Bovine Tuberculosis in France in 2014: a stable situation

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Abstract
The overall situation of France regarding bovine tuberculosis remained highly satisfactory: annual incidence was well below 0.1% and in most of the infected herds that have been detected, the number of animals with lesions was very low. Diagnostic slaughtering increased slightly in 2014, proof of growing awareness among stakeholders and improved investigation of suspected cases. Information campaigns on slaughterhouse detection began to yield encouraging results with a rise in suspected cases, although the number of actual confirmations remained stable. The epidemiological situation improved in some areas, while others faced unexpected re-emergence. The persistence of the disease in some areas both in livestock and wildlife requires special attention and long-term efforts in order to achieve eradication.

Keywords
Regulated disease, Bovine tuberculosis, Surveillance, Cattle

Résumé
Tuberculose bovine en France en 2014: une situation stable
La situation sanitaire de la France vis-à-vis de la tuberculose bovine demeure globalement très satisfaisante en 2014 : l'incidence annuelle est restée largement inférieure à 0,1 % et dans la plupart des élevages infectés détectés le nombre d'animaux présentant des lésions est extrêmement limité. Le nombre d'abattages diagnostiques a encore augmenté légèrement en 2014, témoignant d'une mobilisation croissante des acteurs permettant une meilleure investigation des suspicions. La sensibilisation faite sur la détection en abattoir porte également ses fruits avec une augmentation des suspicions tout en conservant un nombre de lésions confirmées stable. Certaines zones voient leur situation s'améliorer, tandis que d'autres ont connu des résurgences inattendues. Enfin, certaines voient la maladie persister en élevage ou au sein de la faune sauvage ce qui impliquera une attention et une implication soutenue et raisonnée dans le temps afin de mener à bien l'éradication.

Mots-clés
Maladie réglementée, tuberculose bovine, surveillance, bovins

The data presented are based on data consolidated by the Departmental Directorates for Protection of the Population (DDecPPs) in the food information system (SIGAL) as well as on data submitted under DDecPP responsibility for the annual report.

Surveillance of tuberculosis

Organisation of programmed screening on farms

An overview of surveillance requirements and health control measures for bovine tuberculosis is presented in Box 1. Wildlife surveillance is also implemented under the Sylvatub scheme through several systems of varying intensity, depending on the situation in each *département* (Box 2).

In most *départements*, screening campaigns for tuberculosis on livestock farms are scheduled for the October to April wintering period, and not based on the calendar year. Therefore, the results for the 2014 calendar year shown here correspond to the end of the 2013/2014 surveillance period and to the beginning of the 2014/2015 campaign, possibly with slight differences in implementation methods.

The rate of screening for 2014 reported by the DDecPP is shown in Figure 1 and Table 1. Most *départements* (n=52) have discontinued systematic tuberculin testing for several years now. An increasing number of *départements* (n=20) have chosen to determine a tuberculin testing schedule for a specific zone ("zoning") that is different from the rest of the département. Zoning is established by the Departmental Prefect and must be submitted for an opinion to the DGAL. This also applies to changes in screening intervals at *département* level.

The geographic distribution of tested farms (Figure 2) is consistent with that of the screening intervals per *département* (Figure 1). Screening is carried out primarily in *départements* that have undertaken zoning but also in herds classified at-risk located in *départements* where programmed screening for tuberculosis through tuberculin tests has been discontinued. This may be the case for instance following identification of an epidemiological link with an outbreak or because of at-risk production, such as raw milk. In all, over the year 2014, 13,714 cattle farms underwent single intradermal tuberculin testing (SITT) or single intradermal comparative tuberculin testing (SICTT),

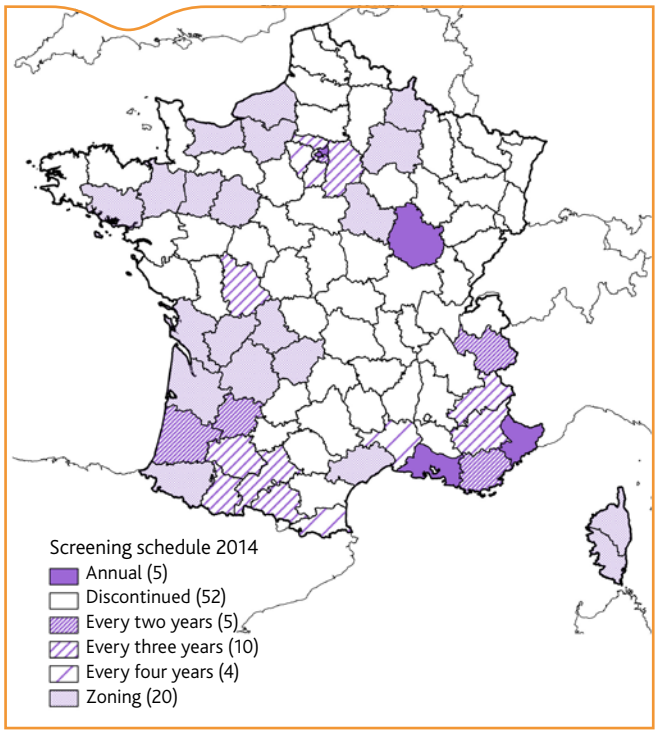

Figure 1. Programmed screening intervals for bovine tuberculosis by *département* in 2014

Box 1. Surveillance and health control measures for bovine tuberculosis

Objectives

The general objective of tuberculosis surveillance is to detect cases in order to eradicate the disease and maintain the officially disease-free status at farm and country levels.

Scope of surveillance programme

Bovine tuberculosis due to *Mycobacterium bovis, Mycobacterium tuberculosis* or *Mycobacterium caprae*.

The population monitored

All cattle farms across France.

Other susceptible populations undergo routine surveillance through *post-mortem* inspection at the slaughterhouse, particularly goats, sheep, and swine, as well as farmed deer.

Monitoring of wildlife such as deer, wild boars and badgers is performed through the Sylvatub specific surveillance scheme.

Definition of a case

The applicable definitions are those described in the regulations. In short:

- animals are considered infected either following detection of one of the mycobacteria referred to in the regulations by cell culture or PCR, or for various combinations of results for *post-mortem* tests (these combinations follow regulatory definitions),
- animals are considered suspect after a non-negative reaction is found in one of the screening tests that can be used when the animal is alive or if lesions suggestive of bovine tuberculosis are observed at the slaughterhouse,
- animals are considered likely to be contaminated when there is an epidemiological link to infected herds.

