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An epidemiological overview of small ruminant diseases in Algeria

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Summary

Small ruminant production is one of the main sources of meat in Algeria and plays a vital role in the country's food security. Algeria's small ruminant industry has the potential to improve the living standards of farmers and households, as well as to increase animal protein availability to the public, and as a consequence to alleviate poverty and improve health. This review describes the main infectious diseases that have an impact on small ruminant production in Algeria. It also discusses the adopted control measures for these diseases. The epidemiological status of small ruminant diseases in Algeria is striking and the main infectious diseases threatening its small ruminant industry are peste des petits ruminants, bluetongue, foot and mouth disease, sheep pox/goat pox, brucellosis and Rift Valley fever. Therefore, the establishment of early warning systems and the proper implementation of control measures are needed in order to prevent, control and/or eradicate these diseases that have a significant impact on Algeria's economy.

Keywords

Algeria – Bluetongue – Brucellosis – Epidemiology – Foot and mouth disease – Goat pox – Meat production – Peste des petits ruminants – Rift Valley fever – Sheep pox.

Introduction

Algeria is the largest country in Africa. It is located at 28°N 3°E. Most of its coastal area (northern region) is hilly, sometimes even mountainous. South of the northern region is a steppe; and farther south is the Sahara desert. Algeria's land area is 2,381,741 km^2 with a population of about 40 million people. More than 60% of the population live in coastal areas (1). For reasons of animal health, the transportation of animals is forbidden between the Sahara and the northern region.

The small ruminant population in Algeria is more than 32 million head (27 million sheep and 5 million goats), where 65% of the total populations are females and 35% males (1, 2). Nonetheless, both sheep and goats are reared under the traditional extensive system in Algeria, intensive husbandry systems only recently being introduced to the country (1, 2).

In spite of the population size advantage that small ruminants have in Algeria, diseases and poor herd-health management practices pose a significant challenge to efficient herd management and profitable production (2). Furthermore, the country faces a huge deficit in dairy and meat production; this problem imposes an enormous annual spend evident from the annual import invoice, which amounted to US$ 2.045 billion for milk and US$ 0.307 billion for meat in 2014 (3).

By virtue of Algeria's geographical location and its borders with North African and Sahel countries, the country is vulnerable to several transboundary diseases, including peste des petits ruminants (PPR), bluetongue (BT), foot and mouth disease (FMD), sheep pox/goat pox (SPGP), brucellosis and other diseases. In this paper, the author summarises the published literature and research on these diseases in

Algeria. The objectives of this review are to describe the epidemiology of small ruminant diseases in Algeria with special emphasis on the assessment of the factors enabling the spread of these diseases in Algeria and the adopted countermeasures to control and subsequently eradicate these diseases.

The epidemiology of peste des petits ruminants in Algeria

History of peste des petits ruminants occurrence and distribution

Peste des petits ruminants is an acute, highly contagious and transboundary viral disease of sheep and goats (4). Morbidity and mortality rates can be as high as 100% and 90%, respectively, depending upon the endemicity in the area (4, 5). Following the PPR epidemiology in Morocco in 2008 (caused by lineage IV of the virus), where 257 outbreaks were recorded with severe economic losses (6), in 2011, De Nardi *et al.*, reported PPR in the Sahrawi refugee camps in Tindouf Province, at the south-western border of Algeria with the Western Sahara, Mauritania and Morocco. The sequence analysis clustered the circulating virus under lineage IV of the peste des petits ruminants virus (PPRV) (7). A year later, Kardjadj *et al.* described the first serological and molecular typing of the PPRV strain implicated in an outbreak in the Ghardaïa district, in the centre of Algeria. The strain clustered under lineage IV of PPRV and shared 97–99% similarity with the strain implicated in neighbouring Morocco and Tunisia (8).

