



The importance of veterinary diagnostic laboratories for disease surveillance, research, and postgraduate studies in animal health in Brazil¹

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This article describes the importance of Veterinary Diagnostic Laboratories (VDLs) for the development of animal health research and postgraduate education in Brazil. It also addresses the limitations, difficulties, and potential of these laboratories as an efficient alternative for the consolidation of epidemiological surveillance of animal diseases in the country. These laboratories should also be used as efficient tools for the development of research, teaching, and extension, practiced in an associated manner in undergraduate and postgraduate education in veterinary medicine.

INDEX TERMS: Animal diseases, animal health, veterinary education, veterinary diagnostic laboratories.

PURPOSE

The purpose of the Veterinary Diagnostic Laboratories (VDLs) is to determine the occurrence, epidemiology, economic importance, and methods of control and prophylaxis of livestock diseases. This broad purpose explains the multidisciplinary nature of VDLs: diagnostic activity is not the end goal but a starting point for effective disease control. This control involves epidemiological surveillance, the establishment of research projects that allow for the elucidation of unknown aspects of diseases, and extension activities that transfer the knowledge acquired about the occurrence of diseases and the methods of prevention and control to farmers, veterinarians from public and private services, and undergraduate and graduate students. Considering the participation of farmers and students, it is clear that VDLs, in addition to research, are strongly involved in extension and teaching – these activities occur simultaneously and are inseparable. A critical point for the efficiency of a VDL is that all data obtained as part

of the diagnostic routine must be recorded and processed systematically.

ACTIVITIES AND OPERATION

Most VDL activities are performed by pathologists, who are responsible for collecting samples, mainly from necropsies, although they can also be forwarded by veterinary practitioners outside the laboratory. These samples are processed for histopathological diagnosis and forwarded to other laboratories such as microbiology (virology, bacteriology, and mycology), parasitology, polymerase chain reaction (PCR) and other molecular techniques, clinical pathology, serology, toxicology, and/or mineral analysis. The results are analyzed together, and the final diagnosis must also consider the clinical picture and epidemiology of the disease in question. This form of operation implies that the study of diseases must be carried out from a multidisciplinary point of view. In some cases, such as in Garanhuns, at the “Universidade Federal Rural de Pernambuco” (UFRPE) Cattle Clinic, which has been operating since 1979, diagnostic activities have been coordinated by veterinary clinicians with the collaboration of pathologists, sometimes from other institutions.

In this article, we discuss some essential aspects of the proper operation of a VDL. The starting point is the existence of qualified veterinarians for diagnostic activities. Without them, none of the subsequent stages are viable. The second point is that a VDL must be equipped with the appropriate equipment to perform the techniques relevant to the region in

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which it is located and the production systems in that region. For example, the structure and techniques used are different in a region of intensive poultry and/or swine production, such as western Santa Catarina, compared to a region of extensive ruminant production, such as the southern region of Rio Grande do Sul State or the semiarid region of the Northeast. Within the concept of VDLs' multidisciplinary activities, all information obtained from the cases must be processed and stored. In addition to qualified personnel and infrastructure, VDLs depend on financial sources, which must cover routine operations, such as acquiring materials needed to perform laboratory tests and allowing the VDL team members to go to the farms immediately to respond to health incidents. This endeavor requires the constant availability of transportation. Finally, we must consider that conducting research is one of the purposes of a VDL and that this research originates as a result of animal health problems on farms. Therefore, a VDL fundamentally performs applied research and must aim to solve real and relevant problems from a socioeconomic point of view. We must bear in mind that it is a waste of resources for a VDL to exist without research. Moreover, historically, all university VDLs have operated with financial support for research obtained from sources outside of the universities (CNPq, CAPES, FINEP, State Research Foundations, etc.). It is necessary to have researchers capable of applying for and obtaining grants to achieve this.

RESEARCH

Given the importance of conducting research at VDLs, we need to understand what types of research they should conduct. There are three main categories:

1) The occurrence, etiology, and pathogenesis of diseases that have not been fully studied. Although it is difficult to define or even accept that some diseases have been fully studied, we can include diseases previously undiagnosed in a region, either because they were recently introduced or because of the previous absence of laboratory methods that would allow their diagnosis. We must consider that the conditions under which diseases occur vary according to biomes and production systems. Thus, well-known diseases in one region may not be sufficiently known in another.

