

THE IMPACT OF ELECTROMAGNETIC FIELDS ON LIVESTOCK HEALTH

On 18 February 2021, the Parliamentary Office for Scientific and Technological Assessment organised a public hearing on the impact of electromagnetic fields on livestock health, following a request by the National Assembly's Sustainable Development and Spatial and Regional Planning Committee.

This public hearing took the form of two round tables. The first addressed the phenomena observed and the scientific explanations provided. The second related to the way in which the problems encountered by some farmers are currently taken into consideration and managed.

1. A COMPLEX AREA IN WHICH SCIENCE HAS SO FAR ONLY PROVIDED PARTIAL ANSWERS

A. THE ROLE OF ELECTROMAGNETIC FIELDS IN BEHAVIOURAL DISTURBANCES IN ANIMALS HAS NOT BEEN SCIENTIFICALLY DEMONSTRATED

- **The diversity of electromagnetic fields and their effects**

Depending on their emission sources, the frequencies of electromagnetic fields vary. Telecommunications masts generate high-frequency electromagnetic fields while high-voltage power lines create low-frequency electromagnetic fields. **However, for a given voltage, the interactions between electromagnetic fields and the environment vary considerably as a function of their frequency.**

It is also useful to make a distinction between the direct and indirect effects of electromagnetic fields.

The direct effects of high-frequency fields are thermal effects, while those of low-frequency fields are induction phenomena.

The indirect effects concern the electrical currents generated that can create so-called parasitic currents, which spread through metal structures¹ as a result of suboptimal earthing. These parasitic currents may have an internal origin, related to farm operations, and/or an external one, due to the effects of neighbouring power lines.

In terms of the direct effects of electromagnetic fields, no scientific study has established a direct causal link between proximity to a power line and animal health. Similarly, all attempts to identify a

¹ The electric field alters the distribution of electric charges on the surface of metal structures and causes a potential difference that depends on the intensity of the field and the area of the metal surface (the terms electric induction and capacitive coupling are used). A magnetic field's variations create a current throughout the metal structure (magnetic coupling).

link between electromagnetic fields and immune system disruptions or physiological stress remain fruitless.

In terms of indirect effects, **studies examining behavioural changes in animals in response to the electric currents generated have identified moderate to severe stress responses, which vary from one species to another.**

Moreover, studies commissioned by the ANSES (National Agency for Food, Environmental and Occupational Health and Safety) to characterise the exposure of livestock to electromagnetic fields found exposure levels well below the maximum exposure values defined at European level (100µT for the electromagnetic field and 5kv/m for the electric field for a frequency of 50Hz).

- **Symptoms that do not make it possible to establish a link with electromagnetic field exposure**

Science has also struggled to establish a direct link between the difficulties observed and animals' exposure to electromagnetic fields in the absence of pathognomonic symptoms. In reality, the conditions observed - mastitis, lameness, hormonal imbalances, etc. - can have various causes. Similarly, the behavioural changes observed are not specific to an electric and/or magnetic disturbance.

However, the fact that a cow, which is supposed to drink around 80 litres of water per day by submerging her muzzle in the water, starts to lap the surface as a cat would, suggests that electric disturbances may be affecting the animal. Another sign is an animal's refusal to go to specific locations within the farm (some or all of the cowshed, milking robot).

B. IN SITU OBSERVATIONS HIGHLIGHT SEVERAL FACTORS: THE HIGHLY SENSITIVE NATURE OF ANIMALS, THE ROLE OF PARASITIC CURRENTS AND THE INFLUENCE OF GEOLOGY

Observations on the ground of the problems encountered by some farms reveal trends that should guide scientific research.

- **A concomitance between the installation of power or telecommunications infrastructures and the onset of behavioural disturbances in animals**

At the public hearing, several farmers highlighted the concomitance between the installation of electricity infrastructures and the onset of behavioural disturbances in their livestock.

A milk producer testified that following the replacement of an overhead power line by an underground line some twenty metres from his farm buildings, he observed abnormal behaviour in his animals - abnormal huddling, refusal to go to the milking robot -, a drop in milk yield and quality and excess calf mortality. These disturbances disappeared when he moved the underground line 150 metres further away.

A chicken and suckler cow farmer stated that she believed that abnormalities observed in her poultry - increasingly heterogeneous batches - and her cows - increased infertility - had appeared following the installation of a mobile telephone mast.

Conversely, disturbances observed in livestock on two farms close to the Quatre Seigneurs wind farm appeared as soon as the earthworks started, i.e., well before the presence of electricity on the site.