Surveillance programmes

Screening

Surveillance of bovine tuberculosis involves several complementary systems.

- Systematic surveillance at the slaughterhouse: inspection of all animals slaughtered for human consumption. Only *post-mortem* inspection is truly relevant for tuberculosis. It involves examination of a certain number of organs including the primary tuberculosis sites such as the lungs and retropharyngeal, tracheobronchial and mediastinal lymph nodes. If suspect lesions are detected, the organs are removed along with associated lymph nodes and examined in a laboratory qualified for PCR/bacteriological testing of mycobacteria.
- Programmed surveillance on the farm: testing required to obtain and maintain the officially disease-free status of herds. Depending on the health situation in the *département*, the screening interval can be adapted, ranging from the annual screening of all animals over six weeks of age to discontinuation of programmed screening. In some situations, zoning is performed and testing is reinforced in certain municipalities based on a health risk assessment. Irrespective of the interval in effect in a *département*, programmed screening can be requested annually for a period of three to five years on farms that are classified at-risk due to epidemiological links to an infected farm.
- Alongside programmed surveillance, screening can also be implemented when animals are moved. Given that the health system is considered robust and that France is officially TB-free, screening of animals on introduction may be waived, except in certain cases:
  - > if it takes more than six days for the animals to transit between two establishments,
  - > if the animals leave a farm classified as at-risk due to proximity to a domestic or wildlife outbreak or because of previous infection,
  - > if the animals transit through a farm with a high turnaround and come from a farm located in a *département* where the cumulative 5-year prevalence of bovine tuberculosis is higher than the national average.
- In all cases, screening is performed using either single intradermal tuberculin testing (SITT) or single intradermal comparative tuberculin testing (SICTT) depending on knowledge of the risk of atypical reactions. Tests are read 72 hours post-injection. Under specific conditions, especially for animals whose containment is difficult (fighting bulls), SITT screening can be reinforced using systematic IFN- gamma testing. The sensitivity (Se) and specificity (Sp) of these tests are not perfect and depend on their conditions of use (whether there are intercurrent agents, breed-related or physiological factors, etc.) (Vordermeyer 2006):
  - > SITT: Se ~ [80% – 91%] and Sp ~ [75% – 99.9%]
  - > SICTT: Se ~ [55% – 93%] and Sp ~ [89% – 100%]
  - > Bovigam IFN-gamma: Se ~ [81% – 100%] and Sp ~ [88% – 99%]
  - > Recombinant IFN-gamma: Se ~ [84% – 98%] and Sp ~ [92% – 96%]

Management of suspected cases and health control measures

Control measures aim to confirm or disprove the status of suspect animals and, if necessary, to eliminate infection from the herd. Testing protocols for suspected cases have been harmonised nationally, taking into account the different initial tests (SITT or SICTT). The following principles are applicable in all cases:

- If non-negative results are found for a farm, a risk analysis is carried out by the DDecPP to assess whether the suspicion is low or high. This analysis takes into account epidemiological criteria and, if necessary, further tests are performed to retest all or part of the herd, based on the health control measures. These tests are carried out using SICTT or, when available, by experimental IFN-gamma including specific peptides. In the event of low suspicion, animals are retested six weeks later or are directly slaughtered for diagnostic purposes. In this case, samples are taken to test for mycobacteria by PCR and cell culture, even if there are no macroscopic lesions. If suspicion is high from the outset, or because reactions to tests performed six weeks after low suspicion confirm the suspected cases, reactors are slaughtered diagnostically and the herd is retested after this diagnostic slaughter. An experimental protocol has been used since the 2013/2014 campaign to evaluate whether the IFN-gamma test carried out when reading the intradermal tuberculin result could replace tuberculin retesting carried out six weeks later, in order to assess inconclusive results. When infections are confirmed, herds that are likely to be contaminated, i.e. those with an epidemiological link to the infected herd, are screened with no limitation on the period of contact. This screening can detect links to fattening herds that received cattle many years before. Once all of the cattle from the outbreak or those that have been in contact with the animal from the outbreak have been slaughtered, the DDecPP can stop the investigations based on its assessment of the risk. In other cases, testing is undertaken using SITT, IFN-gamma or SICTT, or there is diagnostic slaughter, either of the reactor animals or systematically in some cases. When necessary, the herds are classified as at-risk, to be monitored through annual screening for three years.
- If an infection is confirmed, the infected farm must be cleansed. This generally involves complete depopulation of the herd with increased inspection at the slaughterhouse, followed by cleaning-disinfection of farm facilities. Until now, in certain specific cases, justified by preservation of local breeds or experimentally in Dordogne and Côte-d'Or, cleansing measures may have involved partial depopulation. Since July 2014, this procedure is available in all *départements* but requires an opinion from the mandated veterinarian, the GDSs, the TB coordinator, and the Directorate General for Food. In this scenario, animals are tested using SICTT or IFN-gamma on several occasions. Reactor animals are slaughtered for diagnostic purposes. The herd is considered to be cleansed after two favourable tests have been performed at a two-month interval, and is considered re-certified after two further favourable controls at two-month intervals.

Regulatory References

Council Directive 64/432/EEC of 26 June 1964 on animal health problems affecting intra-Community trade in bovine animals and swine

French Rural Code, Book 2, Preliminary Title and Title II

Ministerial Order of 15 September 2003 establishing the technical and administrative framework for collective prophylaxis and control measures for bovine and caprine tuberculosis

Table 1. Data on programmed screening of bovine tuberculosis by tuberculin testing on certified livestock farms in 2014 in France

Cattle herds as of 31/12/2014		212,550
ODF herds as of 31/12/2014 (%)		212,290 (99.88)
Schedule of programmed screening (number of départements)	Discontinued	(52)
	Annual	(5)
	Every two years	(5)
	Every three years	(10)
	Every four years	(4)
	Zoning	(20)
Herds undergoing SITT (%)*		10,990 (5.2)
Herds undergoing SICTT (%)*		2,724 (1.3)
Number of screening SITTs*		475,330
Number of screening SICTTs*		215,424
Number of SITT-positive herds (% of tuberculin tested herds)*		127 (1.2)
Number of SITT-non-negative herds (% of tuberculin tested herds)*		584 (5.3)
Number of SICTT-positive herds (% of tuberculin tested herds)*		115 (4.2)
Number of SICTT-non-negative herds (% of tuberculin tested herds)*		695 (25.5)
Number of non-negative SITTs (% of SITTs performed)*		2,069 (0.4)
Number of postiive SITTs (% of SITTs performed)*		660 (0.1)
Number of non-negative SICTTs (% of SICTTs performed)*		1,863 (0.8)
Number of postiive SICTTs (% of SICTTs performed)*		204 (0.1)
Veterinary practices involved*		909
Veterinary practices reporting non-negative intradermal tuberculin tests (%)*		278 (30.6)
Number of tests on movement		139,429

* as part of programmed screening
ODF: officially disease-free

accounting for about 6.5% of farms (Table 1). The main changes *versus* 2013 are related to adaptation of zones based on cases detected in 2013. For instance, screening was reinforced in Calvados, Sarthe and Marne. The Charente, Côte-d'Or, Dordogne and Pyrénées-Atlantiques *départements* account for approximately 6% of all French herds, but had 38% of the herds tested using SITT and 57% of those tested using SICTT. Special attention is therefore paid to the results of these four *départements*.

