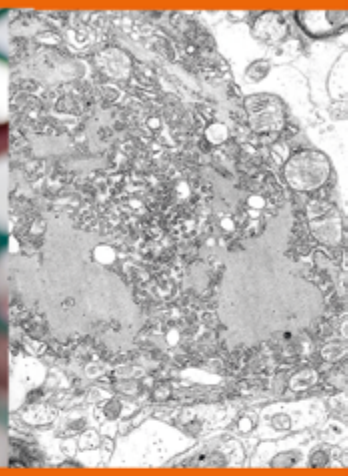
Regional program of

Rabies in Livestock

PAHO Pan American Health Organization

World Health Organization
REGIONAL OFFICE FOR THE Americas

PANAFTOSA
Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health



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PRESENTATION

The Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health of the Pan American Health Organization/World Health Organization (PANAFTOSA/VPH-PAHO/WHO) has the privilege and honor of presenting the Regional Program of Rabies in Livestock.

This document is one of the follow up actions to the 2nd Virtual Meeting with the Directors and Chiefs of Rabies Control Programs of the Countries of the Americas, of July 23rd, 2020. It describes the objectives, goals, activities, and indicators of the Regional Program, providing technical support to the National Programs. This document was developed thanks to the joint efforts and technical experience of professionals of the official veterinary services of the countries of the Region, with extensive knowledge in leading and managing rabies control programs in livestock, with the technical support of PANAFTOSA/VPH-PAHO/WHO.

The Regional Program represents a great advance for the Region, supporting the monitoring and following up of the execution and the quality of the work of the official veterinary services provided in the countries of the Americas. It represents a unified approach and will support all countries in the Region, both those that need to establish and those that need to review their programs, to be guided by a Regional common reference. This document will help to develop an Action Plan for next years, and to monitor the future progress of the countries.

PAHO/WHO, through PANAFTOSA/VPH, will continue providing technical cooperation to its Member States in rabies control, supporting actions to animal and public health in the Americas, an essential condition for the wellbeing of the people of this Region.

Dr. Ottorino Cosivi

Director of the Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health, of the Pan-American Health Organization/World Health Organization.