In other cases, disturbances are observed in animals in the absence of any electric installations in the vicinity - masts, wind turbines, power lines.

- **A relative consensus regarding the role of strong animal sensitivity and parasitic currents**

Livestock sensitivity is higher than that of humans. It varies according to the species and depends on their electrical resistance (500 ohms for cows). This resistance is high for poultry and decreases for sheep, pigs and cattle. Animal sensitivity also varies between individuals within the same species and it is influenced by the seasons and the environment (increase in the number of electrical appliances, conductivity of metal equipment in contact with the animals, soil moisture).

Experiments conducted in laboratory rats exposed to electrical currents help provide an understanding of behaviour in livestock exposed to electric stress: avoidance of specific areas when leakage is possible; prostration with clinical and zootechnical consequences and impacting production when the animals are unable to get away from the electrical disturbances; modification of herd behaviour with the development of aggression and mounting in cattle, or even cannibalism in pigs.

The immediate environment surrounding livestock can favour the appearance of parasitic currents. Electromagnetic fields, and currents associated with electrical installations, can cause parasitic currents and voltages on the different metal surfaces present on farms, starting with the buildings themselves. They manifest themselves by electric shocks received by animals when they come into contact with metal surfaces (**touch voltage**) or by current travelling through their body via the application of a potential difference (**step voltage**).

These parasitic currents can be exacerbated by the fact that rules governing the electrical compliance of buildings are not always respected during their construction or installation. This electrical compliance can also be altered as metal structures deteriorate over time, which can lead to a galvanic effect (ground that starts off as a poor conductor then becomes a good conductor of electricity).

However, some animal behaviours remain unexplained, even though no electrical voltage is measured. **Several speakers suggested the potential role played by the underground environment in the transmission of stray currents.**

C. THE NEED TO FINANCE RESEARCH

- **Poorly documented scientific fields have been clearly identified**

During the public hearing, **three fields in which knowledge needs to be improved were highlighted: exposure of livestock to electromagnetic fields and the effects of this on their health; the updating of thresholds relating to the perception of parasitic currents by animals and their compatibility with existing electrical standards; the circulation of currents on the ground and underground.**

In terms of livestock exposure to electromagnetic fields, very little data is available and until now no large-scale long-term studies had been conducted in France. As for the effects of electromagnetic fields on livestock, the expert assessment published by the ANSES in 2015 noted that the studies conducted were insufficient to draw any conclusions. That is because the studies in question were undermined by the absence of protocol standardisation and, at times, inadequate scientific rigour, particularly concerning metrology, characterisation of the source of the electric and/or magnetic fields and the real level of animal exposure (intensity, frequency and duration).

In addition, several speakers mentioned the **need to re-evaluate animals' perception thresholds and question the relevance of existing electrical standards.** The recommended thresholds were established by the GPSE (Permanent Group for Electrical Safety) at the end of the 1990s and have never been re-evaluated, while farm buildings and the electrical environment to which animals are exposed have evolved significantly. Similarly, continuous parasitic currents have not been the focus of any studies despite the fact that they are present on farms.

As for electrical and magnetic standards, maximum exposure limits relating to magnetic fields have been decreed with reference to humans, without taking into account the specific characteristics of animals. Some speakers estimated that earth resistance values (below 100 ohms in a house and below 50 ohms in a damp environment) were too high to protect livestock from parasitic currents.

Standard NF C-15-100 was also questioned insofar as its purpose is to prevent electrocution, but it does not address stress phenomena associated with the use of electricity on farms.

A broad consensus emerged regarding the need to conduct studies focusing on the circulation of currents on the ground and underground, the role of faults and groundwater as well as their interference with the electrical and metal equipment present on farms and their impacts on animal welfare.

- **Financial resources are required**

In its 2015 report, the ANSES identified the fields in which research efforts were required. But no funding has been allocated. Due to a lack of resources, neither the National Research Institute for Agriculture, Food and the Environment (INRAe) - for research on animal exposure -, nor the Office for Geological and Mining Research (BRGM) - for research on the influence of geology on the circulation of stray currents - have been mobilised to tackle these issues, despite the fact that they possess the necessary skills and expertise.

Similarly, a lack of funding has meant that no multidisciplinary scientific investigation is underway on farms experiencing recurrent and unexplained difficulties, despite the fact that the GPSE has a network of experts that could be mobilised.

During the public hearing, the French Ministry for Agriculture was challenged about the issue of research funding. It would appear that some financial tools, particularly within the framework of the government's recovery plan, could be mobilised for the purpose.

