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Current Trends of Bovine Trypanosomosis in Ethiopia: A Review

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Abstract: Trypanosomosis is a disease complex caused by several species of unicellular protozoan parasites of the genus *Trypanosoma*. The most important trypanosomes, in terms of economic loss in domestic livestock are tsetse transmitted species: *T. congolense*, *T. vivax* and *T. brucei*. Trypanosomosis still remained as serious challenge and causes economic losses especially in western and southwestern parts of Ethiopia and it remains the main constraint of livestock production and rural development in the country. Previous control methods mostly involved with negative environmental impacts but later more ecologically and politically acceptable methods has been developed. The distribution of bovine trypanosomosis is found to be widespread covering most parts of the western and south-western parts of the country. The distribution, prevalence and impact of bovine trypanosomosis are often affected by anthropogenic environmental changes that alter the interactions between the host, the parasite and the vector. Even though there is a variation in distribution and prevalence of bovine trypanosomosis among regions, very recent estimate indicates that trend of decrement in distribution and prevalence of the disease in Ethiopia. Many controversies surrounding a range of various control methods. The focus on particular control methods has meant that alternatives have often been overlooked and the perspectives of livestock keepers living with the disease have not been taken into account. All supporting strategic tools and technologies that could indicate the distribution and the prevalence of the disease and its vector could improve the existing control methods and diagnostic techniques should be implemented. The current initiatives like progressive control pathways, which are stepwise approaches for the reduction, elimination and eradication of human and animal diseases is highly recommended.

Key words: Control · Distribution · Prevalence

INTRODUCTION

African animal trypanosomosis (AAT), also known as nagana is widely distributed across the tsetse-infested belt of sub-Saharan Africa, where approximately 60 million heads of cattle are estimated to be at risk of infection over an area of about 10 million km^2 [1]. It is responsible for the death of 3 million heads of cattle yearly [2]. Trypanosomosis has long been recognized as a massive constraint on animal husbandry, livestock production and mixed farming in vast areas of rural sub-Saharan Africa [3]. In countries such as Ethiopia, where livestock is an important part of the agricultural sector, trypanosomosis contributes to the direct economic losses of crop-livestock production. Animal trypanosomosis is an important livestock disease in Africa which is considered as a threat to the ongoing effort on poverty alleviation in the continent. It is a serious disease in domestic livestock that causes a significant negative impact in food production and economic growth in many parts of the world [4] particularly in sub-Saharan Africa [5].

Trypanosomosis (It is also known "Nagana") is a disease complex caused by several species of unicellular protozoan parasites of the phylum Sarcomastigophora, order Kinetoplastida, family Trypanosomatidae and genus *Trypanosoma*. It is mainly transmitted cyclically by an arthropod of the genus *Glossina* (Tsetse flies), but also transmitted mechanically by several biting flies (Tabanids, stomoxes, etc). The disease can affect various

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species of mammals but, from an economic point of view, tsetse-transmitted trypanosomosis, is particularly important in cattle. It is mainly caused by *T. congolense, T. vivax* and, to a lesser extent, *T. brucei brucei* [6].

The disease causes heavy direct losses to livestock keepers as measured by mortality, morbidity and reduced productivity at the herd level. In the deprived rural settings where it occurs, AAT further reduces food security by limiting the exploitation of animal draught power and by constraining the optimal utilization of fertile lands [7]. Shortage of nutrition, reproductive insufficiency, management constraints and animal disease are the major constraints [8]. Since more than 90% of crop production in Ethiopia are dependent on animal draught power mainly on ploughing oxen, many large fields remained fallow due to lack of these animals in trypanosomosis infected area [9] which worsen the food supply and living conditions in affected areas.

Ethiopia is known for its large and diverse livestock resource endowments. Livestock is primarily kept on small holdings where it provide draught power for crop production, manure for soil fertility and fuels, serves as a sources of family diet and sources of cash income (from livestock and livestock products). Despite large livestock population, Ethiopia fails to optimally utilize this resource due to different constrains facing the livestock subsector [10].

