STATUS FOR CONTROLLING BOVINE TUBERCULOSIS IN AFRICA

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ABSTRACT
Bovine tuberculosis (TB), caused by *Mycobacterium bovis,* is a serious problem for a developing dairy industry in Africa as its main route of transmission is through milk products. Informal milk production with lack of adequate pasteurisation is not uncommon in rural Africa and milk from infected cows is particularly dangerous for young children: those who most need the nutritive value of milk to supplement an inadequate diet. Bovine TB also poses an occupational risk for those working with dairy cattle as it can be inhaled. The high prevalence of HIV infection makes this risk even higher for workers in developing countries. The symptoms of *M. bovis* infection in humans, which include swelling of the lymph-nodes of the neck, tubercles in the intestines and abdominal cavity, skin tuberculosis or even primary lung TB in workers who inhale the bacillus, are not easily differentiated from human TB caused by *M. tuberculosis*. Dairy cattle can become infected with human TB by infected workers, and, although the infection is transient, *M. tuberculosis* can contaminate milk or be spread by droplets from a cow with a respiratory infection to other workers. In dairy cattle bovine TB is incurable and valuable breeding stock may easily be lost through death or slaughter. This can be of considerable socio-economic importance in developing countries where replacement of equivalent breeding stock may be unaffordable. Literature reports indicate that approximately 85% of the cattle and 82% of the human population of Africa are in areas where bovine TB is either partly controlled or not controlled at all. The lack of veterinary infrastructure required for the surveillance and control of TB in cattle may be one of the main reasons for this. Possibilities for better control include alternate methods of diagnosis and/or an effective vaccine.

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INTRODUCTION
Tuberculosis is caused by acid fast bacteria of the members of the *Mycobacterium tuberculosis* complex. This disease manifests in cattle as tubercles, which typically consist of a necrotic caseous core surrounded by granulomatous inflammation. These tubercles can be found in any organs but are most common in the lymphnodes, particularly of the mammary gland and lungs [2,3].

The mycobacteria included in the so-called "tuberculosis complex", which contains the species *M. tuberculosis, M. bovis, M. caprae*, *M. africanum*, *M. microti, M. canetti*i and *M. pinnipedii* are all obligate pathogens that cause typical tubercles in humans and/or animals. *M. bovis*, which causes bovine tuberculosis, affects a wide variety of animals, including humans [1, 3, 6]. It can survive for up to two years, in soil or manure and possibly even longer in sputum [2, 9, 17]. The humidity of the climate probably plays a role in this, and it can be assumed that survival of the pathogen is shorter in arid areas such as are found on the South Western part of Africa that it would be in tropical areas such as Central Africa. It can be transmitted between cattle percutaneously, by oral ingestion, venereally and though the teat canal [2]. However the main route is through inhalation of infected droplets from another animal or dried secretions in dust. The congenital route is also important and calves may be born with bovine tuberculosis. Humans with open tuberculosis caused by *M. bovis*, can transmit it to cattle by the aerogenous route, spitting, coughing or urinating [2]. It is this organism that is of significant economic importance to the dairy farmer, as world-wide control measures are in place to slaughter cows that are found to be positive on intra-dermal tuberculin tests. The carcasses are condemned, resulting in a total loss of income for the farmer [10,11].

M avium and *M tuberculosis* can also infect cattle and cause a positive reaction to tuberculin, but are regarded as transient infections [5, 10, 16]. However, localised lesions can develop in infected cows and may persist for a number of months [2]. The zoonotic transfer of *M.bovis* to humans via un-pasteurised milk and droplet inhalation from coughing cows, is well known [3, 4, 6, 8,14]. A single infected cow can contaminate the bulk milk produced by 100 other

cows and still cause infection in a susceptible human [2]. Extra-pulmonary tuberculosis is almost always due to drinking infected cow's milk. *M. tuberculosis* is most often found in cows in close contact with infected humans [2, 8,14]. *M avium*, which is also common in the environment, is regarded as an opportunistic infection of both cows and humans and is now considered to be a major opportunistic infection in immuno-compromised humans [2]. A variety of different mycobacteria, including *M tuberculosis,* have also recently been isolated from dairy cattle and milk in Tanzania [8].

Human immunodeficiency virus infection (HIV) has become widespread worldwide and is frequently followed by secondary infection with *Mycobacterium* spp.. In geographic areas where the climatic humidity and population density is high, the risk of transfer of infection between dairy cows and dairy workers is high, particularly if these workers are immuno-compromised [4, 11]. This paper explores the constraints and opportunities for the control of tuberculosis is dairy cattle in Africa.

