetse flies are used while in individual tubes or in test boxes (Clausen, et. al., 2011). The former was adopted in this study.

Deltamethrin is the active ingredient in ZFL and whose insecticidal action is well documented. Its insecticidal action on tsetse flies was demonstrated in this study. This insecticide is broken down by UV light but its longevity is enhanced by use of UV absorber compounds. Potent action was demonstrated for 14 months in this study. The cut - off period for longevity of insecticidal action was to be demonstrated at the earliest duration post – exposure when at least 80% of the exposed tsetse flies were knocked down or dead within 6 hours. 100% knockdown occurred within 10 minutes and proceeding to mortality in less than two hours post – exposure, implying that no re-treatment with insecticide was required that far. Possibly also, incorporation of the insecticide into the polyethylene molecule prolonged its lifetime, whilst also being available to the tsetse flies to effect a rapid kill action. Such duration of time is not reported for other tsetse control products.

Another observation was that after 14 months of field exposure, the ZFL as well as the non-insecticide treated equivalent screen had not succumbed to vagaries of the weather or punctures of holes by insects other than tsetse. Normal wear and tear and holes punctured by other insects were frequently observed on netting in conventional use (mosquito or builders netting) even as early as three months post – installation. This implies that physical protection of livestock in zero – grazing units is soon lost when using conventional netting as opposed to the ZFL.

This bioassay study indicated effectiveness of ZFL for 14 months post – exposure. Previous field studies have shown protection of livestock and impact of screens on zero grazing units on field population of disease vectors with concomitant increase in livestock production and productivity. For six months, this was demonstrated in Western Kenya (Bauer et. al., 2006) against tsetse flies, and a 90% reduction in tsetse population in two months in pig farms in Ghana (Bauer et. al., (2011). Against other biting flies, mostly Stomoxys sp. impact on was demonstrated in Kenya (Saini et. al., 2011), while against these and other biting and non-biting flies and mosquitoes in Burkina Faso and Mali (Lassane et al, 2009). The potential benefits on both medical and veterinary perspectives on the use of ZFL around zero grazing units are described in FAO (2014).

## Conclusion and Recommendations

The potent and long acting insecticidal activity of ZFL against tsetse was demonstrated in this study under actual conditions of tsetse infestation. This is compounded by prolonged durability of mechanical strength of the polyethylene netting. If and when the screens are erected to surround a zero – grazing unit therefore, the screens provide both a physical and chemical barrier with the latter killing the insects through insecticide. Enhanced and intensive use of the screens would undoubtedly lead to a sustained reduction of field tsetse populations. By extension, ZFL could also offer superior nets flanking visual cloth targets used in tsetse control.

## Acknowledgement

We wish to thank the management of Gathua Farm and Archdiocese of Mombasa Seminary in Kwale for allowing the study in their farms. We also recognize the support of staff from the Department of Veterinary Services on the ground. This study was financially supported by Vestergaard Frandsen and Director KARI.

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# SOCIO-ECONOMICS, LAND USE AND ENVIRONMENT

# THE IMPORTANCE OF SKILLS AND INDIGENOUS KNOWLEDGE OF PASTORALISTS IN THE SOCIOECONOMIC SURVEYS OF TSETSE & TRYPANOSOMOSIS IN TSETSE INFESTED AREAS OF THE SUDAN

# L'IMPORTANCE DES COMPETENCES ET DES CONNAISSANCES AUTOCHTONES DES PASTORALISTES DANS LES ENQUETES SOCIO-ECONOMIQUES DANS LES ZONES INFESTEES DE GLOSSINES DU SOUDAN

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## Résumé

Des séries d'enquêtes socio-économiques ont été conduites dans l'État du Nil Bleu (BNS). Les répondants ont été sélectionnés par la technique d'échantillonnage logique dans chacun des villages autour de la ville d'Edmazin. Les données sont collectées en utilisant des questionnaires, les observations directes, les interviews des leaders de la communauté ainsi que les discussions de groupe. Les pastoralistes de BNS connaissent la mouche tsétsé, les autres mouches piqueuses et la trypanosomose. La transhumance a été utilisé comme mode de vie pour éviter les fortes populations de tsétsés et de mouches piqueuses. La présente étude indique que les paysans ont acquis de nombreuses compétences et des connaissances indigénes dans le domaine des vecteurs des maladies et les maladies du bétail dans l'État. La majorité des paysans reconnaisse la trypanosomose comme l'un des problèmes les plus sérieux qui se répand dans leurs troupeaux et qui se classe en première position devant les autres contraintes liées à la production des bovins. Selon les connaissances des pastoralistes, la trypanoomose est classée comme la première maladie à transmission vectorielle dans toutes les zones de l'enquête et est classée comme la plus importante et la plus sérieuse menace pour les troupeaux de bovins par 63,3% des répondants de l'État. 97,0% des répondants de l'État considère la trypanosomose comme un sérieux problème pour les bovins. 83,3% des ménages dans le BNS classe le niveau des mouches tsétsé au Soudan.

**Summary:**

Series of socio-economic surveys were conducted in the Blue Nile State (BNS). Data was collected using questionnaires. Respondents were selected by purposive sampling techniques in each village around Edmazin town together with direct observations and direct personal interviews with community leaders as well as the group discussions. Pastoralists in the BNS recognize tsetse flies, other biting flies and trypanosomosis. Transhumance as a mode of living evolved to avoid high populations of tsetse and biting flies. The present study indicates that farmers have acquired several skills and indigenous knowledge in the field of disease vectors and livestock diseases in the state. Most farmers recognize trypanosomosis as one of the most serious problems which is widely spreading among their cattle and it ranked above other constraints associated with cattle production. According to the knowledge of pastoralists trypanosomosis comes as the first vector-borne disease throughout the survey areas and is ranked as the most important and serious threat to cattle herds by 63.3% of respondents in state. 97.0 % of respondents in the state consider trypanosomosis a serious problem of cattle. 83.3% of households in the BNS classified the level of tsetse and trypanosomosis as high in their area. Farmers have their own skills and indigenous knowledge in trypanosomosis diagnosis; they know the clinical symptoms and the drugs and how to treat clinically sick animals, 95.0 % of cattle owners use Berenil which is a more preferable trypanocides and Ethidium. Some use Antrycide although Samorin is completely absent and some farmers have never heard of it. However, in the state most farmers recognized tsetse flies; about 28.3 % of them did not recognize it, although they heard about it. Trypanosomosis is given the local name Marad Um Bogani as a popular name used by all cattle owners throughout the state with other vernacular names in the tribal dialect of each tribe. Biting flies are well-known by all farmers and are common at the onset of the rains. Several vernacular names are given to biting flies in the state. The Fulani use different vernacular names in their tribal dialects. Both Kennana and Rufaa Elhoy use several vernacular names in the local spoken Arabic for tabanids including Abu Rababa, Lasaga and Tair. Skills and indigenous knowledge of pastoralists are very important for any tsetse and trypanosomosis intervention in tsetse infested areas. At present, this huge battery of information is used in community collaboration programmes for tsetse control project in the Sudan.