The presence of animal trypanosomosis is a major constraint to the introduction of highly productive exotic dairy animals and draught oxen to lowland settlement and resettlement areas for the utilization of large land resources [11]. In Ethiopia animal trypanosomosis is still among the most important diseases limiting livestock productivity and agricultural development due to its high prevalence in the most arable and fertile land of Western and South Western part of the country. Thus, the objective of this paper is: to provide literature review on the current trend of bovine trypanosomosis in Ethiopia with particular emphasis on the prevalence, distribution and control of the disease in Ethiopia.

Prevalence of Bovine Trypanosomosis in Ethiopia: Prevalence of bovine trypanosomosis varies with different agro ecological areas from place to place as well as from time to time. For instance it was 5.43% in Mandura, Benishangul Gumuz [13] 6.3% in Kindo Koisha, in SNNP [14] 6.86% in Lalo Kile district of Oromia regional state [15] 4.43% in Arba Minch [16] 6.9% in Chena district, South West Ethiopia [17] 4.2% in South Achefer district, Northern Ethiopia [18] 1.02% in West Gojam, Ethiopia [19] 27% in Arbaminch [20] 10.67% in Debre Elias district, North west Ethiopia [21] 2.66% in Tselemti Woreda, Western Tigray [22] 14.2% in Humbo district, Wolaita Zone [23] 11.33% in Jawi district of Amhara region [24]. This observed variation might be due to agroecological difference.

There is report that the most prevalent trypanosome species are *T. congolense* and *T. vivax*. Various authors have reported that the prevalence of trypanosomosis in tsetse infested areas range from 11.85-37% [25, 26]. In non-tsetse infested areas of Northwest Ethiopia, the prevalence of trypanosomosis was in the range of 2-9% [12, 27].

Recent systematic nationwide analysis of bovine trypanosomosis described the prevalence estimates derived from scientific reports and the prevalence varied over time, with lowest levels was recorded since 2010 (Table I) [28]. It suggested that previous and ongoing tsetse control activities in the affected areas of Ethiopia could be the reason for the decrement in the prevalence of bovine trypanosomosis.

It reported that significant variations have been observed in the prevalence of bovine trypanosomosis among regions and the variation among states would seem to indicate differences in effort and attitudes to tsetse and trypanosomosis control and eradication. It showed that the prevalence was significantly higher in Benishangul Gumuz Regional state, which is considerable remote with little tsetse control effort [28].

Since trypanosomosis is a transboundary disease it is very difficult for demarcation among regional states for disease occurrence. Showing prevalence in regional level is better to plan and implement control programs at regional level. But to bring the national effort together and to plan and implement control programs at national level it is preferred to show the prevalence at national level. Prevalence of the disease is still significant in different parts of the country though the diagnosis of trypanosomosis is mainly relies on the less sensitive parasitological diagnostic techniques. ITS1 or nested ITS1/ITS2- based PCR assays have proven useful in trypanosomosis diagnosis and in epidemiological studies. The authors claimed that the universal ITS-based PCR assays reduce cost and time of running several species-specific assays, especially in large-scale studies. ITS1 PCR that was used in an epidemiological survey in Ethiopia revealed a five-fold higher detection rate for *T. vivax* compared to HCT [29].

Table I: Pooled prevalence estimates of bovine trypanosomosis, stratified by sub-groups [28].

					Parameters		Heterogeneity	
Variables	Sub-groups	No. of studies	Sample size	Cases	Prevalence (%)	95 % CI	I^2 %	P-value (Cochran's Q)
	Overall	24	27,719	2274	8.12	6.88-9.35	93.1	0.000
Regions	Afar	1	82	4	4.88	0.19-9.57	0.00	1.00
	Amhara	6	15,937	1263	8.05	6.79-9.31	85.09	0.000
	B.Gumuz	4	2284	286	13.30	7.73-18.88	93.56	0.000
	Oromia	8	2943	189	6.18	3.63-8.72	91.02	0.000
	SNNPR	6	4045	366	7.87	4.56-11.19	92.93	0.000
	Tigray	1	411	32	7.79	5.19-10.39	0.00	1.00
Survey year	1997-2004	5	10,984	897	10.27	7.34-13.20	95.17	0.000
	2005-2009	6	8059	1045	9.17	7.41-10.93	81.85	0.000
	2010-2015	13	8676	332	6.81	5.00-8.62	92.18	0.000
Sample size	<□384	3	959	84	8.25	3.99-12.51	84.01	0.002
	384-1000	8	5982	482	8.72	7.16-10.29	93.96	0.000
	□≥□1000	13	20,778	1708	7.74	5.49-9.98	92.78	0.000

