

Outbreak of *Trypanosoma evansi* in the Brazilian Pantanal.

A financial analysis

A.F. Seidl¹ A.S. Moraes¹ R.A.M.S. Silva²

Key words

Horse - *Trypanosoma evansi* - Economic analysis - Brazil.

Summary

The Brazilian Pantanal is a seasonal flood plain of about 138,000 km² located in the center of South America. Extensive cattle ranching is the most important economic activity controlling about 80% of the land. The Pantanal's approximately 1,100 ranches are populated with about 3 million head of cattle and 49,000 horses. Horses play a central role in the industry. *Trypanosoma evansi*, locally known as "Mal de Cadeiras," kills horses within about ten days and is endemic to the Pantanal. Using a partial farm budget approach, the financial impact of an outbreak of *T. evansi* was analyzed in nine ranches in the Brazilian Pantanal in 1994. Treatment, animal collection and diagnostic costs, animal mortality and risk estimates were used to assess the efficacy of curative and preventive treatments relative to the observed and expected disease losses. The infection of more than 750 horses and the subsequent death of more than 10% of them due to the disease represented an economic loss of more than US\$38,000. Results indicate that from 27 to 91% of these losses could have been avoided through the timely and appropriate implementation of available treatment strategies.

■ INTRODUCTION

The Brazilian Pantanal is a seasonal flood plain of about 138,000 km² (13.8 million ha) located in the center of South America between 16 and 21° S, 55 and 58° W. Land use in the Pantanal is determined by its climate and cyclical flood pattern. Extensive cattle ranching is the most important economic activity in the Pantanal with sales valued at more than US\$60 million per year and controlling about 80% of the land. The Pantanal's approximately 1,100 ranches vary in size from less than 1,000 ha to over 200,000 ha and are populated with about 3 million head of cattle and 49,000 horses (6). Horses play a central role in the industry.

Trypanosomes adversely affect tropical and subtropical livestock production. Among the five most common species of trypanosomes, *T. evansi* (alternatively, *T. equinum*) in horses and buffalo and *T. vivax* in cattle have substantial impact on the Pantanal region of

Brazil. Equine trypanosomosis is widely known as "surra". In the Pantanal and the subtropical regions of Argentina it is known as "Mal de Cadeiras" (2). If left untreated, death occurs in horses within about ten days of infection.

The most serious outbreaks of Mal de Cadeiras follow extensive seasonal flooding in the region. Unlike other extensive ranching systems, animals in the Pantanal are under the greatest stress and in their weakest condition during the rainy season due to inadequate forage and space (8). *T. evansi* is found in or carried by a number of animals in the Pantanal including dogs, capybaras (*Hydrochaeris hydrochaeris*), coatis (*Nasua nasua*), buffalo and cattle (1, 2, 3). Buffalo, dogs and capybaras are susceptible to the disease (2, 7). Although cattle are carriers, they are not directly affected by *T. evansi*. During the rainy season there is greater interaction among these species due to space constraints caused by flooding.

The aim of this study was to detail the direct economic impact of a *Trypanosoma evansi* outbreak on nine ranches in the subregions of Nhecolandia and Paraguay within the Brazilian Pantanal between January and July 1994. This analysis will point to the best available technology to mitigate the deleterious economic impact of this disease on cattle ranching in the Brazilian Pantanal. In addition, recommendations will identify potential avenues for improving available technology in this area.

1. EMBRAPA/PROMOAGRO, Centro de Pesquisa Agropecuária do Pantanal (CPAP), Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Rua 21 de Setembro, 1.880, CX Postal 109, CEP 79.320-900, Corumbá, MS, Brasil

Tel: 011 55 67 231 1430, ext. 252; fax: 011 55 67 231 1011

E-mail: Loureiro@cpap.embrapa.br

2. Laboratory of Ecopathology, CPAP, EMBRAPA, then same address as in 1

■ MATERIALS AND METHODS

Partial farm budget methodology

A partial farm budget approach focused on the aspects of ranch management that were affected by the disease. It enabled the authors to calculate both the expected and observed financial losses to the affected ranches due to *T. evansi*. An analysis of the observed financial burden relative to the simulated treatment strategies provided an opportunity to view potential avenues to mitigate the impacts of the disease.

Costs were divided into mortality losses and treatment costs. Treatment costs represented the rancher's investment in mitigating the effects of the disease. Benefits to the rancher were in the form of anticipated horse mortality losses foregone due to alternative control strategies. The annual expected horse mortality losses foregone less the estimated investment in disease control yielded the annual expected net benefit of each strategy.

Components of the estimated cost-benefit relationships included diagnostic (US\$175/veterinarian-day), transportation (US\$0.13/km), animal collection (US\$7.32/130 animal-day) and treatment costs (see below), expected horse mortality apart from risk (10.5%), horse replacement costs (US\$375) and an assessment of the risk of infection with the disease (9.6% year-round; 0.96% dry season and 8.6% wet season). The best available strategy is that which most greatly reduces animal mortality at minimum cost per animal (4).

