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A cross-sectional survey of population demographics, the prevalence of major disease conditions and reason-specific proportional mortality of domestic cattle in the Kingdom of Bhutan

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ABSTRACT

We describe the population demographics, rudimentary measures of reproductive performance, the prevalence of major disease conditions and reason-specific proportional mortality for cattle owned by villagers in 16 dzongkhags (districts) in Bhutan based on the findings of a cross-sectional study carried out between March 2012 and May 2014. The animal health issues that were of concern for livestock owners are also identified. Study households were selected using a stratified, two-stage cluster design. Districts (dzongkhags) formed the strata. Villages within dzongkhags were the first sampling stage and households within villages the second sampling stage. All cattle within each selected household comprised the study population.

Questionnaires were collected from 409 households with 1480 standing cattle. A total of 71.0% (95% CI 67.9%–74.1%) of the standing cattle population were female and the median age of cattle was 5 years (Q25 3 years; Q75 7 years). Exotic breeds of cattle (Jerseys, Brown Swiss, and their crosses) comprised 41.4% of the cattle population with local breeds making up the remainder. Although exotic breeds of cattle had a significantly lower age at first calving (median 4 years) compared to local breeds (median 4.8 years) there was no significant difference in the number of calving events per cow for the two breed groups. Diarrhoea was the most prevalent disease condition with 2.8 (95% CI 1.5–4.6) cases per 100 animals followed by bovine enzootic haematuria with 1.9 (95% CI 1.0–3.3) cases per 100 animals. The most frequently cited cause of death was misadventure (proportional mortality 26.2%, 95% CI 15.7%–39.2%) followed by old age (17.8%, 95% CI 9.5%–29.4%). A lack of access to adequate fodder and pasture was the animal health issue that was cited by interviewees most frequently.

We provide no evidence that exotic breeds of cattle have superior reproductive performance compared with local breeds. The major cattle health concern cited by interviewees, lack of access to fodder, is likely to contribute to suboptimal productivity and the relatively high incidence of bovine enzootic haematuria in this population. We propose that a prospective cohort study of Bhutanese cattle is warranted to more fully elucidate factors affecting the productivity and longevity of cattle in Bhutan.

1. Introduction

Bhutan is a landlocked country located in the eastern Himalayas. It shares its borders with China to the north and India to the east, south, and west. There is wide diversity in agro-ecological zones within the country, with elevations ranging from 160 m above sea level in the south to more than 7000 m in the north (National Statistics Bureau, 2013). The country has three distinct climatic zones: subtropical, temperate and alpine which contribute to distinct patterns of vegetation coverage and livestock husbandry practices characterised by transhumant agro-pastoralism and sedentary livestock rearing systems (Namgay et al., 2014; Wangchuk et al., 2014).

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Cattle are a central component of livestock production in Bhutan. The role of cattle are diverse including provision of draught power, transport, manure for fertiliser and milk for human consumption (National Statistics Bureau, 2013). Although Bhutanese sedentary farms share similarities with crop-animal farming systems that are common throughout South Asia (Devendra and Sevilla, 2002), livestock production in Bhutan has some unique features. Part of Bhutanese culture is deeply grounded in a tantric form of Mahayana and Vajrayana Buddhism where, according to its principles, animals are not slaughtered and allowed to die from natural causes. Permits for livestock slaughterhouses are not issued by the Government in Bhutan and approximately 90% of beef for human consumption is imported from India and other countries (Ministry of Agriculture and Forests, 2013; Namgay et al., 2014).

Since 1985 the Government of Bhutan has encouraged livestock producers to keep dairy cattle and their crosses (referred to as 'exotic' breeds in the remainder of this paper) in an effort to improve the livelihood of small holder farmers (Phanchung et al., 2001; Samdup et al., 2010). While numbers of exotic cattle have steadily increased since 1985, little information is available to indicate how purebred dairy cattle and their crosses compare with local breeds in terms of longevity, fertility and milk production. If small holder dairy production is to provide long-term benefits to rural communities in Bhutan it is essential to collect baseline population data to quantify the rate at which cattle are removed from the population and to determine if mortality for exotic cattle differs from that of local breeds. We reason that the results of studies investigating risk factors for removal carried out in other countries cannot be directly extrapolated to Bhutan because, as explained above, culling (the removal of inferior, live cattle from herds) is not routinely used as a management technique.

