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Review Article

Tsetse fly management and trypanosomiasis control strategies in Ethiopia

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Abstract

Animal trypanosomiasis, caused by protozoan parasites of the genus *Trypanosoma*, is a major constraint to livestock production in sub-Saharan Africa, including Ethiopia. The disease, primarily transmitted by tsetse flies (*Glossina* spp.), leads to anemia, weight loss, reduced milk and meat production, infertility, and mortality in affected animals, causing significant socio-economic losses. In Ethiopia, tsetse flies are concentrated in the southwestern and western regions, with key species including *G. pallidipes*, *G. morsitans submorsitans*, *G. fuscipes fuscipes*, and *G. tachinoides*. The main causative trypanosome species are *T. congolense*, *T. vivax*, and *T. brucei*, with *T. vivax* capable of mechanical transmission by other biting flies, expanding its distribution.

Increasing resistance to trypanocidal drugs, particularly Diminazene aceturate and Isometamidium chloride, has been reported in several regions, driven by substandard drugs, frequent unsupervised use, and weak veterinary infrastructure. Resistance compromises treatment efficacy, exacerbates production losses, and threatens the sustainability of control programs. Effective mitigation requires integrated strategies, including vector control, prudent and supervised chemotherapy, monitoring of drug efficacy and resistance, farmer education, and research into new drugs and alternative therapies. Strengthening regulatory frameworks, veterinary services, and community participation are essential to reduce disease burden and sustain livestock productivity in tsetse-affected areas.

Keywords: Animal trypanosomiasis, Bovine trypanosomosis, *Trypanosoma congolense*, *Trypanosoma vivax*, *Trypanosoma brucei*, Tsetse flies, *Glossina* spp., Drug resistance, Ethiopia, Vector control, Livestock production

Introduction

Animal trypanosomiasis is a parasitic disease that imposes severe economic losses and constrains livestock production across tropical Africa [1]. It is caused by hemoprotozoans of the genus *Trypanosoma* (family Trypanosomatidae), which multiply in the bloodstream, lymphatic system, and tissues such as cardiac muscle and the central nervous system [2]. In cattle, African trypanosomiasis—commonly known as nagana—is primarily caused by three species: *Trypanosoma congolense*, *T. vivax*, and *T. brucei*. These parasites are mainly transmitted by tsetse flies (*Glossina* spp.), although mechanical transmission by other biting flies and the movement of infected animals can extend their distribution. Notably, *T. vivax* has established populations in South America, where mechanical vectors, rather than tsetse flies, are responsible for transmission [3].

In Ethiopia, tsetse flies are largely restricted to the southwestern and northwestern regions (longitudes 33°–38°E, latitudes 5°–12°N), covering an estimated area of 240,000 km² [4]. Approximately 14 million cattle are at risk of infection [5]. The economically important *Trypanosoma* species in Ethiopia include *T. congolense*, *T. vivax*, and members of the *T. brucei* group, which collectively cause significant reductions in livestock productivity [6]. Infection leads to trypanosomosis, characterized by anemia, weight loss, reduced milk yield, infertility, and, in severe cases, death.

Among these species, *T. congolense* is generally the most pathogenic, whereas *T. vivax* can spread mechanically beyond tsetse-infested areas. Members of the *T. brucei* group, although less prevalent, pose a potential zoonotic threat.

Only five tsetse species—*Glossina pallidipes*, *G. morsitans submorsitans*, *G. fuscipes fuscipes*, *G. tachinoides*, and *G. longipennis*—have been documented in Ethiopia. Multiple species infest regions such as Amhara, Benishangul-Gumuz, Oromia, Southern, and Gambella, heightening the risk of disease transmission and its impact on livestock productivity [7].

Currently, no effective field vaccine exists for bovine trypanosomiasis. Control strategies rely on chemotherapeutic and chemoprophylactic drugs, tsetse control or eradication programs, and the use of trypanotolerant cattle breeds [8].

