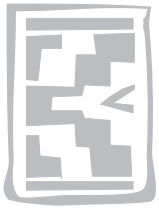

Tsetse and trypanosomosis in Africa: The challenges, the opportunities

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ABSTRACT

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Tsetse-fly and the disease it transmits, trypanosomosis, remain an enormous disease challenge in the 37 countries of sub-Saharan Africa where the impact continues to be manifest in disease burden, increased level of poverty and decreased agricultural productivity. The impact also extends over an estimated 10 million km^2 (a third of the African continent) of land area, a third of which contains some well-watered part of the continent, thus denying humans and livestock of potentially rich arable and pastureland.

The disease is a threat to an estimated 50 million people and 48 million cattle with estimated annual losses in cattle production alone of 1–1.2 billion US$. These losses are due to stock mortality and depressed productivity, which may be of meat, milk, reproduction or traction. Beyond its direct effects on humans and livestock is its impact on African agriculture and the livelihood of the rural population in the affected countries: the fly and the disease influence where people decide to live, how they manage their livestock, and the intensity and the mix of crop agriculture. The combined effects result in changes in land use and environment which may, in turn, affect human welfare and increase the vulnerability of agricultural activity. Trypanosomosis is, therefore, both a public health and an agricultural development constraint. The challenges that the elimination or control of tsetse fly and trypanosomosis pose as well as the opportunities to develop appropriate intervention technologies are discussed in this presentation.

INTRODUCTION

At this momentous occasion when we are celebrating 100 years of the establishment of the Onderstepoort Veterinary Institute (OVI), it is worth recalling that it was here in South Africa, on the Ubombo hills of Zululand that Dr David Bruce and his colleagues who, between 1894 and 1899, carried out experiments that led to the identification of the causal agent of 'tsetse fly disease' or 'nagana' (Bruce 1897). The centenary marking that epoch finding took place in Africa and Europe some 8 years ago. Just about the same time, the rinderpest epidemic broke on Africa in 1896 and led to the massive destruction of bovines and indigenous antelopes, one of the major reasons for the apparent disappearance of tsetse fly in the confined areas of Transvaal and Zululand where the fly was prevalent. By 1905, however, with the containment of rinderpest and recovery of the wild antelopes and bovines, the flies were back and nagana became prevalent again. It was left for Du Toit and his colleagues (Du Toit 1954; Du Toit, Kluge & Fiedler 1954) to devise means of eradicating the major fly involved in the transmission of trypanosomosis, *Glossina pallidipes*, from the fly belts in Zululand using insecticide (BHC) by helicopter application. The other two *Glossina* species, *Glossina austeni* and *Glossina brevipalpis,* considered at the time to be relatively unimportant in the transmission of pathogenic trypanosomes in the country, were not much affected and has remained low-level vectors of trypanosomosis in KwaZulu-Natal at this time.

Returning to the issue of my remit, it is enough to remind us that African trypanosomosis is a disease complex unique to sub-Saharan Africa, affecting both humans (sleeping sickness) and animals (nagana or African animal trypanosomosis [AAT]). It is caused by a protozoan blood parasite, the trypanosome, and is transmitted by the tsetse fly (*Glossina*) which is confined to sub-Saharan Africa. The impact of the disease extends over 37 countries and an estimated 10 million km^2 (a third of the continent) of land area. Of this 10 million km^2, some three million are covered by equatorial rain forest while the remaining area contains some well-watered parts of the continent, thus denying humans and livestock potentially rich arable land and pastures. The disease is a threat to an estimated 50 million people and 48 million cattle with estimated annual losses in cattle production alone in the range of 1–1.2 billion US$ due to stock mortality, depressed productivity, which may be of meat, milk, reproduction or traction. But beyond its effects on humans and livestock is its impact on African agriculture and the livelihood of the rural population in the affected countries: the disease influences where people decide to live, how they manage their livestock and the intensity and the mix of crop agriculture. The combined effects result in changes in land use and environment, which affect human welfare and increase the vulnerability of agricultural activity. Trypanosomosis is therefore both a public health and an agricultural development constraint.

AAT contributes to food insecurity and poverty over vast tracts of sub-Saharan Africa. Apart from being a threat to livestock, it undermines environmentally sound and economically viable animal and agricultural production and rural development. Eighty-five percent of the African poor are located in rural areas and more than 80 % of the population depends on agricultural production for their livelihood. Tsetse and Trypanosomosis (T & T) is one of the transboundary insect pest and disease problems that constitute a key bottleneck to sustainable agriculture and rural development (SARD) in sub-Saharan Africa, including South Africa. To respond to the problem, the Food and Agriculture Organization (FAO) Conference in 1997 endorsed the establishment of the Programme against African Trypanosomosis (PAAT). This programme seeks through the FAO, International Atomic Energy Agency (IAEA), African Union (AU) and World Health Organization (WHO) to ensure a coordinated and sustainable approach through the development and implementation of integrated interventions against T & T. PAAT is concerned with providing affected countries and the donor community with the information needed both to improve understanding and to facilitate policy, technical, financial and decision-making with respect to interventions, including the underlying pest management principles. PAAT's strength lies in its multidisciplinary and inter-sectoral approach to a problem that has traditionally been tackled through unilateral veterinary or entomological interventions. Because tsetse fly does not respect international boundaries, effective control or elimination of the fly depends on concerted action by the tsetse-infested contiguous countries.

