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Review of livestock pathology in the central African region: epidemiological considerations and control strategies

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Abstract — Disease has consistently featured among the major constraints of livestock production in the central African region, causing important economic losses. This article reviews livestock diseases of economic importance, the major ones of which include foot-and-mouth disease, trypanosomiasis and dermatophilosis in cattle, peste-des-petits-ruminants virus and gastrointestinal helminthiasis in sheep and goats, and Newcastle disease in poultry. Some aspects of epidemiology such as pathogen identification, prevalence and risk factors are examined in the light of research findings in the region. Control tools such as vaccines, chemotherapeutic/prophylactic agents and protocols developed for their efficiency have also been reviewed. Constraints hindering the effective use of tools have been identified as mostly due to institutional inadequacy. Measures for improvement are proposed, including the promotion of private professional veterinary services with greater responsibility in animal health care, creation and promotion of community-based animal health care units in areas of marginal professional coverage and the adoption of a regional approach to the control of diseases of economic importance.

Résumé — *Revue bibliographiques sur les pathologies animales dans la région de l'Afrique centrale : quelques aspects épidémiologiques et stratégies de contrôle. La maladie a été identifiée à plusieurs reprises comme la contrainte majeure de l'élevage en Afrique centrale, avec des pertes économiques conséquentes importantes. Cet article propose une synthèse bibliographique sur les maladies recouvrant une importance économique comme la fièvre aphteuse, le trypanosomose et la dermatophilose chez les bovins, la peste des petits ruminants et les helminthoses gastrointestinales des moutons et des chèvres et la maladie de Newcastle des volailles. Quelques aspects épidémiologiques tels que l'identification des pathogènes, la prévalence et les facteurs de risque sont traités dans le cadre des résultats de recherche dans la région. Les outils de contrôle de la maladie tels que les vaccins, les produits chimiothérapeutiques/chimioprophylactiques et les protocoles de leurs utilisation sont examinés. Les contraintes liées à l'utilisation efficace de ces outils relèvent en grande partie d'insuffisances institutionnelles. Des mesures d'amélioration sont proposées comme la promotion de services vétérinaires privés tout en leur accordant davantage de responsabilités dans la gestion de la santé animale, la création et promotion de services de santé animale communautaires dans les régions faiblement couverte, et l'adoption d'une approche régionale de contrôle des maladie d'importance économique.*

Introduction

In the semi-arid and sub-humid regions of sub-Saharan Africa, livestock play an important socio-economic role in the lives of rural people on a micro-level and of the entire population on a large scale. As a result of a changing environment, livestock systems are evolving rapidly from extensive nomadic and transhumant systems to semi-sedentary and fully sedentary ones integrated with cropping. De Leeuw et al. (1995) stressed that relevant and adequate information is essential for decision-making aimed at optimising the performance of these systems. In a review of the state of veterinary epidemiology, James (2005) notes that the acquisition and availability of such information remain the principal constraints to the application of available epidemiological techniques in disease monitoring and control. Meanwhile

disease has consistently featured among the major constraints of livestock production in the region (Awa et al., 2004; Thys et al., 2005). An estimated 10 million km^2 of land in the humid and sub-humid regions of sub-Saharan Africa are tsetse infested (Van den Bossche and Chigoma, 2001) and about 30% of cattle in the region graze on the fringes of infested zones (Black *et al.,* 2001). Both direct losses through infections and indirect losses arising from the unsuitability of tsetse-infested areas to livestock rearing in sub-Saharan Africa were estimated at US $5 million per year (ILRAD, 1994). Pathologies of similar economic importance include dermatophilosis and foot-and-mouth in cattle (Achukwi and Saliki, 1990; Sow *et al.,* 2005; Awa *et al.,* 2004, 2008), peste-des-petits-ruminants virus and gastrointestinal helminthiasis (Ndamukong *et al.,* 1989; Awa *et al.,* 2002; Njoya *et al.,* 2005), and Newcastle disease in poultry (Maho *et al.,* 2004; Mopaté and Maho, 2005; Awa *et al.,* 2008).

Meanwhile, in most countries of the region, the measures taken to reduce disease prevalence are often ineffective. This is due to several factors, including the difficulties involved in controlling animal movements and the government's inability to set up sustainable disease monitoring and control operations. However, the most important factor may be the poor organisation of the animal health sector and the services it offers. In the central African region about two decades ago, animal health care shifted from being a state monopoly to a shared responsibility with veterinarians in private practice. Most of the latter, however, struggle to survive for several reasons, including the lack of initial investment capital, the intrusion of charlatans into the profession and state restrictions on their service mandate.