2. A FUNDING EFFORT THAT REQUIRES IMPROVEMENT

A. THE GPSE: A BODY SET UP TO SUPPORT FARMERS THAT NEVERTHELESS DRAWS CRITICISM

- **A body that has continued to act despite State withdrawal**

Following the publication in July 1998 of a report commissioned by the Ministry for Agriculture relating to the influence of electromagnetic fields on livestock farms, a protocol agreement was signed in 1999 between the Ministry for Agriculture and EDF (Électricité de France), paving the way for the setting up of the GPSE, initially chaired by Professor Henri Gallouin of AgroParisTech.

When it was first set up, and for more than 10 years thereafter, the GPSE operated as a working group, without any formal structure, in accordance with the protocols concluded between the Ministry for Agriculture and EDF, and then EDF and RTE (Réseau de transport d'électricité). The first protocol agreement signed in 1999 closed at the end of 2003 and was renewed in 2006 to cover the period to the end of 2008.

During this period, the GPSE conducted an inventory of available knowledge, highlighted existing electricity-related problems on farms and proposed a methodology for resolving disputes with EDF.

At the end of this period, the issue of renewing protocol agreements between the Government and electricity operators was back on the agenda. Presented in 2010, the Parliamentary Office's report relating to the effects of electric fields on health and the environment underlined the work accomplished by the GPSE and recommended that *"the State should fully resume its role"*.

The Ministry for Agriculture preferred to advocate the creation *"of an exchange protocol between agricultural producer representatives and electricity distributors"*, limiting its role to the *"facilitation of dialogue between the parties as needed"*.

In 2014, this situation resulted in the GPSE becoming a private association, named the Permanent Group for Electrical Safety in Agriculture, with RTE, Enedis and the APCA (Permanent Assembly of Chambers of Agriculture) as founding members. The SER (Renewable Energies Union) and

France énergie éolienne (representing wind energy) joined the association. The ministries concerned (Agriculture, Sustainable Development, Energy) are executive board members with no voting rights. The association does not have a public service mission but shares its expertise with livestock farmers faced with suspected parasitic currents linked to external electrical infrastructures. It does not deal with problems allegedly related to masts.

- **A global approach to individual cases**

The GPSE intervenes as an arbitrator. **Two types of interventions are proposed: rapid interventions**, with no protocol agreement, aimed at establishing an independent electrical diagnosis; **in-depth interventions, formalised by a protocol agreement signed by the parties concerned**, aimed at establishing a comprehensive diagnosis of the farm facing a complex problem. The local chamber of agriculture must submit a request to the GPSE and systematically supports the farmer throughout the procedure.

Based on the observation that symptoms caused by parasitic electric currents are not specific and that the problems encountered on farms are always multifactorial, **the investigation method applied by the GPSE is hinged around three areas of expertise: electrical audit, comprehensive health assessment, zootechnical expertise**. The GPSE's recommendations almost systematically relate to the upgrading of private installations to ensure compliance with standards; once the recommended work has been carried out, an improvement is generally observed. Nevertheless, the elimination of parasitic currents, be they associated with the farm's own installations or public electricity infrastructures, does not always solve all of the initially observed problems. **Of the 49 interventions conducted between April 2014 and October 2020¹, 35 cases were considered to have been resolved. Eighteen were conducted within the framework of a protocol agreement but five failed to resolve the problems observed.**

- **A body that is not immune to criticism**

Two criticisms are levelled at the GPSE: its late intervention and its dependence on electricity operators for the funding of its expert assessments.

The intervention of the GPSE takes place several years after the onset of problems. While it is not responsible for the delay, the fact remains that when it is consulted, the problems faced by the farm have taken on a significant multifactorial dimension. The electrical fault, irrespective of origin, has been compounded by other issues, leading to a significant deterioration in the health of the herd, which is difficult to correct in a few months. It is for this reason that just 1% of the GPSE's spending is dedicated to the upgrading of installations while spending related to veterinary expertise and health-related actions absorb 39% of the budget.

Since the GPSE does not have its own funds,² interventions are entirely financed by electricity operators within the framework of protocol agreements signed after discussions on a case-by-case basis. Situations do arise whereby funding is not sufficient to complete an investigation, or indeed is not available at all if the operator feels that intervention by the GPSE is not justified. The independence of the expertise is also challenged by some farmers, insofar as funding is provided by the company potentially responsible for the problem.

¹ of the 72 requests submitted to the GPSE.

² A "partnership fund" to which all members of the board contribute was set up in 2019 to finance rapid interventions.