Up to recent years, *T. congolense* has been considered as the most important trypanosome species in Ethiopia; but in some areas *T. vivax* is being reported to be the most predominant trypanosome species [21, 30, 31]. According to Fikru *et al.* [29] the burden of non-tsetse transmitted trypanosomosis like trypanosomosis caused by *T. vivax* is being reported to be considerable, the occurrence of mechanically transmitted trypanosomosis caused by *T. vivax* is very widespread than previously thought. It was suggested that the high prevalence of *T. vivax* most likely indicates the local transmission in the non-tsetse infested area by biting flies. It is indicated that *T. vivax* can adapt to a non-tsetse dependent transmission cycle. As a consequence, the eradication of tsetse fly in Ethiopia, which is a core focus area of PATTEC and other tsetse control initiatives, might have little effect on the prevalence of *T. vivax* [28]. So it is better to follow area-wide holistic approach in tsetse and trypanosomosis control and eradication campaigns.

When sex preference is considered generally trypanosome infection is more prevalent in males and adult cattle than in females and young ones [32-34]. The higher prevalence in male animals might be associated to the frequent exposure of male animals to the bites of tsetse flies during traction period and herding system of male animals. The age difference could be linked to size of the animal, reproduction and work stresses to which most adult cattle are exposed for the bite of tsetse flies. The disease animal African trypanosomosis causes significant anemia that is evidenced by fall in mean PCV values was regardless of the trypanosome species detected in those parasitologically positive animals [12, 27, 25, 35]. To assess community acceptance and farmers' perception regarding bovine trypanosomosis and its impact was well recognized although there was little variation between tsetse infested and non-infested areas. It was higher in tsetse infested area than in non-tsetse area [36]. Five years ago Zewdu and coauthors reported that at Baro-Akobo and Gojeb river basins of Western Ethiopia, 94.1% of the respondents considered bovine trypanosomosis accounts for 64.6% of the total annual deaths of cattle in 2011/2012. It was reported that to combat the problem, farmers use diminazene aceturate (DA) and isometamidium chloride (ISM), the most commonly available trypanocidal drugs in the areas which are also similar for other places [37].

Distribution of Bovine Trypanosomosis in Ethiopia: The most important trypanosome species affecting cattle in Ethiopia are *T. congolense*, *T. vivax* and *T. brucei* [17]. It is reported that the distribution of bovine trypanosomosis is found to be widespread covering most parts of the western and south-western parts of the country. That area has long been known to be the major tsetse and trypanosomosis belt in Ethiopia (Figure I & II) [28]. The area is one of the wettest and agriculturally productive parts of the country.

Estimates made decades ago reported that 180,000-220,000 km^2 land in the western and south western parts of the country to be suitable for tsetse, the biological vector of trypanosomosis. Very recent estimate indicate that, more than 140, 000 km^2 otherwise agriculturally suitable land in the western and southwestern parts of the country is found to be potentially suitable for tsetse. More than twelve million livestock population which are reared in this area are at risk of contracting tsetse-transmitted trypanosomosis in