2) The epidemiology and economic importance of known and subclinical diseases. Although many diseases are well known in terms of their diagnosis, VDLs need to systematically diagnose these diseases and study their epidemiology. Knowledge of the frequency of diseases is essential for evaluating health programs. We must also remember that diseases have distinct geographic distributions, and the same disease may present variations related to the biome or production system. We can exemplify these points with the increase in anaplasmosis outbreaks in Mato Grosso do Sul after the concentration of cattle-raising systems in the Pantanal biome and the increase in intensive finishing systems in the Cerrado biome. Another example in this State, is the drastic reduction in cases of botulism in cattle raised extensively and the increase in the frequency of the disease in feedlots (Lima et al. 2024).

3) Alternatives to control diseases. Research developed for this purpose must consider that disease control measures should include the social and economic aspects of the region of the VDL and the production system. For example, control

measures impractical from economic and/or social points of view cannot be considered efficient.

A particularity occurs with diseases not characterized by mortality outbreaks or that respond to treatment. The first group includes helminthiasis and mineral deficiencies in cattle, and the second includes neonatal diarrhea in calves. These diseases may not cause high mortality rates for different reasons, so the cases are not referred to a VDL. Research on the epidemiology, economic impact, and control of these diseases requires the development of research projects with a methodology appropriate for their diagnosis. Many times, the losses, although significant, do not cause deaths and, therefore, are not referred for necropsy.

In addition to the importance of diagnosing and establishing disease control methods to support farmers, diagnostic activities are also relevant for any country. These activities serve as an efficient surveillance system for disease prevention and official control programs and a mechanism for immediately diagnosing exotic diseases that may be introduced into the country.

COLLABORATIVE WORK BETWEEN VETERINARY DIAGNOSTIC LABORATORIES (VDLs)

The successful relationship between VDLs and research and postgraduate studies can be summarized in the Regional Diagnostic Laboratory of the Federal University of Pelotas (LRD/UFPel) activities. The LRD/UFPel was created in 1978. Over the 44 years of its existence, it has produced more than 400 scientific articles on diseases of livestock that have been published in national and international journals. Other important LRD/UFPel activities include the uninterrupted publication of the LRD yearly bulletin for 42 years; it describes the diseases diagnosed in the previous year and makes this information available to veterinarians, farmers, and undergraduate and postgraduate students. The LRD/UFPel has also published several books on diseases of ruminants and horses, toxic plants and mycotoxicosis. Initially, these publications had a regional nature, but they have been expanded and today have a national and international scope. The book "Doenças de Ruminantes e Equinos" (in English: Diseases of Ruminants and Horses) in its latest edition (Riet-Correa et al. 2023) represents a collaboration of more than 100 authors from different institutions in Brazil. The work can be considered the most important book on livestock diseases in Brazil. Another book, "Intoxicaciones por Plantas, Micotoxinas y otras Toxinas em Rumiantes y Équidos en Sudamérica" (in English: Poisonings by Plants, Mycotoxins and other Substances in Ruminants and Equids in South America) (Riet-Correa et al. 2024), was published in Spanish with Uruguayan and Argentinian authors. This type of publication is only possible as a result of the joint work of various VDLs.

Another example of integrated action between VDLs is the National Institute of Science and Technology (INCT) for the Control of Plant Poisoning. This endeavor involved researchers from 17 diagnostic centers in different regions of Brazil. The success of this project can be highlighted by the increase in the number of known species of toxic plants in Brazil over time. In 2000, 80 species of toxic plants were known in Brazil, 12 of which were in the Northeast. Currently, 174 species of toxic plants are known in Brazil, 65 of which

are in the Northeast. Additionally, with the cooperation of foreign research institutions, the toxic compounds of 34 toxic plants in Brazil have been determined.