Regular PPRV epizootic activity across the tropical and sub-tropical areas of North Africa has resulted in the spread of the disease to uninfected areas within the continent (8). The recent results obtained by Kardjadj *et al.* (9) described an overall PPR flock seroprevalence of 42.66% (64/150). The results showed a mean within-flock prevalence of 29.87% ± 2.11 (Table I) suggesting a widespread distribution and endemic establishment of PPR in the Algerian small ruminant population. For the risk factor study, univariate analysis followed by multiple logistic regression identified mixed flocks (odds ratio [OR] = 2.64, 95% confidence interval [CI] 2.30–5.38; $p = 0.007$) and contact with other flocks (OR = 2.27, 95% CI 0.99–5.21; $p = 0.053$) as risk factors in the spread of the disease in Algeria (9).

The adopted control countermeasures

Following the first description of PPRV in Ghardaïa in the centre of Algeria in 2012 (8), Kardjadj *et al.* preformed a study to assess, for the first time, the immune response of a commercial PPR vaccine (Pestevac®, Jovac, Amman, Jordan) (Nig.75/1) in goats and sheep flocks in Algeria during 18 months (600 days). The vaccine showed a good post-vaccination immune response (10). Subsequently, in September 2013, the Algerian Veterinary Authority proceeded for the first time with PPR vaccination in Ghardaïa and its neighbouring districts (Laghouat, Adrar and El Bayadh) using 200,000 doses of the vaccine strain Nig.75/1 to avoid the spread of the disease to other areas (10). However, the results of the epidemiological survey performed by Kardjadj *et al.* in 2014 described the widespread distribution and endemic establishment of PPR in the Algerian small ruminant population (9).

In Morocco, PPR was well controlled at the national level through mass vaccination, thus providing very strong evidence for the ability to control PPR in Northern Africa. Moreover, after the vaccination campaigns, the epidemiological situation was assessed. No viral circulation could be observed among young unvaccinated animals, and a good immune protection rate was achieved in vaccinated adults (11).

The epidemiology of bluetongue in Algeria

History of bluetongue occurrence and distribution

Bluetongue (BT) is an infectious, non-contagious disease of ruminants transmitted by *Culicoides* biting midges. It is caused by the bluetongue virus (BTV) and it is classified as a reportable disease by the World Organisation for Animal Health (OIE). Clinical disease is often observed in sheep, occasionally in goats, and rarely in cattle

(12). In July 2000, Algeria reported its first outbreaks of serotype 2 of BTV in the north-eastern part of the country. The disease spread subsequently throughout the country (13).

Bluetongue is of significant veterinary concern to small ruminant producers, wildlife managers and veterinary diagnosticians because of the frequent occurrence of outbreaks among domestic and wild ruminants in geographical regions previously known to be BT-free (12). Between 2000 and 2011, three serotypes (serotypes 1, 2 and 4) were circulating in Algeria (13, 14, 15) (Table II).

In 2014 Kardjadj *et al.* reported an overall flock seroprevalence and individual seroprevalence of 13.33% (95% CI 9.86–16.8) and 5.70% (95% CI 3.45–7.95), respectively (16). Risk factor analysis, comprising univariate analysis followed by a multiple logistic regression, identified transhumant flocks (OR = 2.44, 95% CI 2.09–3.58; p = 0.041), wetland proximity to flocks (OR = 3.39, 95% CI 2.20–5.48; p = 0.023) and the lack of *Culicoides* control operations (OR = 7.87, 95% CI 3.93–11.75; p = 0.023) as risk factors for bluetongue in Algerian small ruminant flocks.

The adopted control countermeasures

Since the incursion of BT into the country in July 2000, Algerian veterinary authorities have implemented surveillance programmes to control the disease, detect new clinical cases by serological diagnosis, and determine the presence and distribution of known vectors of the disease. Once BT was confirmed in a flock or premises, flocks were isolated and dead animals buried. Sick animals, animal holdings and surrounding areas were sprayed with insecticide. Therefore, vector control operations were initiated in the country but vaccinations were not carried out (13, 14).