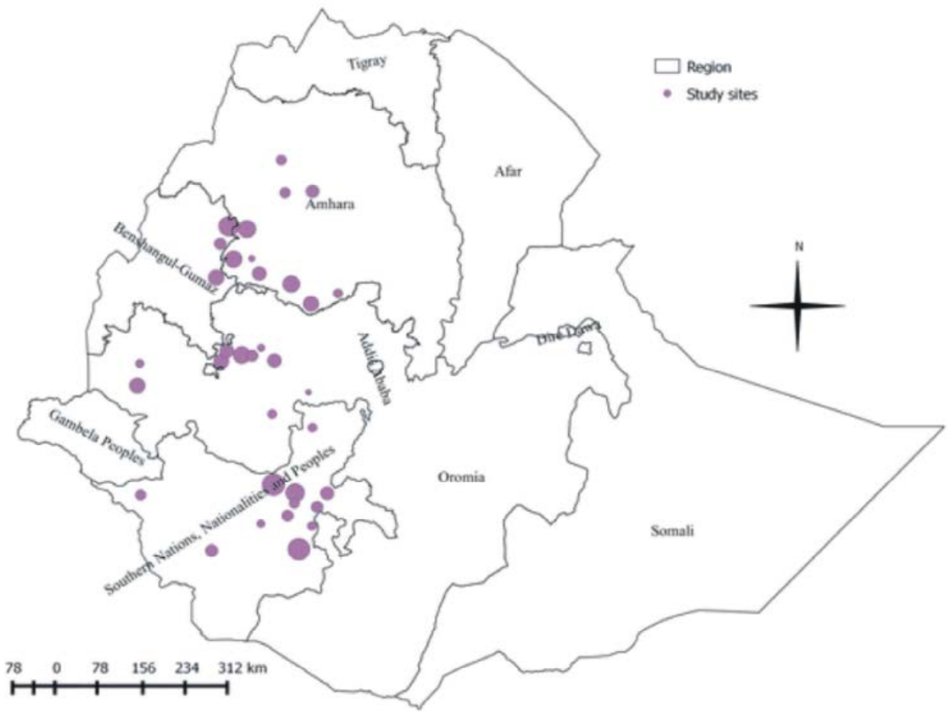

Fig. 1: Observed spatial distribution of bovine trypanosomosis in Ethiopia [28]

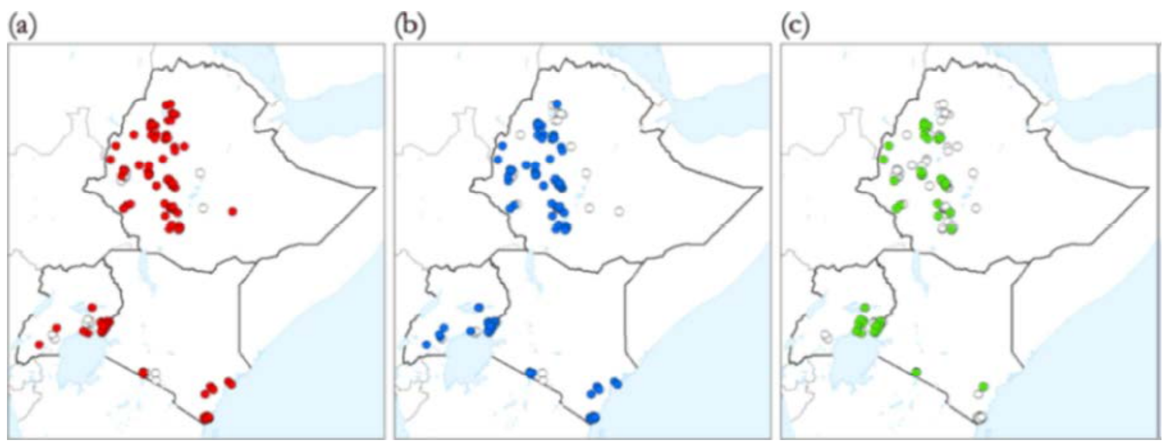

Fig. 2: Absence of detection and presence of *T. vivax* (a), *T. congolense* (b) and *T. brucei* (c) in livestock. White circles: absence of detection. Coloured circles: presence. Reporting period: January 1990 - December 2013 [44]

Ethiopia [28]. However, they suggested that it is important to note that the comparison between previous and present estimates should be done very carefully since different methodology had been applied. So, the difference in estimates observed may or may not reflect the decreasing risk of trypanosomosis in Ethiopia.