Involvement of veterinary professionals

Tuberculin testing (215,424 SICTTs and 475,330 SITTs) was carried out by 909 veterinary professionals (veterinarians or veterinary associations). The number of tuberculin tests was slightly lower *versus* 2013 but the number of professionals was the same.

Of the 753 veterinary professionals carrying out SITTs, the median number of farms tested by professionals was 3 and the mean number of SITTs was 636. Of the 366 veterinary professionals that performed SITTs on at least four different farms, there were 28 farms screened on average and 1,239 SITTs on average.

Of the 311 veterinary practices that carried out SICTTs, the median number of farms tested as part of programmed screening by professionals was 2 and the mean number of SICTTs performed was 698. Of the 166 veterinary professionals that performed SICTTs on at least two different farms, there were 16 farms screened on average and 1,261 SICTTs.

Of note, more than half of the veterinary professionals carried out testing in only one or two farms. It is important that these professionals be included in training and information campaigns to ensure quality screening procedures.

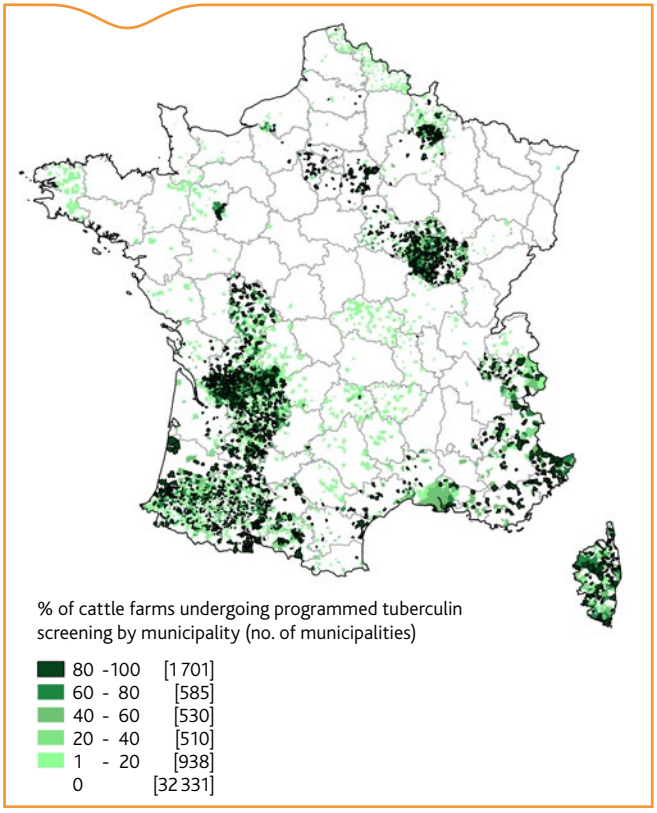

Figure 2. Rate of cattle farms undergoing tuberculin testing by municipality in France in 2014 as part of annual programmed screening campaigns

Use of interferon gamma

In *départements* where cattle are raised for bullfighting and where conditions for carrying out tuberculin testing are particularly difficult, first-line tuberculosis screening using interferon-gamma (IFN-gamma) was scheduled alternating with or in addition to intradermal tuberculin testing. An article presenting the full results of the study in the Camargue is available (Desvaux *et al.* 2015). In the Landes *département* in 2013-2014, 26 herds of ganaderia, in which animals are intended for shows, were screened using IFN-gamma. Dordogne has also implemented a strengthened follow-up protocol using interferon in parallel with intradermal tuberculin testing for screening. This protocol mainly targets farms with epidemiological links (n=68 in 2013-2014).

Surveillance on animal movements

Tuberculin testing on movement of animals was carried out for 139,429 cattle in 20,370 herds. However, data from several *départements* could not be processed due to data entry issues.

Scheme coordination

Training sessions and awareness meetings were again organised in 2014 to maintain the effectiveness of the surveillance system. The general training session on bovine tuberculosis, as part of occupational training for veterinarians to carry out certain public functions under contract with the administration (the "health mandate"), was organised by the Ministry of Agriculture and the National society for technical veterinary groups (SNGTV) in 33 *départements* with the participation of 178 veterinarians. Practical training on tuberculin testing continued to be developed *versus* 2013 and included 36 *départements* in 2014 with 209 veterinarians participating. In 2014, 86 professionals participated in the national training session on bovine tuberculosis intended for staff at the DDecPP. Also in 2014, the number of meetings organised by the DDecPP with bovine tuberculosis on the agenda was 93 with mandated veterinarians (109 in 2013) in 66 *départements* (63 in 2013) and 116 with livestock farmers (149 in 2012) in 40 *départements* (43 in 2013).

Furthermore, 57 meetings (96 in 2013) were organised in 32 départements (49 in 2013) for implementation and follow-up of the Sylvatub surveillance scheme.