Objective of the review

To provide an overview of effective control and preventive strategies against bovine trypanosomiasis in Ethiopia.

Distribution of Tsetse and Trypanomosis in Ethiopia

Tsetse flies (*Glossina* spp.) are primarily confined to the western and southwestern parts of Ethiopia [9], following river valleys and lowland areas. Key regions include Amhara, Benishangul-Gumuz, Oromia, Gambella, and the Southern Nations, Nationalities, and Peoples' Region (SNNPR). Only a few species are widely significant: *G. pallidipes*, *G. morsitans submorsitans*, *G. fuscipes fuscipes*, and *G. tachinoides*. Their distribution is influenced by altitude, vegetation, and proximity to rivers, with densities highest in riverine lowlands and decreasing toward highlands and arid zones (**Table 1**) [10].

Bovine trypanosomosis is also a major disease affecting other livestock species, particularly equines and goats. Surveys conducted in the Jimma zone of Oromia—a region notable for its large cattle population and reliance on crop production—indicate that farmers attribute reductions in draft power, meat and milk production, prolonged calving intervals, increased mortalities, and changes in breed composition and management practices to the impact of African animal trypanosomiasis (AAT) [10].

The *morsitans* group of tsetse flies is distributed across several areas in Ethiopia, including the Didessa Valley near Wonago and Lado (east of Lake Abaya), Shambo, the Mugher and Dabous Rivers (Wollega), the Baro and Gilo Rivers (Gambella), and Illubabor, associated with the Akobo River. Populations are also found in savannah regions near Turmi and around Mizan Teferi. The distribution of *G. pallidipes* in the Rift Valley appears connected to populations in the Omo River area, likely via a narrow corridor linking the upper Galana Dulei Valley (Woitto) and the Maze River Valley (Daramalo) [11].

G. fuscipes fuscipes has been reported in Maze, Gorgora, Bazo, and Cuccia Rivers (Gamo Gofa), on the Ketto tributary and at Degeno of the Birbir River (Wellega), on the tributary of the Gojeb River (Kaffa), and near the bridge on the Omo River and along the Addis Ababa–Jimma highway [12].

Importance of the Disease

Economic importance (Table 2)

Recent field studies reinforce the magnitude of economic loss from animal trypanosomosis. In a study from the Gamo Zone of Ethiopia, cattle mortality associated with trypanosomiasis

Table 1. Distribution of tsetse flies and trypanosomosis in Ethiopia.

Region	Tsetse Species Present	Trypanosoma Species Detected	Notes/Remarks
Amhara	*G. pallidipes*, *G. f.fuscipes*	*T. congolense*, *T. vivax*, *T. brucei*	Infested with multiple tsetse species
Benishangul-Gumuz	*G. tachinoides*, *G. f. fuscipes*	*T. congolense*, *T. vivax*	Mixed tsetse infestation
Oromia	*G. pallidipes*, *G. morsitans submorsitans*	*T. congolense*, *T. vivax*	High livestock impact
Southern Ethiopia	*G. pallidipes*, *G. morsitans submorsitans*, *G. tachinoides*	*T. congolense*, *T. vivax*, *T. brucei*	Multiple species coexist, increasing transmission risk
Gambella	*G. f. fuscipes*, *G. longipennis*	*T. congolense*, *T. vivax*	Endemic tsetse areas; mixed infections possible

Table 2. Recent case studies showing economic losses from animal trypanosomiasis.