The epidemiology of foot and mouth disease in Algeria

The history of foot and mouth disease occurrence and distribution

Foot and mouth disease is a highly infectious and contagious transboundary animal disease and is one of the most economically devastating diseases that affect cloven-hoofed livestock, including cattle, goats, sheep, pigs and wild ungulates. The disease is caused by a highly variable RNA virus that belongs to the genus *Aphthovirus* and family *picornaviridae* with seven serotypes (A, O, C, Asia 1, SAT 1, SAT 2 and SAT 3), Within these serotypes, more than 65 subtypes have been recognised (17). The high degree of antigenic variation may be attributed to the high rate of mutation, genetic recombination and the quasi-species nature of the virus (17). In small ruminants, FMD is generally dormant and has not received much attention from Veterinary Services in developing countries. However, the role of small ruminants in the epidemiology of FMD in Asia and Africa is well documented, where small ruminants contaminate river water, ponds, pastures, shrubs and other environmental features. In Algeria, cattle are the main host for FMD followed by sheep and goats (18, 19, 20, 21, 22).

In 1989, Tunisia, a country previously free from FMD, reported the disease in cattle following the importation of sheep and goats from the Middle East. Subsequently, the disease spread to FMD-free Algeria (Table III) and Morocco. In 1999, cases of FMD were suspected in cattle in the Algiers district, Algeria (18). Sequencing showed that the Algerian virus (O/ALG/1/99) belong to the West-African topotype with 99% similarity to a strain isolated in Côte d'Ivoire (O/CIV/8/99) in 1999 (20, 21, 22). Indeed, zebu cattle introduced illegally over the Algerian southern border during February 1999, were intercepted within the southern borders of the country. At the time of capture, these zebu cattle did not present any clinical signs of FMD. Nevertheless, their presence demonstrated that transboundary animal movement had taken place on the southern borders with Mali and Niger, in which FMD is endemic (20, 21, 22).

At the end of April 2014, an FMD outbreak was detected in Sétif Province in the east of Algeria, 260 km from the border with Tunisia. The source of the outbreak was attributed to the illegal introduction of animals from Tunisia. When the virus was isolated, it was identified as having O/ME-SA/Ind-2001d lineage matching 99.69% to field strain O/TUN/1031/2014 isolated in Tunisia (21, 22). By the end of August, more than 350 outbreaks in 33 different provinces had been recorded since the epidemic had begun. All the cases recorded were from cattle and there were no clinical signs of FMD in small ruminants. However, in March 2015, 12 FMD outbreaks involving sheep were reported in El Bayadh and El Oued Provinces ending nearly five months freedom from the disease in Algeria (21, 22).

Nevertheless, at the end of March 2017, FMD outbreaks in domestic cattle were reported in the west (Relizane Province), centre (Medea Province) and east (Bordj Bou-Arréridj Province) of Algeria (22). Clinical signs and lesions typical of FMD were observed, including fever, blisters, lameness and mammary lesions (22). Samples were forwarded to the OIE/Food and Agriculture Organization of the United Nations (FAO) Reference Laboratory in Brescia, Italy – Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna (IZSLER) – for analysis. Sequence analysis of the virus revealed a genetically different type A virus from the strains that were currently circulating in neighbouring Libya (Asia/Iran-05^{BAR-08}) (21). The origin of the infection was therefore unknown; however, phylogenic analysis showed that the Algerian virus belong to African topotype lineage G-IV with 98.4% nucleotide identity to field strains isolated in Nigeria in 2015 (21, 22).

According to an OIE report, the source of the outbreaks was the illegal movement of ruminants (22). Oueslati reported that most uncontrolled movements of ruminants in the region occurred by land transport between the Sahel and the Maghreb countries, due to the very long borders that stretch into the desert (23). Furthermore, Kardjadj stated that political unrest in the Sahel countries and Libya increased the potential risk of transboundary diseases spreading into neighbouring countries, especially Algeria, due to the disruption of public health services, insecurity and the massive displacement of refugees across borders (19).