The Regional Diagnostic Laboratory of the Federal University of Pelotas (LRD/UFPel)

The LRD/UFPel deserves special mention because it was created differently than other Brazilian university laboratories that perform diagnostic activities. Specifically, it was created based on a proposal submitted to the central administration of UFPel, which approved the proposal entirely. Thus, the LRD/UFPel was created as an autonomous sector, with infrastructure, technical and administrative staff, and its own vehicles. To begin its operations, the LRD/UFPel hired five veterinarians for pathology, microbiology, virology, and clinical pathology. In addition, it had 10 laboratory technicians and a secretary. The participation of professors in diagnostic activities was optional. However, numerous professors from related areas of knowledge (pathology, microbiology, virology, mycology, clinical pathology, public health, parasitology, toxicology, and reproductive diseases) also participated in diagnostic activities.

Other Veterinary Diagnostic Laboratories

At other institutions that perform veterinary diagnostics in Brazil, especially universities, no structure has been created specifically for this purpose. Diagnostic activities are not fully coordinated, and actions are developed based on collaboration between different university laboratories. Although less efficient, these laboratories have tried – to the best of their abilities and by seeking alternatives such as collaboration with other established laboratories – to reproduce the same way by which the LRD/UFPel operates. It can be said that the concepts developed by the LRD/UFPel have resulted in the implementation of different VDLs that have spread throughout Brazil. University VDLs actively participate in postgraduate studies in Brazil alongside their diagnostic and research activities. Below, we briefly summarize this participation in chronological order. The examples are limited to institutions or states where the authors have worked or developed joint activities with institutions in the mentioned states.

In Rio Grande do Sul, the Desidério Finamor Veterinary Research Institute was created in 1942 by the state government. Despite its importance for animal health research, the institution did not implement a postgraduate program. On the other hand, several of its researchers participated in the Postgraduate Program in Veterinary Medicine at the Federal University of Rio Grande do Sul (UFRGS). The Federal University of Santa Maria (UFSM) began its diagnostic activities in 1964, and the master's degree was implemented in 1974. At this institution, postgraduate studies, initially with a master's degree and, from 1997 onwards, a doctorate, have been developed based on the work of a diagnostic laboratory. The UFRGS implemented a master's degree in 1974 but only began to perform veterinary diagnostics systematically in 1995. The institution implemented a doctorate in 1997, which has been strongly linked to diagnostic activities since its creation.

In Rio Grande do Sul, the LRD/UFPel can be considered an exception because its implementation in 1978 not only coincides with the implementation of the master's degree but was the reason for its creation. In 2006, the institution implemented the doctorate, following the same guidelines.

Other universities, such as the University for the Development of the State of Santa Catarina (UDESC), the Federal University of Mato Grosso do Sul (UFMS), the Federal University of Mato Grosso (UFMT), and the Federal University of Pará (UFPA), in Castanhal, have also developed postgraduate courses associated with diagnosis. In these cases, diagnostics preceded the postgraduate courses. An interesting case occurred in the state of Paraíba, where two postgraduate programs were implemented practically simultaneously with the diagnostic activities. At the Federal University of Campina Grande (UFCG), diagnostic activities began in 2002, and the postgraduate program began with a master's degree in 2003 and a doctorate in 2008. During this period, up to July 2024, 386 theses and/or dissertations were produced. If we consider that each thesis or dissertation gives rise to at least one scientific publication, we can have a clear idea of the impact of the association between postgraduate studies and diagnosis. At the Federal University of Paraíba (UFPB), on the Areia campus, the master's program was created in 2012, concomitantly with the beginning of diagnostic activities. The doctorate was implemented in 2024. Up to the beginning of 2024, 84 dissertations have been produced. In addition to the aforementioned VDLs, at least 27 federal or state universities in Brazil have developed diagnostic activities for animal diseases associated with research, teaching, and extension in various regions of the country.

Below, we address the issue of diagnosis in Brazil in a general context, analyzing all institutions that perform diagnostics or have the potential to perform this activity. The first laboratories to perform diagnostic and surveillance activities for animal diseases in Brazil were state or federal veterinary research laboratories, including the Biological Institute of São Paulo, created in 1927; the Institute of Animal Biology (IBA) of the Ministry of Agriculture of Rio de Janeiro, created in 1933; the Desidério Finamor Veterinary Research Institute in Rio Grande do Sul, created in 1948; the State Agency for Animal and Plant Health Defense (IAGRO) in Mato Grosso do Sul, created in 1979; and the Marcos Enriette Diagnostic Center in Paraná, created in 1981. To these non-university laboratories, we can add EMBRAPA Suínos e Aves in Concórdia/SC, created in 1975.