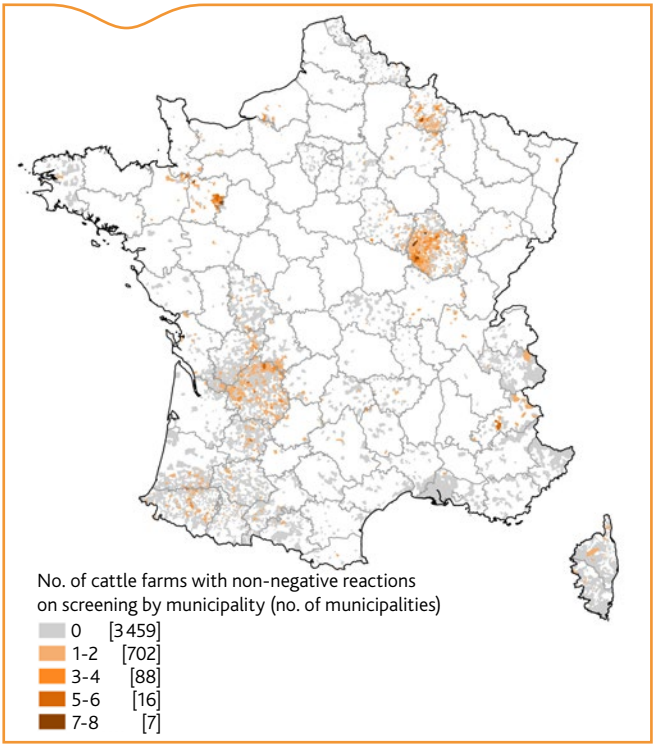

Figure 3. Distribution of the number of farms with a non-negative reaction in 2014 by municipality

Results of programmed screening

Tuberculin tests with non-negative results

Data available for 2014 show relative stability compared to 2013. 3,932 non-negative reactions (i.e. 0.6% of tuberculin tests *versus* 0.7% in 2013) were found on 1,279 farms (i.e. 9.2% *versus* 9.6% in 2013) (Fediaevsky *et al.*, 2013). The proportion of animals with non-negative reactions per herd was 0.47% on average using SITT and 1.6% using SICTT. These findings are surprising given the higher specificity expected with SICTT. The hypotheses and values for a few *départements* are indicated below.

There was an inconsistent geographic distribution of farms that had at least one non-negative reaction to a test (Figure 3). It is difficult to interpret why there were zones with tuberculin testing that had no non-negative results, because this depends on the influence of factors likely to cause reactions in cattle, the size of herds in the zone (and therefore the type of production), local testing conditions, and satisfactory data transmission. On average, 5.3% of herds tested with SITT presented at least one non-negative reaction, *versus* 25.5% of herds tested with SICTT. The difference is slightly smaller than in previous years. The proportion of herds presenting at least one non-negative reaction was 5.1% in Charente (7.8% in 2013), 31.7% in Côte-d'Or (36.7% in 2013), 9.6% in Dordogne (7.5% in 2013), and 3.9% in Pyrénées-Atlantiques (3.5% in 2013). The levels remain consistent, with a very high level of non-negative herds in Côte-d'Or.

The number of reactor cattle was lower *versus* 2013. In 2014, it was 2,069 (04%) for SITT and 1,863 for SICTT (0.8%), *versus* 2,716 (0.6%) and 2,171 (1.0%), respectively in 2013. Of the cattle with a non-negative SITT result, 31.9% presented a positive result. Of the cattle with a non-negative SICTT result, 11.0% presented a positive result, which is consistent with the higher specificity of SICTT. In Charente, the proportion of cattle with at least one non-negative reaction was 0.1% using SITT (0.8% in 2013), in Côte-d'Or 0.7% using SICTT (SITT no longer used), in Dordogne 0.3% using SITT (0.4% in 2013), and 0.7% using SICTT (1.4% in 2013), and lastly in Pyrénées-Atlantiques, it was 0.1% with SITT (1.1% in 2013) and 0.4% with SICTT (0.3% in 2013).

The finding of a lower proportion of non-negative cattle with SITT, although less specific, than with SICTT, across all *départements* in 2014, is surprising. This difference can be explained by various factors, including the use of SICTT in zones with a high prevalence of atypical reactions, greater attention paid by professionals during measurement of skin folds related to the method, and lastly a classification bias due to the risk of results corresponding to retests in herds with SITT reactions having been erroneously attributed to intradermal tuberculin screening results.

The non-negative results were reported by 278 veterinary practices, i.e. an increase of 16% *versus* 2013. The veterinary practices that reported at least one non-negative reaction carried out 72% of tuberculin tests country-wide *versus* 60% in 2013. They accounted for 86.8% of tuberculin tests carried out in Charente (30.3% in 2013), 97.0% in Côte-d'Or (84.8% in 2013), 94.7% in Dordogne (39.6%inn 2013) and 68.8% in Pyrénées-Atlantiques (42.1% in 2013). These increases may be partial indicators of greater sensitivity of detection on the basis of a better rate of reporting in these four *départements*.

In 2014, the number of SITTs and the proportion of non-negative results detected are positively correlated (correlation $\tau = 0.26$ $p<10^{-16}$), this is also true of the number of SICTTs and the proportion of non-negative results detected (correlation $\tau = +0.19$, $p<10^{-6}$). Given that tests are not infallible in terms of specificity, this positive correlation was expected.

Screening with IFN-gamma

Use of this test was reported in a specific article about surveillance in the Camargue (Desvaux 2015). In the Landes *ganaderias*, eight farms presented non-negative results with interferon. As part of reinforced surveillance in Dordogne, 22 farms presented a reaction that was non-negative on intradermal tuberculin testing.

Surveillance on animal movements

Based on collected data, non-negative results were obtained for 186 animals (0.1% of tested animals) in 141 herds, i.e. 0.7% of herds tested

Table 2. Surveillance of bovine tuberculosis at the slaughterhouse in 2014 based on reasons for inspection

		Number	Proportion (%)
Routine surveillance	ODF herds with suspected case at slaughterhouse	>532	100%
	Cattle from an ODF herd with suspected bovine TB lesions	532	
	Cattle from an ODF herd with a lesion confirmed to be bovineTB (rate of confirmation %)	25	4.7%
Diagnostic slaughter	Herds having undergone diagnostic slaughter	841	0.4%
	Herds with confirmation on diagnostic slaughter (rate of confirmation %)	84	10%
	Cattle undergoing diagnostic slaughter	2,203	
	Cattle undergoing diagnostic slaugher confirmed infected (rate of confirmation %)	90	4.1%
Partial depopulation	Herds undergoing partial depopulation*	44	
	Cattle undergoing partial depopulation*	2,926	
	Reactor cattle undergoing partial depopulation*	184	
	Cattle undergoing partial slaughter confirmed infected*	36	1.2%
Complete depopulation	Herds undergoing complete depopulation	61	
	Herds undergoing complete depopulation with lesions	29	47.5%
	Cattle slaughtered under complete depopulation	7,669	
	Cattle slaughtered under complete depopulation with lesions	175	2.28%

* based on data available in SIGAL and reported by the DDecPP in the annual report
ODF: officially disease-free