The objective of this paper is to review and update information on animal health and health management, which is useful in the identification of new constraints, as a first step towards research and development priority definition.

Information sources

This review is principally based on research carried out in the sub-humid and semi-arid savannah zones of the central African states of Cameroon, Chad and the Central African Republic (RCA), either within the framework of national research programmes, projects initiated by individual researchers or regional projects such as the *Projet Régional de Recherche sur les Petits Ruminants* (PRRPR) involving Cameroon, Chad and Niger, the *Pôle Régional de Recherche Appliquée au Développement des Savanes d'Afrique Centrale* (PRASAC), involving Cameroon, Chad and the Central African Republic, and the *Projet Garoua* in Cameroon. Data were generated through surveys, observational studies and experimentation covering a period of about two decades from the late 1980s. Aspects of livestock pathology investigated include disease epidemiology (pathogen identification, disease quantification, identification of risk factors), development and tests of treatment and control methods, as well as an analysis of existing animal health care delivery systems. The principal livestock species include cattle, small ruminants (sheep and goats) and poultry. Some of the information included comes from the authors' unpublished findings.

Bovine pathology (microbial and parasitic)

Endemic bacterial diseases of cattle in the region, such as pasteurellosis, black quarter, anthrax and contagious bovine pleuropneumonia, are generally kept under reasonable control through annual vaccination campaigns and, therefore, epidemic outbreaks are rare. There has been no vaccination against viral diseases ever since the Rinderpest vaccination was stopped in Cameroon almost a decade ago, as a first step towards declaring the country free of the disease. The Rinderpest situation is similar in Chad. However, in the Central African Republic (RCA), outbreaks are still reported along the borders with Sudan.

In the region, the cattle diseases of primary economic importance, which are not vaccinated against, are dermatophilosis, foot-and-mouth disease (FMD) and trypanosomiasis (Awa *et al.,* 2004, 2008; Bayemi *et al.,* 2005).

Dermatophilosis

Bovine dermatophilosis caused by *Dermatophilus congolensis* occurs worldwide. It is of particular importance in the warm humid tropics were it is prevalent and causes considerable economic losses (Faibra, 1989; Hermeso de Mendosa *et al.,* 1994; Chitikobo *et al.,* 2004). Studies in Cameroon indicated

that the disease is an important cause of production loss and is the third most important cause of milk loss in zebu/exotic cross dairy cattle (Mbah, 1982; Tanya and Salah, 1985; Bayemi *et al.,* 2005). In north Cameroon, loss in milk production and skin value due to the disease in a high prevalence herd, scaled to 100 head of cattle, were estimated at over 1.7 million francs annually (Awa *et al.,* 2009).

Farmers in the central African region identify dermatophilosis as an important endemic condition with a herd prevalence of > 90% (Awa *et al.,* 2004, 2008). Prevalence at individual animal level of 1.8% is decreasing in southern Chad compared to 10-40% reported by Faibra (1989). However, it is worth noting that survey data may underestimate prevalence because culling due to the disease is common and more cases are found in cattle markets and slaughterhouses. Recent studies (Awa *et al.,* 2009) revealed an incidence of 32% within 3 months in research zebu cattle in north Cameroon, giving an indication of a higher prevalence than previously reported (CZR, 1988).

It has been widely documented that temperate cattle breeds and their crosses with the tropical zebu are more susceptible to dermatophilosis than pure zebus. Recent studies have also revealed that clinical prevalence is higher in sedentary than in transhumant zebu herds (Awa *et al.,* 2009), which is explained by factors relating to the different livestock systems. Sedentary herds tend to have closer animal-to-animal contact, which favours pathogen transmission (Woldemeskel and Taye, 2002). Furthermore, intensive practices common to sedentary herds, such as permanent grazing space and night enclosures, favour the concentration of pathogens and their vectors.

The association of dermatophilosis with infestation by the tick *Amblyomma variegatum* has been extensively documented (Stachurski *et al.,* 1993; Camus and Barre, 1995; Lloyd and Walker, 1996; Molia *et al.,* 2008). Livestock owners in the region are aware of this and place a lot of importance on tick control as a preventive measure.

