ILRAD REPORTS APRIL 1985

Published by the International Laboratory for Research on Animal Diseases
Volume **3** Number **2**

---

Scientists explore resistance to trypanosomiasis



---

# Scientists explore resistance to trypanosomiasis

Vast humid and semi-humid areas of Africa are held captive by tsetse flies and the trypanosomes they transmit. Trypanosomiasis occurs throughout much of the best watered and most fertile land on the continent. Much of this region could be used immediately for livestock or mixed agricultural development, without stress to the environment, if trypanosomiasis could be controlled.

The limited data available indicate that the area infested with tsetse flies *(Glossina* ssp) has been increasing steadily since the 1950s. With growth of the human population in the region, there is mounting pressure on tsetse-free pastures and farmlands for increased food production. Many of these tsetse-free areas are in the drier regions of Africa where the local ecology is too fragile to support continuous heavy use. Problems associated with overgrazing here further emphasize the need to bring into full production the more favourable agricultural areas currently underutilized due to trypanosomiasis.

Several factors contribute to the magnitude of the trypanosomiasis problem in Africa, including the complexity of the disease and limitations in the methods currently available for control. Three species of trypanosome infect cattle, sheep and goats in Africa, and these are transmitted cyclically by different species of tsetse—each adapted to different climatic and ecological conditions. At the same time, trypanosomes infect a wide range of hosts, including many wild animals which become carriers and constitute an important reservoir of infection.

*N'Dama cattle on a beef ranch in southwestern Nigeria*

The success of trypanosomes as parasites is due to a large extent to their ability to vary the antigens on their surface coats and thus evade host immune responses. A large number of different antigen types may be expressed during a single infection. To make matters worse, every trypanosome species comprises an unknown number of parasite population—called serodemes—each capable of displaying a different repertoire of surface antigens. In many field situations, livestock may be exposed to hundreds of different antigenic types; no vaccine currently available can protect against them all. Thus, control programs are based on regular treatment of livestock with trypanocidal drugs or treatment of grazing areas by insecticide spraying. These methods can be highly effective if properly applied, but their net impact across the continent has been limited.

## Trypanotolerant livestock

Small populations of humpless *Bos taurus* cattle and dwarf sheep and goats are found in West and Central Africa which possess some degree of resistance to trypanosomiasis. This ability, which has been termed trypanotolerance, is generally attributed to the N'Dama and West African Shorthorn breeds of cattle, Djallonke sheep and Dwarf West African goats.

A rigorous process of natural selection over many thousand years has produced this unique group of domestic animals which can survive in the face of tsetse challenge, along with the wild animals indigenous to Africa. It is thought, on the basis of ancient Egyptian drawings and carvings that humpless longhorn cattle arrived in the Nile Delta from the Near East at about 5,000 B.C. Both the N'Dama and the Texas Longhorn breeds are descended from these animals. Rock paintings and statuettes along the Mediterranean shore and the western deserts of North Africa are evidence of their spread throughout the region.

Humpless shorthorn cattle were introduced into Egypt between 2,750 and 2,500 B.C. The humped *Bos indicus* cattle, which are the prevalent type today, did not become numerous in Africa until after the Arab invasion of 669 A.D. They are generally regarded as susceptible to trypanosomiasis.

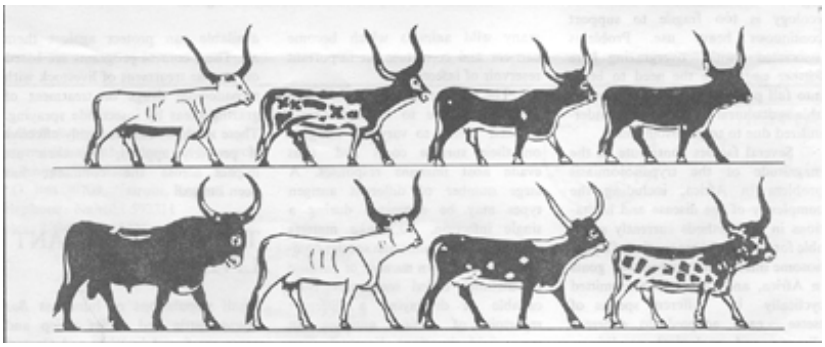
The trypanotolerant animals become infected with trypanosomes, but they are able to control the multiplication of parasites in their bloodstreams. Comparative studies carried out at ILRAD in mouse strains resistant and susceptible to trypanosomiasis suggest that resistance is associated with an event that regulates parasite development and multiplication in the bloodstream. This in turn determines the speed of the host's immune response. Anaemia, due to the destruction of red blood cells, is one of the chief clinical signs of trypanosome infection, and trypanotolerant animals appear to develop less severe

anaemia than susceptible animals. A series of studies on infected N'Dama and Zebu cattle has shown that differences in the severity of anaemia generally reflect differences in the ability to control the number of parasites in the bloodstream, rather than: the ability to replace damaged red blood cells.