Seidl *et al.* (4) found that three potential strategies are financially feasible within the Pantanal. The year-round application of the curative treatment is the best alternative. The seasonal adoption of this strategy ranks second and is the most widely observed in the region. The preventive strategy is the third best alternative based upon economic criteria (4). The curative control strategies involve the application of a diminazene aceturate treatment. However, diminazene aceturate is not an effective prophylactic agent since it is rapidly excreted requiring costly reapplication, approximately every two weeks for prophylaxis. Isometamidium chloride treatments provide financially justifiable *T. evansi* prophylaxis in the Pantanal, although the drug is not yet approved by the Brazilian government. Following protocol and using local prices, diminazene costs about US\$10.12 per treatment and the isometamidium treatments cost about US\$23.92/horse-year exclusive of animal collection costs (4).

The observed costs or losses due to the outbreak of *T. evansi* were calculated by multiplying the replacement value of horses by the number of dead horses and adding the costs of diagnosis and treatment with diminazene where infected horses were found. Expected financial losses under the "no treatment" scenario were calculated by multiplying the estimated disease risk by the number and value of exposed horses. Expected financial losses under the year-round curative treatment scenario were calculated by multiplying the infection risk by the sum of the percentage of expected animal losses and the cost of treatment by the number and price of affected horses. Calculations of expected financial losses under the wet season curative strategy took into account that 90% of the disease risk occur during the high vector wet season (8). Financial losses of the preventive strategy were calculated as the cost of the investment in treatment since no animal losses were anticipated: the number of horses multiplied by the isometamidium treatment cost per horse per year, inclusive of animal collection costs. The observed costs by ranch and study region were subtracted from the estimated costs of each strategy in order to arrive at the expected net benefits of each in relation to the observed costs.

Study area

Outbreaks of *T. evansi* occurred in two subregions of the Pantanal during 1994; Pantanal de Nhecolândia and Pantanal de Paraguay. The outbreaks occurred in nine ranches (R0-R8). Four of these ranches are located in the Pantanal de Paraguay (R0-R3) and the others are in Nhecolândia (R4-R8). The P. de Paraguay subregion is an open plain near Jacindo Lake in the basin of the Paraguay River. It has abundant water and is surrounded by mountains and primarily forested by species of the Paraguayan Chaco. Nhecolândia is a seasonal flood plain with vegetation dominated by savanna species (5). Ranches R0-R2 are neighboring one another. R3 is about 20 km away. R4-R8 are neighboring one another in Nhecolândia and are about 150 km from R0-R3. The city of Corumba lies between the two regions. It is a central hub of 80,000 inhabitants and provides many of the people's needs in the Southern Pantanal, including veterinary services and medical supplies.

The outbreak began in January 1994 when seven horses became sick on R0. Two weeks later four horses on R1 became sick. In February, all 95 horses on R2 became infected with *T. evansi*. One week later 10 horses and a dog on R3 were diagnosed with *T. evansi*. One dog on R4 and two dogs and a horse on R5 were infected in February. From March to June there were no cases reported by the ranchers. In July 12 horse deaths occurred on ranches R6-R8. Two deaths were reported on R6 and 5 each on R7 and R8. In total, from January to July 1994 at least 129 horses in Nhecolândia and P. de Paraguay were infected with *T. evansi* and 70 died before treatment could be administered. One hundred percent of those receiving curative treatment survived and no measurable morbidity losses were observed (5).

■ RESULTS

The estimated financial losses by ranch from the 1994 outbreak of *T. evansi* ranged from close to nothing to almost US\$20,000 (US\$4,310 mean). Mortality losses due to the disease represented 0-51.6% (10.5% mean) of a rancher's horses. Total losses from this outbreak on these ranches were estimated at more than US\$38,000 (table I).

Table II details the potential cost savings for each of the nine affected ranches under each of the three alternative treatment strategies. The observed mortality rate in the region of study was 10.5% even with the (often late) adoption of a curative strategy. The assumed risk in the Pantanal region is 9.6% based upon epidemiological studies (ab-ELISA) (1). The expected annual losses in the course of a no treatment strategy were calculated at this level of risk. Four ranches were observed to have lower than annual expected losses based upon 9.6% risk. The other five ranches exceeded the expected annual losses due to *T. evansi* during 1994. On average these nine ranches suffered greater losses than would be expected in an average year under any of the strategies (table II).