The adopted control countermeasures

After the 1999 epidemic, yearly FMD vaccination with the O-Manisa strain was carried in Algeria on cattle only. Moreover, since the incursion of serotype A into Libya in 2003, Algerian Veterinary Services have added the A22 strains to the FMD vaccine (18). In addition, in 2011, Algeria, Morocco and Tunisia commenced working together using a regional approach to controlling the disease and to becoming officially recognised as free of FMD. In October 2011, these three countries submitted their dossiers on this matter to the OIE. Before presentation to the 80th General Session of the World Assembly of Delegates of the OIE, the *ad hoc* Group for the Evaluation of Member Country Status for Foot and Mouth Disease and the Scientific Commission for Animal Diseases of the OIE evaluated the dossiers in May 2012. This work was fully consistent with the FAO/OIE Progressive Control Pathway for Foot and Mouth Disease (PCP-FMD) and the eventual aim will be to achieve the official OIE status of Member Countries free from FMD with vaccination (for Algeria and Tunisia) and Member Country free from FMD without vaccination (for Morocco). In May 2012, Algeria, Morocco and Tunisia were recognised by the OIE as Member Countries with endorsed control programmes for FMD.

Following the FMD epidemic in Tunisia in April 2014, several measures were implemented in Algeria:

– crisis cell centres were instituted at the national and regional levels

– vehicles leaving affected or suspected provinces were disinfected

– a vaccination campaign throughout Algeria was performed using the O-Manisa strain, with a campaign rate of 85% in cattle, however, Algeria's small ruminant population was completely naïve (had never been vaccinated against FMD) (21, 22).

However, a summary of vaccines matching data generated at the World Reference Laboratory for Foot-and-mouth Disease (WRLFMD) for the O/ME-SA/Ind2001d lineage from Algeria and Tunisia showed that O/TUR/5/09, O-3039 and O/TAW/98 are matched against these lineages, while the *in-vitro* test indicates a poorer match for O-Manisa and O-BFS (21). Arguably, this may be the reason for the occurrence of the FMD epidemic in Tunisia and Algeria despite the vaccination efforts applied by the two countries. In August 2014, the vaccine strain O/TUR/5/09 was used in Algeria, which allowed for the control and resolution of the episodes (18).

The livestock population of Algeria is completely naive to serotype A (19). In fact, without effective vaccination, several outbreaks have been recorded in other provinces in Algeria from April to June 2017. Furthermore, on the 28 April 2017, serotype A was recorded in Tunisia; the origin of the infection is unknown (22). It is expected that this serotype will spread widely in the Maghreb region and may affect a high proportion of livestock until it is limited by natural immunity or the imposition of an effective vaccination programme (19). According to WRLFMD, the appropriate vaccine strains to control the Nigerian lineage are A/TUR/06 or A/ERI/98 (21), and at the beginning of July 2017, Algerian Veterinary Services launched an FMD vaccine campaign using A/ERI/98.

The epidemiology of sheep pox and goat pox in Algeria

The history of sheep pox and goat pox occurrence and distribution

Sheep pox and goat pox are clinically indistinguishable and are considered by the OIE to be a single disease, referred to in this paper as sheep pox and goat pox (SPGP). Strains of sheep pox virus (SPPV), goat pox virus (GTPV) and lumpy skin disease virus (LSDV) cannot be differentiated serologically, although distinct host preferences exist for most strains of SPPV and GTPV causing a more severe disease in the homologous host (24, 25). The geographical distribution of lumpy skin disease (LSD) differs from that of SPGP. The former (LSD) is currently endemic in almost all African countries (excluding a few to the north – Libya, Tunisia, Algeria and Morocco), while the latter (SPGP) is endemic in Africa (excluding the south), Asia, the Middle East and Turkey, with sporadic outbreaks occurring in Greece and some eastern European countries (22, 25).