Foot-and-mouth disease (FMD)

Foot-and-mouth disease (FMD), also known as aphthous fever, is a viral disease of cloven-footed animals caused by an aphthovirus from the Picornaviridae family. It is endemic in Africa, causing economic losses in cattle through calf mortality, drop in milk production, loss in weight gain and loss of draught value (Abel *et al.,* 1992, Awa *et al.,* 2006). Seven known serotypes of the virus exist and antibodies from one serotype do not cross-protect against another. For this reason, up to four outbreaks per year may be reported in the same herds in the region. A sero-neutralisation test against the 7 serotypes on serum, obtained from cattle recovering from natural infection in north Cameroon (Tanya, 1985), gave strongly positive results for types A, Asia 1, Sat1 and Sat3 and weakly positive results for types O, C and Sat2. Although the author wondered if the weak positive results were due to cross-reactions, he concluded that the existence of all the serotypes in the region was very likely. Four years later, the National Veterinary Laboratory (LANAVET) of Cameroon detected a high titre of antibodies against type O, using an unspecified serological test in samples from infected cattle from the same area as the previous study. Meanwhile, the same laboratory had earlier confirmed the presence of antibodies against types A, O, Sat1, Sat2 and Sat3 from the North West Province of Cameroon. Ekue *et al.,* (1989) indicated that types A and O are prevalent in the high plateaux of the west and the Adamawa regions of Cameroon. Recently, more accurate molecular tools have permitted in-depth studies of FMD in the Adamawa region of north Cameroon, confirming the existence of types O, A and Sat 2, with an average clinical prevalence of 60% over 12 months (Bronsvoort *et al.,* 2004a,b). The authors concluded that the high level of endemicity and the potential for disease spread present a significant challenge for control and eradication.

Trypanosomiasis

In the central African region, bovine trypanosomiasis caused by both *Trypanosoma vivax* and *T. congolense* is prevalent in areas where rainfall is above 1000 mm (Awa *et al.,* 2004). In these areas, it is considered the most important cattle disease. Parasitaemia prevalence varies from 7% in areas of low vector density to up to 50% in areas of high vector density. The latter are thus not suitable for permanent cattle rearing. Instead, they are frequented in the dry season by transhumant herds in search of food and water. During such periods, the vector population decreases, although the disease remains a threat. Herd owners recognize the importance of treating their animals with trypanocides on return from transhumance (Awa *et al.,* 2006).

Losses in production due to trypanosomiasis have been well documented. Rowlands *et al.,* (1999) found that there was a decrease of 57% in calf mortality and an increase of 8% in adult male body weight of cattle on a farm, where trypanocides and vector control were used over a 10-year period in the Ethiopian highland region. In the tsetse zone of the Benue valley of north Cameroon, a mean weight difference of 49 kg was observed between treated and untreated zebu cattle over 4 months during peak vector activity (Awa and Ndamkou, 2006).

Small ruminant pathology

Peste-des-petits-ruminants virus and gastrointestinal helminthiasis have been identified as the most important diseases of sheep and goats (high mortality rates) in the region (Martrenchar *et al.,* 1997, Njoya *et al.,* 1997).

Peste-des-petits-ruminants virus

Peste-des-petits-ruminants virus (PPR) caused by a paramyxovirus is an important disease of small ruminants. It is widespread in the sub-Saharan belt of Africa (Roeder *et al.,* 1994). It is considered as the primary cause of small ruminant mortality in the region. Epidemics occur annually during particular periods of the year, which vary slightly from one area to another. Flock mortalities are generally above 50% and sometimes even higher than 80% (Idriss *et al.,* 1989; Awa and Ngo Tama, 1997). Goats are generally more susceptible than sheep and dwarf goats are more susceptible than the Sahel breed, according to the findings of Idriss *et al.,* (1989). According to farmer reports in the savannah region of central Africa, epidemics mainly occur during the cold dry period from November to January.

Pathogens of importance that could complicate the epizootiology of the respiratory pathology of small ruminants are *Pasteurella multocida* and *Mycoplasma* spp. Martrenchar *et al.,* (1995) identified several serotypes of *P. multocida* and suggested that they play a significant role in the respiratory tract pathology of small ruminants. Although they also isolated *Mycoplasma mycoides* subsp *mycoides* and *M. ovipneumoniae* from apparently healthy animals, no clinical cases have been recorded.

