

Evaluation of Surra Treatment Strategies for Horses and Buffaloes in East Sumba District, Nusa Tenggara Timur Province of Indonesia (2010 – 2016)

Dewi RS^{1,2}, Wardhana AH³, Soejoedono RD⁴, Mulatsih S⁵

¹ Indonesian Agricultural Quarantine Agency, Ministry of Agricultural of Indonesia, Jl Harsono RM Ragunan, Jakarta

² Veterinary Public Health, IPB Postgraduate School, IPB University, Kampus IPB Darmaga Bogor

³ Departement of Parasitology, Indonesia Research Center for Veterinary Sciences, Jl R.E Martadinata No. 30, Bogor

⁴ Department of Animal Disease and Veterinary Public Health, IPB University, Jl. Agatis, Kampus IPB Darmaga, Bogor

⁵ Departement of Economic Science, IPB University, Jl. Babakan, Kampus IPB Darmaga, Bogor

(received 25-09-2018; revised 18-03-2019; accepted 18-03-2019)

ABSTRACT

Dewi RS, Wardhana AH, Soejoedono RD, Mulatsih S. 2019. Evaluasi strategi penanganan surra untuk kuda dan kerbau di Kabupaten Sumba Timur, Provinsi Nusa Tenggara Timur Indonesia (2010 – 2016). *JITV* 24(1): 39-48. DOI: <http://dx.doi.org/10.14334/jitv.v24i1.1864>

Surra adalah penyakit yang menyerang ternak dan disebabkan oleh protozoa berflagella, *Trypanosoma evansi*. Kepulauan Indonesia telah dilaporkan sebagai negara endemik penyakit ini, kecuali Pulau Sumba. Namun, wabah Surra terjadi di pulau ini pada tahun 2010 karena lalu lintas ternak dari pulau tetangga, Sumbawa. Hal ini menyebabkan kematian yang tinggi pada ternak, khususnya kuda dan kerbau. Tujuan penelitian ini adalah untuk mengevaluasi efektivitas strategi pengobatan Surra di Kabupaten Sumba Timur dari tahun 2010 – 2016 and untuk memprediksi kejadian kasus Surra pada 12 bulan mendatang (*forecast*). Strategi pengobatan Surra di Kabupaten Sumba Timur dibagi menjadi dua periode, yaitu periode I pada tahun 2010-2011 menggunakan isometamedium sebagai obat tunggal dan periode II pada tahun 2012 – 2016 menggunakan kombinasi antara *diminazene aceturate* sebagai obat penyembuhan and *isometamedium* sebagai obat pencegahan. Data untuk studi ini diperoleh dari Dinas Peternakan Kabupaten Sumba Timur dari 2010 – 2016 ketika wabah Surra terjadi. Efektivitas kedua strategi pengobatan tersebut dianalisis menggunakan uji proporsional. Hasil studi membuktikan bahwa morbiditas dan mortalitas kuda dan kerbau pada periode I lebih tinggi daripada periode II. Strategi pengobatan pada periode II mampu menurunkan proporsi morbiditas pada kuda dan kerbau, masing-masing menjadi 1,44% dan 0,66%. Demikian pula, proporsi mortalitas pada periode II lebih kecil daripada periode I, yaitu dari 3,79% menjadi 1,30% pada kuda dan 2,8% menjadi 0,55% pada kerbau. Berdasarkan analisis *forecasting* menggunakan metode “*control program with decomposition*” untuk 12 bulan mendatang membuktikan bahwa strategi pengobatan periode II mengurangi kejadian dan kematian ternak karena Surra. Strategi pengobatan menggunakan kombinasi antara *isometamedium* dan *diminazene aceturate* in Sumba Timur lebih efektif daripada menggunakan *isometamedium* sebagai obat tunggal.

Kata Kunci: Surra, *Trypanosoma evansi*, Pengobatan, Trypanosidal, Sumba Timur

ABSTRACT

Dewi RS, Wardhana AH, Soejoedono RD, Mulatsih S. 2019. Evaluation of surra treatment strategies for horses and buffaloes in East Sumba District, Nusa Tenggara Timur Province of Indonesia (2010 – 2016). *JITV* 24(1): 39-48. DOI: <http://dx.doi.org/10.14334/jitv.v24i1.1864>

Surra is a disease attacking livestock caused by a flagellated protozoan, *Trypanosoma evansi*. Indonesia archipelago is reported as an endemic country of the disease, except Sumba Island. However, Surra outbreak occurred in this Island in 2010 due to livestock movement from the neighbour island, Sumbawa. It generated high mortality in livestock, particularly in horses and buffaloes. The aim of this study was to evaluate the effectiveness of Surra treatment strategies in East Sumba District from 2010-2016 and to estimate the incidence of Surra in the next few months (*forecast*). The treatment strategy of Surra in East Sumba was divided into two periods namely: the first period in 2010-2011 using Isomethamedium as the single drug (period I) and the second period in 2012 - 2016 using a combination between diminazene aceturate as curative and isomethamedium as a prophylactic drug (period II). All data in the present study was obtained from the local livestock agency of East Sumba District from 2010 – 2016 when Surra outbreak occurred. The effectiveness of those two treatment strategies was compared using the proportion test. The results demonstrated that morbidity and mortality of horses and buffaloes were significantly greater in the period I (2010-2011) compared to period II (2012-2016). The treatment strategy in the period II was able to decrease the proportion of morbidity in horses and buffaloes for 1.44% and 0.66%, respectively. Likewise, the proportion of mortality in period II was also less than the period I from 3.79% to 1.30% for horses and from 2.80% to 0.55% for buffaloes. Based on forecasting study analysis using the control program projected with decomposition method for the next 12 months demonstrated that the treatment strategy in the period II could reduce the incidence and death of livestock by Surra. The treatment strategy using a combination between isometamedium and diminazene aceturate in East Sumba District might be more effective compared to using isometamedium alone.