The appropriate application of an annual or a seasonal curative strategy could have resulted in cost savings for all ranches in this study except R4 in 1994. A preventive strategy could have generated savings to all except those with the least losses in 1994 (R4-R6). An annual curative strategy should reduce total costs of the affected ranches by 91% providing a net benefit of about US\$35,000 over observed losses and nearly US\$25,000 over the average expected losses. A seasonal application of the curative strategy results in a cost reduction of 58% over the no treatment strategy and 85% over observed costs. The preventive strategy against *T. evansi* results in an average annual reduction of total costs to the nine ranches of about 24% (51% over observed costs) (table II).

Table I

Direct economic losses due to *T. evansi* in Pantanal de Nhecolandia and Pantanal de Paraguay in 1994

Ranch	Num. total horses	Num. (% of total) horse mortality	Horse losses	Diagnostic and treatment costs	Total financial losses
			US\$	US\$	US\$
R0	85	7 (8.3)	2,625	1,024	3,649
R1	15	4 (26.7)	1,500	328	1,828
R2	95	49 (51.6)	18,375	1,123	19,498
R3	40	10 (25.0)	3,750	576	4,326
R4	180	0 (0.0)	0	172	172
R5	70	1 (1.4)	375	875	1,250
R6	95	2 (2.1)	750	1,123	1,873
R7	90	5 (5.6)	1,875	1,073	2,948
R8	120	5 (4.2)	1,875	1,372	3,247
Total	790	83 (10.5)	31,125	7,666	38,791

Table II

Observed and expected costs and benefits from alternative treatment strategies for *T. evansi* in the Brazilian Pantanal

Ranch	Expected net benefits from each strategy relative to observed financial losses -US\$			
	No treatment	Year-round cure	Seasonal cure	Preventive
R0	589	3,253	2,986	1,587
R1	1,288	1,744	1,698	1,440
R2	16,078	19,057	19,178	17,208
R3	2,886	4,130	4,006	3,351
R4	(6,309)	(649)	(1,215)	(4,164)
R5	(1,270)	921	702	(454)
R6	(1,547)	1,433	1,135	(429)
R7	(292)	2,656	2,247	766
R8	(1,073)	2,695	2,318	347
Total	10,350	35,240	33,055	19,652

■ DISCUSSION

Several explanations or caveats are necessary to weigh the validity of the adopted techniques. First, this study only attempted to estimate the direct effects of Mal de Cadeiras outbreaks on ranchers. Changing the boundaries of analysis to include other potential stakeholders would include additional sources of benefits and costs, often considered indirect effects. For example, veterinarians benefit from disease outbreaks and the adoption of curative treatments. Distributional effects of potential strategies were not explored here; there are economies of scale of curative strategies over preventive strategies. Animal welfare impacts were not addressed; preventive strategies are preferable to curative treatments on this scale.

The effect of potential variation in variables used in the estimations were not explored here. However, an extensive sensitivity analysis of the estimates resulted in no changes in the relative ranking of the treatment strategies explored here. High prices and risk make preventive strategies more attractive in relation to curative or no treatment strategies. Early detection is pivotal for the curative treatment strategy traditionally adopted in the Pantanal. The lag between detection and treatment, particularly

in R2, provides an explanation for the differences between observed and expected losses. Late treatment is more costly in some cases than no treatment.

Finally, this analysis assigned collective risk based on the assumption of individual risk; it assumed independence among economic agents. It did not allow for the potential to mitigate risk over time *via* strategic cooperation. For example, if four neighboring ranches agreed to notify one another at the first indication of an outbreak of the disease (i.e. first deaths) the risk for the region as a whole would remain the same, but the risk for the consortium of four could be diminished to as little as one quarter of the regional risk. Cooperative strategies would only have implications for curative treatments.

■ CONCLUSION

This work has discussed the economic impact of an outbreak of *Trypanosoma evansi* in the Pantanal region of Brazil in 1994. The infection of more than 750 horses and the subsequent death of more than 10% of them due to the disease present an economic drain on ranchers of more than US\$38,000. Estimates indicate that

from 27 to 91% of these losses could have been avoided through the timely and appropriate implementation of available treatment strategies. While conclusions from this work should be extrapolated with great care and further research is necessary, it can be asserted that curative and, potentially, preventive treatment against *T. evansi* within the Pantanal region are appropriate and cost effective strategies for mitigating the economic effect of the disease on the region.