Food and Agriculture Organization (FAO) and Programme Against African Trypanosomosis (PAAT) provide support to the African Union Pan African Tsetse and Trypanosomiasis Eradication Campaign (AU-PATTEC) initiative and there have been efforts to harmonize. PAAT brought together the efforts of the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) and the African Union Inter-African Bureau for Animal Resources (AU-IBAR). It was suggested that if sound decisions are to be made, these important initiatives need reliable epidemiological information at a range of spatial scales. For example, spatially-explicit evidence is necessary to

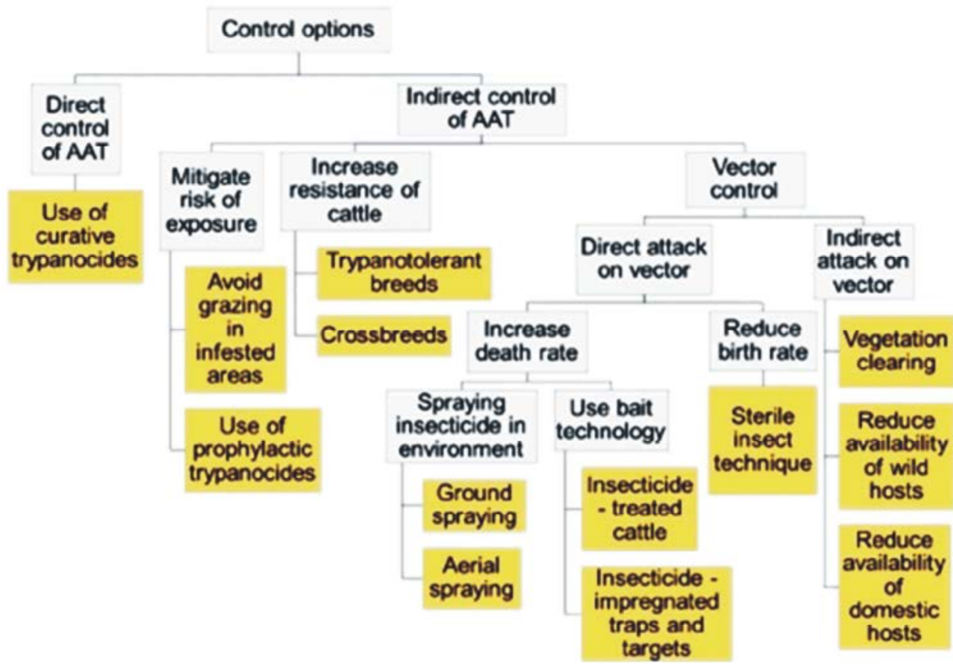

Fig. 3: Summary diagram of the techniques available to control tsetse and AAT [49]

select priority areas for intervention, both where disease control can be regarded as a cost-effective option [38, 39] and where the elimination of the tsetse fly vector appears as a feasible and sustainable endeavor. In order to meet this need for harmonized and comprehensive spatial information, a recent WHO/FAO initiative in the framework of PAAT i.e. the Atlas of Human African Trypanosomosis (HAT), has focused on the systematic mapping of HAT occurrence [40, 41] and risk [42, 43]. In a related activity, a comprehensive and spatially-explicit dataset has also been assembled for sleeping sickness cases reported from non-endemic countries [42]. Similar efforts should be made for AAT by all partners and one health approach should be followed.

Control and Prevention of Trypanosomosis: Several scientific and policy debates surrounding the control of the disease and its vector, the tsetse fly have been being made. Many controversies surrounding a range of control methods, including bush clearance, game culling, baits and traps, sterile insect release, animal breeding, drugs and vaccines, among others. The focus on particular control methods has meant that alternatives have often been overlooked and the perspectives of livestock keepers living with the disease have not been taken into account. In addition, competition for dwindling research and operational funds, combined with a lack of institutional coordination, has resulted in the failure to develop an integrated approach; one that links ecological and disease dynamics with socioeconomic conditions [45]. One of the major components of sustainability of trypanosomosis control methods is the active participation of the majorities of the communities contributing to a relevant production system in a given environment or region. Continuous awareness creation and practical trainings for communities how to control tsetse and trypanosomosis in different parts of the country resulted in a significant reduction in prevalence of the disease and vector infestation rate. However, this positive outcome doesn't warranty for future unless the control and awareness creation among community is sustained. Many AAT control options are indicated in the Figure below (Figure 3).