Gastrointestinal helminthiasis

Nematodes and cestodes in the gastrointestinal tract of sheep and goats have been shown to contribute significantly to high mortality rates (Ndamukong *et al.,* 1986, 1989; Awa and Njoya, 1997). A post-mortem examination conducted on sheep that died at the IRAD Garoua research station in 1994, revealed the presence of the nematodes *Haemonchus contortus, Trichostrongylus colubriformis, Oesophagostomum columbianum, Gaigeria pachyscelis, Bunostomum trigonocephalum* and *Trichuris glubolusa*, and the cestode *Moniezia expenza*. Up to 75% of mortalities were attributed to helminth infections, particularly haemonchosis and monieziosis. There was evidence of resistance of *H. contortus* to benzimidazoles. In farmers' flocks, diarrhoea is a frequent disease symptom observed throughout the rainy season and often associated with helminth infections.

Poultry pathology

Avian pathology as a constraint to poultry production is not specific to this region, it is a continent-wide problem. Newcastle disease (ND) features as the most important health problem (Mopaté and Idriss, 2001; Alabi and Isah, 2002; Maho *et al.,* 2004; Awa *et al.,* 2004, 2008; Mopaté and Maho, 2005), particularly for traditional poultry production, where vaccination is not routinely carried out. In the semi-arid and arid regions of Cameroon and Chad, two epidemic periods have been noted: the first peak during the intense heat of March and April and the second in the cold dry months of December and January, causing mortality that varies from 70 to 100% (Awa and Ngo Tama, 1997; Maho *et al.,* 2004; Mopaté and Maho, 2005; Awa et al., 2008). At present, the role of Gumboro disease in traditional poultry is rather ill defined. However, its importance in intensive production units has been underlined (Alabi and Isah, 2002).

Factors that favour high disease prevalence and epidemics include poor access to veterinary services and medication, poor housing (Swatson *et al.,* 2001; Awa *et al.,* 2006) and dissemination through gifts and precipitated sales of birds exposed to the disease during outbreaks (Maho *et al.,* 2004; Nzietchueng *et al.,* 2007).

Pig pathology

In the central African region, pig diseases of economic importance include haemorrhagic diseases, such as erysipelas, and particularly African swine fever (ASF). However, these conditions are limited to the humid regions of the south where epidemics are frequent, causing enormous economic losses (Ekue and Tanya, 1985). A serological survey in the semi-arid North and Far North Provinces of Cameroon (Awa *et al.,* 1999) revealed the absence of ASF antibodies. This finding, combined with the fact that no outbreak has ever been reported, led the authors to the conclusion that the region was free of the virus.

Therefore, although pig production in the savannah region is not limited economically by pathological problems, it is associated with pathogens that are a risk to public health. In Garoua, a prevalence of tuberculous lesions (33%) and cysts from the human tapeworm *Taenia solium* (12%) were recorded in slaughtered pigs (Awa *et al.,* 1999). In a recent study, Mopaté *et al.* (2009) used a less sensitive technique, namely the oral examination of live pigs, and recorded a prevalence of 10% in Pala (South Chad) and 6.4% in Garoua. This situation is favoured by the prevailing practices, where pigs roam freely and have easy access to pathogens from human waste.

Control and prevention strategies

Disease control and prevention strategies include prophylactic treatments to keep endemic conditions at acceptably low levels, immunisation of animals through vaccinations, fight against disease vectors and adopting livestock practices that minimise the risk of exposure.

Farmer solutions

The presence of both state and private veterinary services in the field is insufficient overall in the region. Therefore, in most cases the farmers take the initiative to manage the health of their animals. A sectorial study of veterinary inputs and services in Cameroon, Chad and the Central African Republic (Mal Mal *et al.,* 2009) revealed that practically all livestock owners rely on modern drugs for treatment and prophylaxis, with 20 to 30% associating this with traditional remedies. Cattle are privileged for treatment, while sick small ruminants and poultry are more often salvaged for consumption. The majority of farmers buy drugs from the village markets and it is difficult to evaluate their quality, since both veterinarians in private practice and quack drug dealers frequent the same markets.

The most commonly used drugs are trypanocides and antibiotics. Anthelmintics are used to a lesser extent. Farmers seem to be well informed about dosing trypanocides. On the other hand, antibiotics are administered in sub-normal doses in virtually all cases. Although Miller *et al.* (2006) indicate that there is evidence of substantial gains in productivity from the use of antimicrobials by farmers, possible development of multiple resistance, as a result of under-dosing and the use of inappropriate antimicrobial agents, is a cause for concern.

