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The economic impact attributable to brucellosis among goat farms in Peninsula Malaysia and cost benefit analysis

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Abstract

Brucellosis is known to cause economic losses to livestock farmers around the world. The amount of direct economic loss suffered by farmers has not been reported in Malaysia. This study reports the cost benefit analysis of goat farming and the economic impact attributable to brucellosis in goat farms in four states of Malaysia. Data about production indices and management was collected from farms through interviewer-administered structured questionnaires. The cost-benefit analysis of goat farming in Malaysia shows that it is a profitable business with 42 farms yielding about RM 2 million (USD 645,161.29) a month. Comparing fifteen farms from the four states when they had no brucellosis infection and after they were infected with brucellosis using the culling of the goats and farm value as criteria the fifteen farms had a financial loss of at least RM 156,212.50 (USD 50,391.13) which was found to be significant ($P<0.05$) at 95% confidence level using Wilcoxon signed rank test with IBM SPSS version 20. There was no significant difference in the economic impact on the farms between the various states at 95% confidence level using Kruskal-Wallis test with IBM SPSS version 20. Based on reported seroprevalence rate of 2.9% using complement fixation test it was estimated that annually the economic impact due to caprine brucellosis was RM7,974263.8 (USD 2,572343.1). This study highlights the colossal waste to the economy due to caprine brucellosis and underscores the urgent need to take more drastic measures to eradicate brucellosis in Malaysia through a combination of test and slaughter policy with vaccination of goats and a total ban on importation of live goats into Malaysia from any endemic country.

Keywords: Economic impact; brucellosis; goats; farms; Malaysia

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Introduction

Brucellosis is a zoonotic disease that causes significant economic losses to farmers and to national economies due to reduction in animal's productivity and debilitation of affected humans (Kaufmann et al., 1997). It has been constantly ranked among the most economically important zoonoses worldwide with multiple economic impacts attributable to human, livestock and wildlife disease (Perry, 2002, Zinsstag et al., 2007, Perry and Grace, 2009; Mcdermott et al., 2013). In least developing and developing countries disease control may not be possible due to lack of resources and financial support (Sulima and

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Venkataraman, 2010). Losses to farmers are usually from culling of reactor animals without or with minimum compensation (Bahaman et al., 2007; Hegazy et al., 2011), abortion and infertility (Sulima and Venkataraman, 2010), missed reproductive cycle periods, lowered milk yield, reduced productivity, loss in market value of animals, man hours due to illness, birth of weak offspring and low birth weight, costs of veterinary services and miscellaneous factors arising from brucellosis on farms (Blasco and Molina-Flores, 2011).

The South-east Asia region has an estimated ruminant population of 21,247,586 and is predicted to have 616,180 cases of brucellosis annually with 164 outbreaks reported in the year 2010 to World Animal Health Organization with a brucellosis prevalence of 2.9% with heavy economic losses (ILRI, 2012).

Annual economic losses due to brucellosis vary from country to country. Not many countries reported their losses but a few that reported such as Argentina, the annual losses are estimated at US$60,000,000 (Samartino, 2002) and for the whole of Latin America official figures put annual losses at US$600,000,000 (Seleem et al., 2010). In India, the annual economic losses per animal were estimated at Rs. 1180 per sheep (USD21.58) and Rs. 2121.82 per goat (USD38.80) (Sulima and Venkataraman, 2010), in Egypt about 60 million Egyptian pounds (USD 9,810,480.62) (Anon, 1995), in the United States, it costs dairy and beef producers approximately US$30 million (Bittner, 2004) and in Kyrgyzstan about US$10.6 million. In two important livestock producing states in Nigeria, the annual economic losses due to brucellosis in small ruminants was estimated to be USD 3.2 million (Brisibe et al., 1996).

In this study, we employed a combination of the partial budget analysis involving direct costs of the disease and the cost benefit analysis to elucidate the economic impact of brucellosis caused by *B. melitensis* in goat farms in Malaysia (Horst et al., 1999; Marsh, 1999; Morris, 1999; Bennett, 2003).

The policy of the Malaysian government to stamp-out brucellosis is by culling/slaughtering all serologically confirmed positive goats using the complement fixation test (Bahaman et al., 2007; Shahaza et al., 2009). The farms that were confirmed as reactors are disallowed to sell or market any of their animals or their products until the herd is tested and retested and confirmed free from brucellosis. This policy has a significant impact on the operational activities of the farms which consequently affect their economy.