The finding of Dr David Bruce and his colleagues that the causative agent of the scourge that afflicted humans and cattle in Southern Africa was a protozoan parasite belonging to the genus *Trypanosoma*, apart from its great scientific significance, has helped to shape field control of the disease and its vector. The centenary celebrations both in Europe and Africa of David Bruce's finding was, however, confronted with many questions, a major one being the failure to rid the African continent of this scourge during the 100 years that had elapsed since the epoch discovery despite the huge investments in the treatment, control and elimination of the disease and its vectors, and the comparatively low reproductive capacity of the vector! The celebrations were also marked by the recognition by African Heads of State and Governments at their meeting in Lomé in 2000, of:

> *"…the seriousness of the problem of one of Africa's greatest constraints to socio-economic development, severely affecting human and livestock health, limiting land use, causing poverty and perpetuating underdevelopment on the continent…"*

following which they declared the:

> *"…year 2001 as the year of control of the tsetse-fly, to mark the beginning of renewed efforts in the campaign for the eradication of tsetse flies…"*

This campaign, named Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC), is at the vanguard of mobilizing political and funding support for the programme to eradicate the fly and therefore, the disease, from the African continent.

THE CHALLENGES

The demographic and food security challenge

AAT is a dynamic disease, both in space and time. The most important factor affecting the disease to-

day is the rapidly expanding human population complicated by differing local situations. According to Mattioli, Feldmann, Hendrickx, Wint, Jannin & Slingenbergh (2004) about 620 million people live in tsetse-infested countries (*cf.* Europe population: 730 million) with rural populations accounting for 68 % of this figure, i.e. 420 million, with a total labour force of 255 million. Of the latter figure, the agricultural labour force accounts for 180 million (> 70 %). With the population growth averaging 2.5 %, from where will the additional food to feed such rapidly expanding populations come? Removal of the constraints imposed by tsetse fly and trypanosomosis on vast tracts of land denied to agriculture will therefore open up opportunities to utilize the land for food cultivation, reduce food deficit and rural to urban drift, and improve the livelihood of rural dwellers in affected countries. Because tsetse is vulnerable to agricultural cultivation pressure, tsetse eradication will be facilitated and reinvasion of cleared areas will be checked.

The challenge of controlling or eradicating the fly

Allsopp (2001) reviewed the currently available options for vector control against trypanosomosis in Africa. The options include ground spraying using non-residual insecticides, sequential aerial application of low-dosage, non-residual aerosols (SAT), the bait technology and the sterile insect technique (SIT). Different species of tsetse require different approaches to their control. Generally however, the effectiveness of each approach depends on the ecological situation existing in a given area, including distribution patterns, environmental requirements, behavioural characteristics, densities, high resilience and farming systems.

There are 30 species or subspecies of the tsetse fly, of which 22 are recognized as of economic importance because of their role in the transmission of pathogenic trypanosomes. There is a fairly well defined limit to their spread, the northern and southern limits. Generally, distribution of the different species of tsetse is determined principally by climate and influenced by altitude, vegetation and the presence of suitable host animals. The distribution varies markedly—some are widespread all over sub-Saharan Africa, while others have relatively limited distribution. Many of the affected countries harbour two to three species of tsetse flies. Thus, the presence of multispecies and their widespread distribution is a major challenge. Furthermore, when tsetse belts expand from one country to the other it creates a major problem in control or eradication unless the affected countries act in concert. An example is the recent reclamation work done in the Okavango Delta of Botswana which has been quite successful but did not include the neighboring countries of Namibia and Zambia where extensions of the tsetse belts to these countries are found. PATTEC has been encouraging the three countries to collaborate to ensure that no reinvasion of tsetse occurs in cleared areas; otherwise it will be difficult and costly to maintain a barrier. The presence of tsetse in difficult terrains, e.g. in gorges, lowlands, deltas and high forests as occurs in most of Central Africa where access is a major problem and where the only livestock kept are the trypanotolerant breeds is a major challenge to control or eradication.