Key Words: Surra, *Trypanosoma evansi*, Treatment, Trypanocidal, East Sumba

INTRODUCTION

Trypanosoma evansi (*T. evansi*) is a haemo – protozoan of the genus *Trypanosoma* as the causative agent of Surra. The parasite is geographically distributed in the tropical and subtropical areas such as Central and South America, Africa, Middle East and Asia, including Indonesia and attacks multispecies animals characterized by polymorphism of its clinical symptoms (Camoin et al. 2017; Aregawi et al. 2019). Surra is transmitted mechanically from an infected animal to another susceptible animal by haematophagous flies particularly *Tabanus* spp, *Stomoxys* spp, *Haematopota* spp, *Lyperosia* spp and *Chrysops* spp. (OIE 2012; Desquesnes et al. 2013) leading to reduce productivity, high mortality of host, various neurological disorders and major economic losses (Ponnudurai et al. 2015; Tehseen et al. 2017). According to Sivajothi et al. (2014) that the incidence and the severity of Surra depend on the strain of the parasite (level of virulence) as well as the species of host affected.

The first incidence of Surra in Indonesia occurred in Semarang of Central Java Province attacking horse herds. Furthermore, some outbreaks of Surra were found in cattle and water buffaloes in East Java Province (Payne et al. 1991). The disease was rapidly widespread throughout the archipelago and presented on all the main islands (Luckins 1998), excluding Sumba Island until 2009. However, Sumba Island was introduced to *T. evansi* in 2010 due to livestock movement from Sumbawa Island (endemic area of Surra). It caused severe Surra outbreak causing high mortality in horses and buffaloes in 2010 – 2012.

The largest district possessing large savannah which is traditionally major site of livestock farming with large herds of cattle, horses, buffaloes and other animals. In addition, the population of livestock in East Sumba District relatively higher compared to other regions. It plays a role as one of the main supplier of livestock for other area of Indonesia. Accordingly, Sumba Island is one of the national center for livestock development in Indonesia and Surra became a serious threat which potentially devastated livestock population in Indonesia, particularly in Sumba.

In order to control Surra, the Regent of East Sumba issued Decree of Regent No: 185 / Disnak.524.3 / 570 / VII / 2010 and Instruction of Regent No: 147 of 2010 in July on the emergency response from Surra threat in East Sumba district in 2010. Singh & Singla (2015) proposed that there were three steps to prevent Surra transmission in the field e.g. controlling of the parasite, controlling of the vector (biting flies) and using of innate resistance of the host to the effect of the infection. At the beginning of Surra outbreak in Sumba, those steps could not be employed because Sumba was previously region free from Surra so that all livestock did not have innate immune. When Surra was taken out from the list of

strategic animal diseases in Indonesia, the availability of Surra drug was very few, including in East Sumba. The local vets and farmers faced difficulties to deal with the disease. Later, the government supported isometamedium with a limited number in 2010 -2011 and provided diminazene aceturate in 2012. They employed two treatment strategies to cure livestock from *T. evansi* infection. Unfortunately, they did not have a proper program of vector control. As a result, the mortality level of horses and buffaloes increased dramatically.

To date, no comprehensive assessment of the drug effectiveness has been carried out for Surra in livestock in Indonesia, particularly in East Sumba District. Therefore, this study was designed to evaluate Surra treatment strategies applied in East Sumba during and after Surra outbreak, including predicting the incidence of Surra in the future using forecasting study involving retrieval of historical data (2010-2016) (Heizer & Render 2009).

MATERIALS AND METHODS

Samples and locations

The present study was conducted in East Sumba District, East Nusa Tenggara Province. The district consists of 22 sub-districts (Figure 1). Time series data of Surra from 2010 – 2016 was obtained from the local livestock agency. They were mortality, morbidity, the population at risk, treatments and laboratory observation data. In addition, an interview was conducted to some local vets, staffs at the local livestock agency and farmers to support and confirm the data. The number of the infected animal from 2010-2016 can be seen in Table 1. The infected livestock was confirmed by both the clinical symptom and laboratory test (blood smear). The local livestock agency of East Sumba collected and recorded the data from farmer's reports, surveillance and monitoring results.

Treatment periods

There were two periods of Surra treatment in East Sumba District. The difference between the first and the second periods was the drug used and the strategy of treatment management employed (Figure 1).

Period 1 was the treatment strategy applied when the first Surra outbreak occurred in East Sumba District in 2010 – 2011. Isometamedium was the only available drug of Surra at the time. The drug was used for both curative and preventive treatments. Due to limited drug number, the treatment was not followed by further observation and only delivered to positive cases or herd of livestock at the pen.

Period 2 was the treatment strategy of Surra carried out in 2012 – 2016. There were two drugs of Surra registered in Indonesia e.g. isometamedium and

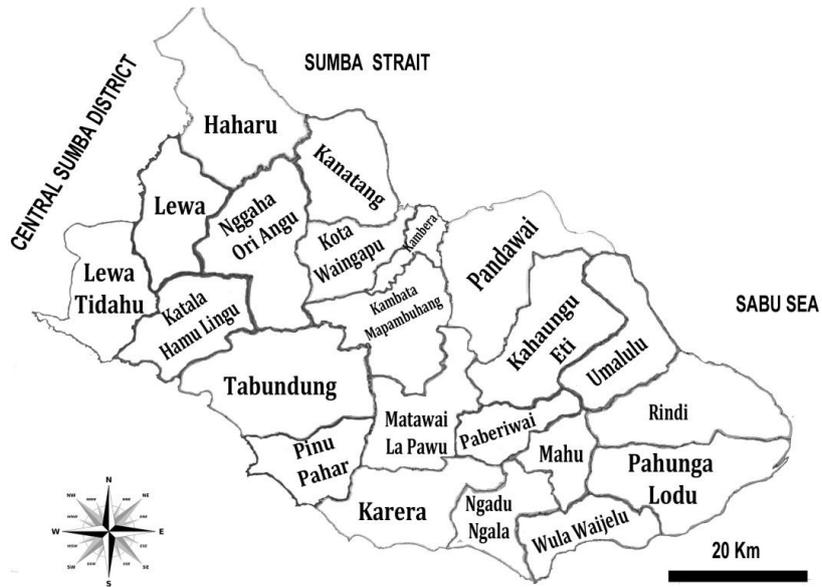


Figure 1. Map of East Sumba District with 22 sub-districts marked by name of the sub-district.