Anecdotal evidence exist that farms suffered significant impact from brucellosis in Malaysia. However, the economic implications of brucellosis in goat farms in Malaysia have not been studied and reports of the economic impact of brucellosis generally are sparse. While it is agreed that farmers suffer losses due to this infection but to what extent is unknown. Therefore, this study was undertaken to elucidate the economic impact due to brucellosis in goat farms in Peninsula Malaysia with special focus on the culling of seropositive goats in four selected states.

Materials and Methods

Study design

The study was conducted between July and September 2011. A total of 42 farms were involved in the study based on their brucellosis status for ten years (2000-2009) with 22 of this number being positive farms and 20 negative farms for brucellosis which include Melaka, n=12 farms (positive n=7, negative n=5) (28.6%), Negeri Sembilan, n=10 farms (positive n=5, negative =5) (23.8%), Pulau Pinang, n=10 farms (positive n=5, negative =5) (23.8%) and Selangor, n=10 farms (positive n=5, negative =5) (23.8%). A farm was considered positive if 1 or more goats within the herd were confirmed to be seropositive using the complement fixation test (CFT) by the serology unit of the Veterinary Research Institute, Ipoh, Malaysia and negative if all the animals in the herd tested negative, for a period of 10 years. The CFT procedure was performed as described by the OIE (OIE, 2009) as well as prescribed by the Protocol of the Department of Veterinary Services of Malaysia (DVS, 2010). By the year 2010 about 545,682 goats were present in the country mostly by importation from other countries (DVS, 2011; Aziz et al., 2012). Sample size was calculated using Open Epi Epidemiologic statistics for Public Health software version 3.01 based on the method of Sullivan et al. (2009).

Sampling

The farms were chosen based on surveillance data on their Brucella status using the CFT which is the confirmatory test for brucellosis in goats at the Veterinary Research Institute, Ipoh, Malaysia. The economic impact attributable to brucellosis among goat farms in Malaysia was determined using interviewer-administered questionnaires to positive and negative farms in four states of Malaysia which include Selangor, Negeri Sembilan, Melaka and Pulau Pinang. Briefly, the questionnaire sought information on herd size of farms, cost of purchase of animals, cost of sale, breeding activities, feeding, cost of maintaining farm in terms of utilities and wages of staff, number of animals culled, animals death due to other causes, age categories of animals on the farm and any other relevant information available or given by the farmers. Whenever possible, we attempt to obtain written farm records but almost all farmers sampled have very poor

record keeping. Therefore, all questions were asked pertaining to the previous year's (2010) farm activities to ensure that recall bias was minimized.

The partial budget method analysis method was used to elucidate the economic impact (Rushton et al., 1999; Bennett, 2003; Munoz-del et al., 2007) which is the standard method for herd-level economic analysis (Morris, 1999; Ramsay et al., 1999; Tisdell et al., 1999) that covers a period of one year.

We used several parameters to estimate the farm losses such as:

1. Number of animals culled
2. Farm value
3. Herd size
4. Weight of goats
5. Cost per unit of animals
6. Farm economic impact

Cost benefit analysis of goat farming in Malaysia and farm level economic analysis

Cost-benefit analysis: The Cost Benefit Analysis (CBA) of investing in goat farming was calculated based on interviewer-administered questionnaire estimates from 42 goat farms from 4 states in Peninsular Malaysia using the method of Rushton et al. (1999) and Morris (1999). An average amount of RM 13.4 per kg body weight was used as purchase price of goats and RM 18.1 per kg body weight was used for selling price and value of goats irrespective of breed, sex or age based on average from interview data (available on request). The costs of feeds, utilities, veterinary services and salary/allowances of workers were computed based on data supplied by the farmers through an on the spot interview and interviewer-administered questionnaires. Where a few values were missing in the questionnaire data due to recall bias and memory failure from the farmers the missing values were replaced using serial means by IBM SPSS version 20 (SPSS Inc. Chicago, IL) and/or reasonable estimates. The computation was done as follows:

Total Cost (TC) = $\sum(Cost_p + Costv + Cost_f + Cost_u + Cost_s + Cost_m)$

Where:

$Cost_p$=cost of purchase of goats

$Cost_v$=cost of veterinary services

$Cost_f$ =cost of feed

$Cost_u$=cost of utilities

$Cost_s$ =cost of salaries and wages

$Cost_m$ =other costs not mentioned

Total revenue (TR) = Σ RM from sale of goats

Cost Benefit Analysis: Total income = TR - TC

Cost Benefit Ratio= Benefit/Cost.