There are also laboratories in Brazil of the Ministry of Agriculture and Livestock (MAPA) dedicated to the diagnosis of rabies; these facilities are distributed throughout the country (Fig.1). Because many of these laboratories could also be used to diagnose other diseases, we consider these laboratories to be underutilized.

DIAGNOSTIC LABORATORIES AND KNOWLEDGE OF DISEASES OF LIVESTOCK IN BRAZIL

By jointly analyzing the presence of laboratories that work in diagnosis and the relevant scientific publications in the area, we can estimate which Brazilian states have good knowledge about animal diseases in their territories. This estimate is shown in Figure 2. Some states in the North, Northeast, and Central-West regions do not have an adequate diagnostic structure; therefore, in these areas, knowledge about diseases in farm animals is very limited. On the other hand, we cannot guarantee that good knowledge in other areas translates into adequate surveillance due to the limited interaction in most states between the official animal health service and laboratories that do not belong to the official service.



Fig.1. Distribution of Ministry of Agriculture and Livestock (MAPA) rabies diagnostic laboratories. Blue symbols = State Veterinary Services, green symbols = Federal Superintendencies of Agriculture, orange symbols = Rabies Diagnostic Laboratories. Source: MAPA.



Fig.2. We consider the blue area to be regions with adequate knowledge of livestock diseases. The white areas are those where knowledge of livestock diseases is very limited or non-existent.

MEETINGS

A milestone in the history of veterinary diagnostics was the creation of the National Meeting on Veterinary Diagnostics (ENDIVET). The event began in 1992 in Santa Maria at UFSM. Initially scheduled to be held every two years, it was interrupted in 1996 and resumed in 2006. From that year onwards, the event was held uninterrupted until 2018. Due to the coronavirus disease 2019 pandemic, the meeting scheduled for 2020 was not held, although the meeting was resumed in 2022. In addition to ENDIVET, VDLs in Brazil actively participate in other scientific events such as “Encontro Nacional de Patologia Veterinária” (ENAPAVE) and the Brazilian Congress of Buiatrics.

OBJECTIVES ACHIEVED BY THE VDLs IN BRAZIL

Despite several factors that limit their performance, which will be discussed later, several of the objectives proposed by the VDLs have been achieved:

- 1) Applied and relevant research aiming at solving real problems;
- 2) Interaction between VDLs and different production systems;
- 3) Training of human resources in undergraduate and graduate courses;
- 4) Interinstitutional research;
- 5) Knowledge of the epidemiology, control, and prophylaxis of diseases in different regions and different production systems;
- 6) Realization of ENDIVET and other meetings.

All these achievements can be measured by the production of scientific articles and other bibliographical materials such as books, technical notes, bulletins, lectures, and participation in events by researchers working in diagnostics. It is worth noting that many of these publications are produced through collaborations between VDLs in Brazil and other countries. ENDIVET plays a fundamental role in this collaboration. Since

the 2006 edition, it has constantly and progressively included researchers outside Brazil. This measure has had an important effect on the establishment of international cooperation. Regarding the training of human resources, there has been a notable increase in the number of VDLs in Brazil in recent years. This increase has been facilitated by postgraduate programs. It is also important to emphasize that most scientific publications involve the participation of postgraduate students.

LIMITING FACTORS

Several factors limit the performance of VDLs in Brazil; most of them are because they are part of universities. In principle, universities should offer the necessary structure for fast and efficient service that meets the needs of farmers, which is not the case in almost all universities. As mentioned, these conditions include the lack of budgetary resources and exclusive vehicles for VDLs and the hiring of veterinary professionals specialized in the different areas necessary for diagnosis. Unfortunately, university leaders do not see the activities of VDLs as a unique opportunity for veterinary education that combines teaching, research, and extension.