Location (Country)	Livestock Type / Scale	Estimated Annual Loss per Household or Region	Key Findings / Notes
Gamo Zone (Arba Minch & Zuria), Ethiopia	Small-holder cattle (182 households)	~ ETB 9,528 (~ US $176) per house hold for trypanocidal drugs(13)	Mortality ~8.8%. Draft-power loss was a major issue.
Ethiopia (national estimate)	Crop & livestock production	~ US $94 million/year countrywide (13)	Also noted crop production falls by ~14% when trypanosomiasis co-occurs with oxen death.
Metekel Zone, NW Ethiopia [13].	Cattle in three villages	Mortality rate ~4.4%. High costs in treatment and draft power loss.	Older data but shows meaningful losses in draft power and treatment cost.
Buliisa District, Uganda [14].	Pastoral/agro pastoral cattle	~ US $653 per household (≈83% of loss due to mortality) [14].	Shows the large proportion of mortality in economic losses.
Africa continental summary	Beef/milk production across livestock	Direct losses ~ US $1.2 billion/year; broader agricultural losses up to ~ US $5 billion/year.	Emphasizes the large scale of the economic burden continent wide.

was ~8.8 % and households incurred annual drug cost losses of ~USD 176 [13]. In Uganda's Buliisa district the mean annual cost per household was USD 693, with mortality accounting for ~83 % of losses. Nationally in Ethiopia the disease was estimated to cause losses of ~USD 94 million per year. In Kenya the impact is estimated at ~USD 143 million annually for livestock alone and possibly up to USD 5 billion when broader agricultural losses are included [14].

Zoonosis importance (Table 3)

Trypanosomiasis is not only an important veterinary disease but also has significant zoonosis implications, particularly for humans in endemic regions. The zoonosis relevance varies depending on the *Trypanosoma* species and the local ecology of the tsetse vector [15]. The *Glossina* species that are important vectors of bovine trypanosomosis include *G. morsitans*, *G. palpalis*, *G. longipalpalis*, *G. pallidipes*, and *G. austeni*. Infection rates are influenced by multiple factors, including the parasite species, vector biology, host susceptibility, and environmental conditions [16].

Biological and Microbiological Mechanisms of Trypanosoma Infection

Transmission by tsetse fly

- The cycle begins when an infected tsetse fly (*Glossina* species) bites a mammalian host, injecting metacyclic trypomastigotes from its saliva into the bloodstream [17].

Bloodstream differentiation and multiplication

- Metacyclic trypomastigotes transform into bloodstream trypomastigotes, which are replicated by binary fission in the blood and lymphatic system.
- Some trypomastigotes invade tissues such as the heart, spleen, and central nervous system [17].

Immune evasion

- The parasites display antigenic variation via variable surface glycoprotein (VSGs), which continually change to avoid host antibody detection.
- They can suppress macrophage activation and modulate cytokine production, allowing chronic infection [18].

Pathogenesis at the cellular level

- Parasites induce inflammation and tissue damage in multiple organs.
- They interfere with immune signaling and may cross the blood-brain barrier, causing neurological symptoms characteristic of late-stage trypanosomiasis.

Ingestion by tsetse fly

- When a tsetse fly bites an infected host, it ingests bloodstream trypomastigotes.

Development in the tsetse fly

- In the midgut, parasites transform into procyclic trypomastigotes, multiply, and then migrate to the salivary glands.
- In the salivary glands, they differentiate into infective metacyclic trypomastigotes, completing the cycle [17].

Trypanocidal Drug Resistance: Prevalence, Implications and mitigation in Ethiopia

Prevalence and evidence of drug resistance

In Ethiopia, resistance of animal trypanosomes to the primary trypanocidal drugs—Diminazene aceturate (DA) and Isometamidium chloride (ISM)—has been increasingly reported:

- ***Kellem Wollega zone (Oromia):*** Among 50 naturally infected cattle treated with ISM at the recommended dose, 68% had persistent infections at day 28. Similarly, 36% still had detectable parasites on day 14 after DA treatment [19].
- ***Gurage zone (southwestern Ethiopia):*** A survey of drug quality and usage revealed that 28% of trypanocide samples failed quality tests. Additionally, 85% of farmers reported treating cattle seven or more times per year, indicating a high risk of treatment failure and resistance.
- ***Northwestern Ethiopia:*** Experimental infections using isolates from both tsetse-infested and non-tsetse areas demonstrated relapses; one isolate was resistant to DA at higher doses, and others showed potential resistance to both DA and ISM, confirming the presence of resistant strains in the field [20].