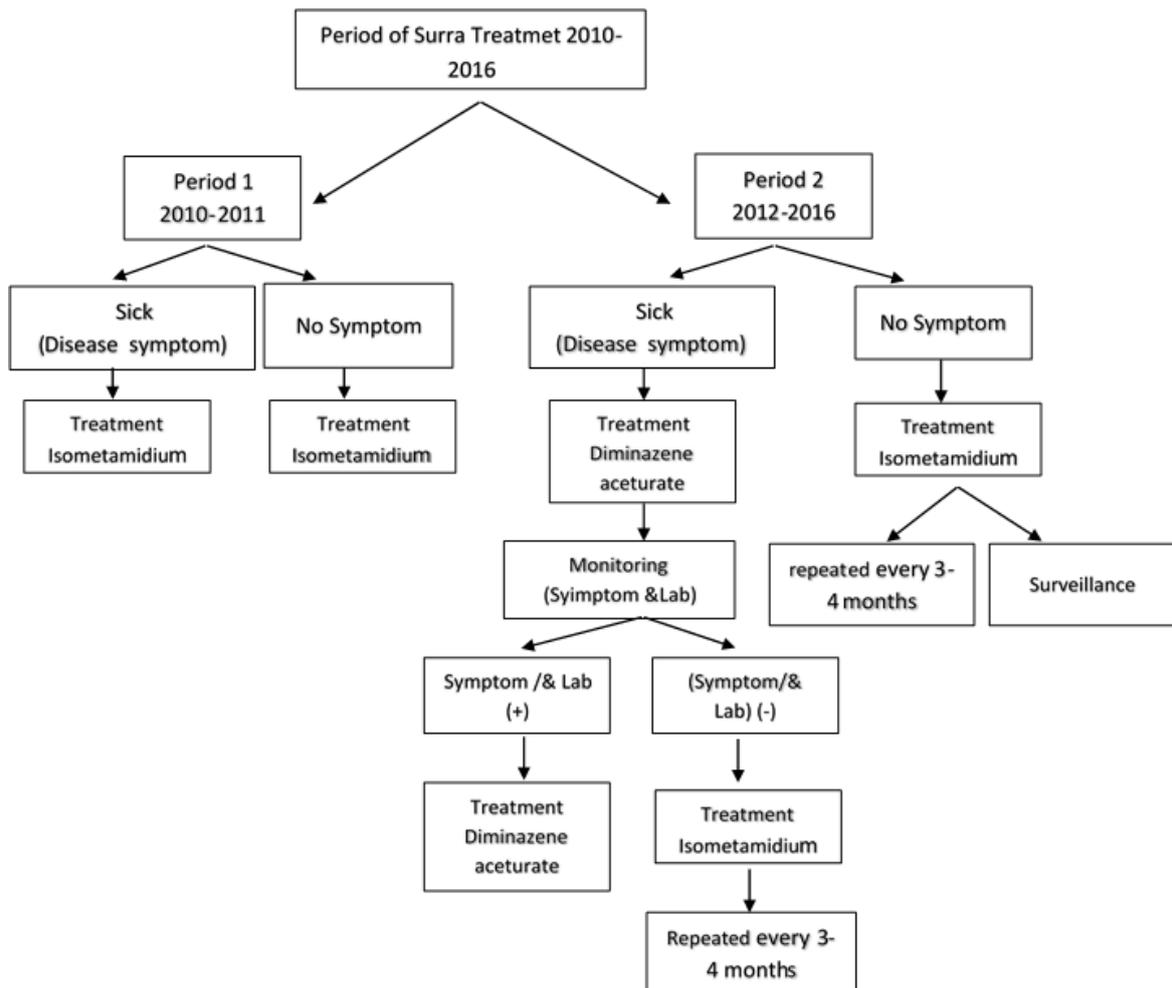


Figure 2. The Strategy of Surra treatment in East Sumba 2010-2016.

diminazene aceturate with sufficient number. The treatment management system of Surra has been compiled comprehensively using those drugs and conducted at the village level. For infected livestock, they were treated using diminazene aceturate as curative treatment and uninfected livestock (population in risk) were treated using isometamedium as a preventive treatment. Subsequently, they were observed for two weeks. If the infected livestock remained sick, they would be re-treated using diminazene aceturate, followed by second observation after two weeks. For those livestock recovered from Surra, they would be monitored regularly every 3 – 4 months and treated using isometamedium as preventive (Figure 2).

Forecasting study

Forecasting is a scientific calculation that aims to predict future conditions using data and information in the past (Harlan et al. 2018). The study was addressed to generate a prediction of Surra cases in the future based on time series data by analysis of trends. The models used in the present study were simple and ignore a number of complexities such as level of infection, number of the parasite, host heterogeneities and the population dynamics of vectors (Coen et al. 2001). Data of morbidity, mortality and fatality from 2010 – 2016 were analyzed in this study. According to Putt et al. (1988), the morbidity is defined as the proportion of affected individual in a population and the mortality is the proportion of animal dying in a population, and case fatality rate is the proportion of animal dying within affected animals.

Data analyses

Comparison of those treatment strategies analyses was performed using the proportion test consisting of the proportion of morbidity, mortality and case fatality rates. In addition, forecasting analysis with decomposition method was used to predict the incidence of Surra in the future. The model analysis selected was the method with the smallest errors and the best accuracy using minitab 16 Statistical software (Heizer & Render 2009).

RESULT AND DISCUSSION

In general, livestock raised in Sumba Island is an extensive traditional management system defined as a system of husbandry where livestock released during the day and stable at night, and or released on grazing day and night. In this way, the farmer intervention is very limited (Kapa et al. 2017). *Trypanosoma evansi* was introduced into Sumba Island starting from Southwest Sumba, and then rapidly spread to West Sumba, Central Sumba, and East Sumba Districts (Dongga 2013). First Surra outbreak occurred in 2010

attacking horses and the second outbreak was in 2011 attacking buffaloes. It generated a major problem both in economic and social aspects (Ndiha et al. 2018). Due to the extensive traditional management system, the farmers did not realize if the number of their livestock decreased because of Surra.