## Introduction:

Indigenous knowledge is the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment, including technologies, know-how skills, practices and beliefs that enable the community to achieve stable livelihoods in their environment (World Bank, 2004). It can be used as indicator to assess pastoralists' awareness and their desire to put efforts and contribution prior any intervention in tsetse infested areas.

The objective of this paper is to encourage researchers and policy-makers to incorporate indigenous knowledge and skills into their project proposals, feasibility studies, implementation plans and project assessments, to take them into account in all activities affecting local communities. Many researchers are working on projects in which indigenous knowledge plays an essential and practical role. It is very important that information about this kind of projects is made available world-wide so that other people can benefit from their experiences. Such studies will play an important role in building a bridge between research and policy empirical solutions. The aim of this paper is to highlight the importance of skills and indigenous knowledge of pastoralists on T&T to assess their awareness about these scourges to mobilize and sensitize the entire local community about these problems and to increase their involvement in the decision making prior tsetse intervention in their areas.

**Material and Methods:**

*Study area: (Map 1)*

The study was conducted in the Blue Nile State (BNS) (350 80'- 330 80'E, 120 35' - 90 30' N). BNS possesses huge numbers of livestock, particularly cattle; it owns about 3,870,600 head of cattle, 4,565,000 sheep, 3,200,000 goats and 140,000 camels (MAR-D, 2005). The state is infested with several species of tsetse flies including G. mmorsitans. submorsitans and G. fuscipes fuscipes along River Khore Yabous.

*Primary data*

Primary data were collected using questionnaires of respondents who were selected by using purposive sampling techniques. It is non-random probability sampling which is easier and more practical than probabilistic sampling and sometimes is the only way to reach a particular population (Michell, 2001).

*Secondary data*

Secondary data were obtained from published information in scholarly journals, thesis, meeting proceedings and official reports.

*Data analyses*

Data from individual location was inserted into MS Excel spread sheets program (Microsoft Corporation) to create a database and transferred to Statistical Packages for Social Science (SPSS, 1999) version 10.0 for computer analyses. Descriptive statistic was used as means of data analysis such as Bar and pie charts and Relative frequency.

**Results:**

*Communal Residence.*

Fig.1 shows the percentages of each tribe in the BNS. The dominant tribes are Fulani, Kenana, Rufaa and the Angasana group, in a decreasing order. The only exogenous tribe is Nuba from Kordofan who have settled in the area as a result of the recent civil strife at home that had acted as a push factor for their displacement.

*3.2 Ranking of livestock diseases affecting cattle herds*

In the BNS 63.4% of cattle owners believe that trypanosomosis is the most serious disease affecting cattle herds (Fig. 2). In spite of the absence of tsetse flies in the areas surveyed there is seasonal tsetse-cattle contact during the dry season migration to the southern parts of the state.

Percentage of community members who recognized trypanosomosis as a problem and ranked it as an important (economic) disease.

Trypanosomosis believed to be a major problem affecting cattle herds in the BNS by 71.7 % of the respondents whereas others stated that trypanosomosis falls among the first three important diseases of livestock. Only 5.0 % admitted that other diseases have higher priorities (Fig. 3).

*Trypanosomosis challenge in residence cattle.*

Fig. 4 indicates that more than 83.0% of households in the state classified the level of tsetse and trypanosomosis as high in resident cattle their area.

*Immigrant cattle that come from T& T high and medium challenge.*

More than 91.7 % of the cattle owners in the state stated that the immigrant cattle come from areas where T&T challenge is high. The rest of cattle owners believe that the immigrant cattle in their areas come from medium level of tsetse and trypanosomosis challenges (Fig. 5).

Trypanocidal drugs and Percentage of cattle owners who use each drug for treatment of trypanosomosis