Farm-level economic analysis: Because positive goats for brucellosis are usually culled by veterinary officials, the value of animals culled due to brucellosis was computed as the economic impact due to brucellosis on the farm. A reconciliation table (available on request) was used to reconcile the data obtained from on-farm one on one interviews with the farmers with farm information for the year 2010. A total of 22 positive goat farms and 20 negative goat farms were interviewed and data collected. Due to recall bias and lack of records some farmers could not recall a lot of information. Where possible, average or reasonable values that approximate the normal values were inputted for such farms and farms with too many missing data and information were discarded leaving a total of 15 positive farms used for the analysis. Economic impact calculations were done taking into consideration compensation paid to farmers at RM 5.60 per kg (Table 3) and all monetary unit calculations were done in the local currency (Malaysian Ringgit) and the total converted to the US dollar. The currency exchange rate from Malaysian ringgit to the US dollar was pegged at RM 3.1 to USD 1. The average amount lost per goat was extrapolated to calculate the total loss incurred based on the population of goats in Malaysia in the year 2010 and the prevalence rate for the South East Asia region reported as 2.9% (ILRI, 2012). Therefore, the economic impact for year 2010 will be:

Average impact per goat × (Prevalence rate × Total goat population for year 2010).

The economic analysis was calculated based on:

1. The financial value of the farms before they were infected with brucellosis
2. The financial value of the farms after infection and culling as a result of brucellosis for the same farms in 1 above

Let EI = Economic impact due to brucellosis on the farm calculated as total unit weight of goats culled × RM 12.5 (economic impact suffered per goat with minimal compensation).

Let FV = Farm value of individual goat farms = monetary value of farm based on number of animals and their total value in a year with other factors assumed constant (i.e. estimated cost of goat per kg multiplied by total weight of goats and all summed up together in that particular farm) using an excel spread sheet reconciliation table based on partial budgeting and direct costs (Morris, 1999; Bennett, 2003).

Let FVB = Farm value with brucellosis infection leading to culling of infected goats in a farm.

$\therefore$ FVB = FV - EI

Total Economic Impact for the 15 positive farms will be:

$FVB_{Total} = \sum FV - \sum EI$

Only data from the 15 positive goat farms were used for the economic impact analysis to compare a before brucellosis infection scenario on the farm values and after brucellosis infection scenario on the farm

values and data from all 42 farms were used to compute average costs of goats and related data. The average cost per kg of goat was calculated based on the total average value for all the farms interviewed. The Kruskal-Wallis test was used to determine any difference in the mean economic impact value between states and between the various positive farms before and after brucellosis infection scenarios. The Wilcoxon sign rank test was used to elucidate if the economic impact on positive farms before and after infection was statistically significant (Esposito et al., 2006; Schwaber et al., 2006; Thrusfield, 2013). All tests were conducted using IBM SPSS version 20 at 95% confidence level unless otherwise stated.

Results

Table 1 gives a summary of the economic impact data for the 15 positive farms studied. From this table the average amount for goats per Kg is RM18.1 which is the amount lost by the farmers per Kg if their goats are culled and there is no compensation. If farmers are compensated then it is RM12.5 per Kg body weight of the goats lost. The lowest economic impact on any farm was RM225 with only 1 goat culled from a herd of 131 goats and the highest was RM47250 where 126 goats were culled in a herd of 469 goats. Total brucellosis impact in the 15 farms was RM156212.50 (USD 50,391.13) for 310 goats giving an average amount of RM503.91 lost per goat. The total economic impact for the whole of Malaysia in 2010 was RM7,974263.8 (USD 2,572343.1).

Comparing a Brucella positive farms value with brucellosis and same farms before brucellosis infection, the values as a result of brucellosis was significant using Wilcoxon signed rank test showing that brucellosis had a negatively significant economic impact upon the farms. The mean economic impact is RM 10,414.17 of all the farms (Table 2). The herd size ranges from a minimum of 131 to a maximum of 3650 with a mean of 833 goats in the farms during the course of the investigation (Table 2). The compensation schedule used for compensating farmers by the government through the Department of Veterinary Services is given (Table 3).