Although scientists still do not fully understand the factor(s) which mediate trypanotolerance, studies in cattle, initiated at ILRAD in 1977, have confirmed that it is an innate characteristic. While there is evidence that innate levels of resistance may be increased by exposure to trypanosomiasis, resistance may also be reduced under certain adverse conditions. Thus, in order to realize the full potential of trypanotolerant breeds, it is essential that the main factors affecting the stability of trypanotolerance be identified and their relative importance evaluated. For example, it is known that as tsetse challenge increases the resistance of N'Dama cattle to trypanosome infection is diminished, resulting in stunting, wasting, abortion and even death. Similarly, stress factors—such as overwork, pregnancy, parturition, lactation, poor nutrition and intercurrent disease—have been identified as affecting the susceptibility of trypanotolerant cattle to infection.

However, because of the limitations of other measures currently available to control trypanosomiasis, the use of trypanotolerant breeds, such as the N'Dama and West African shorthorn, is now widely accepted as an important means of exploiting many tsetse-infested areas. An ILCA/ FAO/UNEP report on trypanotolerant livestock in West and Central Africa, published in 1979, emphasized the importance of trypanotolerance by indicating that trypanotolerant breeds are at least as productive as other indigenous African breeds in areas of zero to low tsetse challenge, and in areas where tsetse challenge is substantial only the trypanotolerant breeds can survive.

On the basis of these results, N'Dama heifers and bulls are now being imported by several countries in West and Central Africa to form the nucleus of livestock development programs in tsetse-infested areas. The recent successful transfer by ILRAD of frozen N'Dama embryos from The Gambia to Kenya has encouraging implications for the further multiplication of trypanotolerant breeds.



*Drawing of Egyptian longhorn cattle, taken from an ancient painting. Derived from H. Epstein (1971).* The origin of the domestic animals of Africa.. *Two volumes. New York: Africana Publishing Corporation.*

## Collaborative research network

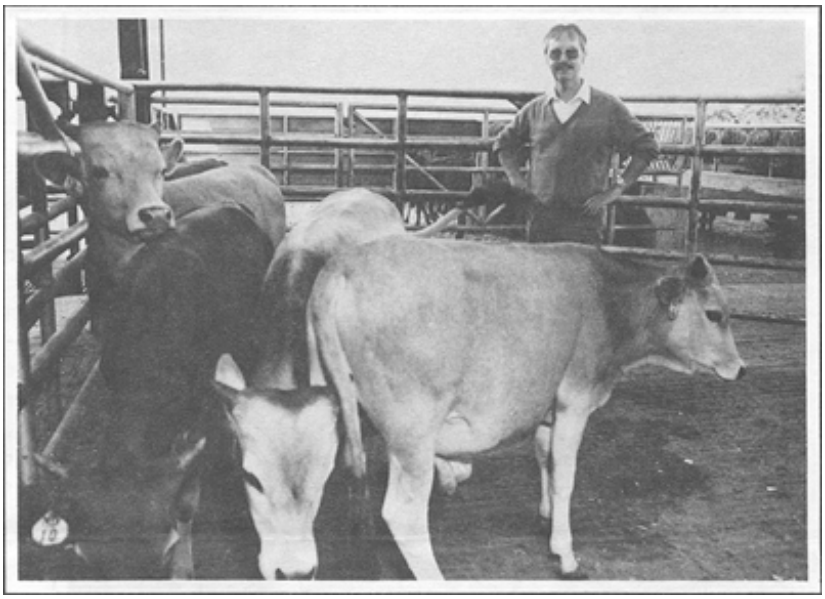
A collaborative trypanotolerance research network has been established by the International Livestock Centre for Africa (ILCA) and ILRAD to evaluate the productivity of trypanotolerant breeds of cattle, sheep and goats exposed to different degrees of tsetse challenge, in different ecological zones and under different management systems. The overall aim is to improve livestock production in tsetse-infested areas of Africa by achieving a better understanding of genetic resistance, acquired resistance, environmental factors which affect susceptibility and the efficacy of present control measures, and by ensuring better application of existing knowledge and recent research findings. Essential baseline data will be provided for economic planners of livestock development projects. At the same time, by applying economic analysis to composite productivity indices, it should be possible

to evaluate the cost-effectiveness of introducing existing and new measures to control trypanosomiasis.