REFERENCES

- FRANKE C.R., GREINER M., MEHLITZ D., 1994. Investigations on naturally occurring *Trypanosoma evansi* infections in horses, cattle, dogs and capybaras (*Hydrochaeris hydrochaeris*) in Pantanal de Pocone (Mato Grosso, Brazil). *Acta trop.*, **58**: 159-169.
- MONZON C.M., MANCEBO O.A., ROUX J.P., 1990. Comparison between six parasitological methods for diagnosis of *Trypanosoma evansi* in the subtropical area of Argentina. *Vet. Parasitol.*, **36**: 141-146.
- NUNES V.L.B., OSHIRO E.T., 1990. *Trypanosoma (Trypanozoon) evansi* in the coatí from the Pantanal region of Mato Grosso do Sul state, Brazil. *Trans. R. Soc. trop. Med. Hyg.*, **84**: 692.
- SEIDL A.F., MORAES A.S., SILVA R.A.M.S. Financial analysis of alternative treatment strategies for *Trypanosoma evansi* in the Brazilian Pantanal. *Pre. vet. Med.* (in press)
- SILVA R.A.M.S., BARROS A.T.M., HERRARA H.M., 1995. Trypanosomosis outbreaks due to *Trypanosoma evansi* in the Pantanal, Brazil. A preliminary approach on risk factors. *Revue Elev. Méd. vét. Pays trop.*, **48**: 315-319.
- SILVA J. DOS S.V. DA, SEIDL A.F., MORAES A.S., 1997. Evolucao da Agropecuária do Pantanal Brasileiro, 1970-1985. Corumba, MS, Brasil, EMBRAPA - CPAP. (in press)
- STEVENS J.R., NUNES V.L.B., LANHAM S.M., OSHIRO E.T., 1989. Isoenzyme characterization of *Trypanosoma evansi* isolated from capybaras and dogs in Brazil. *Acta trop.*, **46**: 213-222.
- WILCOX R., 1992. Cattle and environment in the Pantanal of Mato Grosso, Brazil, 1870-1970. *Agric. Hist.*, **66**: 232-256.

Reçu le 9.4.97, accepté le 6.1.98

Résumé

Seidl A.F., Moraes A.S., Silva R.A.M.S. Recrudescence de *Trypanosoma evansi* dans le Pantanal brésilien. Analyse financière

Le Pantanal brésilien est une plaine d'environ 138 000 km², régulièrement inondée et située au centre de l'Amérique du Sud. L'élevage extensif du bétail est pratiqué sur plus de 80 p. 100 du territoire, constituant ainsi l'activité économique la plus importante du Pantanal. On y compte approximativement 1 100 élevages avec environ 3 millions de têtes de bétail et 49 000 chevaux. Les chevaux jouent un rôle capital dans l'industrie. *Trypanosoma evansi*, appelé localement "Mal de Cadeiras", est endémique au Pantanal et tue les chevaux en une dizaine de jours. La connaissance du budget partiel d'une ferme a permis d'analyser l'impact financier d'une recrudescence de *T. evansi* sur neuf élevages du Pantanal brésilien en 1994. Pour évaluer l'efficacité des traitements curatifs et préventifs relatifs aux pertes prévisibles et réellement causées par la maladie, il a été tenu compte du coût du traitement lui-même, celui du ramassage des animaux et de leur diagnostic, du taux de mortalité animale et de l'estimation des risques. La contamination par la maladie de plus de 750 chevaux, entraînant la mort de plus de 10 p. 100 d'entre eux, a représenté une perte économique de plus de 38 000 \$US. Des études montrent qu'entre 30 et 90 p. 100 et plus de ces pertes auraient pu être évitées si les stratégies de traitements possibles avaient été mises en place de manière opportune et appropriée.

Mots-clés : Cheval - *Trypanosoma evansi* - Analyse économique - Brésil.

Resumen

Seidl A.F., Moraes A.S., Silva R.A.M.S. Brote de *Trypanosoma evansi* en el Pantanal de Brasil. Análisis financiero

El Pantanal brasileño es una llanura temporalmente inundable de alrededor 138 000 km², localizada en el centro de Sur América. La actividad económica de mayor importancia es la ganadería extensiva, ocupando alrededor 80% del territorio. En Pantanal existen alrededor de 1 100 ranchos, poblados con aproximadamente 3 millones de cabezas de ganado y 49 000 caballos. Los caballos ocupan un papel central en la industria. *Trypanosoma evansi*, conocido localmente como "Mal de cadeiras", mata a los caballos en más o menos 10 días y es endémico en el Pantanal. En 1994, se analizó el impacto financiero de un brote de *T. evansi* en nueve ranchos del Pantanal Brasileño, usando un enfoque presupuestario parcial de una finca. Se utilizaron los costos de tratamiento, recolección de animales y de diagnóstico, las estimaciones de riesgo y de mortalidad animal, para asesorar la eficiencia de los tratamientos curativos y preventivos, en relación con las pérdidas observadas y esperadas de la enfermedad. La infección de más de 750 caballos y la muerte subsecuente de más de 10% de éstos, debida a la enfermedad, representaron más de US\$ 38 000. Los resultados indican que de 30 a más de 90% de éstas pérdidas podrían haberse evitado mediante una implementación apropiada y a tiempo de las estrategias de tratamiento al alcance.

Palabras clave: Caballo - *Trypanosoma evansi* - Análisis económico - Brasil.