There were two hypotheses explaining Sumba Island getting *T. evansi* from a neighbour endemic island (Sumbawa Island). Firstly, an infected horse came from Bima (Sumbawa Island) to Sumba Island when there was a traditional horse racing. People in Sumba dan Bima have a similar cultural approach to horse racing. There is an annual traditional horse racing in both places. If the racing is conducted in Sumba, many horses from Bima come to Sumba for joining the event. Conversely, if the racing is held in Bima, people in Sumba will transport their horse racing to Bima. This event might facilitate the spread of Surra from Bima (Sumbawa Island) to Sumba Island (Dongga 2013). Secondly, introducing Surra to Sumba was facilitated by buffaloes trading from Sumbawa to Sumba Island. The price of buffaloes in Sumbawa Island is cheaper than in Sumba Island so that many farmers or livestock trader buy and transport buffaloes from Sumbawa Island to Sumba Island.

In 2010, all villages in both Lewa and Lewa Tidahu sub-district were endemic Surra and around four sub-districts surrounded were threatened from *T. evansi* infection e.g. Nggaha Ori Angu, Katala Hamu Lingu, Kota Waingapu and Kampera. Furthermore, the disease spread to Tabundung sub-district, particularly in Praingkareha village in 2011 and distributed widely to Ngadu Ngala and Wula Waijelu sub-districts in 2012. The accumulation data of Surra from 2012 – 2016 revealed that the heights number of Surra cases was found in Kota Waingapu sub-district, followed by Wula Waijelu, Ngadu Ngala, Pohunga Lodu and Lewa. The widespread Surra among sub-districts in East Sumba was caused by livestock movement related to the traditional culture of Sumbanese called “Bellis”, a tradition of dowry gift (normally livestock e.g. horses, buffaloes, cattle) from men to women in the marriages. It was believed as a primary causative source of surra distribution in East Sumba because some traditional farmers did not follow the procedure of animal inspection conducted by the staff from local livestock agency in East Sumba District.

In East Sumba district, the farmers raise horses, buffaloes and cattle together. It puts horses under severe risk because buffaloes and cattle act as a source of *T. evansi* infection (Kundu et al. 2013). Sumbria et al. (2017) stated that open grazing practices in equine might increase the risk of the infection. Advanced management and disease control program is fundamentally needed to reduce the chance of *T. evansi* infection in equines. Nurulaini et al. (2013) strongly recommended that buffaloes do not graze together with other animals including horse because they are able to harbour *T. evansi* in the body without showing clinical signs. It was also revealed by

Table 1. Distribution of Surra cases attacking horses and buffaloes in East Sumba District, Indonesia in 2010 - 2016

Periods	Year	Livestock									
		Horses					Buffaloes				
		Infected	Death	Population in risk	Morbidity (%)	Mortality (%)	Infected	Death	Population in risk	Morbidity (%)	Mortality (%)
I	2010	65	44	577	11.27	7.60	3	0	280	1.07	0.00
	2011	381	278	7921	4.81	3.51	48	30	1093	4.39	2.74
	2012	350	350	7579	4.62	4.62	148	148	9602	1.54	1.54
II	2013	47	16	9606	0.49	0.17	21	0	10132	0.21	0.00
	2014	34	5	5657	0.60	0.09	9	0	3894	0.23	0.00
	2015	7	0	2180	0.32	0.00	3	0	865	0.35	0.00
	2016	43	7	4041	1.06	0.17	12	0	1325	0.91	0.00

(Data source : Local livestock Agency Reports from 2010 – 2016)

Camoin et al. (2017) that all elephant infected by *T. evansi* in Thailand have been associated with the cattle and buffaloes.

Generally, morbidity of Surra attacking horses in East Sumba District in 2010 was greater than buffaloes for 11.27% and 1.07 %, respectively (Table 1). However, it seemed to be a similar rate for horses and buffaloes in 2011 for 4.81 and 4.39, respectively. In term of mortality, a number of horses killed by *T. evansi* infection was also relatively higher than buffaloes. According to Tehseen et al. (2017) and Camoin et al. (2017) that horses are more susceptible to *T. evansi* than buffaloes. They develop acute and most often fatal effect from the disease. The high mortality of horses in the Brazilian Pantanal was also reported by Seidl et al. (2001) reaching about 13% when there was no control program employed. In addition, horses are reported as an indispensable animal to the traditional extensive ranching management system employed like in East Sumba District (Seidl et al. 2001). Accordingly, the number of morbidity and mortality of horses caused by *T. evansi* infection were greater than other livestock.

During seven years (2010-2016), the highest mortality rate occurred in 2012, followed in 2011 and 2010. After 2012, the mortality rate declined dramatically and there was no animal death reported in 2015. However, in 2016, the morbidity of horses and buffaloes slightly increased. It was probably due to discontinues of prophylactic treatment. The local livestock agency in East Sumba District postponed treating livestock because they must wait for the drugs from the central government so that the treatment was temporary halted.

There are some various factors which contribute to the high mortality in East Sumba District. *Trypanosoma evansi* is able to develop a well-known strategy to escape from the host immune system by exhibiting various main membrane surface glycoproteins (Desquesnes et al. 2013; Holmes 2013). The hot and humid tropical climate in East Sumba

District is suitable for the breeding of vectors (Jesse et al. 2016). The population density of vector plays a role in increasing the transmission of Surra from infected livestock to others (Menon & Mathew 2008).

Dongga (2013) also investigated factors influencing Surra widespread rapidly in East Sumba District. They were frequent livestock movement, infected and suspected livestock slaughtered without any prior inspection and traditional culture of Sumbanese (livestock used for ceremony of funeral and marriage). Another factor is the lack understanding on the knowledge of Surra control, transmission of the disease and how to treat the infected livestock. In addition, the farmers are reluctant to report the incidence of Surra when their livestock was infected by *T. evansi*.

To reduce Surra cases in East Sumba District, the local government conducted controlling and monitoring programs such as curative and prophylactic treatment, including vector control by spraying insecticides. In 2010 – 2011 (period 1), isometamedium was the only available drug in Indonesia and it was employed to treat livestock as curative and prophylactic in East Sumba District. The chemical is reported to be able to cleavage trypanosomes kinetoplast Deoxyribonucleic acid-topoisomerase (kDNA-topoisomerase) complexes and cause disintegration of minicircle network within *T. evansi* kinetoplast through mechanisms which are independent of kDNA to eventually cause the parasite death (Kaminsky et al. 1997). In addition, Vreysen et al. (2013) and Desquesnes et al. (2013) stated that isometamedium (0.25-1.0 mg/kg BW) provides longer protection period. It will be up to 4 months at 1.0 mg/kg BW so that the drug is suitable for the purpose of prophylactic to treat herd in an endemic area. However, after implementing treatment strategy in period I (Figure 2), Surra cases remained a serious problem for the farmers and the disease widely spread to another sub-districts.