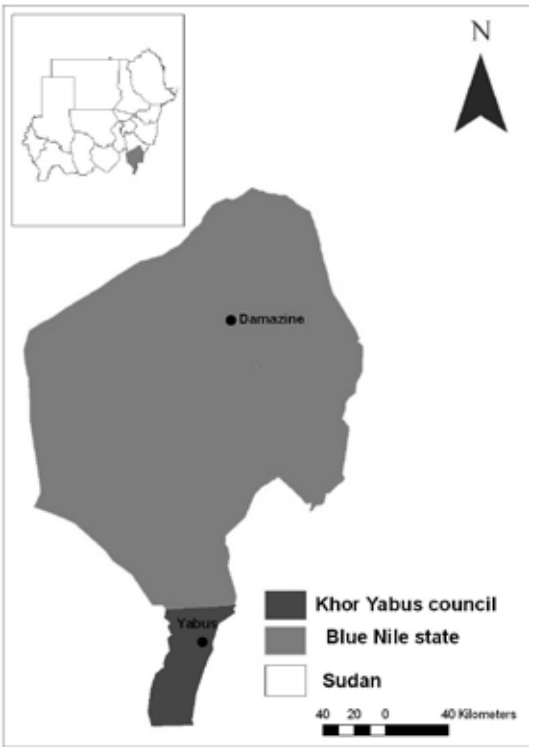



***Figure.1:*** *Tribal composition of communities inhabiting the BNS*

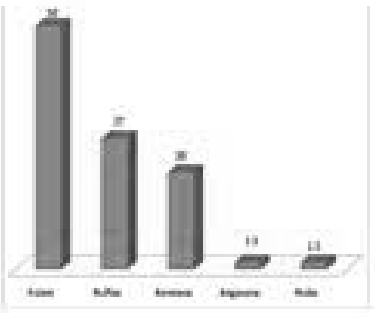


***Figure 2:*** *Ranking of livestock diseases affecting cattle herds in the BNS*

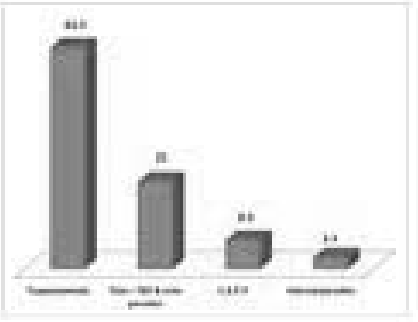


***Figure 3:*** *Percentage of respondents who recognized AAT as a problem & considered as an economic diseases in the BNS*

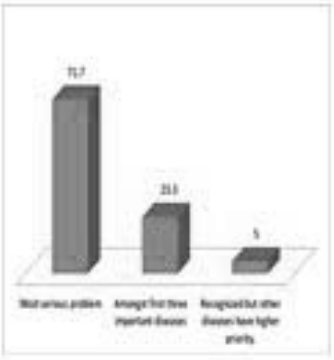


***Figure 4:*** *Challenge of trypanosomosis in resident cattle in the BNS*

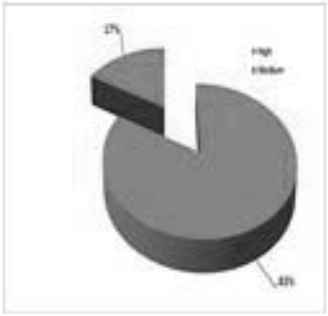
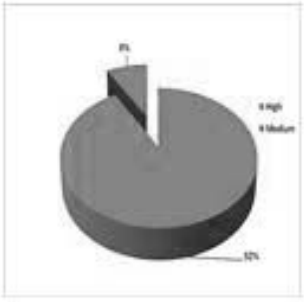


***Figure 5:*** *Challenge of trypanosomosis in immigrant cattle coming to BNS from tsetse infested areas*



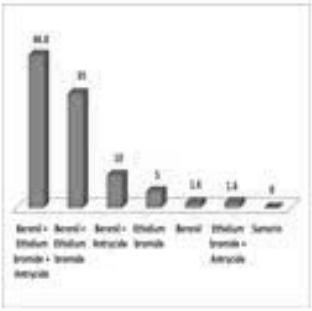


***Figure 6:*** *Trypanocidal drugs used in the BNS*

Chemotherapy together with chemoprophylaxis is presently the major and the only method to control trypanosomosis in livestock in the state. As shown in Fig. 6 about 95.0 % of cattle owners use Berenil which is a more preferable trypanocides that is widely used in the state together with Ethidium. In addition to the above drugs, Antrycide is also used as chemoprophlactic drug (Fig.6). From this survey it is quite clear that Samorin is completely absent and some farmers have never heard of it. .

*Respondent's recognition of tsetse flies.*

28.3 % of the cattle owners in the state have not seen tsetse flies and are not familiar with them although they have heard about tsetse flies the rest of the cattle owners have their own indigenous knowledge about tsetse flies and are familiar of them.

*Vernacular names used for tsetse flies and trypanosomosis*

Different vernacular names are used for tsetse flies and trypanosomosis. 3.0% of the herders in the BNS don't have any vernacular name for trypanosomosis in the areas surveyed but the rest of cattle owners they use special names for trypanosomosis in their local language. Marad Um Bogani is the famous vernacular name for trypanosomosis together with Marad Elduban. Loge and Babosi to mean trypanosomosis. Bobi is used for tsetse fly in the Fulani local dialect.

*Respondent's recognition of biting flies and their vernacular names in the tribal language.*

Cattle owners in the BNS are very familiar with biting flies especially Tabanidae and have vernacular names for these insects. The Fulani use Beuit and Attar for T. taeniola, Um Nalato and Alarge for T. bigutatus, Beli for A. agrestis, Abu Rababa for T. taeniola, Lusaga for T.sufis, Sarot for Hippobosca spp, Eltaer, Taer Elbagar and Taer Elgamos for T. bigutatus, Elgebesha, Eltaer Elagabesh and Elsohaeba for A. agrestis, Um Kokab for Philloliche magrettii are common vernacular names for tabanids used by Kenanna and Rufaa Elhoy.

**Discussion**

Most households surveyed are from different indigenous and exogenous tribes. Of these the Fulani with their special tribal dialects are the dominant tribe in the state. Then Ruffaa Elhoy and Kennana tribes who speak Arabic. Agropastrolists belonging to the indigenous Angasana tribe together with the exogenous Nuba from South Kordofan were also studied. These ethnic groups and tribes have mud-walled houses or thatched grass or thatched bamboo as traditional huts. Domestic livestock are kept in halt by thorny enclosures nearby. This is similar to the Maasai pastoral communities in Kenya, where Warinda (2001) stated that most of the households surveyed had temporary dwellings, Manyatta, for transhumance purposes, It is the men's responsibility to surround the kraal with a thorn bush fence (usually from Acacia spp) for protection from wild animal, lion in particular. Meanwhile women are responsible for construction of houses which are made from mud, sticks, grass, cow dung and cow's urine.

Cattle owners recognize tsetse flies, other biting flies, trypanosomosis, ticks and tick-borne diseases. Most of them are familiar with trypanosomosis as one of the most serious problems which is widely spread among their cattle. It comes as the first vector-borne disease throughout the survey areas, 63.3% of respondents ranked it as the most important and serious threat to cattle herds. In Busia, western Kenya, Machilla *et al.,* (2003) reported that trypanosomosis was ranked next to tick and tick-borne diseases. Cattle owners in the BNS

have their own skills and indigenous knowledge in trypanosomosis diagnosis; they know the clinical signs and the drugs and how to treat sick animals. However, in the state most farmers recognized tsetse flies; about 28.3 % of them did not recognize it, although they heard about it.