THE LIVESTOCK/ CATTLE INTERFACE IN AFRICA

In Africa there is a dichotomy between commercial dairy production from specialised dairy breeds, often of European origin, and traditional milk harvesting from extensively managed cattle. It can be accepted that commercial farming systems are in essence similar to those in other parts of the world and are characterised by intensive management of production and diseases. Milking is done by machine and there is little direct contact between milker and cow. Although these herds are in a minority in Africa, most of them are regularly tested for tuberculosis and positive reactors are culled, in line with the recommendations of the OIE [14]. The risk of zoonotic transmission is also reduced because the milk of these herds is pasteurised or further processed at temperatures known to destroy pathogenic Mycobacteria. In addition, some small scale farmers (most recently in Zimbabwe) follow the "Heifer International" zero-grazing model where one to three specialised dairy cows are kept per villager and there is a communal milk harvesting and marketing scheme in place [7].

Pastoral and traditional milk harvesting is far more common than the commercial system described above and probably constitutes the 85% of herds described by Cosivi [4] as not being tested for Tuberculosis. Traditionally in Africa, cows suckle their calves and are milked at the same time. Usually the cow is separated from the calf for about 12 hours, either at night or, more usually, during the day and milked as the calf is returned to her. People live closer to the animals. Due to hand milking, the contact between cow and human is also much closer and there is a good possibility that droplet-mediated transmission of tuberculosis could occur – an infected human could exhale contaminated particles into the bucket of milk or at the cow. An infected cow could, in turn, produce milk containing mycobacteria, or cough infected droplets in the direction of the milker. Milk is seldom pasteurised in pastoral societies, and, even if soured, can still contain infective levels of mycobacteria [2,8]. Animals in traditional African farming systems are seldom culled and there is a greater chance for chronic tuberculosis in old cows, particularly those subjected to stress [12]. The level of testing and control of bovine tuberculosis in Africa is also considerably constrained by the lack of infrastructure, both veterinary and transport related [8]. Transhumance means that cattle herds are not sedentary and may move hundreds of kilometres a year. In many countries in Africa, access to the herds is difficult due to lack of roads or areas that become inundated during the rainy season. Even when cows are infected, it is difficult to force culling, because the cattle value is deeply interwoven with the social system and they are the savings of the rural poor [12].

IMMUNODEFICIENCY IN HUMANS

The incidence of human tuberculosis increased globally in 2003, but incidence, prevalence, and death rates were approximately stable or decreased in all countries except Africa**.** Of the 15 counties in the world with the highest rates of tuberculosis, 13 are in Africa. It is estimated that 2.4 million Africans become infected and 540 000 die annually from the disease [13, 14,15]. HIV infection results in humans becoming much more susceptible to all forms of tuberculosis and it is estimated that 50% or more of new cases are related to prior HIV infection [15]. This not only poses a risk for other humans but also results in cows being

exposed to far higher levels of *M. tuberculosis* and other Mycobacteria than was previously the case. Mixed infections of different *M. tuberculosis* strains in the same patient have also been demonstrated [18]. The cycle of tuberculosis infection between HIV positive workers and cows, has yet to be fully explored.

CONSTRAINTS TO DIAGNOSIS AND CONTROL

In countries where there is a high or unknown incidence of tuberculosis in cattle and dairy products face trade barriers. Yet a large proportion of the countries in Africa do not have control measures in place (Figs 1,2 and 3).

*Figs 1,2 and 3 Control measures for bovine tuberculosis based on test-and-slaughter policy and disease notification, Africa .

According to Cosivi, 1998, of 55 African countries investigated, 25 reported sporadic or low occurrence of bovine tuberculosis; six reported enzootic disease; two, Malawi and Mali, were described as having a high occurrence; four did not report the disease; and the remaining 18 countries did not have data . Of all the nations in Africa, only seven applied disease control measures as part of a test-and-slaughter policy and consider it as a notifiable disease; the remaining 48 control the disease inadequately or not at all. Only about 15% of the cattle population in Africa are found in countries where bovine tuberculosis is a notifiable disease and a test-and-slaughter policy is used. Thus, approximately 85% of the cattle and 82% of the human population of Africa are in areas where bovine TB is either partly controlled or not controlled at all [4].