The cost-benefit analysis of goat farming in Malaysia shows that it is a profitable business with 42 farms yielding about RM2 million(USD 645,161.29) a month (Table 4) with a benefit-cost ratio of 1.28 with Negeri Sembilan state generating the highest income per state (Table 5). Though some states and farms appear to have lost more goats than others there was no statistically significant difference in the economic impact across states and farms (P>0.05).

Discussion

Livestock farming especially goats is a very profitable business and goats have a high degree of adaptability to every climate and are found in every nation (Mowlem, 1992; Gürsoy, 2006; Kocho et al., 2011; Mestawet et al., 2012). In this study, the CBA of goat farming revealed it as a very profitable and self-sustaining business in Malaysia in spite of the high costs of feed and price for purchasing and raising the goats. The average goat farmer could make about RM 5 profit for every kg body weight of goats sold. This may explain why many are into goat farming in Malaysia

Table 1: Economic Impact of brucellosis in goats in 15 positive farms in 4 States of Malaysia

State	Farm No.	Herd size	No. Of goats culled	Average Unit wt (kg) culled	Total wt (kg) culled	RM/ kg. NC	RM /kg. WC	Impact (RM) =EI	Farm value (RM)=FV	Farm value-Impact =FVB
Selangor	S5	875	1	30	30	18.1	12.5	375	549650	549275
Selangor	S8	676	3	35	105	18.1	12.5	1312.5	339550	338237.5
Selangor	S10	449	1	40	40	18.1	12.5	500	210450	209950
Negeri Sembilan	N1	2065	40	50	2000	18.1	12.5	25000	1018540	993540
Negeri Sembilan	N4	590	1	25	25	18.1	12.5	312.5	188050	187737.5
Negeri Sembilan	N8	240	1	30	30	18.1	12.5	375	92650	92275
Negeri Sembilan	N9	369	7	20	140	18.1	12.5	1750	245800	244050
Melaka	M2	1095	46	35	1610	18.1	12.5	20125	692160	672035
Melaka	M4	3650	20	50	1000	18.1	12.5	12500	1755150	1742650
Melaka	M10	618	7	50	350	18.1	12.5	4375	333200	328825
Pulau Pinang	P2	449	2	50.5	101	18.1	12.5	1262.5	296800	295537.5
Pulau Pinang	P4	469	126	30	3780	18.1	12.5	47250	234200	186950
Pulau Pinang	P6	299	53	61	3233	18.1	12.5	40412.5	79100	38687.5
Pulau Pinang	P9	524	1	35	35	18.1	12.5	437.5	614900	614462.5
Pulau Pinang	P10	131	1	18	18	18.1	12.5	225	100100	99875
Total		12499	310	559.5	12497			156212.5	6750300	6594087.5

Key: NC=No Compensation (amount lost per kg without compensation); WC=With Compensation (amount lost per kg with compensation); EI=Economic Impact (direct financial loss of a farm); FV=Farm Value (The total financial worth of a farm before brucellosis infection); FVB= Farm Value after brucellosis infection; Wilcoxon signed Rank Test for significance of economic impact comparing FVB and FV: P=0.001.

Table 2: Descriptive statistics of the economic impact data for 15 positive farms

Parameters	Minimum(RM)	Maximum(RM)	Mean (RM)	Std. Deviation
Impact (RM)	225.00	47250.00	10414.17	15701.61
Farm value-impact (RM)	38687.50	1742650.00	439605.83	443987.13
Farm value (RM)	79100	1755150	450020.00	445107.91
Herd size	131	3650	833.27	907.17
No. of goats culled	1	126	20.67	34.34

Table 3: Compensation Table from DVS Malaysia

Species	Category	Partial Compensation (RM)	Full Compensation (RM)	Means of Identification
	Calves	530 (USD166.25)	800 (USD250.94)	No permanent incisors
Cattle	Adult beef cattle	800 (USD250.94)	1600 (USD501.88)	
	Adult dairy cattle	1000 (USD313.68)	2000 (USD627.35)	
	Pedigree	2000 (USD627.35)	4000 (USD1254.71)	Breed records
	Calves	530 (USD166.25)	800 (USD250.94)	No permanent incisors
Buffaloes	Adult	1000 (USD313.68)	2000 (USD627.35)	
	Pedigree	2500 (USD784.19)	5000 (USD1568.38)	Breed records
Goats	All	RM5.60 (USD1.77) per Kg body weight		Not applicable

Source: Department of Veterinary Services, Malaysia, 2012

therefore underscores the need for more proactive measures to control and eradicate diseases of economic importance.