In and around Damazin the natural vegetation type and habitat are unsuitable for tsetse flies but there is seasonal tsetse cattle contact in the hot dry season when cattle move to the southern parts of the state where Mohamed-Ahmed (1989) reported the presence of G.fuscipes fuscipes and G.m.submorsitans along the River Khore Yabous. Additionally, in bad years cattle are driven past the international borders into the Ethiopian in-land inside the tsetse zones. Trypanosomosis is given the local name Marad Um Bogani as a popular name used by all cattle owners throughout the state. Fulani use Bobi as vernacular name for tsetse fly and Loge and Babosi for trypanosomosis in their tribal dialect. All cattle owners differentiate between trypanosomosis and other livestock diseases. In Kenya the Maasai call the tsetse flies Ndorobo and they use Malale for trypanosomosis as a vernacular name in the Kisiwahili language (Warinda, 2001).

In all areas surveyed most pastoralists noted that trypanosomosis is a disease which affects their animals and causes death in cattle and its situation is severe as they ranked it. Ticks and TBDs come second to trypanosomosis. Similar findings were reported by Ocaido *et al.,* (2005) who found that trypanosomosis and TBDs are the most serious problems of cattle in Serere County, Soroti District, Uganda.

In the study areas biting flies are well-known by all cattle owners and are common at the onset of the rains, from May up to the beginning of the cool dry season in late October. Several vernacular names are given to biting flies. The Fulani use Um Nalato, Alarge, Beuit, Attar and Beli as local names for biting flies in their tribal dialects and they are well-known and familiar to those communities. Both Kennana and Rufaa Elhoy use several vernacular names in the local spoken Arabic for tabanids including Abu Rababa, Lusaga. Oldroyed (1954) reported several vernacular names of tabanids in different African countries. Balad stand for T. morsitans in Somali land, in Sieraleone cattle owners used Fott for tabanids in general, Eltakasha is used for Haematopota in the Blue Nile; cattle breeders in Northern Nigeria used Wayam for Ancala latipes.

The economics of biting flies come from their role in the mechanical transmission of trypanosomosis in the absence of tsetse flies T.vivax infections occur in cattle when and where mechanical vectors such as Stomoxys spp

and Atylotus agrestis are present. As in Ethiopia (Sinshaw *et al.,* 2007), cattle owners believe that the severity of trypanosomosis coincides with the abundance of biting flies during the wet season, a situation which forces them to migrate to areas of low biting fly challenge. In the BNS, Fulani herders who penetrate inside the Ethiopian in-land in the dry grazing season mix with resident and migratory cattle in the wet and cool dry seasons. Such migratory cattle disseminate trypanosomosis mechanically to resident cattle through the agency of biting flies (tabanids and Stomoxyinae) where they occur in high numbers (Karib 1961 and Yagi & Abdel Razig 1972). Rahman (2002) observed that cattle of the Western Baggara breed posses a certain degree of tolerance to trypanosomosis. Therefore they may act as reservoir hosts for nagana trypanosomes. Since Western Baggara cattle are trekked to all parts of the Sudan as beef cattle they may be a major source of trypanosomes infection to resident cattle in different parts of the country. Circumstantial evidence for the mechanical transmission of trypanosomosis has been obtained in Sinnar state (Abdulla, 1996), South Kordofan (Rahman *et al.,* 1990), Khartoum, Gazera, Managel, Sinnar and the Blue Nile states (Rahman 1994). The role of tabanids and stable flies in mechanical transmission of trypanosomosis has been proved beyond doubt in the laboratory by Mihok *et al.,* (1995) in Kenya and Desquesnes and Dia (2003, 2004) in Burkina Faso.

**Conclusion**

The present study indicates that farmers have their own indigenous knowledge and acquired several skills in the field of disease vectors and livestock diseases in the state

Cattle owners in the BNS recognize tsetse flies, other biting flies, trypanosomosis, ticks and tick-borne diseases.

Transhumance as a mode of living evolved to avoid high populations of biting flies.

Skills and indigenous knowledge of pastoralists are very important for any tsetse and trypanosomosis intervention in tsetse infested areas. This huge battery of information must be used in community collaboration programmes for tsetse control projects in tsetse infested areas in the Sudan.

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# ANNEXES

## ANNEX 1: COMMUNIQUE

### 32nd INTERNATIONAL SCIENTIFIC COUNCIL FOR THE TRYPANOSOMIASIS RESEARCH AND CONTROL (ISCTRC) CONFERENCE

### KHARTOUM, SUDAN

### 8-12 SEPTEMBER 2013

The 32nd ISCTRC Conference was held at the "Friendship Hall" of Khartoum, Sudan from the 8th to the 12th of September 2013.

The conference which was held under the theme "Tsetse and Trypanosomiasis Research and Control for Sustainable Agricultural and Rural Development: Promoting partnership and Learning Agenda in the Context of African Renaissance" was attended by over 200 scientists. Participants were from tsetse-infested countries, international organisations, research institutions and the private sector.

The chairperson of the National Organizing committee of the Sudan, Dr Ahmed Abdul-Rahman welcomed participants and thanked the African Union for choosing Sudan for the 32 ISCTRC conference. Dr. Sadou Maiga, the Chairman of the ISCTRC Executive Council, highlighted the activities the Executive Council had undertaken in Steering the Council.