## Organization

In cooperation with national organizations and donor agencies, ILCA's Livestock Productivity and Trypanotolerance Group in Nairobi is coordinating investigations at sites in nine countries of West and Central Africa. ILRAD is providing supervision in animal health and tsetse evaluation, while ILCA is responsible for animal production, nutrition and data processing.

Altogether, eight scientists from ILCA and ILRAD are involved in the trypanotolerance research network. Since 1982, 24 field staff have come to ILRAD for training in data collection methods to ensure correctness and standardization of results. Training courses are conducted in English and French, based on a training manual prepared by staff from ILRAD, ILCA and the International Centre on Insect Physiology and Ecology (ICIPE).



*Dr Max Murray, one of the ILRAD scientists who helped initiate the trypanotolerance research network, with the N'Dama calves brought to ILRAD from The Gambia as embryos. The 10 calves were born at ILRAD in March and April, 1984.*

In order to produce results which can be compared between different sites, all field operations involve the simultaneous collection of data on animal productivity and health and level of tsetse challenge. Staff at all field sites record data on simple preprinted forms for transmission to Nairobi every month. These are checked for completeness, verified and entered into a computer file in Nairobi. Major analyses carried out in Addis Ababa involve the computation of productivity indices based on reproductive performance, viability, calf growth and cow weight, as well as the assessment of possible factors affecting animal performance at different sites.

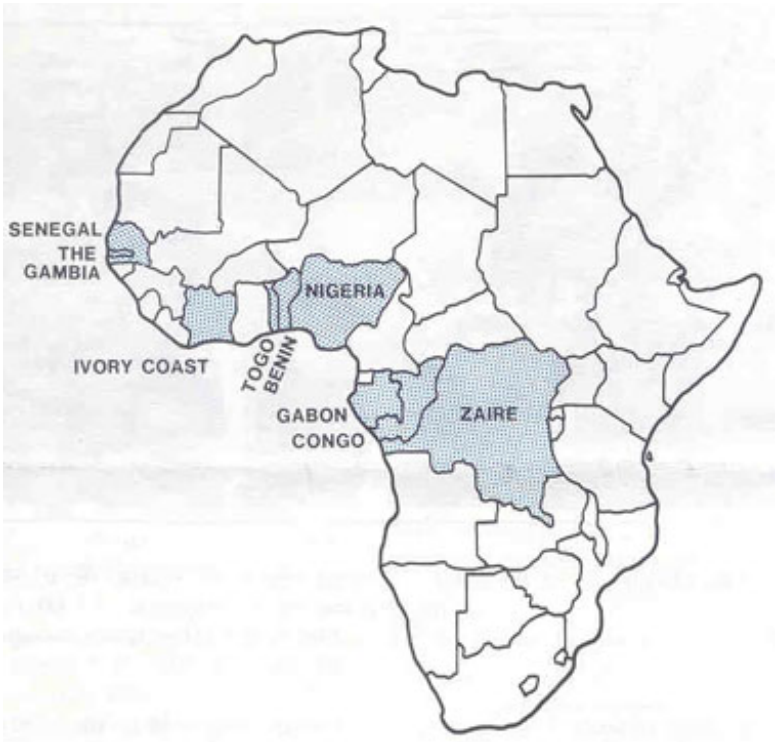
The important cattle performance traits being recorded are cow reproduction, cow and calf viability, calf growth and cow weight. Such data require several years to collect, and it is only now that a full analysis can be started on the various network situations. However, detailed records of matching animal health, animal productivity and trypanocidal drug treatments have been kept for many years at two large ranches in East Africa, and these have provided a valuable source of information on cattle production under tsetse challenge and a means of developing and testing the data analysis programs currently being used by the trypanotolerance research network.