Traditional pharmaceutical agents are primarily of plant origin (salts derived from plant ashes, extracts from tree bark and leaves). They are of a wide range, including unusual substances like cow milk injections for the treatment of lumpy skin disease and animal urine and donkey faeces for FMD. Medicinal plants in common use include *Khaya senegalensis*, *Vitellaria paradoxa* and *Acacia albida.* The most targeted diseases are trypanosomiasis and FMD. The practice of traditional medicine is more common among the traditional cattle producers. Schillhorn van Veen (2005) asserts that although abuse and quackery exist in the practice of ethno-veterinary medicine, the practice seems to make sense in areas lacking adequate veterinary services. Its use empowers farmers seeking to solve their herd health problems more cost-effectively.

Role of state and private animal health services

For a long time, national ministries of livestock in the region enjoyed an exclusive mandate to administer veterinary services to farmers. This lasted until the early 1990s when the veterinary profession was liberalised and those in private practice were permitted to share the responsibility. In most cases, the private veterinarians' mandate has been limited to clinical operations and drug sales. Mass vaccination campaigns and major disease surveillance and interventions remain the exclusive responsibility of state veterinary services. Activities in this domain are directly under the ministries of livestock in Chad and Cameroon. However, in RCA the responsibility has been given to a special body, the *Agence Nationale du Développement de l'Elevage* (ANDE), affiliated to the ministry of livestock (Mal Mal *et al.,* 2009).

Farmers complain that the presence of state veterinary services is felt only during cattle vaccination campaigns. These usually take place once a year, except in cases of emergency. The private veterinarians see their exclusion from vaccination campaigns as a major setback to their progress. Veterinary centres are often located too far away from farmers. They offer minimal clinical and pharmaceutical services because private veterinary clinics are expected to assume a greater part of the responsibility. Mal Mal *et al*. (2009) provide more detailed information on state and private animal health services in the region.

Research contributions to animal health improvement in the region

Effective disease control and prevention depends on the accurate identification of the causes of disease and the factors affecting occurrence. Strategies are then developed to target either the cause directly or the factors, with the aim of reducing disease frequency. Identification of pathogens (disease causes) was covered under the different diseases treated above. In this light, one of the objectives of the works of Tanya *et al. (*1987) and Ekue *et al.* (1989) on FMD was to look at the possibility of proposing the production of a vaccine depending on the serotypes of the virus found in Cameroon. The results obtained indicate that this objective is difficult to attain since all seven known serotypes exist in the region. Polyvalent vaccines exist, for example there is a quadrivalent vaccine against serotypes Sat1, Sat2, O and A in Malawi. However, it may be difficult to produce a vaccine that will protect against seven serotypes. FMD control in this region thus remains a problem aggravated by extensive livestock mobility.

There have been considerable advances in the control of PPR through vaccination, unlike FMD. Up until the late 1990s, vaccination against PPR in the region was conducted using the bovine Rinderpest tissue culture vaccine (TCRV) (Martrenchar *et al.,* 1997; Njoya *et al.,* 1997). This vaccine was withdrawn from use progressively as a step towards the eradication of Rinderpest from the region. It thus became necessary to develop a specific vaccine against PPR. The joint efforts of CIRAD and LANAVET led to the production of Capripestovax, specific for PPR (Diallo *et al.,* 1989; Martrenchar *et al.,* 1997, 1999). Studies have been conducted to evaluate the efficacy of the vaccine and to define conditions of use that will provide optimal results. Martrenchar et al (1997) found that the vaccine was effective at protecting animals against experimental infections at doses as low as $10^{0.8}$ $TCID_{50}$.

The immune response of *Fulbe* sheep and *Kirdi* goats of north Cameroon to vaccination with Capripestovax was investigated by Awa *et al.* (2002). They found that pre-vaccination antibody prevalence in animals that were last vaccinated 3 year ago with TCRV was 29% and 44% in sheep and goats, respectively. Antibody sero-prevalence rose to 100% after vaccination and stayed above protection threshold during the 12-month observation period. Maternal antibodies in kids and lambs from vaccinated dams were detectable at up to 6 months of age. However, they fell below the protection threshold at 3.5 and 4.5 months of age in lambs and kids, respectively. These results confirmed the annual vaccination interval and indicated the appropriate ages for vaccinating young animals from immunised dams.