The Director of the Inter-African Bureau for Animal Resources Prof. Ahmed El-Sawalhy, outlined the broad objectives of the conference which included information sharing, the review of T&T control technologies, strategies and policy options, the identification of research gaps and to make recommendations for the next two years. He expressed his sincere appreciation for the excellent arrangements that have been made by the Government of the Sudan for the hosting of the conference

Her Excellency Madam Rhoda Peace Tumusiime, the Commissioner for Rural Economy and Agriculture of the African Union Commission in a keynote address appealed to participants to use this opportunity to reflect on the progress made so far in the fight against the scourge of Trypanosomiasis which continues to cause severe economic losses to the detriment of most rural homes in Africa. The commissioner urged African countries to sign up to the National and Regional Comprehensive Africa Agriculture Development Programme (CAADP) to ensure that T&T is given enough attention. In the same vein she urged African Countries to include T&T control in their poverty

reduction strategy papers. She commended the African Union Pan African Tsetse and Trypanosomiasis Eradication campaign (PATTEC) for initiating projects that have yielded significant benefits to rural communities.

The Minister for Livestock, Fisheries and Rangeland, Dr. Faysal Hassan Ibrahim, highlighted the negative impact of trypapanosomiasis on rural development of the Sudan and urged scientists and development partners to harness their energies and resources towards a sustainable solution to the problem

The conference was officially opened by the First Vice President of the Republic of the Sudan, His Excellency Ali Osman Muhammed Daha. His Excellency highlighted the importance of the joint African Cooperation and emphasized the role of Pan Africanism in the development of Africa. He reiterated the importance of livestock and the importance of protecting livestock from animal diseases for food security. He encouraged platforms like ISCTRC to continue providing information that would aid the the fight against T&T.

During the last 5 days 95 presentations were made out of which 70 were oral and 25 as poster. The thematic areas covered were contribution of International Organisations; PATTEC and Country reports; Human and African Animal Trypanosomiasis; Glossina Biology, control and eradication; Land Use, Environment and Socio-Economics.

The meeting observed the Capacity gaps existing for the control and elimination of tsetse and trypanosomisis and the need to be address them. It was observed that the number of young African Scientists that have taken keen interest in T&T Research and publication has increased. It was encouraging to note the increasing synergy between actors in endemic countries, international organisations, research institutions, development partners and the private sector in the fight against T&T. This state of affairs has been facilitated by the good advocacy carried out by AU-PATTEC.

The meeting noted the progress that is being made in the development of new diagnostic tools and new therapeutics. Interest in the use of non-invasive methods for the early detection of second stage of Human African Trypanosomiasis continues to take a center stage in HAT. The need to ensure proper combination of drugs and dosages for the treatment of HAT was emphasized. The meeting noted with appreciation the contribution of countries towards the elimination of HAT as evidenced by the declining incidence of the disease. Endemic countries were however cautioned not to relent on HAT surveillance.

Considerable work was reported on tsetse genetic profiling as a step towards the development of area-wide tsetse control and/or eradication.

The conference noted a general trend towards the adoption an integrated approach to the management of T&T using methods that are appropriate for given circumstances. Some of the methods include the use of the Sequential Aerosol Technique(SAT), Ground Spraying, insecticide impregnated targets and screens, Sterile Insect Technique (SIT), and chemotherapy. These efforts have been targeted at improving both human and animal health. Suggestions were made for the involvement of the United Nations Environment Programme (UNEP) in the formulation and implementation of tsetse programmes.

Participants called for AU-PATTEC to play a leading role in identifying management and resource challenges facing member countries in the fight against T&T and to propose sustainable ways of addressing these challenges.

**ANNEX II**

**FIND – WHO Symposium on diagnostics for HAT**

**10th September, 32nd ISCTRC Khartoum, Sudan**

**Agenda**

1. HAT diagnostics development activities supported by FIND– Joseph Ndung'u
2. Presentation by the WHO: role of WHO to accelerate the elimination process of HAT – José Ramon Franco
3. Development of a screening test – Sylvain Bieler
4. Intensified control of T.b.gambiense HAT in Uganda–Charles Wamboga
5. Characterization of health facilities to support intensified control of HAT – Paul Bessel
6. Discussion

**Chair: Dr. Hassane H. Mahamat**

The session was opened by the chair who took the opportunity to introduce FIND, mentioned its mandate and roles to the plenary. There after invited panelists to proceed with presentations

**HAT diagnostics development activities by Joseph Ndung'u**

In his introductory remarks Dr. Joseph noted that FIND and WHO have been holding this symposium since 2006 and that this time round members will receive an update after the Mali 31st ISCTRC where it had been stated that a 1st generation RDT was in the pipeline. The RDT for HAT is now available being produced by SD diagnostics at US$ 50 cents.

Also mentioned was that a second generation RDT using a recombinant antigens was under way and that it would be effective for both T.b.gambiense and T.b.rhodeisense. Also, he reported about completed projects on the evaluation of the LED microscope and LAMP. About staging: he reported that in 2014 there could be a new marker for staging but still required a lumbar puncture but that in the pipeline there are tests aimed at doing away with the Lumbar puncture which could possibly be ready by 2016.

Members were informed that all progress reports, proposed future plans and any other information can be accessed on the FIND website. In his comment about support of implementation of activities, he noted that FIND usually does support improvement of facilities in areas of where activities are implemented especially lab facilities. Finally presented a list of all funders supporting FIND activities and acknowledged their support

**Role of WHO to accelerate the elimination process by Jose**

In his presentation Dr. Jose mentioned that there are two main strategies for employed in HAT control: 1) active case detection which is effective in high prevalence areas, but it is expensive and 2) passive case finding involving available health facilities.

The choice of strategy depends on the epidemiological setting, accessibility and existing capabilities of existing health facilities. The diagnosis entails clinical suspicion, screening the suspect with serological tests and or molecular tests, then parasitological testing (MUST) and staging to decide on treatment.

Of recent RDTs (preferable to be called rapid screening test) have been developed that are device free, thermo stable and individualized.

Amidst all there still exist the following research gaps

- New screening tools using new antigens (easy to produce)
- New affordable parasitological tests
- Less invasive tests for staging preferably using blood, urine, or saliva
- Rapid diagnostic tests for T.b.rhodesiense HAT

**Presentation on development of RDT for HAT by Sylvain Bieler**

The presenter noted that a list of 32 antigens were identified at screening, out of which only two antigens were finally included in the final RDT product which is being manufactured by SD diagnostics.

Two laboratories were involved in the process for the search of antigens. The current RDT for HAT is individually packed and thermo stable up to 40˚c.