Garba et al. (2017) reported the effect of isometamedium chloride after being used to treat donkeys infected by *T. evansi*. The animals showed rapidly drop in mean parasitemia on day 2 (87.5%) and reach zero parasitemia on day 11 after treatment based on direct Micro Haematocrit Centrifugation Test (MHCT) and wet film. The parasite remained negative on days 21 and 50 according to Mice Inoculation Tests (MIC). However, the animals became positive parasitemia on days 100 indicating the presence of latent parasitemia status. Even though 60% of inoculated mice were positive of *T. evansi*, there was no mortality of mice recorded. The result demonstrated that isometamedium chloride did not completely remove the parasite from the treated animals, however, the remaining parasite remained rendered non-pathogenic and avirulent. Hutchinson et al. (2007) explained that the finding might be due to the resistance of *T. evansi* facilitated by switching off its surface glycoprotein coat. It seemed that the treatment strategy in period I in East Sumba District using isometamedium was ineffective or *T. evansi* has been resistant to the drug and infected other livestock. Unfortunately, due to a limited number of drugs and lack knowledge of Surra, the treatment was not followed by further observation. As a result, the morbidity and mortality of Surra in period I remained relatively high.

In period II, the treatment strategy was changed by using a combination of isometamedium and diminazene aceturate. The local vets in East Sumba District employed isometamedium as a preventive drug and diminazene aceturate as a curative drug (Delespaux et al. 2006; Wainwright 2009; Gutierrez et al. 2013). According to Radostits et al. (2006), diminazene aceturate is a chemocurative for Surra, the first line of treatment in trypanosomosis. This statement is in line with Miller (2003) mentioning that diminazene aceturate is stable, easy to use, and low toxicity so that it is relatively safe for the animals. The chemical was investigated to be highly bound to plasma proteins of buffalo calves and also bound to DNA and interferes with parasitic replication (Pandey

et al. 2010; Melaku & Birasa 2013). In addition, diminazene aceturate has a strong affinity in the base pair AT, particularly in the minor groove region of DNA followed by inhibition of enzymes such as topoisomerase and nuclease (Gillingwater 2007; Kuriakose et al. 2012; Gutierrez et al. 2013).

Comparison of morbidity, mortality and fatality proportions of Surra attacking horses and buffaloes between period I and II in East Sumba District can be seen in Table 2. The result demonstrated that the proportion of morbidity and mortality for horses and buffaloes in period I was significantly greater than in period II ($P < 0.0001$). Treatment strategy in 2012 - 2016 was able to decrease morbidity with proportion in horses and buffaloes for 1.44% and 0.66%, respectively. It indicated that treatment using a combination of isometamedium and diminazene aceturate (period II) might be more effective compared to using isometamedium alone (period I). The previous report demonstrated that diminazene aceturate and isometamedium are therapeutically effective against clinical Surra in buffaloes in India (Joshi & Singh 2000).

Diminazene aceturate is recommended only for therapeutic use because of rapidly excreted activity. The chemical was also able to binds to trypanosomal kinetoplast DNA and hinders the synthesis of RNA primers, generating an accumulation of replicating intermediates. As a result, the kDNA replication is inhibited (Sivajothi & Reddy 2016). However, trypanosomes have developed resistance if they were used regularly in low doses. Sivajothi & Reddy (2016) recorded that polypeptide profile of diminazene aceturate resistant isolates of *T. evansi* removed from buffaloes in India had different bands pattern from the previous finding indicating the presence of variations in the isolates. It could maintain the fatality case rate relatively high.

Based on the proportion of fatality analysis, the case fatality rate (CFT) of period II provided significantly higher than the period I ($P < 0.0001$). Eloy & Lucheis (2009) mentioned that surra cases might

Table 2. Comparison of morbidity, mortality and fatality proportions of Surra attacking horses and buffaloes between period I and II in East Sumba District

Livestock	Criteria	Period I	Period II	P - value
Horses	Morbidity	5.25	1.44	< 0.0001
	Mortality	3.79	1.30	< 0.0001
	Fatality	70.20	90.21	< 0.0001
Buffaloes	Morbidity	3.71	0.66	< 0.0001
	Mortality	2.80	0.55	< 0.0001
	Fatality	58.82	82.94	0.0003

be decreasing but the severity of the disease could be worse. It indicated that some infected livestock would be difficult to cure. This might happen due to *T. evansi* in the field more pathogen.

The impact of treatment on reducing the number of infected livestock and deaths on horses and buffalo based on treatment strategy period II was projected forward using forecasting analysis for the next 12 months by decomposition method. In this study, it was assumed that the main control of Surra using trypanocidals either as curative or preventive actions was better, because other controls such as vector control and livestock movement were assumed the same from period 1 and 2. Surra's projection of horses and buffaloes and the death of horses and buffaloes seemed to be on the downward trend in Figure 3 (horses) and Figure 4 (buffaloes). It indicated that the control program implemented in Sumba (a combination of isometamedium and diminazene aceturate) could reduce the incidence and of Surra and death of livestock by Surra in the next 12 months.

In term of mortality rate, the forecasting analysis showed that the number of horses killed by *T. evansi* infection in the next 12 months would be higher than buffaloes. The horse mortality would fluctuate ranged 0 to 49 cases however, the mortality rate in buffaloes was less ranged 0 – 8 cases. It was not surprised because the horse is more susceptible than buffaloes from Surra disease. Meanwhile, according to Coen et

al. (2001) who applied Susceptible-Infected-Susceptible (SIS) model demonstrated that the buffaloes in Indonesia would be a clear infection in an estimated mean time period of 16.8 months (ranged 12.5 – 25.9 months) since the acquisition, either by drug treatment or self-cure.