Recently progressive control pathways are being promoted. Progressive control pathways (PCPs) are stepwise approaches for the reduction, elimination and eradication of human and animal diseases. They provide systematic frameworks for planning and evaluating interventions. It was outlined that PCP for tsetse-transmitted animal trypanosomosis, the scourge of poor livestock keepers in tropical Africa. Initial PCP stages focus on the establishment of national coordination structures, engagement of stakeholders, development of technical capacities, data collection and management and pilot field interventions.

The intermediate stage aims at a sustainable and economically profitable reduction of disease burden, while higher stages target elimination. It was suggested that the mixed-record of success and failure in past efforts against animal African trypanosomosis (AAT) makes the development of PCP a high priority [46].

Chemotherapy/Chemoprophylaxis: Drugs to treat AAT are available, but efficacy is limited, particularly as there is concern over increasing disease resistance to the drugs, which were developed 40 to 50 years ago. Diminazene aceturate**:** have remarkable curative properties. It is very active, stable and easy to use and have very low toxicity. These advantages make it a practical and risk free trypanocide. Diminazene solution can only be kept for two to three days. It is injected subcutaneously in cattle (slight local reaction is possible) or intramuscularly (Very rapid absorption) at a dose of 3.5 mg/kg live weight for treating *T. vivax* and *T. congolense* infections. Infections due to *T. b. brucei* can be treated in cattle with the dose of 7 mg/kg. Diminazene derivatives bind to DNA and interfere with parasite replications. This class of drugs has tendency to accumulate in tissue, therefore half-life is very long, which may lead to residual problems in food producing animals [47].

Isometamidium: Isometamidium is a phenanthridine aromatic amidine with a narrow therapeutic index which has been marketed for both a prophylactic and therapeutic trypanocidal agent. Isometamidium chloride is used as curatively at lower dosage rates and prophylactically at higher dosage rates. It is usually prepared as red powder easily soluble in water. It is used in a 1 or 2% aqueous solution and administered by deep intramuscular injection at the rate of 0.25-1 mg/kg, depend on drugs resistant risk. Strain of trypanosomes resistant to isometamidium and other phenanthridine appear frequently, but they remain susceptible to diminazene aceturate. It is given to the animal at dose rate of 0.51 mg/kg and it will be protected for two to four months depending on the extent infections risk [48]. Emergence of drug resistance presents a threat to the control of trypanosomosis and has triggered research on new compounds against African trypanosomes.

Vector Control: Clear goals and priorities are crucial to tackling trypanosomosis effectively on a national level and even more soon a continental level. Goals and priorities inevitably reflect the perceived severity of the problem in the affected human and livestock populations [50]. Later FAO launched the Atlas of tsetse and AAT, an initiative to which IAEA has adhered to in the framework of PAAT [51]. Continued technical support by FAO and IAEA to tsetse-affected countries facilitates access to this broader base of contemporary field data on AAT [52, 53] and it also permits dissemination of the methodology at the local level through a range of capacity development activities. It was reported that the potential exists for affected countries to build national Atlases of tsetse and AAT and activities in this direction are ongoing in a number of countries [54]. Also, data sharing tools are available through the PAAT Information System (FAO Geonetwork), which can be used to maximize dissemination of geospatial information on AAT [55]. It is also very important to develop open database & build national atlases and geospatial information on AAT [41].

The government of Ethiopia fully recognized the impact of this devastating disease trypanosomosis and has been engaged in the control and eradication of the disease as well as the vector that transmits animal African trypanosomosis (AAT). The government has established new institution for control and eradication of tsetse and trypanosomosis & improving the existing organizational setup to bring significant change in the livestock sector of animal disease control especially animal African trypanosomosis (AAT).

The Ethiopian government, Pan-African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) and International Atomic Energy Agency (IAEA) have been making a considerable effort to suppress tsetse fly challenge especially in Oromia, Amhara and SNNP regions. Deltamethrin impregnated targets and Deltamethrin pour-on formulation have been widely used in Ethiopia to reduce tsetse challenge and the impact of trypanosomosis. However, in SNNP, the Ethiopian government in association with IAEA has been using sterile insect technique (SIT) to eradicate tsetse and reports indicate a significant reduction in tsetse and trypanosomosis challenge. The joint project between Ethiopian government and IAEA, Southern Tsetse Eradication Project (STEP), aimed to eradicate tsetse from an estimated 25,000 km^2. According to Geja and his colleagues [56] the fly density, trypanosomosis prevalence and cattle mortality due to trypanosomosis have been significantly reduced in the project area. Additionally, the government of Ethiopia has conducted a massive settlement program in early 2000s to the tsetse and trypanosomosis belt. So, the destruction of the tsetse habitat by the settlers believed to lend a hand to the tsetse and trypanosomosis control programs in reducing the potential tsetse suitable areas.