The presence of brucellosis on a farm would lead to economic losses in various forms in the short and long term. The loss of RM 18.1 per kg live weight or average of RM 503.91 per goat in the farms is higher than that reported for India of Rs. 2121.82 (approximately RM 121.59) per goat (Sulima and Venkataraman, 2010). The higher losses may be due to the loss of adult animals mostly by culling which are mainly exotic breeds brought from other countries (Bahaman et al., 2007).

Significant economic losses due to brucellosis have continued to plague farmers in Malaysia and reasons for the continued presence of brucellosis in livestock in Malaysia are multifaceted and greatly ramified. Speculations have blamed this largely on importation of goats from endemic countries and poor quarantine procedures for imported goats (Aziz et al., 2012). Malaysia is a rapidly advancing developing country with a Gross Domestic Product (GDP) of 11.52% and is the 4th most open economy in the world with exports and imports being the greatest contributor to its rapidly growing economy (Ahmed, 2012). Such massive economic losses will affect not only the livestock industry but also the national economy since agriculture is a significant contributor to the GDP of Malaysia contributing some 10.5% in total GDP with livestock contributing 7.6% to the agriculture sector (Vu, 2007) and brucellosis infection will surely hamper the economic growth of the livestock industry of Malaysia because it affects farmers. This could in turn affect the distribution of income among individuals and the economy of the nation in general (Mulok et al., 2012).

The economic impact across states and farms was not statistically significant as the impact of brucellosis is not related to where animals are from and which farm is involved. With infection of brucellosis it has the potential to devastate economically any region or farm (Seleem et al., 2010). For example one state may suffer the economic impact of brucellosis measured as RM 2000 because it had only 5 goats culled and another may suffer losses upto RM 20,000 because it lost 50 goats due to culling. The economic effect will be similar in both scenario considering the economic strength of each state farms.

In this study, the major indices for determining the economic impact of brucellosis was from the value of animals culled. Other economic impacts bordering on time lost and man hours due to brucellosis, losses in milk production and reduced fertility and other parameters were not measured due to lack of information and data. It is known that the goats value are based on the amount spend in feeding them, the time invested by the farmer in taking care of them, money spend on utilities on the farm and miscellaneous inputs in the farm. All these are taken into consideration before a farmer fixes a market value for his goats in order to not only break-even but also make profit for the farmer. So when such an animal is culled the farmer loses some money due to the culling but also gains a lot from the fact that other goats will not be infected and cause more severe losses to the farm in terms of abortions, weight loss, weak kids, decreased meat production, decreased sales of hide and skins, reduced milk production, missed reproductive cycles (Munoz-del et al., 2007).

It is worthy of note that in many countries including Malaysia goats are kept as source of revenue for the farmer and to help the family income and in

Table 4: Cost-Benefit Analysis for goat farming operation in four sampled states (monthly)