Overall, the treatment strategy in East Sumba District by a combination of curative and preventive methods was relatively effective to deal with Surra. Seidl et al (2001) stated that the best method for treatment of *T. evansi* from a horse mortality perspective is the preventive strategy. The effectiveness of this strategy has been proven and employed in Africa, Bolivia and Paraguay. The preventive strategy would provide 100% protection for horses. In addition, the control of trypanosomosis in an endemic area like East Sumba District may ideally involve control of vectors, prophylactic treatment and good husbandry of the animal at risk. In addition, Jesse et al. (2016) mentioned that total elimination of trypanosomosis would be ineffective however, the treatment strategy to achieve tolerable level could be possible to deal with Surra. Due to East Sumba District has been an endemic area for Surra, the preventive treatment must be implemented regularly to anticipate the wider spread of the diseases and reduce the mortality of livestock, particularly in horses and buffaloes.

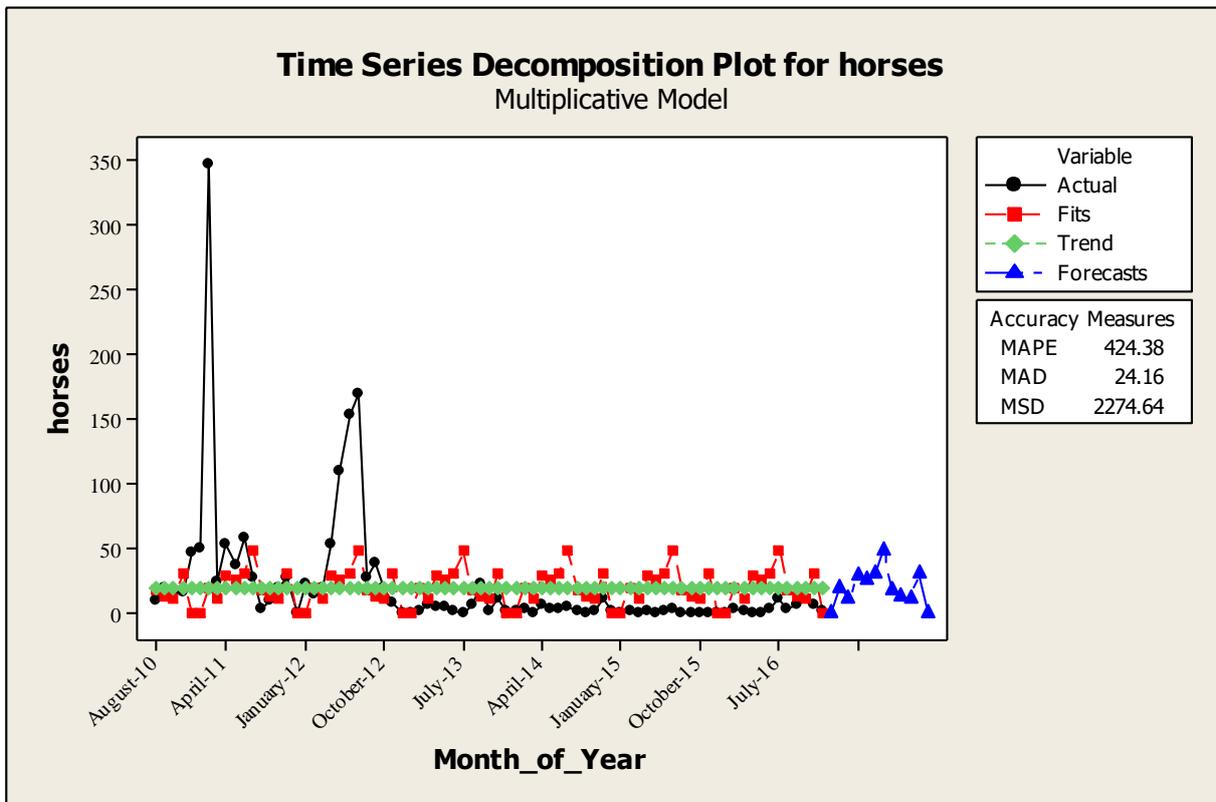


Figure 3. Sura cases projection on horses for the next 12 months based on forecasting study analysis.

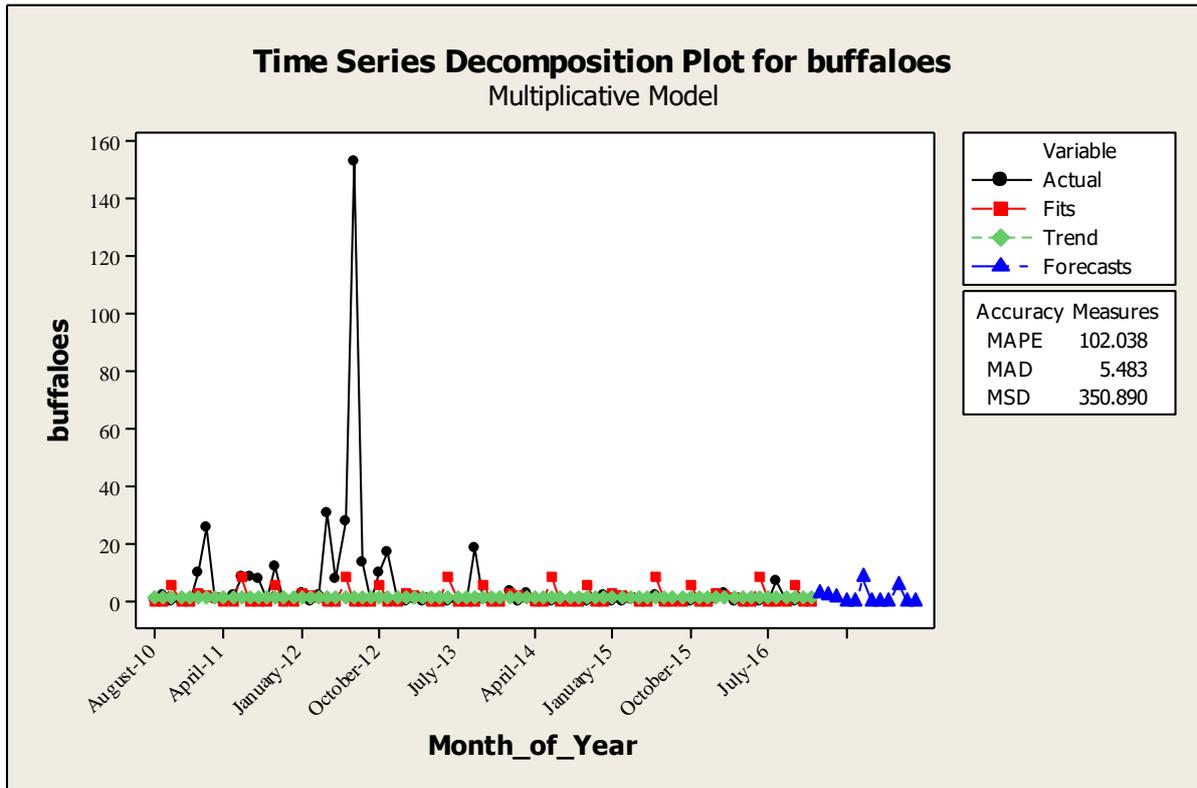


Figure 4. Surra cases projection on buffaloes for the next 12 months based on forecasting study analysis.