HOW TO IMPROVE THE EFFICIENCY OF DIAGNOSTIC LABORATORIES

Despite several limitations, VDLs play an important role in animal health in Brazil. For this reason, we address some points that could help to improve VDLs. The first point is to continue the studies on epidemiology, economic importance, control, and prophylaxis of diseases in different production systems. The second is to seek multidisciplinary knowledge of production aspects, feeding, and management, as well as the market and production costs (including health costs), aiming to minimize economic losses caused by diseases. It is essential to understand that diagnostic work is multidisciplinary;

therefore, professionals working in the area must have a multidisciplinary vision.

In this context, we need to understand the role of VDLs in animal health in Brazil. We look for an integrated animal health system with high-level scientific activity to protect the country from the economic public health impacts of animal diseases. For these reasons, animal health research in Brazil must meet the following criteria:

- 1) Be multidisciplinary and multi-institutional;
- 2) Be international;
- 3) Be at the forefront of knowledge;
- 4) Generate publications in high-impact journals;
- 5) Aim for epidemiological surveillance (know, evaluate, minimize, and mitigate the risks of diseases, including exotic ones);

- 6) Train highly efficient human resources.

For greater efficiency and also to improve the performance of existing structures, activities must be developed in a coordinated network of VDLs, which must meet the following requirements:

- 1) Systematized information available to users;
- 2) Emphasis on epidemiological studies of already known diseases;
- 3) Advanced and standardized diagnostic techniques;
- 4) Immunohistochemistry;
- 5) PCR, other molecular techniques, genetic sequencing, genomics, bioinformatics;
- 6) Clinical pathology;
- 7) Analysis of minerals, residues and toxic substances;
- 8) Electron microscopy.

To optimize infrastructure and equipment usage and also to reduce costs, some of these activities can be shared in collaboration between different VDLs.

Looking at Figure 2, it is clear that there is a need to find ways for regions without adequate knowledge about livestock diseases to move in this direction. One possibility is for veterinary schools operating in these regions to start performing diagnostic activities. To do this, they should hire professors (with a doctorate) who have graduated from universities with postgraduate programs with a strong focus on diagnostics. Once hired, these professors should develop diagnostic activities for which they can count on the help of researchers from other institutions who are always willing to collaborate. This endeavor depends on the university leaders' appropriate decision-making and planning. It is also essential to create postgraduate programs with livestock diagnostic activities. This should be an initiative of the institution, but, unfortunately, university leaders rarely consider the needs of the communities in which they are located, in this case, the farmers. Regardless of the planning undertaken by universities, the development of diagnostic activities in many states and regions has been based on hiring or training professionals with a comprehensive and modern view of animal health and, in almost all cases, associated with postgraduate programs. Moreover, adapting MAPA laboratories so that they can diagnose diseases other than rabies would be extremely useful for these regions. It would be even better if these laboratories work together with the universities.

AGRICULTURAL RESEARCH

After discussing advances in veterinary diagnostics and animal health research in Brazil and outlining future action plans,

we must reflect on why agricultural research does not always achieve the expected results. In this sense, some questions need to be answered:

- 1) Is the research relevant?
- 2) Are appropriate technologies being generated?
- 3) Is there an extension problem?
- 4) Why does the farmer not adopt certain technologies?

It is certainly easier to elaborate on these questions than to answer them. Nevertheless, we can propose two initial steps. The first is to conduct a survey with these questions, to apply them directly to farmers, and, based on their responses, to design research projects to meet their needs. The second is to replace disciplinary research with multidisciplinary research after identifying farmers' demands. In addition to the technological aspect, this new research should address aspects related to credit, product marketing, inputs needed for production, and farmer well-being and education. Considering that many universities have postgraduate courses in areas such as animal science, veterinary science, agronomy, soil and water management, ecology, and biodiversity, which operate in isolation, one way is to promote the joint action of these programs.

CONCLUSION

Veterinary Diagnostic Laboratories (VDLs) have contributed fundamental knowledge about animal diseases. However, there are still large areas of the country where information regarding animal health is very limited. Since Brazil is the world's largest meat exporter, diagnostic and epidemiological surveillance activities must be extended to all regions of the country. This should be achieved by developing veterinary diagnostic activities in universities and MAPA laboratories. These disease surveillance and diagnostic activities are essential to establish an integrated animal health system, with high-level scientific activity aimed at protecting the country from the threat and economic and public health impacts of animal diseases.

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