Name of farm	State	Total cost (RM)	Total Revenue (RM)	Income (RM)
Farm 1	Melaka	248325.93	324243.4	75917.47
Farm 2	Melaka	226668.2	297256.3	70588.1
Farm 3	Melaka	132606.8	170176.2	37569.4
Farm 4	Melaka	655462	844908	189446
Farm 5	Melaka	74991.61	95644.02	20652.41
Farm 6	Melaka	93840	121270	27430
Farm 7	Melaka	186109.49	249736.56	63627.07
Farm 8	Melaka	29795.6	28945.52	-850.08
Farm 9	Melaka	69979.07	87086.34	17107.27
Farm 10	Melaka	292512.92	369851.78	77338.86
Farm 11	Melaka	28275.11	30625.2	2350.09
Farm 12	Melaka	65189.67	80009.24	14819.57
Farm 13	Pulau Pinang	45190.75	53785.96	8595.21
Farm 14	Pulau Pinang	98656.8	126736.2	28079.4
Farm 15	Pulau Pinang	68599.32	81359.5	12760.18
Farm 16	Pulau Pinang	168726.24	220342.16	51615.92
Farm 17	Pulau Pinang	12933.78	16818.52	3884.74
Farm 18	Pulau Pinang	72220	86250.12	14030.12
Farm 19	Pulau Pinang	85120.44	108357.46	23237.02
Farm 20	Pulau Pinang	645803.92	838008.28	192204.36
Farm 21	Pulau Pinang	160170.9	205049.47	44878.57
Farm 22	Pulau Pinang	47016.18	61773.49	14757.31
Farm 23	Selangor	449487.34	600740.81	151253.47
Farm 24	Selangor	53940.18	70912.18	16972
Farm 25	Selangor	16601.41	15412.15	-1189.26
Farm 26	Selangor	233914.3	307048.4	73134.1
Farm 27	Selangor	135786.92	172112.9	36325.98
Farm 28	Selangor	27941.79	35600.89	7659.1
Farm 29	Selangor	101755.43	115092.47	13337.04
Farm 30	Selangor	18648.8	15059.2	-3589.6
Farm 31	Selangor	109043.78	140577.27	31533.49
Farm 32	Selangor	46847.78	61118.27	14270.49
Farm 33	Negeri Sembilan	281022.4	372606.6	91584.2
Farm 34	Negeri Sembilan	295301.43	377276.4	81974.97
Farm 35	Negeri Sembilan	12011.89	9388.47	-2623.42
Farm 36	Negeri Sembilan	236207.92	307446.6	71238.68
Farm 37	Negeri Sembilan	186043.78	241032.27	54988.49
Farm 38	Negeri Sembilan	88123.6	115007.4	26883.8
Farm 39	Negeri Sembilan	231342.32	301184	69841.68
Farm 40	Negeri Sembilan	36881.22	48115.23	11234.01
Farm 41	Negeri Sembilan	350240.48	464576.32	114335.84
Farm 42	Negeri Sembilan	747742.22	937732.04	189989.82
Total values		7,167,079.72	9,206,273.59	2,039,193.87
Mean		170,644.76	219,196.99	48,552.24

Table 5: Revenue, cost and income per state from goat farming based on sampled farms

	Revenue by state (RM)	Cost by state (RM)	Income by state (RM)
Melaka	2699752.56	2103756.4	595996.16
Pulau Pinang	1798481.16	1404438.33	394042.83
Selangor	1533674.54	1193967.73	339706.81
Negeri Sembilan	3174365.33	2464917.26	709448.07
Total	9206273.59	7167079.72	2039193.87

some cases farmers livelihood are completely dependent on these livestock (Mantur and Amarnath, 2008) which is a good means of alleviating poverty. Hence, any economic loss is very significant to the farmers. In Malaysia some compensation is paid to the farmers at RM5.60 per kg live body weight but this amount translates to just about 30% of the loss suffered by the farmers since on the average they can sale their goats at RM18.1 per kg live body weight. Such colossal losses can be very discouraging to farmers in the industry and aspiring farmers and is partly responsible for the persistence of brucellosis in Malaysia because

some farmers will prefer to hide their infected goats and sale quickly than allow them to be tested and culled due to brucellosis. When a farm is known to be positive for a disease such as brucellosis the farmer's animal marketability depreciates to the detriment of the farmer (Gürsoy, 2006; Kocho et al., 2011; Lamy et al., 2012).

Most of the farmers in our studied farms believe the losses they suffer is significant in spite of the compensation received which is just "consolation" to them and some claimed not to have received any compensation despite losing good breeder animals. Such factors weaken the business moral of farmers and discourage them from investing money, time and skill in the livestock industry. This will ultimately have a negative effect on the livestock industry in Malaysia which is struggling to develop.

Conclusion

Brucellosis has a significant economic impact on the livestock industry for production of goats. The losses incurred by farmers due to this worldwide zoonotic infection can be ameliorated by an upward review of the compensation the government pays to goat farmers to be commensurate with the losses incurred. In order to have an effective eradication program like in a few countries that succeeded there must be adequate monetary compensation by government to farmers (Blasco and Molina-Flores, 2011). The government can also help provide affordable insurance coverage for farmers to encourage them in this industry. In order to facilitate the importation of diseases free goats into Malaysia the quarantine facilities must be adequate and government and authorities concerned can also have a memoranda of understanding (MOU) with all the nations from which goats are imported to ensure that only brucellosis-free goats are imported into Malaysia. Vaccination of animals usually provides a better economic benefit and advantage to farmers than culling them (Peniche-Cardena et al., 2012) and should be practiced in Malaysia along with culling of infected goats. Government may also consider increasing the capacity of farmers to combat this infection by organizing enlightenments campaigns periodically throughout the Department of Veterinary Services of Malaysia which is usually helpful to farmers and animal health experts as well.