Given the foregoing, it is believed that the technical means of either controlling or even eradicating tsetse are available and the problem lies in successfully implementing control measures in a sustainable manner. Tsetse elimination requires that once the process is started, it should be consistently pursued until the goal of either control or eradication is achieved. Otherwise, because the fly has intrinsic ability to recover fast, the remnant may recover rapidly, and sometimes to levels above those before control was applied. The creation of artificial barriers to secure areas cleared of tsetse from reinvasion can be very expensive and may not be sustainable. This partly explains why it has proved difficult over more than 100 years to rid the continent of T & T.

The challenge of selecting technologies and the sequence in which they are applied

Field observation has confirmed that selection of technologies appropriate to a given area and the sequence of their application is crucial to the success or otherwise of any intervention. Area-wide integrated pest management (AW-IPM) of T & T, as a phased approach has been advocated, involving the creation and expansion of tsetse free zones and integrating various technologies that are appropriate and environmentally acceptable (PATTEC 2001; Feldmann & Hendrichs 2001). The selection of technology and the sequence in which they should be applied, however, would depend on prevailing conditions. Some of these conditions include, for example, the size of the area, tsetse distribution patterns and abundance, tsetse vulnerability, livestock systems, agricultural practices, livestock breeds, availability of infrastructure and capacity; availability of and access to intervention technologies and market demands and trade opportunities.

Unless appropriate combinations of technologies are applied, depending on the different environmental and social situations, T & T interventions may fail to achieve the desired objectives.

The challenge of a coordinated approach

The sustainable control or eradication of T & T requires a coordinated and concerted approach. Regrettably this has, for a long time, been lacking, especially in large-scale interventions. To address this issue in a realistic manner, a workshop was convened in May 2002, at the FAO Headquarters in Rome under the umbrella of PAAT, where an agreement was reached by FAO, AU/PATTEC, IAEA and WHO on a harmonized approach to the problem of T & T, and in particular the concept of AW-IPM and the criteria or guidelines for selecting priority areas for joint international intervention in the context of sustainable agriculture and rural development (SARD) (FAO 2002). These criteria are:

- Severity of the impact of T & T
- Opportunity to support poverty reduction, increase food security and maximize the economic returns through:
  - Expansion and intensification of mixed farming
  - Improved subsistence farming and/or production of cash crops
  - Proper land use and tenure as components of sustainability
  - Sustainable and environmentally appropriate utilization of natural resources.
- Factors contributing to increased feasibility of project activities and sustainable outcomes:
  - Presence of natural barriers
  - Possibility for artificial confinement of tsetse population
  - Commitment and involvement of local authorities and communities
  - Existence of technical and logistic support.

The challenge of drug control

Livestock farmers have depended principally on the use of trypanocides to control AAT in the face of years of breakdown of extension services in affected African countries. There is, however, a growing concern on the effectiveness of the currently available trypanocides due to reported widespread drug resistance. The existing trypanocides—isometamidium, diminazine and homidium salts—have been in use for over 40 years and it is estimated that annually, 35 million doses, amounting to about 35 million US$, are administered. With such a low level of use, major drug companies are unwilling to invest in new trypanocide research and development, with the result that no new drugs have come into the market for over 40 years, the last one being diminazine. There is therefore the imperative of ensuring that the existing trypanocides are used judiciously in order to further extend their life-span of effective usage and ensuring that livestock farmers and pastoralists are not frustrated. Geerts & Holmes (1998) have reviewed how drugs can be managed and suggested the way forward. While the use of trypanocides by livestock farmers and pastoralists is popular because it is a private good, supply chains often hamper availability.

The challenge of sustainable agriculture, rural development and natural endowments (SARD)

The issue of SARD should be at the heart of any enduring project, especially T & T interventions, having regard to the painful history of failed projects and the importance of not allowing history to be repeated. The concept of SARD has been around since the 1970s and was incorporated as one of the goals of Agenda 21. SARD has been described as a process that meets the following criteria:

- Basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products.
- Provision of durable employment, sufficient income and decent living and working conditions for all those engaged in agricultural production.
- Maintains and, where possible, enhances the productive capacity of the natural resource base as a whole and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities or causing contamination of the environment.
- Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance.

Many donor-supported large-scale T & T interventions in the past have failed to achieve their goals partly because sustainability was not built into such projects upfront and where this was done, it has not been followed through.