A number of studies have been carried out in Bhutan to quantify the frequency of disease in domestic livestock including foot and mouth disease (Dukpa et al., 2010), rabies (Tenzin et al., 2012) and helminth infections (Tandon et al., 2005). A chronic, debilitating condition of cattle which causes continuous or intermittent passage of red urine has been recognised as a common disorder of cattle in Bhutan since the late 1990s (Sharma, 1999). Together with the widespread presence of bracken fern (*Pteridium* spp.) which grows in most areas of the country, the clinical signs and *post mortem* findings from affected animals indicate that bracken fern poisoning is the predominant cause of this condition, bovine enzootic haematuria (BEH) (Gil da Costa et al., 2012; Sharma et al., 2013). While BEH is often cited as an important health problem of cattle in Bhutan (Phanchung et al., 2001), it is important to make an assessment of the relative importance of BEH amongst other disease conditions affecting productivity. This is particularly important in a developing country because the resources available for disease control programs are often limited. The evaluation of the burden of disease in a population requires information on disorders that are present in the standing cattle population and reason-specific mortality. To the best of our knowledge, there is little quantitative data on either of these measures in Bhutan.

We conducted a cross-sectional study of the Bhutanese cattle population between March 2012 and May 2014. Our objectives were to: (1) describe the age distribution of the standing local breed and exotic cattle population; (2) quantify the prevalence of clinical disorders in the standing cattle population; (3) quantify reason-specific proportional mortality for cattle that were removed from herds between 2010 and 2012; and (4) identify the animal health issues that were of greatest concern for livestock owners. Collectively, this information identifies the major sources of productivity losses in the Bhutanese cattle population. In turn, this allows animal health authorities to better-prioritise the level of intervention effort applied to each of the animal disease control programs under their management.

2. Materials and methods

This study is reported in compliance with the STROBE statement (von Elm et al., 2007).

2.1. Study area and study design

The total land area of Bhutan is 38,394 km^2, approximately 17% of the size of Great Britain. The country is divided into 20 primary administrative areas called dzongkhags (districts). Dzongkhags are further divided into secondary administrative areas called geogs ($n = 205$). Each geog has an animal health extension centre staffed by paraveterinarians who look after routine activities such as administration of vaccines and provision of diagnostic and treatment services to local livestock owners. Each dzongkhag has a district veterinary hospital (DVH) staffed by veterinarians and laboratory personnel who investigate more complex animal health issues that are not handled by paraveterinarians from the local extension centres. The DVHs are further supported technically by Regional Livestock Development Centres (RLDCs), each of which cover one of four jurisdiction regions (Fig. 1). The National Centre for Animal Health (NCAH) located in the national capital Thimphu, provides technical support on all matters related to animal health to each of the RLDCs and DVHs.

This was a cross-sectional study carried out between March 2012 and May 2014. Study households were selected using a stratified, two-stage cluster design. Sixteen dzongkhags from the 20 dzongkhags in Bhutan were purposively selected (Fig. 1) and treated as strata. Villages within dzongkhags comprised the first sampling stage and households within villages the secondary sampling stage. Details were collected for all cattle within each selected household. A digital map of settlement locations in Bhutan (Lham, 2000) provided the sampling frame of 3535 villages in the 16 dzongkhags for the first stage of sampling.

Cattle managed as a single group within individual households were the units of interest. Information on cattle within each household was solicited from household owners using a questionnaire. Questionnaires were administered by staff from the geog animal health extension centres and DVHs with support from the RLDCs. Training sessions on sampling and questionnaire administration were conducted for geog extension centre and DVH staff at each of the four RLDCs in February and March 2012 and April 2014.

2.2. Sample size calculations and household selection

Sample size calculations were carried out to determine the appropriate number of villages and households to be selected to achieve the objectives of our study. Sample size calculations were carried out for each of the quantifiable study outcomes and the largest of these estimates used as the target sample size for the study. Because cattle were clustered within individual households, we applied a conservative design effect of 3 to our crude sample size calculations to increase the required sample size to account for lack of independence in the data.

A total of 1152 individual cattle needed to be sampled to be 95% confident that our estimate of the population mean age (in years) was within 6 months of the true population value assuming the standard deviation of age was five and a design effect of 3. The number of households that needed to be sampled was 384 assuming that, on average, there were three cattle per household. The final number of households to be selected was 640 assuming that only 60% of the households selected for the study could actually be sampled. Because one household was selected per village the total number of villages required was also 640. The number of villages to be sampled in each dzongkhag was determined based on the proportion of the total cattle population in each dzongkhag. A spa-