CONCLUSION

The strategy of Surra treatment by a combination of curative drug (isometamedium) and curative drug (diminazene aceturate) is able to significantly reduce the morbidity and mortality livestock in East Sumba District. According to the forecasting study, the Surra control program carried out continuously can reduce the case of Surra in East Sumba. The local livestock agency of East Sumba and the farmer should continue the program mainly using the combination of trypanocidal. The control of Surra is mainly based on the recognition of infested animal, so that the farmers or livestock keepers should observe the clinical signs and report to the local vet in order to obtain the proper treatment.

ACKNOWLEDGEMENTS

The author would like to thank drh. Martono, drh. Okto Rohi, drh. Rambu Peristiwa Pandjukang and the entire staff of the local livestock agency in East Sumba District for great cooperation during the study. The author also would express gratitude to Dr. Ir. Hamzah Bustomi MM for helping with statistical analyses. The study was supported by the Indonesia Agricultural Quarantine Agency - The Ministry Agriculture of the Republic of Indonesia. Rita Sari Dewi (RSD) and April

H Wardhana (AHW) contributed equally in writing the manuscript.

REFERENCES

- Aregawi WG, Agga GE, Abdi RD, Buscher P. 2019. Systematic review and meta-analysis on the global distribution, host range, and prevalence of *Trypanosoma evansi*. Parasites Vector. 12:1-125.
- Camoin M, Kocher A, Chalermwong P, Yangtarra S, Thongtip N, Jittapalpong S, Desquesnes M. 2017. Adaptation and evaluation of an ELISA for *Trypanosoma evansi* infection (Surra) in elephants and its application to a serological survey in Thailand. Parasitology. 1-7.
- Coen PG, Luckins AG, Davison HC, Woolhouse MEJ. 2001. *Trypanosoma evansi* in Indonesian buffaloes: evaluation of simple models of natural immunity to infection. Epidemiol Infect. 126:111-118.
- Delespaux V, Chitanga S, Geysen D, Goethals A. 2006. SSCP analysis of the P2 purine transporter TcoAT1 gene of *Trypanosoma congolense* leads to a simple PCR-RFLP test allowing the rapid identification of diminazene resistant stocks. Acta Tropica. 100:96-102.
- Desquesnes M, Dargantes A, Lai DH, Lun ZR, Holzmüller, Jittapalpong S. 2013. *Trypanosoma evansi* and Surra: A review and perspectives on transmission,

- epidemiology and control, impact and zoonotic aspects. *Biomed Res Inter*. ID 321237:1-20.
- Dongga RED. 2013. Adopsi Teknologi pengendalian surra oleh peternak kuda di Kabupaten Sumba Timur, Nusa Tenggara Timur (Thesis). [Bali (Indones)]: Universitas Udayana.
- Eloy L, Lucheis S. 2009. Canine trypanosomiasis: aetiology of infection and implication for public health. *J Venomous Anim Toxins Including Trop Dis*. 15:589-611.
- Garba UM, Sackey AKB, Lawal AI, Esievo KAN, Bisalla M, Sambo JS. 2017. Gross and histopathological alterations in experimental *Trypanosoma evansi* infection in donkeys and the effect of isometamedium chloride treatment. *J Vet Sci Anim Husbandry*. 5:1-10.
- Gillingwater K, Buscher P, Brun R. 2007. Establishment of a panel of reference *Trypanosoma evansi* and *Trypanosoma equiperdum* strains for drug screening. *Vet Parasitol*. 148:114-121.
- Gutierrez C, Gonzales-Martin M, Corbera JA, Tejedor-junco MT. 2013. Chemotherapeutic agents against pathogenic animal trypanosomes. In: Mendez –Vilas A, editor. *Microbial pathogens and strategies for combating them: Science, technology and education*. Madrid (Spain): Formatex Research Center. p. 1564-1573.
- Harlan A, Setiawan BD, Marji. 2018. Peramalan jumlah kasus penyakit menggunakan jaringan saraf tiruan backpropagation (Studi kasus Puskesmas Rogotrunan Lumajang). *J Pengembangan Teknologi Informasi Ilmu Komputer*. 2:2781-2790.
- Heizer J, Render B. 2009. *Manajemen operasi*. 9th ed. Jakarta (Indones): Salemba Empat.
- Holmes P. 2013. Tsetse-transmitted trypanosomes their biology, disease impact and control. *J Invertebrate Pathol*. 112:11-14.
- Hutchinson OC, Picozzi K, Jones NG, Mott H, Sharma R, Willburn SC, Caringgton M. 2007. Variant Surface Glycoprotein gene repertoires in *Trypanosoma brucei* have diverged to become strain-specific. *BMC Genomic* 8:234.
- Jesse FFA, Bitrus AA, Abba Y, Sadiq MA, Hambali IU, Chung ELC, Ping FLP, Haron AB, Azmi M, Lila M, Saharee AA, Norsidin MJ. 2016. A clinical case of bovine trypanosomosis in an endemic farm in Malaysia. *J Adv Vet Anim Res*. 3:286-291.
- Joshi SS, Singh B. 2000. Evaluation of therapeutic and chemoprophylactic efficacy of certain drugs against clinical surra in buffaloes. *Indian Vet J*. 77:895-897.
- Kaminsky R, Schmid C, Lun ZR. 1997. Susceptibility of dyskinetoplastic *Trypanosoma evansi* and *Trypanosoma equiperdum* to isometamedium chloride. *Parasitol Res*. 83:816-818.
- Kapa MMJ, Soemarno, Yanuwiyadi B, Suyadi. 2017. Sustainability status of biology dimension of local beef cattle development in the dryland region, Indonesia. *J Econ Sustain Dev*. 8:102-108.
- Kundu K, Tewari AK, Kurup SP, Baidya S, Rao JR, Joshi P. 2013. Sero-surveillance for surra in cattle using native surface glycoprotein antigen from *Trypanosoma evansi*. *Vet Parasitol*. 196:258-264.
- Kuriakose S, Mulene HM, Onyilagha C, Singh R, Jia P, Uzonna JE. 2012. Diminazeneaceturate (Berenil) modulates the host cellular and inflammatory response to *Trypanosoma congolense* infection. *PLoS ONE*. 7:1-8.
- Luckins AG. 1998. Trypanosomiasis caused by *Trypanosoma evansi* in Indonesia. *J Protozool Res*. 8:144-152.
- Local livestock Agency Report. 2010. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur.
- Local livestock Agency Report. 2011. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur.
- Local livestock Agency Report. 2012. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur. Indonesia.
- Local livestock Agency Report. 2013. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur. Indonesia.
- Local livestock Agency Report. 2014. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur. Indonesia.
- Local livestock Agency Report. 2015. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur. Indonesia.
- Local livestock Agency Report. 2016. Laporan Tahunan dan Peta Distribusi Penyakit Hewan Tahun 2010. Sumba Timur (Indones): Dinas Peternakan Kabupaten Sumba Timur. Indonesia.
- Miller DB. 2003. The pharmacokinetics of Diminazene Aceturate and Intravenous Administration in the Healthy Dog (Thesis). [Pretoria (Indones)]: University of Pretoria.
- Melaku A, Birasa B. 2013. Drugs and drug resistance in African Animal Trypanosomosis: A Review. *European J Bio Sci*. 3:82-89.
- Menon DG, Mathew L. 2008. Incidence of *Trypanosoma evansi* in Thrissur town. *Vet World*. 1:275-277.
- Ndiha MRM, Apsari IAP, Dwinata IM. 2018. Prevalensi dan intensitas infeksi *Trypanosoma evansi* pada kuda di desa Kabar, Kecamatan Rindi, Kabupaten East Sumba. *Bul Vet Udayana*. 1:70-75.