Table 3. The zoonosis importance of *Trypanosoma* species

***Trypanosoma* Species**	**Primary Hosts**	**Zoonosis Potential**	**Transmission Route**	**Key Notes**
T. b. gambiense	Humans	High	Tsetse fly (*Glossina* spp.) bite	Chronic form of HAT; mainly West and Central Africa; humans are the main reservoir
T. b. rhodesiense	Humans, livestock, wildlife	High	Tsetse fly bite	Acute form of HAT; East and Southern Africa; livestock and wildlife act as reservoirs
T. b. brucei	Livestock (cattle, goats, sheep), wildlife	None	Tsetse fly bite	It is not infectious to humans but important in livestock disease (nagana)
T. vivax	Cattle, goats, camels	Low/Negligible	Tsetse fly bite, mechanical transmission by biting flies	Mainly veterinary concern; rarely associated with humans
T. congolense	Cattle, sheep, goats	None	Tsetse fly bite	Major cause of animal African trypanosomiasis; no human cases reported
T. evansi	Camels, horses, cattle, dogs	Low	Mechanical transmission by biting flies	Rare human cases are reported; primarily veterinary disease (surra)

- ***National review:*** A recent review summarized that resistance depends on drug use practices, drug quality, and detection capacity. ISM resistance appears more widespread than DA [21].

Implications for animal health, production, and control

Drug resistance has significant consequences for livestock health and agricultural productivity:

- ***Reduced treatment efficacy:*** Persistent parasitemia results in ongoing production losses, including reduced milk yield, impaired growth, increased mortality, and diminished draft power.
- ***Increased cost and burden for farmers:*** More frequent treatments, switching drugs, or increasing doses elevate both direct costs (drug purchase) and indirect costs (lost productivity).
- ***Threat to integrated control programs:*** As chemotherapy becomes less reliable, control programs must rely more heavily on vector control and surveillance, raising operational demands and costs.
- ***Exacerbation in resource-poor settings:*** Limited veterinary services and informal drug markets worsen inequalities; smallholder farmers are disproportionately affected.
- ***Risk of multi-drug and cross-resistance:*** The limited number of approved trypanocides means that resistance to one drug can reduce options, increasing the likelihood of multi-drug resistant parasite populations [22].

Barriers to mitigation

Several challenges hinder effective management of drug resistance:

- ***Weak regulatory and veterinary capacity:*** Quality control of veterinary drugs, supervision of treatment, and restriction of informal markets are often under-resourced.
- ***Limited alternatives:*** Few new trypanocides are available, making conservation of existing drugs critical.
- ***Logistical and educational gaps:*** Farmers often administer treatments themselves; extension and training services may be insufficient, especially in remote areas.
- ***Cost and access constraints:*** Improved-quality drugs and veterinary-administered treatments are more expensive, leading farmers to rely on cheaper, informal options.

Mitigation strategies and recommendations for Ethiopia

To address trypanocidal drug resistance, the following strategies are recommended:

Strengthen drug quality regulation and supply chain control

- Enforce import control, proper storage standards, and market surveillance of veterinary trypanocides.
- Remove substandard or counterfeit drugs from informal markets (e.g., 28% non-compliance in Gurage Zone).

Promote prudent use of trypanocides

- Train farmers and community animal health workers on correct dosing, timing, and avoidance of prophylactic overuse.
- Ensure veterinary supervision of treatments and restrict self-treatment by untrained individuals.
- Encourage treatment only when necessary and integrate with vector control to reduce infection pressure.

Implement drug efficacy monitoring and resistance surveillance programs

- Establish baseline and periodic testing of drug efficacy in key zones for DA and ISM.
- Utilize molecular tools or relapse monitoring to detect early resistance emergence.
- Map resistant hotspots to prioritize interventions.

Integrate chemotherapy with vector control and management practices

- Effective vector control reduces parasite challenges and slows resistance development.
- Incorporate livestock management strategies (e.g., improved nutrition, optimized grazing) to enhance host resilience.