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References

Ahmed EM (2012). Are the FDI inflow spillover effects on Malaysia's economic growth input driven? Econ Mod 29: 1498-1504.

Anon (1995) Arab Organization for Agriculture Development (AOAD). Khartoum, Sudan.

Aziz AJ, Nor Shahidah K, Chua KB, Shamshad S (2012) Emerging Infectious Diseases- A Malaysian Perspective. Office international des epizooties representation for Asia and the Pacific. http://www.rrasia.oie.int/topics/detail011_03.html.

Bahaman AR, Joseph PG, Siti-Khairani B (2007) A Review of the Epidemiology and Control of Brucellosis in Malaysia. J Vet Malaysia 19: 1-6.

Bennett R (2003) The 'direct costs' of livestock disease: the development of a system of models for the analysis of 30 endemic livestock diseases in Great Britain. J Agric Econ 54: 55-71.

Bittner A (2004) An overview and the economic impacts associated with mandatory Brucellosis testing in Wyoming cattle. Wyoming Department of Administration and Information, Economic Analysis Division. Wyoming Department of Administration and Information, Economic Analysis Division. http://eadiv.state.wy.us/Special Reports/Brucellosis_report.pdf.

Blasco JM, Molina-Flores B (2011) Control and eradication of *Brucella melitensis* infection in sheep and goats. Vet Clin North Amer: Food Anim Prac 27: 95-104.

Brisibe F, Nawathe DR, Bot CJ (1996) Sheep and goat brucellosis in Borno and Yobe states of arid northeastern Nigeria. Small Rumin Res 20: 83-88.

DVS (2010) *Brucella melitensis* Veterinary Protocol Malaysia. Pages 1-21. Department of Veterinary Services, Malaysia. Department of Veterinary Services, Putrajaya, Malaysia, Putrajaya.

DVS (2011) Malaysia: Livestock Pupulation 2005-2010. Department of Veterinary Services, Ministry of Agriculture, Putrajaya, Malaysia.

Esposito S, Marchisio P, Bosis S, Lambertini L, Claut L, Faelli N, Bianchi C, Colombo GL, Principi N (2006) Clinical and economic impact of influenza vaccination on healthy children aged 2-5 years. Vaccine 24: 629-635.

Gürsoy O (2006) Economics and profitability of sheep and goat production in Turkey under new support regimes and market conditions. Small Rumin Res 62: 181-191.

Hegazy YM, Molina-Flores B, Shafik H, Ridler AL, Guitian FJ (2011). Ruminant brucellosis in Upper Egypt (2005-2008). Prev Vet Med 101: 173-181.

Horst HS, de Vos CJ, Tomassen FH, Stelwagen J (1999). The economic evaluation of control and

eradication of epidemic livestock diseases. Rev sci tech Off int Epiz 18: 367-379.

ILRI (2012) Mapping of poverty and likely zoonoses hotspots. Zoonoses Project 4. Report to Department for International Development, UK. P: 119. ILRI, Nairobi, Kenya.

Kaufmann AF, Meltzer MI, Schmid GP (1997) The economic impact of a bioterrorist attack: are prevention and postattack intervention programs justifiable? Emerg Inf Dis 3: 83-94.

Kocho T, Abebe G, Tegegne A, Gebremedhin B (2011) Marketing value-chain of smallholder sheep and goats in crop-livestock mixed farming system of Alaba, Southern Ethiopia. Small Rumin Res 96: 101-105.

Lamy E, Harten S, Sales-Baptista E, Guerra MM, Almeida AM (2012) Factors Influencing Livestock Productivity, Environmental Stress and Amelioration in Livestock Production. In: Sejian VS, Naqvi MK, Ezeji T, Lakritz. J, Lal R (editors) Springer Berlin Heidelberg. Pp: 19-51.

Mantur B, Amarnath, S (2008) Brucellosis in India - a review. J Biosci 33: 539-547.