Information on 800 breeding Sahiwal × Ayrshire females was recorded over a 6-year

period at Kilifi Plantations, a dairy ranch in Kenya in an area of light *G austeni* challenge. The Sahiwal is a *Bos indicus* breed, while Ayrshires are European *Bos taurus* cattle considered highly susceptible to trypanosomiasis. Analysis of the Kilifi data has provided evidence of acquired and genetic resistance to trypanosomiasis in this herd. Mkwaja Ranch is a beef operation in Tanzania, supporting 12,000 grade Boran *(Bos indicus)*cattle. These animals are all exposed to tsetse challenge at a level where all cattle die unless treated regularly with trypanocidal drugs. Analysis based on 20,000 calving intervals collected over a 10-year period showed that susceptible cattle can be maintained in this area at economic levels of productivity by the strategic use of chemoprophylactic drugs.

## Network sites

Data are now being collected at network sites in Gabon, Zaire, Ivory Coast, Nigeria and Togo, and sites are being developed in The Gambia and Senegal. Contacts have been made to initiate additional studies in Benin and Congo. Sites are selected where different breeds of cattle, sheep or goats, different levels of tsetse challenge and different management systems can be evaluated. At some sites, field staff are also assessing attempts to improve the productivity of trypanotolerant breeds through the use of chemotherapeutic or chemoprophylactic drugs.




*Countries in West and Central Africa participating in the ILCA/ILRAD trypanotolerance research network.*

In Gabon, work is centred on the ranch of the Office Gabonais de Production de Viande (OGAPROV) at Okouma. Here 2,000 N'Dama, Nguni *(Bos indicus)* and crossbred cattle are raised under various levels of challenge from three tsetse species—*Glossina palpalis, G tabaniformis* and *G nashia* — using trypanocidal drugs under different treatment regimes. Overall, the tsetse infestation rate is high—about 21 %—and probably represents a major trypanosomiasis risk to livestock. Preliminary analysis has established that a significant correlation exists between the presence of trypanosomes in the blood, degrees of anaemia and daily liveweight losses in both cattle breeds and their crosses. Initial results have shown that the performance of the N'Dama is better than that of the Nguni irrespective of the drug regime used.

Studies in Zaire concentrate on two large commercial ranches and on the development of a village production scheme, all producing N'Dama cattle. At Kolo Ranch, a herd of 22,500

cattle are exposed to *G palpalis,* but tsetse dissection reveals a very low infection rate in the flies, and no trypanosome infection has been detected in 350 breeding cows and 200 calves under surveillance. At Mushie Ranch, 10,000 cattle are exposed to *G palpalis* and *G tabaniformis,* with trypanosome infection rates of up to 16% in the flies and averaging 7 % in the 250 breeding females and 150 calves under surveillance. Work in the village situation at Idiofa will start in 1985.

Research is in progress at two sites in northern Ivory Coast, at Boundiali and Tengrela. Altogether, about 1,400 cattle and sheep are being maintained in village production situations under challenge from *G morsitans submorsitans, G palpalis gambiensis* and *G tachinoides.* The cattle are trypanotolerant N'Dama and Baoule, susceptible Zebu (*Bos indicus,* humped) and their crosses, and the sheep are all Djallonke. All animals have been identified and ear-tagged, and are now being monitored on a regular basis.

Matching data on the productivity of trypanotolerant sheep and goats, animal health and tsetse challenge have been collected in two contrasting village situations in southern Nigeria. One village, Fasola, is in a low to medium tsetse challenge zone (*G tachinoides* and *G palpalis),* while the other, Badeku, is virtually free of tsetse. Initial analyses have demonstrated a definite connection between trypanosome infection and productivity in both sheep and goats, along with contrasts in the effects of trypanosomiasis in the two species. The effects of disease have also been compared in two groups of animals which differ in terms of age and physiological status.