Support research into new drugs or combination therapies

- Promote trials of new compounds, drug combinations, and rotation strategies to delay resistance.
- Encourage studies on pharmacodynamics and parasite genetics related to resistance in Ethiopia.

Farmer engagement and participatory approaches

- Raise awareness among local communities about resistance issues, correct drug use, and vector control.
- Use extension services to promote behavior change and reduce informal drug misuse.

Economic and policy support

- Allocate sufficient budget to veterinary infrastructure and surveillance.
- Provide subsidized access to quality drugs under veterinary oversight, ensuring affordability for smallholders.
- Develop policies that integrate regulation, farmer support, and coordinated control measures.

Prevention of Vector and Trypanosomosis in Ethiopia

In Ethiopia, control of bovine trypanosomosis and its vectors—primarily tsetse flies (genus Glossina)—has progressed from general descriptions of methods to increasingly context specific implementation, though significant challenges remain [23].

Current application in Ethiopia

- The National Institute for Control and Eradication of Tsetse and Trypanosomosis (NICETT) (under the Ministry of Agriculture) was established in 2013 to coordinate tsetse and trypanosomosis control at country level. It is equipped with regional offices in tsetse infested zones (Amhara, Benishangul-Gumuz, Oromia, and SNNPR) and a mass rearing facility for tsetse flies in Addis Ababa [23].

- Insecticide treated cattle (ITC) is the most widely used vector control method in Ethiopia, especially where cattle densities are sufficient. In addition, insecticide treated targets, ground spraying, and the sterile insect technique (SIT) have been deployed in some project areas [24].
- Community based interventions have shown measurable success. For example, in the Metekel zone, a community based tsetse fly and trypanosomosis control project reduced livestock deaths dramatically (from ~3 deaths/household to ~0.07) and reduced economic losses [25].
- Chemotherapy (treatment with trypanocidal drugs such as Diminazene aceturate and Isometamidium chloride) remains the primary choice for many farmers. For example, in Northwest Ethiopia, usage of trypanocides is high and treatment frequencies can exceed seven times per animal per year in tsetse infested areas [26].

Farmer education and participation in trypanosomosis control

Farmers are the frontline stakeholders in controlling animal trypanosomosis, as they manage livestock daily and are directly affected by vector-borne losses. Their awareness, knowledge, and active participation can significantly enhance the effectiveness and sustainability of control programs [27].

Key roles of farmers

1. ***Vector surveillance and reporting:*** Farmers can identify tsetse-infested areas, monitor seasonal vector populations, and report outbreaks early.
2. ***Implementation of Control Measures:***
   - **Insecticide-treated cattle (ITC):** Farmers apply pyrethroid treatments to cattle, which kills tsetse flies and other vectors.
   - **Trap and target deployment:** Farmers maintain traps or insecticide-treated targets around pastures, homesteads, or along rivers.
   - **Environmental management:** Clearing riverine vegetation or reducing tsetse habitats on communal land.
3. ***Drug administration:*** Proper dosing and timing of trypanocidal drugs prevent drug resistance and reduce livestock morbidity.
4. ***Community mobilization:*** Farmers can participate in coordinated control programs, ensuring that interventions cover entire villages or grazing areas, which is critical for success.

Implementation challenges in the Ethiopian setting

- Although over two thirds of tsetse infested areas are estimated to be under "some level of control", prevalence of animal trypanosomosis remains significant (national average ~4.8 % but higher in many regions) and efforts must overcome constrained resources, environmental and logistic hurdles [23].
- Drug resistance is increasingly documented. Studies in Ethiopia have found trypanosome isolates resistant (or showing reduced sensitivity) to common trypanocides, linked to irregular dosing, informal supply chains and non-professional administration [28]. Vector control is challenged by the ecology of tsetse flies (riverine, forest, lowland areas) and by the fact that the most at risk land is also agriculturally valuable. For example, the Southern Rift Valley project area spanned 25,000 km² and required sustained investment of time and resources [23].
- Farmer awareness, seasonal variation in vector pressure, and resource constraints also affect effectiveness. For example, in districts of Southwestern Ethiopia, farmers reported that trypanosomosis risk peaks at the beginning of the rainy season and that treatment costs are substantial [29].