THE OPPORTUNITIES

Having briefly outlined the challenges that T & T pose, we must now turn to the opportunities deriving from their control or eradication. The first, of course, is that of opening up of the extensive land hitherto denied to livestock raising and crop agriculture. The success story of the elimination or eradication of tsetse from the island Zanzibar using a combination of suppression followed by the use of SIT and the recently reported case of successful elimination of tsetse using the SAT from the Okavango Delta in Botswana where tourism has reportedly started flourishing with cattle grazing along the delta, has encouraged the African Development Bank (AfDB) to become involved in T & T intervention in six African countries. The six countries involved, namely, Burkina-Faso, Ethiopia, Ghana, Kenya and Mali have been granted about 70 million US$ in loans and grants to eliminate tsetse over a period of 5 years under the PATTEC initiative. Work has already started with collection of baseline data. Negotiation is also in progress in six additional countries to benefit from the AfDB investment. It is however, important that this bold initiative succeed in order to encourage further investment in tsetse and trypanosomosis. It is hoped that the present crisis in the global economy will not have a serious adverse effect on further investment and thus hinder the achievement of the Millennium Development Goals (MDG). Other opportunities can be categorized along the following headings:

The opportunity for improved technology

The refinement of methodologies has led to the greater success of intervention programmes using improved technologies. Aerial spraying using sequential aerosol technology, involving ultra-low level of synthetic pyrethroid insecticide, has led to the success reported in Botswana where tsetse has, to all intent and purposes, been exterminated.

Demographic pressure

The need to reduce the food insecurity by opening up land denied to agriculture and livestock-raising by T & T in Africa is a critical and urgent one. In many affected countries, the presence of T & T forces rural people and their livestock to live in areas of less risk, with the attendant problem of unbalanced exploitation of natural resources leading to increased vulnerability of the environment and natural resources and expansion of rural activities into a fragile environment. An example is the Ethiopian experience where the presence of T & T in the western and southwestern lowlands had forced people to move to the highlands to avoid the tsetse-infested lowlands, which are fertile and relatively underused for agriculture. The result is that the highlands are overpopulated and the land acutely degraded, while animal traction power needed for rural agriculture is severely limited. Removal of the T & T constraints in such places, therefore, will open up the land for expanded and improved livestock raising and agricultural production, reduce the demographic pressure, ensure balanced utilization of land and resources—thereby providing opportunities for improvement and diversification of livestock-agricultural productions. Further, opening up of land will create opportunities for meeting part of the needs of rapidly expanding population growth in Africa.

Opportunities for a significant increase in livestock-crop agricultural production

It has been shown that much of the primary cultivation in sub-Saharan Africa (about 90 %) is carried out by hand (FAO 1987), thus limiting the size of cultivable areas for arable and cash crops. FAO (1994a, b) stated that crops are a major commodity in 28 tsetse-infested countries and in 22 of these indigenous cattle meat is a major commodity. Livestock alone contributes approximately 35 % of agricultural GDP in sub-Saharan Africa and agricultural produce worth 4.75 billion US$ is lost annually. If the constraint of T & T is removed, therefore, the following would be achieved:

- Significant opportunities to reduce livestock mortality and morbidity, enhance human and animal health and increase livestock productivity of meat and milk to satisfy demands, potential or actual, and to support expansion, intensification and harmonization of crops-livestock production.
- Increased livestock production and productivity. Increased productivity in the context of SARD does not necessarily mean the increase in livestock numbers as environmentalists are quick to point out. Admittedly, whatever method is used to control or eradicate AAT can result in overstocking with livestock and consequent degradation of the land, if an effective stocking level is not maintained. This has led to the concern expressed by environmentalists that control of T & T is detrimental to the environment by reason of soil degradation and overexploitation of natural resources in reclaimed areas. In other words, T & T is the protector of environment against exploitation. However, when the debate is considered in a proper perspective, that is, in the light

of SARD, the control or eradication of T & T should be seen as essential component of activities directed at achieving sustainable rural development.

- The use of draught animals for ploughing and other farm activities, for example, transportation of produce and other materials, especially in rural areas, will be enhanced and expanded, leading to increased crop production, greater opportunities for diversification of agricultural activities and improved nutrient cycle. It has been shown that in mixed crop-livestock farming systems, farmers who use animal traction generate 25–45 % more income per unit of land and 140 % more income per unit of labour than farmers who used hoes. Budd (1999) suggested that the use of draught animals alone has the potential to move families from subsistence existence into the cash economy, leading to a better standard of living.
- Expansion of area of cultivation would translate into more food and therefore, increased income for the farmer; provide additional employment opportunities and enhance food security generally.
- Increased contribution to Agricultural GDP. It has been estimated by FAO (1994b) that if the impact of T & T is removed, agricultural GDP will increase between 5 and 10 %. The annual losses in terms of agricultural production, estimated at 4.75 billion US$ annually, will be saved and will improve rural income and encourage cash economy, thus reducing rural-urban drift.

The savings that will be realized from drug control and the relief from drug-resistant trypanosomes will encourage more farmers including crop farmers to invest in livestock agriculture in the affected countries.

CONCLUSION

The challenges of controlling or eradicating a disease that has remained intractable for more than 100 years would appear insurmountable given the history of past failures, yet they provide opportunities to correct past failures, devise environmentally-friendly technologies both for large-scale and farmer-based interventions and reassess the need for approaches that ensure that any intervention has a built-in mechanism for achieving SARD.

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