Table 3. Number of bovine tuberculosis outbreaks in France in 2014, detection circumstances and funding

Incident outbreaks 2014 (herds) (%)	105 (0.05)
Prevalent outbreaks 2014 (herds) (%)	190 (0.089)
Prevalent herds as of 31/12/14 (%)	83 (0.039)
Infected imported cattle	1
Proportion of herds undergoing complete depopulation (%)	58.1
Outbreaks detected at slaughterhouse (%)	20
Outbreaks detected through programmed screening (%)	60
Outbreaks detected through movement surveillance (%)	1
Outbreaks detected by epidemiological survey (%)	18
Outbreaks detected in another way (%)	1
Veterinary fees (%)	11.3
Compensation (%)	63.8
Laboratory fees (%)	19.8
Cleaning-disinfection (%)	0.8
Miscellaneous costs (%)	0.7
State screening subsidy (%)	3.7

in this programme (2% in 2013). These herds were distributed among 44 *départements* of the 78 *départements* that reported results (versus 24 of 60 in 2013).

Slaughterhouse surveillance

Based on collected data, 532 cattle (224 in 2013) from officially disease-free herds in 64 *départements* (45 in 2012) (Table 2) presented suspected tuberculosis lesions at the slaughterhouse. The number of cases confirmed by this system has remained stable and as a result, the confirmation rate of these lesions has dropped to 4.7% (25/532) *versus* 13.5% in 2013. The higher number of suspected cases associated with a reduced rate of confirmation is an encouraging sign of improved sensitivity for this type of screening and of the effectiveness of training set up at slaughterhouses. The stable number of confirmations is also a reassuring indicator of the general veterinary picture for bovine TB. The number of suspected cases at the slaughterhouse is still inconsistent but has increased in three of the four priority *départements*, which is a good sign. This number has changed from zero in Charente, 22 in Côte d'Or and four in Dordogne in 2013 to 7, 46 and 12 respectively for each *département* in 2014. The number of suspected cases (n=11) is stable in Pyrénées-Atlantiques. The number of cattle confirmed as infected in 2014 was one in Charente, two in Côte-d'Or, three in Dordogne and two in Pyrénées-Atlantiques, *versus* zero, one, four and five respectively in 2013. In 2014, 114 slaughterhouse staff had received training on tuberculosis in the previous five years. Given the staff turnover, it is important to pursue this awareness programme.

Surveillance of herds likely to be infected

On the basis of available data, an epidemiological link with an outbreak was identified during the calendar year for 3,655 herds in 73 *départements*. In Charente, data recording was not finalised. 516 herds with a link to an outbreak were found in Côte-d'Or, 1,141 in Dordogne (versus 55 in 2013, but this Figure was recorded very inconsistently in Sigal), and 124 in Pyrénées-Atlantiques. These variable findings may be related to differences in epidemiological situations or different data processing methods. The situation should become more harmonised following publication of a new memorandum enabling greater follow-up of epidemiological surveys with higher quality tools (NS 2015-468).

Tuberculin tests were carried out in nearly three times as many herds with an epidemiological link than in 2013, i.e. 1,483 *versus* 690, there was nonetheless a stable proportion of 41% of investigated links (versus 44% in 2013). Of these, 337 showed non-negative reactions (9% *versus* 22.8% in 2013).

Diagnostic slaughter

Diagnostic slaughter was performed in 8% of herds with an epidemiological link (296/3,655) and in some cases was performed irrespective of the results of intradermal tuberculin tests. These investigations led to confirmation of infection on 33 farms, i.e. a confirmation rate in herds with likely infection and undergoing diagnostic slaughter of around 11% (33/296).

Measures taken in suspect herds

Collected data indicate that 1,301 herds spread across 61 *départements* underwent tuberculin testing as part of health control measures when cases were suspected, and 324 had at least one non-negative reaction (25% compared with 45.3% in 2013). It appears that there was a considerable decrease in the proportion of herds with non-negative reactions. However, data at the herd level were not available for Charente, Dordogne, and Côte-d'Or. In Pyrénées-Atlantiques, there were 96 herds (versus 120 in 2013) with an intradermal tuberculin test as part of control measures, of which nine presented non-negative reactions, i.e. 9.4% *versus* 12.5% in 2013. At the animal level, the number of non-negatives in terms of the number of animals tested was stable in Charente (5.1% in 2014 *versus* 5.0% in 2013), lower in Côte-d'Or (2.1% in 2014 *versus* 2.6% in 2013) and in Dordogne (1.7% in 2014 *versus* 2.1% in 2013), and higher in Pyrénées-Atlantiques (1.33% in 2014 *versus* 0.47% in 2013).

IFN-gamma tests continued to be used for the second consecutive year as part of an experimental diagnostic programme that is being evaluated scientifically. The conclusions are expected in the first half of 2016.

Diagnostic slaughter

One or more diagnostic slaughter orders were issued for 841 farms (976 in 2013). A total of 2,203 cattle were slaughtered for diagnostic

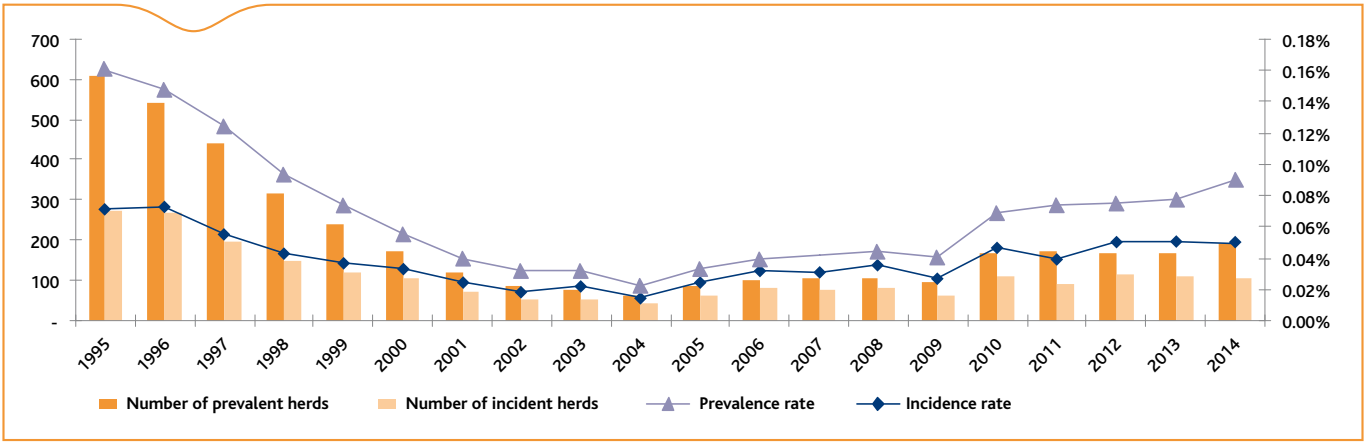

Figure 4. Change in the prevalence and incidence of bovine tuberculosis from 1995 to 2014