PANAFTOSA/VPH-PAHO/WHO

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1. CONCEPTUAL **FRAMEWORK**

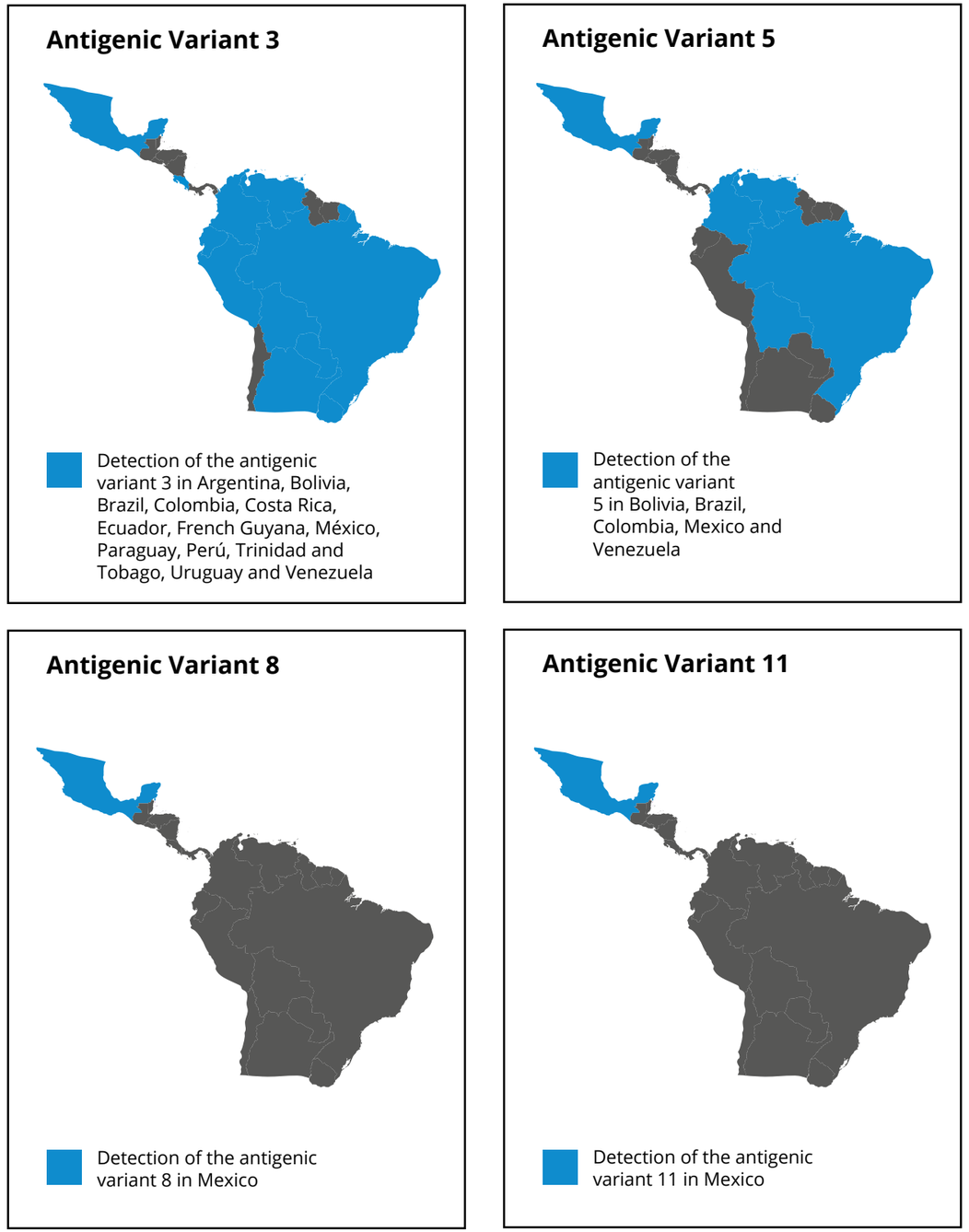
1.1. RABIES IN LIVESTOCK

Rabies is an incurable zoonotic disease that represents a serious threat for public health, animal production and preservation of wild fauna. This is an acute, progressive and fatal illness of the nervous system caused by an RNA virus belonging to the Rhabdoviridae family, genus Lyssavirus (Lyssa, madness in Greek), with the capacity of infecting all mammals. It is mainly transmitted through the saliva of infected animals and, once the virus is inoculated by the byte of an infected animal to a susceptible animal, it disseminates through the peripheral nerves and reaches the central nervous system, causing an acute progressive encephalitis with a mortality rate of 100% (WHO 2018).

The disease has different animal reservoirs and presentations. For instance, in urban settings, domestic dogs are carriers and vectors (variants 1 and 2, "classic rabies virus lineages"), as well as other wild animals that play this role in rural areas (Figure 1). In the rural environment, livestock are predominantly affected by rabies transmitted by hematophagous bats of the *Desmodus rotundus* species, reservoirs of virus Variants 3, 5, 8 and 11, the "lineages consistent with the virus transmitted by *D. rotundus*" (Escobar et al. 2015) (Figure 2).

FIGURE 1. Different cycles of rabies transmission, highlighting the cycle between the *D. rotundus* bats and livestock.

FIGURE 2. Distribution of the antigenic variants of the rabies virus associated to the *Desmodus rotundus* bat in the Americas.



Source: Adapted from Escobar et al. 2015

In livestock, signs start in general with isolation, apathy, loss of appetite, and progress to constant bellowing, tenesmus, hyperexcitability, increased libido, excessive salivation and difficulty swallowing, convulsive movements of the head, motor incoordination, difficulty walking and breathing, opisthotonos, asphyxia and, finally, death. Average duration of the process from virus inoculation to the occurrence of the first signs varies between 30 and 90 days, depending on the extent and depth of the wound, the site of the bite, the amount of virus inoculated, and the virus strain. The role of the livestock is not relevant for the persistence of the rabies virus in the environment, since these animals are at the end of the transmission chain.

Rabies of livestock has an impact on the production system not only because of the detriment to the population due to the death of animals, but also because of the risks to public health, particularly to farm workers in direct contact with ill animals and the possibility of direct transmission of the rabies virus by hematophagous bats to humans. Since the disease has no cure, prevention is the only control method.