A second generation test based on recombinant antigens is under evaluation and results are expected in October 2013.

**Intensified control of T.b.gambiense HAT in Uganda by Charles Wamboga**

This is an on- going project in North West Uganda, launched on 30th July 2013 in Kampala whose main strategy is to introduce a new diagnostic algorithm that combines the use of RDT, LED fluorescence microscopy and LAMP in an area of low prevalence. A total of 166 health facilities are involved in this work and have received equipment for diagnosis, solar power installations to run the equipment and motorcycles for coordination of activities.

**Characterization of health facilities to support intensified control of HAT**

On characterization of health facilities to support intensified control, Paul presented information from various countries including, DRC, Tanzania, Uganda, Tchad and Malawi where mapping had been carried. And enumerated the information is collected about each facility: location of health facility (Lat/ Long), descriptive data ( type, village), Demographic data, Human resources, availability of power, water. This information is the used for planning in allocation of resources during implementation of activities. And finally mentioned the availability of online GIS interface on FIND website where this information can be accessed.

**Discussion**

- Antigen selection process: why follow up tests were were done in only two laboratories,
- Why antigens were placed separately (two lines) on the test instead of having them presented in a single line
- Whether the RDT was evaluated in comparison with other tests like PCR given its high sensitivity of over 90%
- More clarity on the diagnostic algorithm for intensified control of T.b.gambiense HAT in Uganda on whether a LAMP positive test constitutes a case.

**Reactions from panelists**

All issues raised were answered satisfactorily by the panelists.

**Conclusion**

Find was commended for its efforts towards development of diagnostics for HAT and more so their support of implementation of research tools developed.

**ANNEX III**

## Non Tsetse Transmitted Trypanosomoses (NTTAT) Group
## 32nd ISCTRC Meeting 8-12 Sept 2013, Khartoum Sudan

Chair: Dr. Hassane H. Mahamat

Co-chair: Prof. Philiipe Buscher

Rapporteur: Dr. Olaho- Mukani

### Introduction

The Chairman, Dr. Hassane Mahamat called the meeting to order; welcomed members to the meeting and requested them to introduce themselves.

In his introductory remarks, he stressed the importance of NTTAT and that although this group of trypanosomes had been neglected for a long time, though the special effort of Prof. Touratier, the OIE had supported a working group on NTTAT to have its side meeting during the Annual OIE General Conference. However, he informed the meeting that Prof Touratier is not able to attend this meeting and the latter requested the AU-PATTEC Coordination Office to hold a side meeting on NTTAT during the ongoing 32nd ISCTRC Confenerence being held in Khartoum , Sudan (8 – 12. 9 . 2013). The Chairman thanked Prof. Touratier and urged the participants in the meeting to keep the flame burning by carrying on the Challenging work of latter and appealed to the group to bear this burden. Prof. Buscher was also requested by Touratier to ensure that a side meeting on NTTAT was held and the latter contacted the Chairman, who informed both the local and international Committee of the need to facilitate the organization of a NTTAT side meeting and the reauest has benn granted and a room was provided for the said meeting.

In his remarks, Dr Buscher conveyed greetings from Dr Touratier and drew the attention of members to note that NTTAT meant: Trypanosoma equiperdum, T.vivax, T.evansi and to some extent T. theileri, although there was a possibility that the other trypanosome species could as well be transmitted mechanically.

### General Observations

- Noted that currently the groups working on NTTT were fragmented;
- There was need to establish priorities in research on NTTT;

- Need to identify constraints;
- Need to identify Drugs for the treatment of NTTT;
- Need for more research to Identify vectors and design better control strategies;
- Improve Diagnostics;
- Establish collaborations and
- Formulate recommendations on NTTT for the 32nd ISCTRC.

**Discuss on specific NTTTs**

*Trypanosoma equiperdum*

It was reported that on-going work in Ethiopia on a 6 years' project is looking at molecular characterization of T. equiperdum to differentiate the latter from T.b. brucei and that is Sudan T.equiperdum was reported as early as the early 1960s in the Nyala region but since then no work had been done, although there were unconfirmed reports from South Darfur.

*Trpanosoma vivax*

The difficulty of differentiating tsetse transmitted from non-tsetse transmitted T.vivax was noted. There was also the problem of pathogenicity/pathogenesis of different *T. vivax* isolates and the epidemiology of the vectors. It was also noted that rodent adapted *T. vivax* isolates may be present in collection but that this is not known by colleagues' researchers/scientists.

*T.evansi*

The group noted that although T.evansi was the most widely distributed trypanosome species affecting a wide range of mammals, limited attention had been paid to this trypanosome. There is a need to carry out more work on the epidemiology, pathogenesis and diagnostic of this species. The group proposed that research on the role of small ruminants should be carried out.

**Recommendations:**

i. Noting that African groups working on NTTAT are fragmented and uncoordinated, it is recommended that a NTTAT Platform be crated to facilitate coordination and communication between the working groups and scientists on the continent;

ii. Given the wide spread of NTTAT in Africa, AU-PATTEC should broaden its mandate to consider addressing the latter as well; and

iii. Aware that the problem of NTTAT is enormous in Africa and capacities to address the latter are limited, it is recommended that capacities be developed to address the latter;

particularly: more studies to be carried out to:

- Improve diagnosis and characterization of the parasites;
- Map and identify more vector of NTTAT;
- Map the magnitude of NTTT at national and regional levels;
- Elucidate pathogenesis/pathogenicity of NTTATs and isolates;
- Ensure that NTTAT control' strategies been integrated in the implementation of the PATTEC Initiative.

Aware that the African NTTT group needed Leadership to guide and coordinate its activities, Prof. Mahmoud Moussa of Sudan was unanimously elected chairman for the group. He accepted the chairmanship and will be assisted by Dr. Hassane H. Mahamat, Prof. Philippe Busher and Olaho-Mukani. The AU-PATTEC Coordination Office will serve as Secretariat of the Group.

The Chairman of the meeting thanked all participants for the commitments and promised that the group will be formalized and closed the meeting.