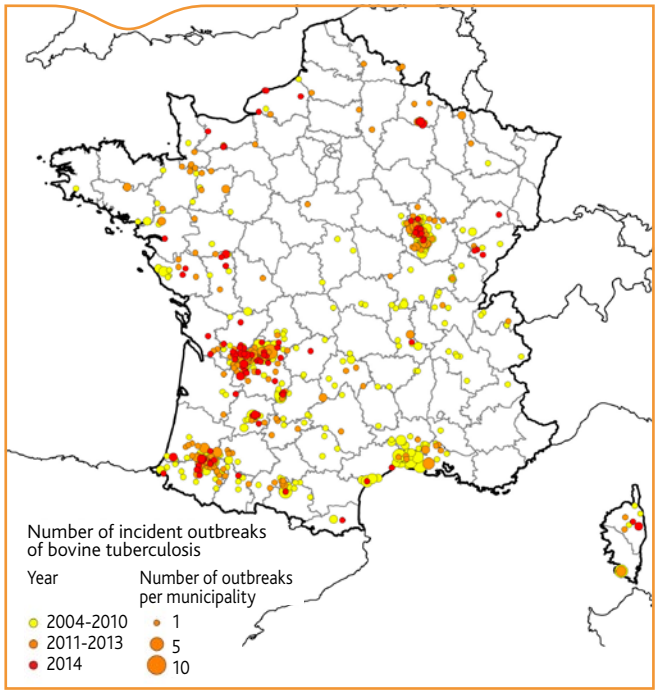

Figure 5. Geographic distribution by municipality of incident outbreaks of bovine tuberculosis in France from 2004 to 2014

purposes (2,004 in 2013), up by 10%. The confirmation rate was 10.0% (84/841) at the farm level (8.0% in 2013) and 4.1% (90/2,203) at the animal level (5.6% in 2013) (Table 3). There were 66 slaughtered cattle in Charente, 381 in Côte-d'Or, 310 in Dordogne, and 235 in Pyrénées-Atlantiques, of which 24.2%, 2.3%, 7.4%, and 2.1% were confirmed as infected, respectively. The situation in Charente (which had a very high confirmation rate among animals slaughtered for diagnostic purposes) contrasted with that of the other *départements*, and with the data for 2013 (2.7% confirmation rate). However, the ratio of the number of cattle slaughtered diagnostically per individual animal with a non-negative reaction on screening by tuberculin test could not be calculated with the available data.

Outbreaks

Incidence, prevalence and geographic location

In 2014, 105 herds were reported as newly infected (112 in 2013), i.e. an incidence of 0.05% (105/212,550) and prevalent cases amounted to 190 infected herds, yielding a prevalence rate of 0.075% (190/212,550). These values have been stable since 2012 (Figure 3) (Fediaevsky *et al.*, 2013).

As for geographic location (Figure 5), 46% of incident outbreaks were detected in Aquitaine with a slight decrease in the number of outbreaks in all of the region's *départements*. Charente however showed a marked increase in the number of outbreaks, with an increase from two in 2013 to 12 in 2014. Following suspicion on necropsy of a goat, an outbreak was identified on a mixed goat and cattle farm in Deux-Sèvres, leading to detection of four outbreaks in all. In the Burgundy region, the number of new outbreaks in Côte-d'Or continued to decrease (-50% in 2014 and -30% in 2013), and no new outbreak was detected in Nièvre or in Yonne. In Ardennes, five secondary outbreaks were detected, still in the same zone, through investigations carried out following the 2012 slaughterhouse cases, and the same BCG strain was involved. In the Camargue, two new outbreaks were detected by programmed surveillance on the farm, confirming the effectiveness of the plan implemented in the zone and the benefits of sustained vigilance. In Ariège, one new outbreak was detected in the at-risk zone identified in 2010. In Mayenne, no new outbreak was identified. In Haute-Corse, outbreaks continued to be detected in zones where they had been identified in the past.

Means of detection

Overall, more than 78% of incident outbreaks in 2014 were detected on farms by skin test screening based either on routine tuberculin screening (60%), (Table 4, Figure 6), or on farms "likely to be infected", i.e. those that have an epidemiological link to an outbreak (18%). The proportion of outbreaks detected through slaughterhouse screening was again lower compared to previous years, which is reassuring.

Control of the disease

Control of infected herds was carried out by partial depopulation in 44 outbreaks in 9 *départements*, and by complete depopulation in 61 outbreaks in 21 *départements*. Since control through partial depopulation is slower, of the 78 prevalent outbreaks as of 31 December 2014, 64% were still undergoing partial depopulation.

According to available data, 2,926 cattle were managed by partial depopulation. Of these, there were 184 reactors (6%) and 36 cattle confirmed as infected (1.2%) spread across five *départements*. On five farms, control initially through partial depopulation was changed to complete depopulation (one in Ardennes, three in Dordogne, and one in Pyrénées-Atlantiques). Complete depopulation led to 7,669 cattle being slaughtered: 175 (2.28%) of them, spread across 29 herds, had lesions suggestive of bovine tuberculosis (Table 3). This means, on the one hand, that in 53% of the outbreaks managed through complete depopulation, no lesions were detected and infection was confirmed positive only through the index case, and on the other, that in 47% of the herds, lesions were found in an average of six cattle. However, this mean Figure masks wide diversity. In Charente, the mean number of cattle with lesions in the herds controlled through complete depopulation and where lesions were detected was 11.3. There were zero cattle with lesions in farms managed by complete depopulation in Côte-d'Or, and a mean of 1.2 in Dordogne, and 8.3 in Pyrénées-Atlantiques, while in these *départements*, there were respectively 11, three, five, and six complete depopulations in 2014, and three, zero, five, and three farms in complete depopulation where lesions were found. These data appear to indicate detection of outbreaks at an advanced stage in Charente, which should prompt greater vigilance in the follow-up of controls and screening the coming years.