Challenges in Trypanosomosis Control and Future Prospects: Vaccination against trypanosomosis is remained the ultimate goal in the fight against this disease, both in case of animal trypanosomosis and HAT. This assumption is based on two main observations: first, taken that it is an impossible task to eradicate the entire parasite reservoir of endemic areas; only vaccination will provide a long lasting economically viable option to prevent human casualties and vast economic losses due to livestock infections. Second, taken that trypanotolerance occurs in many mammals endemic to regions where trypanosomosis occurs and that even in human infections immunological control of the infection has been reported, it appears that immune intervention to prevent the deadly outcome of trypanosomosis should be somehow a feasible target [57].

Over the last four decades, many different approaches have been proposed for the development of protective vaccine strategies for trypanosomosis. Despite all efforts, to date not a single strategy can be considered successful. It has become obvious that trypanosomes have developed multiple mechanisms to protect themselves from the efficient immune attack by antibodies and actively eliminate the B cell memory compartment [58]. To date, not a single experimental anti-trypanosome vaccination protocol has made it to a stage where preliminary promising results have been reported in a field setting. One of the problems of experimental trypanosomosis research might be the general use of murine models for basic research. Possibly, using other, more relevant models for infection, could lead to other outcomes in vaccine trials. While there is no 'easily accessible' alternative for initial murine experiments, maybe such alternatives have to be considered in order to increase the success of finding a future anti-trypanosome vaccination approach, taken the very specific features of host-parasite interactions [57].

Although the trypanosome genome already comprises a vast array of variant surface glycoprotein (VSG) encoding sequences and vsg pseudogenes [59, 60] recombination-based genome plasticity ensures that African trypanosomes are capable of generating a virtually inexhaustible collection of VSGs [60]. This allows these parasites to continuously evade the host antibody response, perpetuating the infection until the host succumbs to either secondary infections or infection associated complications such as encephalitis [61] or inflammatory anaemia [62].

IgM activity has been proposed to be linked to the capacity of anti-VSG IgM to capture C3 complement fragments which, *in vivo*, would contribute to liver-mediated parasite clearance. This could involve the recently described capacity of trypanosomes to remove VSG binding antibodies rapidly from their surface [63].

There seem to be various problems with the available vaccine development technologies and with the intrinsic mechanisms of immune memory development. First, while most experimental vaccine studies are performed in mice, this model might not represent an optimal host-parasite context to allow for the generation of relevant results, due to parasitaemia characteristics that are not representative for natural infections. Second, while *T. b. brucei* (Trypanozoon) and *T. congolense* (Nanomonas) are both used in model systems for experimental 'African Trypanosomiasis' these species of parasites have unique and different interaction with the immune system and an incomparable anatomical distribution in the host and hence cannot be considered similar from an immunological point of view [64, 65]. Anti-trypanosomosis vaccination still remains the best theoretical option in the fight against a disease that is continuously hovering between its wildlife reservoir and its reservoir in man and livestock. While antigenic variation of the parasite surface coat has been considered the major obstacle in the development of a functional vaccine, recent research into the biology of B cells has indicated that the problems might go further than that. The maintenance of high circulating anti-trypanosome antibody titres in the absence of parasite antigen might allow the immediate elimination of metacyclic parasite upon entry in the body, thereby avoiding the potential initiation of active B cell memory destruction by living and dividing parasites.