Meanwhile, the combined effects of vaccination and strategic anthelmintic treatment, which consists of de-worming at the beginning and end of the rainy season, was evaluated in terms of productivity parameters. It was expressed in an economic model at farmer level (Awa *et al.,* 2000; Njoya *et al.,* 2005 a, b). The application of the package resulted in significant increases in fertility and growth rates and reductions in mortality. In economic terms, farmers' profit margins were 2 – 3 times higher for goats and 3 – 4 times higher for sheep. This was determined by considering only animal sales from increased off-takes in treated flocks.

Similar developments have been made with regards to Newcastle disease. Although efficient vaccines exist, vaccination of traditional poultry flocks is generally not practised despite the enormous economic losses incurred each year from mortalities due to the disease. The major constraint is that of the inappropriateness of the intensive vaccination programmes applied in intensive commercial poultry farms, which often involve the use of vaccines that need to be maintained in a cold chain. Having identified high risk epidemic periods in the savannah region of central Africa, two to three vaccination campaigns per year are proposed (Awa *et al.,* 2008; Maho *et al.,* 2009), to pre-empt outbreaks of Newcastle disease in the cold dry period of December-January and the hot humid period of April-June. Field application of the programme using either an inactivated thermo-tolerant injectable vaccine produced locally by LANAVET or an imported live vaccine administered intra-ocularly or in drinking water in selected sites in Cameroon, Chad and RCA led to reductions of mortality from over 90% to less than 20% in most cases during epidemic periods. The programme is highly appreciated by farmers. However, the major constraint is the difficulties of obtaining the vaccines, either due to lack of information about supply sources or because the vaccines are found in distant veterinary pharmacies in urban centres.

The fight against vector-borne (parasitic) diseases, especially bovine trypanosomiasis, is based mainly on two approaches: control of the tsetse vector and chemotherapy/chemoprophylaxis of the host. In this region, the fight currently relies more on the latter, given that ambitious programmes aimed at tsetse control/eradication failed due to inadequate logistics and lack of follow up. Reiss et al (1999) described the example of north Cameroon. For a long time, chemotherapy/chemoprophylaxis has depended on a few chemical molecules, the most common of which are diminazene aceturate and isometamidium, both widely used in the region. Unfortunately, trypanosome resistance against these compounds has been widely documented (Stevenson et al, 2000; Anene *et al.,* 2001, Assefa and Abebe, 2001), including results from north Cameroon (Awa and Ndamkou, 2006). Thus, vector control still remains indispensable to keep bovine trypanosomiasis in check. Previous approaches to tsetse control through extensive sprays and deforestation have now been abandoned in favour of baiting using traps or insecticide-treated animal hosts. This is a cheaper and more environmentally-friendly approach. However, as Hargrove et al (2000) explain, its efficiency depends on the scale of application, i.e. it would be pointless for a farmer in the middle of an extensive tsetse zone to treat his animals alone. A cheap method of host treatment has been proposed using pyrethroid footbaths. Results are comparable to spraying the entire animal, in terms of reducing fly population (Stachurski *et al.,* 2005; Bouyer *et al.,* 2007). This method can easily be applied on a relatively large scale with the construction of communal footbaths.

A significant option to the fight against trypanosomiasis is the use of trypano-tolerant cattle breeds. Apart from the well-known *Ndama* cattle, other local trypano-tolerant breeds, like the *Namchi* cattle of north Cameroon, have been identified (Achukwi *et al.,* 1997, 2006). This is the main cattle breed thriving in the tsetse-infested zone of north Cameroon. The authors are currently working on the identification of genetic markers that could facilitate selection for trypano-tolerance.

Participative approach in animal health management

Animal health service delivery in the region is limited if the primary stakeholders, the livestock owners, do not actively participate. The limitations are characterised by deficiencies in temporal and spatial coverage by state and private veterinary services, interventions by non-professionals in the supply of pharmaceutical products and treatments, and failure to keep disease under control effectively. This constraint has been addressed in some parts of the continent, especially eastern and southern Africa, where community-based animal health services have been introduced (Huttner *et al.,* 2001; Mugunieri *et al.,* 2004, Ahuya *et al.,* 2005). The objective is to supplement over-stretched professional animal health services in marginal areas. In this approach, the farmers' indigenous knowledge of disease epidemiology and traditional medicine is used to develop animal health care services. Efforts have been made in the region to involve farmers actively at the level of diagnosis (identification of health constraints, for example), before defining research and development priorities. This is the case at the level of problem solving, though to a lesser extent: a number of research trials are carried out in the field with the farmers' active participation. However, there is a severe deficiency at the level of problem solving because professional services do not provide adequate coverage and farmers have not been empowered to handle basic health problems. These are all indications to show that professional state and private veterinary services will never be able to provide adequate coverage to animal health. They are located in townships far away from areas of livestock concentration, which are often characterised by difficult access. The empowerment of livestock owners seems to be