Sheep pox and goat pox is a disease of veterinary concern to small ruminant producers, wildlife managers and veterinary diagnosticians because of the tangible and intangible economic losses associated with it such as the temporary reduction in milk production, temporary or permanent sterility, damage to hides and animal death due to secondary bacterial infections (25). In Algeria, SPGP appears only in sheep and, so far, no case has been reported in goats leading to the hypothesis that the circulating viruses over the years affect only sheep in all Algeria's regions. Although infection with SPGP virus was previously described in Algeria and an annual sheep vaccination has been conducted since the 1980s, the disease is still responsible for substantial economic losses in sheep breeding (26, 27).

Recently, Kardjadj reported an overall flock prevalence of 14% (95% CI 11.08–16.92) suggesting that SPGP is endemic in Algeria (27). The risk factor analysis, which comprised the univariate analysis of variables followed by a multiple logistic regression, identified the steppe region (OR = 1.81, 95% CI 0.87–2.57; $p = 0.037$) and transhumance (OR = 3.98, 95% CI 2.59–5.34; $p = 0.021$) as risk factors in the spread of the disease. Furthermore, our study revealed that the use of vaccination as a preventive measure in the selected flocks decreased the odds of SPGP positivity by 5.78 times (95% CI 2.22–9.34; $p < 0.001$) compared to non-vaccinated flocks (27). Clinically, the classical sheep pox vesicular form is usually observed and characterised by the appearance of skin lesions on the entire body surface evolving from macules, to papules, vesicles or vesiculo-pustules and crusts at the end of disease evolution (26, 27).

The adopted control countermeasures

The diagnosis of sheep pox in Algeria includes the early recognition and notification of a suspect clinical situation by field veterinarians. In Algeria, vaccination against SPGP has being conducted nationwide since the 1980s using locally produced live attenuated RM65 vaccine (26, 27). The efficiency of this vaccine has been established worldwide (25). According to the Algerian Ministry of Agriculture and Rural Development, the vaccination rate reached almost 75% of the country's sheep population in 2014 and 2015 (1); this is within the minimum 70–80% herd immunity required to control contagious diseases. However, after decades of vaccination, SPGP is still persistent in Algeria and responsible for substantial economic losses in sheep breeding.

The epidemiology of brucellosis in Algeria

The history of brucellosis occurrence and distribution

Brucellosis in sheep and goats due to *Brucella melitensis* is the most important zoonosis in terms of presenting a serious hazard to public health. The epidemiology of human brucellosis has drastically changed over the past few years due to various sanitary, socio-economic and political reasons, together with increased international travel. New foci of human brucellosis have emerged, particularly in Central Asia, while the situation in certain Middle Eastern and North African countries is rapidly worsening (28).

The first studies made in Algeria on animal brucellosis were in 1907, when it was reported in goats. Published bacteriological investigations in Algeria have characterised *Brucella* at the species and biovar levels. *Brucella melitensis* biovar 3 is the most prevalent in the case of goats (29). The study of the genetic diversity of Algerian *B. melitensis* biovar 3 strains by Lounes *et al.* to assess whether an epidemiological relationship existed with European strains was recently carried out (29). The obtained results showed that the Algerian and European strains cluster together. These results confirmed the existence of a circulating lineage resulting from socio-historical connections between Algeria and Europe (29).

Successful campaigns have been carried out against small-ruminant brucellosis based on a screen-and-slaughter policy, and eradication has been achieved in many developing countries (28). However, a similar policy in Algeria since 1995 has failed to control brucellosis in small ruminants because of many factors chiefly, the type of animal husbandry practised, which determined the effectiveness of the campaign (30). In 2002, the Algerian Ministry of Agriculture and Rural Development conducted a survey to estimate the prevalence of sheep and goat brucellosis in the seven years following the launch of a screening–sloughing programme, the results showed that the endemic character of the disease in Algeria with a national small-ruminant herd prevalence of 5.68% and herd prevalence of more than 10% in the steppe region. Consequently, and within the strategy of control and prevention of this zoonosis, in 2006, the Algerian state adopted a new prophylactic approach, by vaccinating sheep and goats in the steppe region with the Rev-1 vaccine and the screening–sloughing programme was continued in other regions (30).