Currently the gold standard for the control of tuberculosis internationally is the intra-dermal tuberculin test. The main disadvantage of this test in Africa is that it requires a highly trained individual for interpretation and the veterinarian has to return to the herd to inspect the cattle 72 hours later [10,19]. Veterinarians and suitably trained personnel are scarce, distances are long and road networks inadequate [8, 12]. It may be totally unaffordable and impractical for a veterinarian to get back to the farm to check the cows. If the herd is moving from one area to another, it may also not be possible to find the same cows on a subsequent visit. Routine surveillance of abattoirs for positive carcasses, as used in developed countries, is also not possible in many African countries as there are few abattoirs and more than 50% of slaughter may take place informally with no meat inspection [12].

Other, newer techniques have been evolved for the diagnosis of bovine tuberculosis. They are based on genetic typing and research into cellular and humoral responses to infection with *M.bovis* [11]. One of the new tests that is being used with success in Australia and also for testing African Buffalo in South Africa, is the Interferon Gamma Assay. Currently, the two main limitations are the facts that the sample must reach the laboratory within seven to eight hours, and the infrastructure required to process the blood is sophisticated and expensive [2, 11]. However, the main advantage is that the diagnosis is based on a single blood test and it is known from experience with other animal diseases that lay persons with minimal training are able to collect blood from cattle. It also means one visit to the herd, which halves the cost of transport. Marking of the animals and trace-back of the herd following laboratory diagnosis remain a problem. However, even knowing the real extent of the disease in cattle and the strains involved, would already contribute to the management of bovine tuberculosis in Africa.

CONCLUSIONS

It has been stated [16] that eradication of tuberculosis on a national scale is only possible if there is:

- Full control of all movements of cattle
- Compulsory identification
- Payment of compensation for slaughter of positive reactors
- Compulsory testing of all cattle within specified intervals

- Establishment of disease free areas
- Sufficient funds and manpower to fulfil the task

It is fair to say that these conditions only apply to a few countries in Africa. Therefore alternatives will have to be found. Some possibilities worthwhile considering are the development of a vaccine, use of the Interferon gamma test to identify herds or areas with a high prevalence which can then be targeted for a short-term, high impact control strategy, but most important of all, to inform owners of cattle about the risks of bovine tuberculosis and the necessity for pasteurisation of milk and inspection of carcasses after slaughter.

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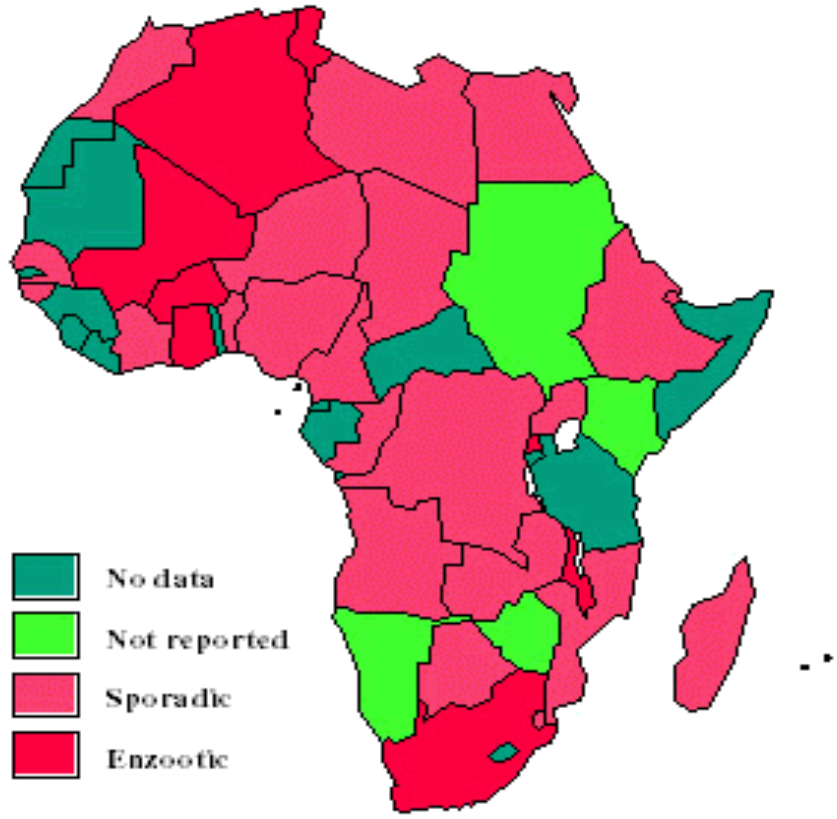