Trypanocidal drug resistance is increasingly reported all over Africa and is now present in 21 sub-Saharan countries including Ethiopia [66]. Using microsatellite DNA markers to strain type *T. congolense* from cattle in Ethiopia following treatment with diminazene, essentially equal occurrences of new infection (40%) and actual relapse (37.5%) were proposed [67]. Drug resistance is suspected when treatment failure occur using standard drug dosages. However, in the field, this interpretation can be erroneous, as treatment failure can result from many factors other than the parasite's increased tolerance to drugs. For example, the presence of parasites in treated animals could correspond to a new infection rather than to recrudescence, particularly in areas of high challenge [68].

Other causes of treatment failure not linked to true drug resistance could be related to the poor health state of the animal (e.g. malnutrition, immunosuppression, concurrent infections), or to incorrect drug use (e.g. irregular treatment or prolonged intervals between treatments), or to under-dosage. The latter can result from poor drug quality (Either due to inappropriate storage or to the use of counterfeit products) [69] or from incorrect drug usage (Wrong dilution, use of unsterilized water or erroneous dosage due to inaccurate estimation of the animal weight) [70].

In spite of the economic importance of the veterinary trypanosomosis (In particular of AAT) and of the spreading specter of drug resistance, new compounds for the diseases have not emerged in many years. In recent years, a public-private partnership, GALVmed (Global Alliance for Livestock Veterinary Medicines), supported by funding from the Bill & Melinda Gates Foundation and the UK Department for International Development, has emerged to fill the gap and has committed to the development of new therapeutic and prophylactic trypanocidal drugs. However, even in the best case scenario, a novel licensed compound is unlikely to be available for several years yet; hence the rational, correct use of the trypanocides already available is of paramount importance [68].

A similar difficulty had befallen HAT in the late 20th century, which sparked the emergence of the Drugs for Neglected Diseases initiative (DNDi) and the Consortium for Parasitic Drug Development (CPDD) [71]. These organizations were founded to fill the gap left by the pharmaceutical industry, who judged the investment required to bring new drugs forward to treat diseases of the world's poorest people had no economic rationale [68].

Recent reports [72, 73] confirmed ISM and DA resistance in *T. vivax* and *T. congolense* in West Africa. In Ethiopia the appearance of drug-resistant trypanosomes has been reported by some authors [74, 75].

Emphasis should go on the correct use of trypanocides to limit the emergence and spread of drug resistance [68] and on efficient and cost-effective vector control techniques, particularly insecticide-treated cattle (ITC) [76, 77] livestock protective fences (LPF) in the case of zero-grazing rearing systems [78] and insecticide treated targets (ITT), especially where tsetse pressure from protected areas has to be prevented [79]. In the field of human health, the serious resurgence of human African trypanosomosis (HAT) during the 1990s has provided clear focus areas for intervention. In the veterinary field, it has been more difficult to highlight areas where the problem was most economically significant [50].

CONCLUSION AND RECOMMENDATIONS

Bovine trypanosomosis is still serious challenge and results in economic losses especially in western and southwestern parts of Ethiopia posing a significant impact on the country's development. Prevalence of the disease has been studied in many parts of the country and varies from region to region and nationally it has shown a trend of decrement in the last two decades. This may be due to the efforts given by federal and regional governments to control the disease. In many studies the diagnostic techniques mainly depend on the less sensitive parasitological techniques. Spatial and temporal distribution of the disease has very limited information in the country. The various initiatives to control trypanosomosis have mainly been based on chemotherapy and vector control. Some of the challenges in the process of control of trypanosomosis include failure to produce effective vaccine, trypanocidal drug resistance, poor funding interest for research and development in the area. Based on this conclusion, the following recommendations are forwarded:

Spatial and temporal distribution and prevalence of trypanosomosis should be widely studied in a coordinated manner and information produced from these studies should be organized centrally to get reliable result and avoid unnecessary duplicate of effort. Control methods of trypanosomosis should be selected from all environmentally friendly existing options and new emerging techniques like progressive control pathway approach based on area specific tsetse and trypanosomosis distribution and prevalence. Concerned government body and animal health professionals should be aware of increasing trypanocidal drug resistance and should take strong measures on the acts of exacerbating the situation. Government and non-governmental organizations should provide financial support for research on new and alternative trypanocidal drug development. Continuous testing by using highly sensitive diagnostic techniques and improving control and eradication methods have paramount importance.

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