B. THE INCREASING ROLE OF GEOBIOLOGY TO TACKLE THE BLIND SPOTS OF SCIENCE

- **The principles of geobiological diagnosis**

Geobiology is a field that looks at the relationships between living things on the one hand, and the environment, buildings and lifestyles on the other hand. The objective is to determine zones to be avoided because they may have a negative impact on animal health. These negative impacts may be of artificial origin (electromagnetic fields associated with high-voltage power lines, masts, wind turbines, transformers, electrical installations on farms, etc.) or telluric origin.

There are two stages involved in a geobiological diagnosis.

First of all, the geobiologist analyses the site, focusing, in particular, on faults and groundwater arteries located in the vicinity, or even beneath the farm buildings, which could potentially have a negative impact on animals.

The geobiologist then conducts an electrical diagnosis, identifying parasitic currents and carefully examining earthing systems. Recommendations are hinged around the definition of resistance values well below existing standards and the installation of earthing systems in a neutral environment, devoid of water courses or underground faults likely to scatter stray currents. Multiple equipotential bonding is carried out to eliminate any difference in potential.

- **A non-scientific field yet to be structured**

The links between geobiologists and agriculture go back a long way and are well established, as reflected in recurrent recourse to geobiology prior to the construction and installation of livestock buildings. Some speakers also called for geobiology to be used preventively when locating electricity infrastructures in the vicinity of farms.

However, the field does not always have unanimous support. While it is partly based on scientific methods, particularly when it comes to electrical measurements, there is an element of subjectivity and perception involved and it may, in some cases, be used by unscrupulous people who appear to want to take advantage of farmers in distress rather than provide genuine solutions. On the other hand, it can play a genuinely preventive role, but like other areas of expertise, geobiology has not been able to provide solutions to the most extreme situations highlighted at the public hearing.

In order to gain legitimacy, the profession of geobiologist needs to be formally structured, particularly with a view to eliminating those claiming to be from the profession with dishonest intentions. Hence, in order to ensure the quality of those operating in the field, the National Geobiology Association, created in 2012, has drawn up a code of ethics as well as a practical and professional charter.

3. THE RECOMMENDATIONS OF THE PARLIAMENTARY OFFICE

This public hearing was an opportunity to recognise the problems encountered by some farmers, the current limits of science when it comes to explaining the phenomena observed, as well as deficiencies in dealing with the most extreme cases.

The proposals put forward, some of which were expressed at the public hearing, are designed to meet three objectives: a better understanding of phenomena and their origins, the systematic prevention of difficulties, and the more effective management of problems encountered by farmers.

They reiterate and supplement the recommendations set out in the Parliamentary Office's report of May 2010 and that of the General Council for the Environment and Sustainable Development (CGEDD)/General Council for Food, Agriculture and Rural Areas (CGAAER) of November 2020.

- **For a better understanding of phenomena and their origins**

- **Define a research framework in the sectors where a lack of knowledge has been identified:** the effects of electromagnetic waves on animals; the nature of parasitic currents on livestock farms, their effects on behaviour and performance, the relevance of animals' perception thresholds and their alignment with existing electric standards; the influence of water and geology in the circulation of electric current on the ground and underground;

- **Conduct, in partnership with the farmers concerned, experiments on farms experiencing difficulties, paying particular attention to the protocol used to take measurements;**

- **Develop a national observatory to make an inventory of, characterise and document farms concerned by alleged difficulties caused by electromagnetic fields.**

- **For a systematic prevention of difficulties**

- **Introduce the widespread use of geological and electrical diagnoses prior to the construction of livestock buildings and/or their renovation, but also prior to the installation of electricity and telecommunications infrastructures** (electricity networks, wind turbines, photovoltaic panels, mobile telephone masts);

- **Raise awareness of chambers of agriculture and reinforce their expertise** to enable them to inform farmers and, if required, advise them when problems arise that appear to be linked to the impact of electromagnetic fields.

- **For the more effective management of problems encountered by farmers**

- **Accelerate the consideration of problems expressed by farmers and, in the most difficult cases, provide them with an emergency solution**, via, for example, the extension of mutual fund missions targeting health and environmental risks;

- **Change the status of the GPSE in order to guarantee its independence and increase its independent intervention budget;**

- **Accelerate the process to establish a formal structure for the profession of geobiologist**, introducing compulsory training requirements and compliance with a code of ethics, such as the one decreed by the national geobiology confederation;

- **Implement the recommendations formulated within the context of the various studies already conducted by the Parliamentary Office, the ANSES and CGEDD/CGAAER.**



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