Figure 1: Distribution o f BTB in Africa, after Cosivi *et al* (1998) modified by Michel, 2006

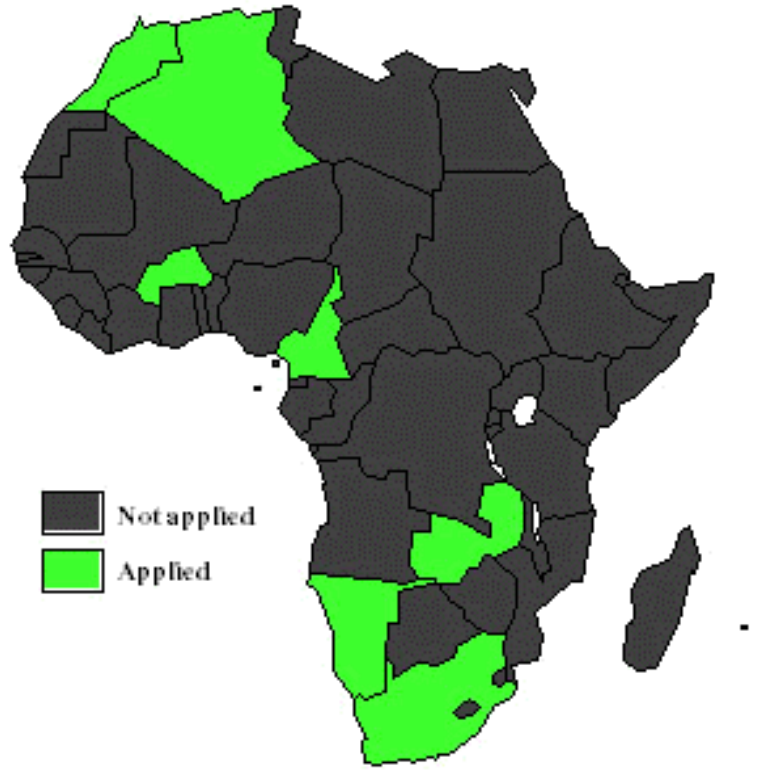

Figure 2: Control measures for BTB based on test-and-slaughter policy and disease notification, Africa
(After Cosivi et al, 1998).

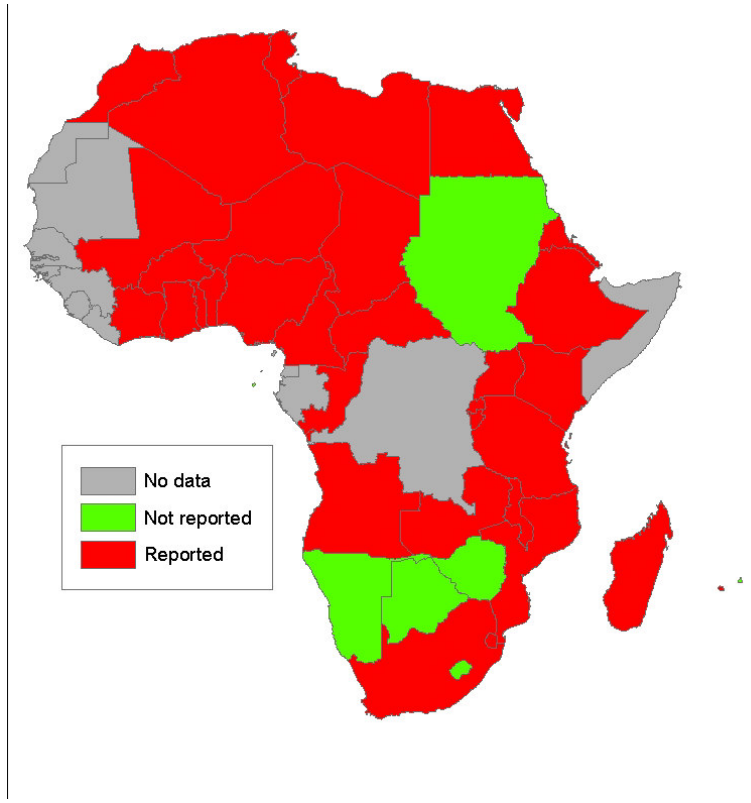

Figure 3: BTB in Africa, 2004, map drawn by R Williams (OVI/ARC) from OIE reports for 2004