Costs

On the basis of cost information provided by the DDecPPs, funding from government for 2014 was €17,537,028 before tax to cover the items listed in Table 3. The mean national expenditure (compensation and disinfection costs) per prevalent outbreak was €107,000 in 2014. This indicator, which hides significant differences, is however stable. The amount was €106,000 in 2013, €114,000 in 2012, and €108,000 in 2011. It will be interesting to follow up this indicator with the opening of partial depopulation to the entire country by the new Memorandum

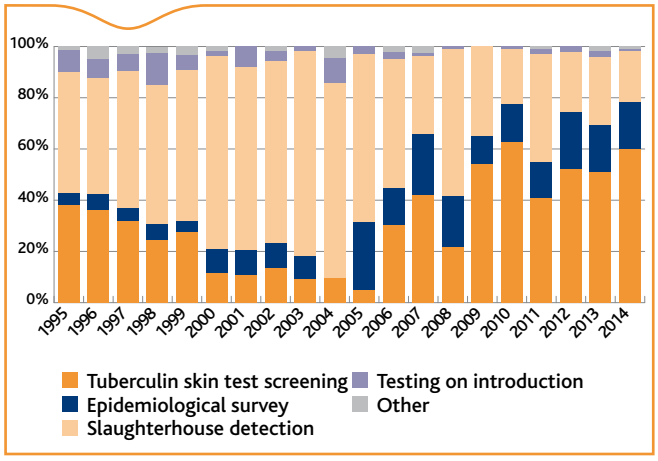

Figure 6. Distribution of detection means (%) for bovine tuberculosis outbreaks between 1995 and 2014

2014-691 of 20 August 2014. Furthermore, these costs must be added to those related to wildlife surveillance estimated at around €1M, with 80% provided by the central administration and 20% by DDecPPs.

Discussion

The completeness and accuracy of collected data could be improved. Tools to simplify the centralisation and extraction of data to coordinate efforts and communicate on the system are being developed. These are structural efforts concerning information systems, their use, and their exploitation, and will help to use data more directly as early as 2015. A significant improvement in data quality is to be expected in the coming years.

In terms of surveillance, on-farm testing has remained stable, measured in particular by the rate of non-negative reactions to skin tests and a decrease in the relative share of outbreaks detected at

Box 2. Sylvatub: Tuberculosis surveillance in wildlife

Since the discovery of the first red deer infected with tuberculosis in Brotonne forest (Seine-Maritime) in 2001, wild infected animals have subsequently been identified in several *départements* across France: Côte-d'Or, Corse-du-Sud, Haute-Corse, Pyrénées-Atlantiques, Dordogne, and Charente, then Ariège (ANSES, 2011; Hars *et al*, 2010). At the end of 2011, on the initiative of the Ministry of Agriculture, a national surveillance program called Sylvatub was established as part of the National Epidemiological Surveillance Platform for Animal Health. It includes outbreak and programmed surveillance protocols with the aim to carry out an integrated assessment of sampling procedures, to harmonise diagnostic methods, and to centralise data from various surveillance systems (Rivière *et al*., 2013).

Badger surveillance

In 2014, 2,727 badgers from 27 *départements* were analysed, including 361 found dead on the roadside or collected by the SAGIR network (outbreak surveillance) in *départements* with reinforced surveillance and 2,366 captured in at-risk areas (programmed surveillance). The number of infected badgers detected was 86 in total in seven *départements*, including 10 from outbreak surveillance (3.2% apparent prevalence) and 76 from programmed surveillance (2.7% apparent prevalence) (Figure 1) *versus* 9/211 (4.3%) and 65/1,508 (4.3%) in 2013. The 60% increase in the number of trapped badgers was associated with a 25% decrease in the proportion of positive badgers. This observation requires critical analysis of the sampling protocol.

Deer

Between 01/08/2013 and 31/07/2014, 347 red deer and 33 roe deer were inspected or analysed from 24 different *départements*. Of these analysed deer, 52 were identified through outbreak surveillance (suspicions on lesions in hunted animals and deer found dead collected by SAGIR network) and 328 through the programmed surveillance plans for hunted animals in at-risk areas. None of the analysed deer were found to be infected (Figure 1), compared to four in 2013.

Wild boar

Between 01/08/2013 and 31/07/2014, 1,372 wild boars were analysed from 30 *départements*. Of these analysed wild boars, 66 were identified through outbreak surveillance (suspicions on lesions in hunted animals and wild boar found dead collected by SAGIR network) and 1,306 through programmed surveillance plans for hunted animals in at-risk areas. In all, tuberculosis infection was detected in 44 wild boars from seven different *départements,* including 10 detected through outbreak surveillance and 34 through programmed surveillance (Figure 1). The proportion of infected animals was therefore slightly higher than in 2013 (6/48 and 20/1270, respectively).

In 2013-2014, infected wildlife was always identified in relation to the presence of the disease in cattle, both in terms of the similarity of implicated strains and the geographic areas. *Départements* with infected wildlife were Ardennes, Charente, Côte-d'Or, Dordogne, Corse-du-Sud, Haute-Corse, Landes, Lot-et-Garonne, Pyrénées-Atlantiques and Seine-Maritime.

The results of the Sylvatub programme should however be interpreted with caution given the wide range of surveillance protocols involved. Detailed reports are available in the the ESA Platform website (www.plateforme-esa.fr).