imperative for animal health management. This can be achieved through the development of community-based animal health services (CBAHS). This initiative was taken in RCA in 1992 (Mal Mal *et al.,* 2009), where the *Fédération Nationale des Eleveurs Centrafricains* (national federation of livestock owners) operates a central pharmacy and also trains personnel who are referred to as auxiliary veterinary staff. The latter deliver animal health services to members of the federation. This approach seems to be working well and could be adopted by the entire region. It could be developed to bring services even closer to the people with the creation of health care units in marginal areas, which are not covered by professional veterinary services properly. This could also be a forum for the use and development of indigenous knowledge in animal health management. It has yielded positive results in other parts of Africa and beyond (Huttner *et al.,* 2001; Mugunieri *et al.,* 2004; FAO, 2005; Heifer International, 2008). Therefore, there should be no reason why it would fail in the central African region.

Deficiencies and perspectives

Livestock disease epidemiology in the central African region is complicated by extensive transhumant movement in search of food and water, both within and across national frontiers. Recently, a significant factor affecting such movements has been the phenomenon of armed bandits. The latter harass large livestock owners, take their children hostage and ask for large sums of money as ransom. As a consequence, families move with their animals to areas that they consider safer, often across national frontiers. Sooner or later, they may find the new home unsafe and so the movement continues. Thus, animals contract new diseases, such as trypanosomiasis as they pass through tsetse-infested zones. In addition, they can spread other pathogens, such as the FMD virus (Awa *et al.,* 2006) to animals they come into contact with along their way or at their destination.

The absence of a regional strategy for the prevention and control of important pathologies is a further handicap to animal health management. Thus, national programmes remain ineffective because of unlimited animal movements (as outlined above). For example, cattle are systematically vaccinated against important endemic diseases in the region, such as black quarters, anthrax, pasteurellosis and contagious bovine pleuropneumonia in Cameroon. However, according to Mal Mal *et al.* (2009), no livestock vaccination of any sort has been conducted in RCA since the Pan African endemic disease control programme (PACE) ended in 1992. The problem is compounded by persistent armed conflicts that result in unstable governments, which do not last long enough to formulate and implement development programmes. There is a real need for the development of a regional disease monitoring and control programme and the harmonisation of practices, such as vaccinating the same diseases that are common to the member states of the region.

Animal health care delivery systems are absent in most cases. When they do exist, they are poorly developed and there is either no adequate legislation defining the role of the different stakeholders or the legislation is not respected. This is demonstrated by the role of veterinarians in private practice in providing animal health care. Recent findings revealed that at the moment there are no veterinarians in private practice in RCA and only three in Chad (Mal Mal *et al.,* 2009). In Cameroon, there are a considerable number. However, it is difficult for them to function because there is no support network. One of their major preoccupations is the chaotic situation with the multiplication of drug vendors. This results in the loss of customers to those who offer cheap but ineffective services to uninformed farmers.

There is no functional legal framework governing private veterinary practice. As a result, practitioners are excluded from mass animal vaccination campaigns. Governments are expected to liberalize the veterinary profession completely and to enforce existing laws or enact new ones, where appropriate, so that the system functions properly. In marginal areas, where there are no professional health service providers, livestock owners should be empowered through training to handle basic animal health problems within the framework of community-based delivery systems.

Conclusion

Disease still constitutes a major constraint to livestock production in the central African region. Efficient tools for the control of most of the important diseases, such as vaccines, chemotherapeutic agents and prophylactic programmes exist. However, considerable efforts are still needed to improve the

organisation and function of animal health care delivery systems in order to achieve optimal results. Private professional veterinary services need to be promoted and given greater responsibility in animal health care and community-based animal health care units should be developed in areas with little professional coverage. A regional approach and the establishment of functional epidemio-surveillance systems would be useful for keeping important diseases under control.

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