The adopted control countermeasures

From the beginning of the campaign in 2006 until the end of 2013, the vaccination covered 32 of the 48 provinces in Algeria and a total of 21,036,314 small ruminants were vaccinated. As a result, in 2014, the herd prevalence of brucellosis in small ruminants in Algeria had slightly decreased to 3.33% (2). In addition, Kardjadj and Ben-Mahdi reported a significant improvement in small ruminant brucellosis sanitary status in the steppe region eight years after the Algerian state had adopted Rev-1 vaccination in 2006 as a prophylactic approach (31), thus providing very strong evidence that brucellosis control can be achieved in Algeria. However in the non-vaccinated region, Gabli *et al.* reported a herd prevalence of 15.84%, which underscores the relevance of vaccination and adequate control, and an eradication programme to avoid complicating the control programme (32). A large number of unpublished studies of the situation in Algeria have suggested an association between *Brucella* seropositivity and abortion in small ruminant flocks (M. Kardjadj, personal communication, 2017). However, Kardjadj *et al.* reported no significant association between abortion history and brucellosis infection in Algerian small ruminant flocks (2).

The epidemiology of other diseases

The epidemiology of Rift Valley fever

Rift Valley fever (RVF) is an acute arthropod-borne disease affecting a wide range of animals, ranging from rodents to camels. However, its most economically important hosts are sheep, goats and cattle, in which high neonatal mortality and abortion in pregnant animals occur (33). It also can induce substantial economic losses through high abortion rates and the death of neonates and young animals during epidemics. The increasing global importance of RVF is clearly demonstrated by its geographical expansion. The presence of a wide range of host and vector species, and the epidemiological characteristics of RVF, has led to concerns that epidemics may occur in previously unaffected regions of Africa, and beyond (33).

Recently, Clements *et al.* presented the first atlas of RVF seroprevalence in Africa; reviewing seropositivity data from surveys conducted in several African countries, including Mali and Mauritania (which border Algeria), Egypt, the Democratic Republic of the Congo, some Eastern African countries, the Horn of Africa and parts of Southern Africa (33).

In 2010, Di Nardo *et al.* reported the presence of IgG antibodies against the RVFV in Sahrawi refugee camps in Tindouf Province, at the Algeria’s south-western border with Western Sahara, Mauritania and Morocco (34). It is worth noting that these camps are settled and located in Algerian territory. Those living in these camps practise high meat consumption, and in order to face the demand, a conspicuous livestock trade has been developed from Mauritania and Mali (both endemic countries) to the refugee camps. Such animals are sold in market areas of refugee camps, where they are slaughtered or incorporated into preexisting flocks and herds. This substantial animal movement through trade with Mauritania and Mali could constitute a main route for virus spread.

The epidemiology of *Chlamydia*

Chlamydia infection is one of the pathologies that induce abortions in small ruminants; two species of *Chlamydia* have been reported to cause infections in sheep, *C. abortus* and *C. pecorum*. These bacteria have a unique developmental cycle. Members of the genus *Chlamydia* are gram-negative bacteria and obligate intracellular bacterial parasites responsible for a variety of diseases in humans and animals, including several zoonoses. The reservoir is large and includes many wild and domestic mammals but domestic ruminants, such as sheep, cattle and goats represent the most frequent source of human infection (35).