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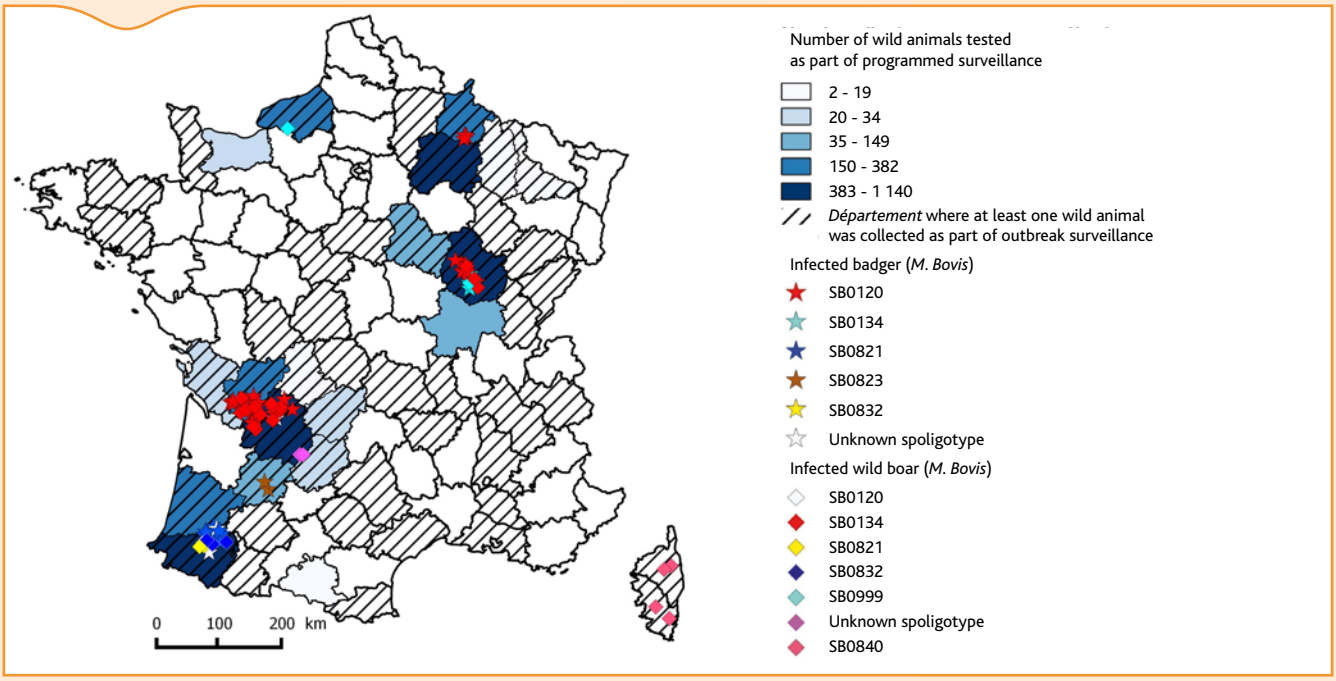

Figure 1. Distribution and results of the analyses undertaken under the Sylvatub program in wild ongulates from August 2013 to August 2014 and in badgers in 2014

the slaughterhouse. This improvement has contributed to detection of outbreaks at earlier stages of infection. The fact that many diagnostic slaughter procedures are carried out with no infection being confirmed should not detract from the fact that some of these negative procedures involve infected non-detected animals (limited sensitivity of diagnostic slaughter), cases that have thankfully been removed (Bekara, 2014). The high increase in the number of suspected cases at the slaughterhouse with no increase in the number of confirmations is a positive sign concerning renewed awareness efforts directed towards slaughterhouse personnel.

The south-west *départements* have an increasingly large proportion of the detected outbreaks. Interlinking of farms through contacts between neighbouring plots and infected wildlife in this zone call for sustained efforts in screening and control measures for farms to guarantee long-term eradication of this disease, without letting a wildlife reservoir develop.

Partial depopulation is a way to improve the social and financial acceptability of control measures for infection generally detected at an early stage. It can now be used not only in certain geographic zones but on the basis of a certain number of criteria aimed at not endangering the effectiveness of the control measures. This will need to be confirmed.

In late 2014, revision of the second version of the national plan for the control of bovine tuberculosis was initiated. The core of this action plan is to put forward proposed actions that take into account the need to control the disease in the long-term and to coordinate efforts, particularly concerning earlier detection. In this context, the role of interferon, the screening strategy in terms of geography and timing, as well as surveillance based on risk (movements in particular) will be re-evaluated through national and regional consultation of the stakeholders through 2015, and in the medium-term through research and modelling projects.

The overall situation in France in 2014 was favourable, with an annual incidence rate below 0.01%, making bovine tuberculosis a rare disease. However, the status of officially disease-free territory does not mean the disease has been eradicated. Therefore, all stakeholders have multiplied their efforts in various areas of the country, with increasing effectiveness, but this should be strengthened in some areas and sustained in others.

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Box 3. Genotype of strains involved in bovine tuberculosis outbreaks in 2014 in France

In 2014, genotypes (spoligotyping + VNTR techniques) of *M. bovis* were determined for 93 of the 105 incident outbreaks in 2014. Twenty different genotypes were found. The phenomenon of regionalisation of strains is still as marked as in previous years. The most commonly represented genotypes among the 93 outbreaks (72%) were "BCG-Ardennes", "BCG-Côte d'Or", "BCG-Dordogne-Charente", F7 in Pyrénées-Atlantiques, and F41 in Lot-et-Garonne.

Less common types such as F1 in Corsica, F61 in Camargue, F15 in Pyrénées-Atlantiques, "GB35-Ariège-Haute Garonne", or "GB54-Sud-Ouest", already observed in these same regions the previous year, were also found in 2014.

Moreover, other locally recurrent types such as "GB54-Doubs", observed in 2011 and 2012, SB0999 regularly found from 2004 up to 2011 in the south of Dordogne, as well as type F5 observed in 2003 and 2010 in Pyrénées-Atlantiques, and F96 observed in Hautes-Pyrénées in 2000 and 2003, reappeared in 2014 in the same regions. Type "GB35-Calvados" observed in 2014 in Calvados, was also found in 2008 in cattle from this area. Concerning the BCG strain in Pyrénées-Orientales, this type was already implicated in outbreaks in this *département* in 2005 and 2011. This re-emergence phenomenon was also found in a more marked manner with the discovery in 2014 of a GB20 type already found in the same mixed caprine/bovine herd in 1990 in Deux-Sèvres. Detecting these uncommon types a long time apart in the same regions highlights the lack of knowledge on the epidemiology of these outbreaks and calls for overall reinforced vigilance in these areas.

This characteristic high level of regionalisation of strains was a helpful guide in determining the origin of outbreaks with F110 type in Dordogne or "GB35 Calvados" type in Corrèze. These two types found in the *départements* in question for the first time were probably introduced to meat production farms that practice milk-fed veal production with dairy cows, by beef cattle cows" from Ille-et-Vilaine for the first and Normandy for the second, where these types had already been found in the past.

Concerning the other strains of spoligotype GB54, the "main" VNTR type was already found in the 1990s in Seine-Maritime but since this is a common type in both France and Spain, it is not possible to establish the origin of the outbreak with certainty *via* strain typing.

Strains of the "GB54 Spain" type belong to strains introduced directly from Spain with imported animals.

In conclusion, local persistence of strains was once again reported in 2014, with some strains being particularly dominant and others being expressed more intermittently. This demonstrates weakness in detection and elimination of the disease in these regions.

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