Recommendations for ethiopia specific strategy

- Expand integrated control: Combine vector suppression (ITC, targets, SIT) with appropriate treatment strategies and landscape based planning for the varied tsetse habitats in Ethiopia [30].
- Strengthen drug use guidelines and veterinary service delivery to reduce misuse of trypanocides, mitigate resistance risk and ensure quality supply chains.
- Enhance community participation and capacity building: Farmers can be engaged in monitoring vector density, managing insecticide treated cattle or targets, as shown by the Metekel example [27].
- Priorities' high-risk zones: Based on the national atlas and regional surveys, allocate resources to the most heavily infested regions (Western, Southwestern Ethiopia) while addressing mechanical transmission in non-tsetse areas [23].
- Monitor and evaluate interventions: Regular entomological (tsetse density, trap catches) and parasitological (animal prevalence, relapse rates) data are essential for adaptive management.
- Consider land use and livestock production systems: Since many of the tsetse areas coincide with fertile land and mixed crop livestock systems, control programs must align with broader agricultural development to be sustainable.

Control Methods for Tsetse Flies

Chemical control methods

The chemical control of tsetse flies employs several approaches designed to reduce vector populations efficiently and sustainably. Live bait techniques involve treating livestock with insecticides such as deltamethrin through dipping, spraying, or pour-on formulations. Treated animals act as mobile baits, killing flies that attempt to feed, though pour-on applications are relatively costly [31–33]. Aerial spraying of non-persistent insecticides disperses fine droplets over tsetse habitats, providing wide coverage and cost-effectiveness, though success depends on favorable weather conditions [34]. Ground spraying, once widely used with persistent insecticides such as DDT (Dichlorodiphenyltrichloroethane) and dieldrin, proved effective against riverine species but is now discouraged due to environmental hazards [35,36]. The Sequential Aerial Technique (SAT) applies ultra-low-volume insecticides at regular intervals to eliminate adult and newly emerged flies efficiently across large areas [36,37].

Use of attractive devices

Insecticide-treated targets—typically blue–black cloth panels—attract and kill tsetse flies through visual and chemical cues. This approach is simple, cost-effective, and environmentally friendly, though field durability can be affected by bushfires, animals, or human activity [38,39]. Insecticide-impregnated traps constructed from blue and black fabric and often baited with attractants such as acetone, octenol, or cow urine, serve both for population suppression and entomological monitoring. These devices are non-polluting, affordable, and effective over moderate distances [40,41].

Sterile insect technique (SIT)

The Sterile Insect Technique (SIT) involves the mass rearing and sterilization of male tsetse flies through irradiation, followed by their systematic release into target areas. Mating between sterile males and wild female's results in no viable offspring, leading to progressive population decline [42,43]. SIT is species-specific, environmentally benign, and most effective at low fly densities, making it particularly suitable for the final phase of eradication programs. Successful applications of SIT include its integration into control campaigns against *Glossina* species and other insect pests such as the New World screwworm fly (*Cochliomyia hominivorax*) [43].

Outcomes

Successful eradication of tsetse flies on Zanzibar (Unguja Island, Tanzania) demonstrates SIT's potential when integrated with other control methods [44]. Pilot SIT programs in Ethiopia's southern Rift Valley have been considered for localized population suppression, though large-scale implementation remains limited [45].

Limitations and barriers

- ***Baseline population requirement:*** SIT is most effective when wild tsetse populations are already low; otherwise, sterile males are overwhelmed [45].
- ***Reinvasion risk:*** Remote or untreated areas allow wild flies to repopulate controlled zones.
- ***Cost and infrastructure:*** Mass-rearing, sterilization, sex-separation, and release logistics require significant investment and technical expertise.
- ***Sustainability:*** Continuous releases and monitoring are necessary to prevent resurgence.
- ***Integration challenge:*** SIT must be part of integrated vector management; standalone application in heterogeneous landscapes may have limited impact.