Chlamydial abortion in small ruminants is a zoonotic disease mainly related to *C. abortus*. This bacterium is the causative agent of abortion in late pregnancy and foetal loss in sheep, goats and cattle in many countries around the world (35). In Algeria, abortion cases are frequently reported by veterinarians but, except for brucellosis which is a notifiable disease in this country, abortive diseases are in general poorly studied. However, recently Merdja *et al.* reported an individual prevalence rate of (35 ± 08%) and a herd prevalence rate of (88 ± 15%) of chlamydial infection in Algerian small ruminants (36). The results suggest that the prevalence of chlamydial infection is relatively large in small ruminants in this region. Veterinarians and people in charge of animal health should adopt an adequate policy of surveillance and prevention in order to control this zoonotic pathology.

The epidemiology of Q fever

Q fever is caused by *Coxiella burnetii*, a bacterium which infects a wide variety of animals, commonly sheep, goats and cattle. Infected animals often do not show signs of disease, but it can cause abortion, stillbirth and early lamb mortality in sheep. Infected sheep and goats with and without signs of the disease may shed the bacterium in their birth fluids, products of pregnancy, milk and faeces (35, 37).

In Algeria, Khaled *et al.* indicated that 58% (95% CI 40–76) of flocks had at least one positive animal, and individual seroprevalence was estimated at 14.1% (95% CI 11.8–16.4) (38). Bacterial excretion was observed in 21 flocks (60%), and 57 females showed evidence of *C. burnetii* shedding (21.3%) (38). These results suggest that *C. burnetii* distribution is high at the flock level and that seropositive and infected (shedder) animals can be found all over the country.

Conclusions

The health status of the small ruminant population in Algeria can be considered as striking. Therefore, the establishment of early warning systems and the proper implementation of control measures at the regional level are needed. Regional strategies for the control of animal diseases should be focused on preventing, controlling and/or eradicating the principal epizootic diseases that have a strong impact on the economy of the region. To establish a common control programme, each region should rank diseases in terms of the potential public health, economic and social significance. The main animal diseases present or with the potential to threaten the small ruminant industry in Algeria and the North African region are PPR, FMD, BT, SPGP, brucellosis and RVF. The epidemiological study of some of these prevalent diseases may indicate the most suitable approach to follow in terms of a regional strategy and may help to establish animal disease control programmes adapted to each country’s particularities. The strategy may also identify regional and/or sub-regional structures able to deal with increasing problems, manage common programmes, and run technical and scientific activities. It seems impossible at present to completely control an animal disease solely at the national level. Owing to the fact that many countries in the region are dependent on each other’s animal disease status, there is a real need for animal health projects within the framework of a regional strategy to control animal diseases.

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Table I

Mean of the within-flock prevalence of peste des petits ruminants in Algeria in 2014 (9)

Variable		Mean ± standard deviation	*p* (t test)
Type of farming	Sheep flocks	5.74% ± 1.06	>0.05
	Mixed flocks	12.93% ± 1.85	
Age	Young	21.83% ± 2.47	>0.05
	Adult	35.36% ± 3.13	
Sex	Male	22.14% ± 2.31	>0.05
	Female	33.11% ± 2.87	
Overall within-flock prevalence		29.87% ± 2.11	

Table II

Bluetongue occurrence in Algeria (14, 15)

Serotype	Year	Origin	Number of outbreaks	Species infected clinically
Serotype 2	2000	Tunisia	297	Sheep and goats
Serotype 1	2006	Sub-Saharan Africa	263	Sheep and goats
Serotype 4	2011	Unknown	6	Cattle, sheep and goats

Table III

Foot and mouth disease occurrence in Algeria (18, 19, 20, 21, 22)

Serotype	Year	Origin	Number of outbreaks	Species affected clinically
O	1989–1990	Tunisia	Unknown	Cattle, sheep and goats
O/ALG/1/99	1999–2000	Sub-Saharan Africa	179	Cattle, sheep and goats
O/ME-SA/Ind 2001d	2014–2015	Tunisia	420	Cattle, sheep and goats
Asia/ Iran-05BAR-08	2017 (ongoing)	Nigeria	Undetermined	Cattle, sheep and goats