**Recommandations**

On PATTEC Initiative and countries' report and Glossina biology, control and eradication

The ISCTRC encourages research aiming at the control of Non-tsetse Transmitted Animal Trypanosomoses (NTTAT), support the recommendation of the 9th Conference of Ministers in Charge Of Livestock urging the OIE to create a Ad-hoc Working Group on Animal Trypanosomoses and acknowledge the MOU between the OIE and the AU- PATTEC Coordination Office;

The Conference urges the AU-PATTEC Coordination Office to integrate within its AW-IPM strategy, communities' participation through active training of veterinary services department and active collaboration with farmers/herders associations;

The ISCTRC recommends AU-PATTEC to speed up qualities' standards for traps and targets in order to ensure reliability and efficacy of proposed

products in the market;

AU – PATTEC and Tsetse and Trypanosomiasis (T&T) affected countries are urging the IAEA to support the implementation of the PATTEC Initiative by fast tracking the use of SIT in areas freed form T&T by training, capacity building and the provision of technical cooperation projects ;

The Conference urges partners working in the field of research to share data with all relevant stakeholders in the field of T&T, collaborate and work in a transparent manner as well as acknowledge individuals, programmes and projects, which have contributed to the studies, reports, among others that will contribute to the implementation of the PATTEC Initiative.

Monday 9 September 2013

Present

| | **Name** | **Country** | **Position and place of work** | **E-mail** |
|---|---|---|---|---|
| 1 | R.E. Changasi | Kenya | | |
| 2 | R.E. Mdachi | Kenya | | |
| 3 | F.Donzoau | Angola | | |
| 4 | F. Regassa | | | |
| 5 | J. Bouyer | France | | |
| 6 | Dia Mahamadou | Mauretania | | |
| 7 | Kitma ElMalik | Sudan | | |
| 8 | Ahmad Ali Ismail | Sudan | | |
| 9 | Mahmoud Moussa | Sudan | | |
| 10 | Inaim Ibrahim | Sudan | | |
| 11 | Mubarak | Sudan | | |
| 12 | Hassane Mahamat | AU-PATTEC Ethiopia | | |
| 13 | Philippe Buscher | Belgium | | |
| 14 | William Olaho-Mukani | Uganda | | |
| 15 | Samuel Kabochi Kamau | Kenya | | |
| 16 | Emad Younis | Egypt | | |
| 17 | Momamed Faisa | Egypt | | |
| 18 | Fina Lubaki | DRC | | |

| | Name | Country | Position and place of work | E-mail |
|---|---|---|---|---|
| 19 | A.Idriss | Chad | | |
| 21 | Malele | Tanzania | | |
| 22 | Banipe Louis | Cameroun | | |
| 23 | Furaha Mramba | Tanzania | | |
| 24 | Elshafie Ibrahim Elshafie | Sudan | | |
| 25 | Nadia .M. Osman | Sudan | | |
| 26 | Sarah. U.E. Osman | Sudan | | |
| 27 | Paulo Afonso | Angola | | |
| 28 | M.M. Santiago Nsenz | Equatorial l Guinea | | |
| 29 | Makhosazana Motloang | South Africa | | |
| 30 | Pete Kingstey | U.K. | | |
| 31 | Vincent Delespaux | ITM Belgium | | |
| 32 | Ahmad Rahaman | Sudan | | |
| 33 | Sadni Manga | Mali | | |
| 34 | Tom Asaku | Uganda | | |
| 35 | Mechtilda Byamungu | Tanzania | | |
| 36 | Joyce Daffa | Tanzania | | |
| 37 | Peter.M. Dede | Nigeria | | |
| 38 | Elnarim .I. Abdi-Elkarim | Sudan | | |
| 39 | Ahmad Ali Ismail | Sudan | | |
| 40 | Joseph Ndungu | FIND Geneva | | |
| 41 | Mohammat Abderahim Toko | Tchad | | |
| 42 | Mohammed Mommar | NITR, Nigeria | | |
| 43 | Mubarak Mustafa | TMRI Sudan | | |
| 44 | Sir El Khatim.M.Salih | Blue Nile Sudan | | |
| 45 | William Shereni | Zimbabwe | | |
| 46 | Issa Degoga | Mali | | |
| 47 | Giuliano Cecchi | Itay | | |
| 48 | Hatim El Tahir | Sudan | | |
| 49 | Abdalla . M. Ibrahim | Sudan | | |

**Groupe sur les trypanosomoses non transmises par la mouche tsé-tsé (NTTAT)**

**32ème Réunion du CSIRLT, 8 - 12 septembre 2013, Khartoum (Soudan)**

Président : Dr Hassane H. Mahamat

Co-président : Pr Philiipe Buscher

Rapporteur : Dr Olaho- Mukani

## Introduction

Le président, Dr Hassane Mahamat, a ouvert la séance, a souhaité la bienvenue aux participants et leur a demandé de se présenter.

Dans ses remarques liminaires, il a souligné l'importance des trypanosomoses non véhiculées par les mouches tsé-tsé (NTTAT), et a indiqué que même si ce groupe de trypanosomes avait été négligé pendant longtemps, l'OIE avait aidé un groupe de travail sur les NTTAT à tenir sa réunion en marge de la Conférence générale annuelle de l'OIE, à la suite des efforts particuliers déployés par le professeur Touratier. Cependant, il a informé les participants que le professeur Touratier n'a pas pu assister à cette réunion et qu'il a demandé au Bureau de coordination de l'UA-PATTEC d'organiser une réunion parallèle sur les NTTAT pendant la 32ème Conférence du CSIRLT qui se tient actuellement à Khartoum au Soudan (8-12 / 9/ 2013). Le président a remercié le Professeur Touratier et a exhorté les participants à la réunion à entretenir la flamme en poursuivant le travail formidable du professeur, et a demandé au groupe d'assumer cette lourde tâche. Professeur Touratier avait aussi demandé au Professeur Buscher de veiller à ce qu'une réunion parallèle sur les NTTAT soit organisée. C'est ainsi que Pr Buscher a contacté le président, qui a informé à la fois le comité local et international de la nécessité de faciliter l'organisation d'une réunion parallèle sur les NTTAT. La demande a été acceptée, et une salle a été mise à disposition pour ladite réunion.