Marsh W (1999) The economics of animal health in farmed livestock at the herd level. Rev sci tech Off int Epiz18:357-366.

Mcdermott J, Grace D, Zinsstag J (2013) Economics of brucellosis impact and control in low-income countries Framework for the economic assessment of brucellosis. Rev sci tech Off int Epiz 32: 249-261.

Mestawet TA, Girma A, Ådnøy T, Devold TG, Narvhus JA, Vegarud GE (2012) Milk production, composition and variation at different lactation stages of four goat breeds in Ethiopia. Small Rumin Res 105: 176-181.

Morris RS (1999) The application of economics in animal health programmes: a practical guide. Rev Sci Tech Int Off Epiz 18: 305-314.

Mowlem A (1992) Goat farming. 2nd edition. The Crowood Press, Trowbridge, Great Britain.

Mulok D, Kogid M, Asid R, Lily L (2012) Is economic growth sufficient for poverty alleviation? Empirical evidence from Malaysia. Cuadernos de Eco 35: 26-32.

Munoz-del RM, Montano MF, Renteria TB, Sanchez E, Moreno JF, Perez A, Saucedo S (2007) Assessment of the Economic Impact of a Brucellosis Control Program in A Dairy Herd Using the Partial Budget Method. JAVA 6: 146-151.

OIE (2009) Caprine and Ovine Brucellosis (Excluding *Brucella ovis*). Pages 2-8 *in* OIE, editor. Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2009. OIE-World Organization for Animal Health.

Peniche-Cardena A, Martinez-Herrera D, Franco-Zamora J, Canudas-Lara E, Barradas-Pina F, Molina-Sanchez B, Gutierrez-Ruiz EJ, Williams JDJ, Morales-Alvarez JF, Flores-Castro R (2012) Economic analysis of efficiency of RB51 strain vaccine of *Brucella abortus* applied in herds naturally infected with brucellosis in tropical climate. JAVA 11: 1784-1789.

Perry B, Grace D (2009) The impacts of livestock diseases and their control on growth and development processes that are pro-poor. Phil Trans Roy Soc B: Biol Sci 364: 2643-2655.

Perry BD (2002) Investing in animal health research to alleviate poverty. ILRI (aka ILCA and ILRAD).

Ramsay GC, Philip P, Riethmuller R (1999) The economic implications of animal diseases and disease control at the national level. Rev sci tech 18: 343-356.

Rushton J, Thornton PK, Otte MJ (1999) Methods of economic impact assesment. Rev sci tech Int Off Epi 18: 315-342.

Samartino LE (2002) Brucellosis in Argentina. Vet Micro 90: 71-80.

Schwaber MJ, Navon-Venezia S, Kaye KS, Ben-Ami R, Schwartz D, Carmeli Y (2006) Clinical and economic impact of bacteremia with extended-spectrum-β-lactamase-producing Enterobacteriaceae. Antimic Agents Chem 50: 1257-1262.

Seleem MN, Boyle SM, Sriranganathan N (2010) Brucellosis: A re-emerging zoonosis. Vet Micro 140: 392-398.

Shahaza O, Khairani-Bejo S, Zunita Z, Bahaman AR (2009) In-house rose bengal plate agglutination test (RBPT) for a rapid diagnosis of brucellosis in goats in Malaysia. Int J Trop Med 4: 116-118.

Sulima M, Venkataraman KS (2010) Economic losses due to *Brucella melitensis* infection in sheep and goats. Tamilnadu J Vet Anim Sci 6: 191-192.

Sullivan KM, Dean A, Soe MM (2009) OpenEpi: a web-based epidemiologic and statistical calculator for public health. Public Health Rep 124: 471-474.

Thrusfield M (2013) Veterinary epidemiology third edition. Blackwell Science.

Tisdell CA, Harrison SR, Ramsay GC (1999) The economic impacts of endemic diseases and disease control programmes. Rev sci tech Int Off Epiz 18: 380-398.

Vu T (2007) Rethinking the Traditional Concept of Livestock Services: A Study of Response Capacity in Thailand, Malaysia and Vietnam. Pro-Poor Livestock Policy Initiative 41: 1-60.

Zinsstag J, Schelling E, Roth F, Bonfoh B, de Savigny D, Tanner M (2007) Human benefits of animal interventions for zoonosis control. Emerging Inf Dis 13: 527.