- Nurulaini R, Premaalatha B, Zaini CM, Adnan M, Chandrawathani P, Fazly AZA, Enie AA, Ramlan M. 2013. Trypanosomiasis outbreak in deer, cattle, buffaloes and pigs in Perak. *Malays J Vet Res.* 4:55-58.
- [OIE] Organization Internationale de Epizootic. 2012. *Trypanosoma evansi* infection. OIE Terrestrial Manual. Chap.2.1.17. p. 1-4.
- Pandey HK, Singh KK, Roy BK, Kumari S. 2010. Pharmacokinetics of Diminazene aceturate in buffalo calves. *J Bioanalysis Biomedic.* 2:013-016.
- Payne RC, Sukanto IP, Djauhari D, Partoutomo S, Jone TW, Luckin AJ, Boid R. 1991. *Trypanosoma evansi* infection in cattle, buffalo, and horses in Indonesia. *Vet Pathol.* 38:253-256.
- Ponnudurai G, Sivaraman S, Rani N, Veeraoabduab C. 2015. An outbreak of Trypanomosis in buffaloes caused by diminazene resistant *Trypanosoma evansi*. *Buffalo Bull.* 34:1-4.
- Putt SNH, Shaw APM, Woods AJ, Tyler L, James AD. 1988. *Veterinary epidemiology and economic in Africa: A manual for use in the design and appraisal of livestock health policy.* Berkshire (UK): University of Reading.
- Radostits OM, Gay CC, Hinchcliff KW, Constable PD. 2006. *Veterinary Medicine: A textbook of disease of cattle, horses, sheep, pigs and goats.* 10th ed. Elsevier Health Sciences. 2065 p.
- Seidl AF, Moraes AS, Silva RAMS. 2001. *Trypanosoma evansi* control and horse mortality in the Brazilian Pantanal. *Mem Inst Oswaldo Cruz, Rio de Janeiro.* 96:599-602.
- Sivajothi S, Chengalva V, Reddy BS. 2014. Detection of *Trypanosoma evansi* by different methods in bovines in Andhra Pradesh. *J Adv Parasitol.* 1:35-38.
- Sivajothi S, Reddy BS. 2016. Polypeptide profiles of Diminazene Aceturate Resistant *Trypanosoma evansi* organisms isolated from a Buffalo. *J Vet Sci Medic.* 4:1-4.
- Sumbria D, Singla LD, Kumar R, Bal MS, Kaur P. 2017. Comparative seroprevalence and risk factor analysis of *Trypanosoma evansi* infection in equines from different agro-climatic zones of Punjab (India). *Revue Scientifique Technique International Office of Epizootics.* 36:971-979.
- Singh V, Singla LD. 2015. Trypanosomosis (Surra) in Livestock. *Veterinary Parasitology.* Department of Parasitology, College of Veterinary Science and Animal Husbandry, S.D Agricultural University. p. 330-305.
- Tehseen S, Jahan N, Desquesnes M, Shahzad MI, Qamar MF. 2017. Field investigation of *Trypanosoma evansi* and comparative analysis of diagnostic tests in horses from Bahawalpur, Pakistan. *Turk J Vet Anim Sci.* 41:288-293.
- The Regent of East Sumba issued Decree of Regent No: 185 / Disnak.524.3 / 570 / VII / 2010 and Instruction of Regent No: 147 of 2010 in July on the emergency response of threat of transmission of infectious animal diseases Surra in East Sumba district. 2010. Nusa Tenggara Timur-Indonesia
- Vreysen MJB, Seck MT, Sall B, Bouyer J. 2013. Tsetse flies: their biology and control using area-wide integrated pest management approaches. *J Invertebrate Pathol.* 112:S15-S25.
- Wainwright M. 2010. Dyes, trypanosomiasis and DNA: a historical and critical review. *Biotech Histochem.* 85:341-354.