Implications for Ethiopia

SIT implementation in Ethiopia is feasible in well-defined, isolated zones but may be challenging for extensive infested areas due to logistical, ecological, and financial constraints. Pilot studies in targeted areas can help evaluate cost-effectiveness and operational practicality.

Treatment

Early diagnosis and proper treatment make trypanosomiasis a curable disease. The choice of treatment depends on the species of protozoan causing the infection and whether the infection has spread to other parts of the body [46]. For livestock, only a few drugs have been licensed for trypanosomiasis treatment. Diminazene aceturate and isometamidium chloride are the most commonly used, although resistance to these drugs is common in some regions. Strategies such as alternating drugs that do not induce cross-resistance have been proposed to maximize effectiveness and reduce the development of resistance. Inadequate treatment or poor-quality drugs can sometimes result in a clinical cure while the infection persists.

Other drugs used include suramin, prothridium, and isometamidium chloride (as a prophylactic), and diminazene aceturate (as a curative) [48]. However, drug resistance has been reported for these treatments. For camels**,** melarsomine (Cymelarsan) is highly effective as a curative against *Trypanosoma evansi*, though currently this drug is only registered for use in camels [47].

Conclusion

Animal trypanosomiasis remains one of the most significant constraints to livestock production in Ethiopia, particularly in tsetse-infested regions of the southwest and west. The disease, primarily caused by *Trypanosoma congolense*, *T. vivax*, and *T. brucei*, leads to substantial economic losses through decreased milk and meat production, reduced draft power, infertility, and increased mortality. Tsetse flies (*Glossina* spp.) serve as the principal vectors, though mechanical transmission by other biting flies has extended the distribution of *T. vivax* to non-tsetse areas.

Drug resistance to commonly used trypanocides (Diminazene aceturate and Isometamidium chloride) has been increasingly reported, with implications for treatment efficacy, livestock productivity, and control program sustainability. Multiple factors contribute to resistance, including poor-quality drugs, frequent unsupervised use, limited veterinary infrastructure, and inadequate farmer awareness. The combination of these challenges underscores the urgency of integrated control strategies that combine chemotherapy, vector management, and community participation.

Recommendations

Integrated disease management

- Combine chemotherapy with robust vector control measures, including tsetse trapping, insecticide spraying, and environmental management.
- Promote livestock management practices that enhance host resilience, such as improved nutrition and strategic grazing.

Strengthening drug use and resistance management

- Enforce quality control and regulation of trypanocides to eliminate substandard and counterfeit drugs.
- Promote prudent and supervised drug use among farmers, emphasizing appropriate dosing, timing, and avoidance of unnecessary prophylactic treatment.
- Implement regular monitoring of drug efficacy and resistance, utilizing both field observations and molecular tools to detect emerging resistant strains.

Research and development

- Support research into new trypanocidal compounds, combination therapies, and alternative strategies to delay resistance.

- Investigate parasite genetics, pharmacodynamics, and local epidemiological patterns to inform targeted interventions.

Capacity building and farmer engagement

- Strengthen veterinary infrastructure and extension services to provide training, advice, and supervision for smallholder farmers.
- Promote participatory approaches that engage communities in vector control, correct drug use, and disease surveillance.

Policy and economic support

- Develop integrated policies that combine regulation, farmer support, and multi-sectoral coordination for disease control.
- Ensure affordable access to quality veterinary drugs through subsidies or support programs targeting smallholder farmers.

Overall, controlling animal trypanosomiasis in Ethiopia requires a multifaceted approach that integrates scientific, managerial, and community-based strategies. Effective implementation of these measures will not only reduce disease prevalence and economic losses but also enhance the sustainability of livestock production systems in tsetse-affected regions.

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