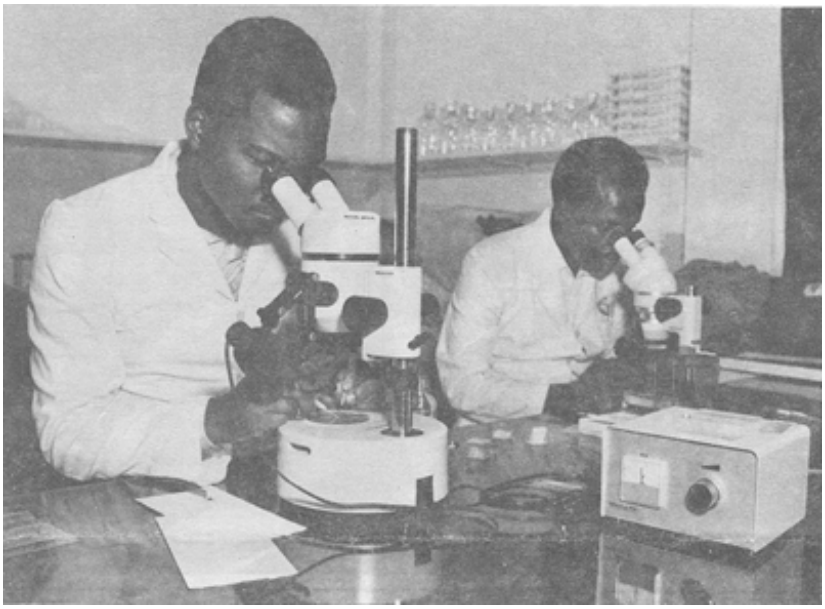
In collaboration with the Centre de Recherche et d'Elevage at Avetonou in Togo, animal productivity, health and tsetse challenge are being monitored in village production situations. Three hundred N'Dama and West African Shorthorn cows are under surveillance in an area infested with G *tachinoides* and *G palpalis.* To the north, in the Sokodo area, the study covers 350 Djallonke sheep and Dwarf West African goats under much higher challenge by the same tsetse species.

In The Gambia, the productivity of N'Dama cattle is being evaluated at different levels of tsetse challenge *(G m submorsitans* and *G p gambiensis)* under village production conditions. Once established, this project will extend into Senegal.

In Benin, the productivity of four cattle groups will be investigated on three farms and in surrounding villages. These are Lagune and Somba (West African Shorthorn), Borgou (a Shorthorn × Zebu cross) and Zebu. In Congo, contacts have been established with the Dihesse ranch, where N'Dama are raised under low to medium trypanosomiasis risk.

*Field workers in northern Ivory Coast examine blood samples for trypanosomes and estimate the degree of anaemia in Djallonke sheep.*

*Staff members at the ILCA office in Nairobi check data from the trypanotolerance network sites and enter them into the computer for detailed analysis.*



*Field workers associated with the trypanotolerance research network learn tsetse identification techniques at ILRAD.*

## Conclusion

By collecting standardized data on animal health, productivity and tsetse challenge in several locations, the ILCA/ILRAD trypanotolerance network is now providing composite productivity indices that allow the evaluation of the trypanotolerant trait, as well as various methods of disease control, in livestock production systems under trypanosomiasis risk. This information is essential for the planning and assessment of livestock development programs. A better understanding of trypanotolerance should lead to more efficient use of trypanotolerant livestock in tsetse-infested areas, which can potentially make an enormous contribution to increasing livestock production in Africa.

## Further reading

ILCA and ILRAD scientists have published more detailed descriptions of the collaborative trypanotolerance research network. A selection of these publications is listed here. Single

copies may be obtained from the authors or from ILRAD's Information Services.

ILCA, FAO and UNDP (1979).

*Trypanotolerant livestock in West and Central.Africa. Two volumes.* Addis Ababa: ILCA, 450 pp.

Murray, Max, Morrison, W.I. and Whitelaw, D.D. (1982). Host susceptibility to African trypanosomiasis: trypanotolerance. In J.R. Baker and R. Muller, eds. *Advances in Parasitology.* Volume 21. London: Academic Press, 1–68 (191).

Murray, Max, Trail, I.C.M., Davis, C.E. and Black, S.J. (1984). Genetic resistance to African trypanosomiasis. *Journal of Infectious Diseases.* 149: 311–19 (257).

Trail, J.C.M., Sones, K., Jibbo, J.M.C., Durkin, J., Light, D.E. and Murray, Max. (1985). *Productivity of Boran cattle maintained by chemoprophylaxis under trypanosomiasis risk.* Research Report 9. Addis Ababa: MCA, 76 pp (346).

Black, S.J., Sendashonga, C., Borowy, N.K., Webster, P. and Murray, Max. (1985). Regulation of parasitaemia in mice infected with *Trypanosoma brucei. Current Topics in Microbiology and Immunology.* Berlin: Springer Verlag. 117: 93–118 (263). *Field workers associated with the trypanotolerance research network learn tsetse identification techniques at ILRA D.*

---

*ILRAD Reports*
International Laboratory for Research on Animal Diseases
P.O. Box 30709, Nairobi, Kenya
Telephone: Nairobi 592311
telex: 22040 ‘ILRAD’