Dans son allocution, Pr Buscher a transmis les salutations du Pr Touratier et a attiré l'attention des membres sur ce qu'il faut entendre par NTTAT : Trypanosoma equiperdum , *T. vivax* , T. evansi et dans une certaine mesure T. theileri, même s'il est possible que d'autres espèces de trypanosome soient également transmises de manière mécanique.

## Observations générales

- Il a été noté que les groupes travaillant actuellement sur les NTTT étaient fragmentés ;

- Il faudrait établir les priorités en matière de recherche sur les NTTT ;
- Nécessité d'identifier les contraintes ;
- Nécessité d'identifier les médicaments pour le traitement des NTTT ;
- Il faudrait poursuivre les recherches pour identifier les vecteurs et mettre au point de meilleures stratégies de contrôle ;
- Améliorer les méthodes de diagnostic ;
- Mettre en place des collaborations ; et
- Formuler des recommandations sur les NTTT pour la 32ème conférence du CSIRLT.

**Débat sur des NTTT spécifiques**

*Trypanosoma quiperdum*

Il a été signalé que les travaux en cours en Éthiopie dans le cadre d'un projet de 6 ans se penchent actuellement sur la caractérisation moléculaire de T. equiperdum pour étabir une distinction entre ce dernier et T.b. brucei. Au Soudan T.equiperdum était déjà signalé dans les années 1960 dans la région de Nyala, mais depuis lors aucun travail n'avait été fait, en dépit des rapports non confirmés provenant du Sud du Darfour.

*Trpanosoma vivax*

La difficulté d'établir une distinction entre les *T. vivax* transmis par les mouches tsé-tsé de ceux non transmis par les glossines a été notée. L'on a également relevé le problème lié à la pathogénicité / pathogenèse des différents isolats de *T. vivax* et à l'épidémiologie des vecteurs. Il a également été noté que les isolats de *T. vivax* adaptés aux rongeurs peuvent être présents lors de la collecte, mais ceci n'est pas connu des collègues chercheurs / scientifiques.

*T.evansi*

Le groupe a fait remarquer que T. evansi a reçu peu d'attention bien qu'il soit l'espèce de trypanosome la plus répandue qui affecte un large éventail de mammifères. Il est nécessaire d'approfondir les travaux sur l'épidémiologie, la pathogenèse et le diagnostic de cette espèce. Le groupe a proposé que des recherches soient menées sur le rôle des petits ruminants.

**Recommandations**

i. Notant que les groupes africains travaillant sur les NTTAT sont fragmentés et non coordonnés, il est recommandé qu'une plate-forme NTTAT soit

mise en place pour faciliter la coordination et la communication entre les groupes de travail et les chercheurs sur le continent ;

ii. Etant donné la large propagation des NTTAT en Afrique, l'UA- PATTEC devrait élargir son mandat pour y inclure également ce problème ; et

iii. Conscient du fait que le problème des NTTAT est énorme en Afrique et que les capacités d'y faire face sont limitées, il est recommandé que les capacités soient développées pour résoudre ce problème ;

Plus particulièrement, des études supplémentaires doivent être menées pour :

- améliorer le diagnostic et la caractérisation des parasites ;
- cartographier et identifier d'autres vecteurs des NTTAT ;
- cartographier l'ampleur des NTTT aux niveaux national et régional ;
- élucider la pathogenèse / pathogénicité des NTTAT et des isolats ;
- s'assurer que les stratégies de lutte contre les NTTAT sont intégrées dans la mise en œuvre de l'initiative PATTEC.

Conscients que le groupe africain sur les NTTT avait besoin d'un responsable pour guider et coordonner ses activités, le Professeur Mahmoud Moussa du Soudan a été élu à l'unanimité comme président du groupe. Il a accepté ce rôle de présidence, et sera assisté par Dr Hassane H. Mahamat, Pr Philippe Busher et Olaho- Mukani. Le Bureau de coordination de l'UA-PATTEC assumera la fonction de secrétariat du Groupe.

Le président de la réunion a remercié tous les participants pour leur dévouement et a promis que le groupe sera officialisé, et a ensuite clos la réunion.

**Recommandations**

En ce qui concerne l'initiative PATTEC et les rapports des pays, et la Biologie, le contrôle et l'éradication des glossines

Le CSIRLT encourage les recherches visant le contrôle des trypanosomoses non transmises par les mouches tsé-tsé (NTTAT), appuie la recommandation de la 9ème Conférence des ministres en charge de l'élevage exhortant l'OIE à créer un groupe de travail ad hoc sur les trypanosomoses animales et prend acte du protocole d'entente entre l'OIE et le Bureau de coordination de l'UA-PATTEC ;

La Conférence exhorte le Bureau de coordination de l'UA- PATTEC à intégrer, au sein de sa stratégie de lutte intégrée contre les ravageurs à l'échelle d'une région (AW-IPM), la participation des communautés à travers la formation active du département des services vétérinaires et la collaboration active avec les associations d'agriculteurs / éleveurs ;

Le CSIRLT recommande à l'UA-PATTEC d'accélérer les normes de qualité pour les pièges et cibles afin d'assurer la fiabilité et l'efficacité des produits proposés sur le marché ;

L'UA - PATTEC et les pays affectés par la mouche tsé-tsé et la trypanosomiase (T & T) demandent à l'AIEA de soutenir la mise en œuvre de l'initiative PATTEC en accélérant l'utilisation de la TIS dans les zones libérées de T & T par la formation, le renforcement des capacités et la mise en place de projets de coopération technique ;

La Conférence exhorte les partenaires engagés dans les recherches à partager les données avec toutes les parties prenantes concernées dans le domaine T & T, à collaborer et à travailler dans la transparence, et à reconnaître les individus, les programmes et projets qui ont enrichi, entre autres, les études et rapports qui contribueront à la mise en œuvre de l'initiative PATTEC.

Lundi, 9 septembre 2013

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