1.2. THE HEMATOPHAGOUS BAT *DESMODUS ROTUNDUS*

There are three species of hematophagous bats in the Americas: *Diaemus Youngi*, *Diphylla ecaudata* and *Desmodus rotundus*. The two former species have evolved to feed on the blood of birds and, therefore, they are not epidemiologically relevant for the transmission of rabies to livestock. Rather, the *Desmodus rotundus* (Figure 3) feeds almost exclusively on the blood of mammals, including humans (Greenhall 1988), and incidentally on the blood of birds, especially when the number of domestic and wild mammals is low (Bobrowiec et al. 2015). The role of the hematophagous bat is essential for the maintenance and transmission of the rabies virus to humans and livestock (Reis et al. 2007). The hematophagous bat belongs to the order Chiroptera, family Phyllostomidae and subfamily Desmodontinae (Neuweiler 2000). In general, this hematophagous bat forms colonies of tens to hundreds of individuals (Uieda 1987) and roosts in holes of trees, abandoned buildings, bridges, caves,mines, and rocky crevices (Bredt et al. 1998).

FIGURE 3. Hematophagous bat of the *Desmodus rotundus* species.
Photograph by: Dias, Ricardo A. Guaratinguetá, State of São Paulo, Brazil, 2017.

Social interaction is essential for the survival of the hematophagous bat. Individuals of the same roost are in frequent physical contact. Every day, after looking for food, bats gather in their roosts and those who have failed start to exhibit a begging behavior, licking the mouth of other individuals. This behavior is a safeguard against starvation since bats can die after three days of fasting (Freitas et al. 2013). Besides, they interact by cleaning each other's furs, a behavior known as grooming. These habits not only allow those bats who were unable to feed during the night to obtain food, but also to uphold the cohesion of the colony (Wilkinson et al. 2016). For these reasons, the social structure of the hematophagous bat is considered well developed and complex (Wilkinson 1985; Kunz and Fenton 2003).

The hematophagous bat has the capacity to adapt to anthropogenic ecological changes. This species is endemic

in Latin America, from the north of Mexico to the north of Argentina (Hayes and Piaggio 2018). During the pre-Columbian era, the hematophagous bat fed on big wild mammals in tropical rainforests; after the XVI century, however, deforestation, agricultural intensification, and urbanization reduced the availability of wild prey but, in turn, provided new and abundant sources of roosts and food (Belwood and Morton 2014). Consequently, the population of hematophagous bats grew exponentially. Domestic animals are constantly attacked at night when hematophagous bats are settled in the area (Voight and Kelm 2006; Mialhe 2014). Hematophagous bats can fly up to 10 km per night to find food (Medina et al. 2007). Yet, the distance of flight is a matter of intense debate since empiric field observation has showed that it is common to observe affected herds or flocks within a radius of 5 km from the *D. rotundus* roosts. A general pattern of bats is that the number of individuals in a roost determines the travelled distance, since some of them can fly further to minimize the competition with their conspecifics (Kunz and Fenton 2003).

FIGURE 4. Colony of *Desmodus rotundus* in a cave.
Photograph by: Natalia Kuzmina (AdobeStock)

1.3. SITUATION ANALYSIS AND IMPACTS

At the time of drafting the elaboration of this document, more than 500 million livestock are reared in the Americas in areas at risk of rabies transmitted by the hematophagous bat *D. rotundus* (adapted from the COSALFA 2018 Report), causing an estimated annual mortality of 100 000 animals (Swanepoel 2004) and annual losses of USD 72 to 97 million due to animal deaths caused by rabies (Adapted from King and Turner 1993, and Belotto 2005). Likewise, it is estimated that for each positive case of rabies in domestic herbivores, there are 9 cases not reported to official veterinary services (Kotait 1998). In addition to the direct damages caused by rabies, the attacks of hematophagous bats produce inestimable damage with secondary infections and parasitic infestations at the site of bite, as well as damages related to the stress animals are constantly subject to.

In 2020, twelve of the 22 countries with presence of hematophagous bats have specific legislation on the topic and 7 of them have established programs for the control of rabies transmitted by the hematophagous bat *D. rotundus* to livestock. This information is extremely important and impressive since, as a basic principle of public actions, standardization is necessary for the application of the necessary public resources for execution.

In 2017, the Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health of the Pan American Health Organization/World Health Organization (PANAFTOSA/VPH-PAHO/WHO) conducted a survey among heads and directors of the rabies programs of veterinary official services from the countries of the Americas regarding rabies in 2015 and 2016 (PANAFTOSA/VPH-PAHO/WHO 2019). In 2015 and 2016, 7,272 suspected cases were inspected in the region and 1,877 were confirmed, which could indicate lack of differential diagnosis to rabies in the countries.

Based on this data, the samples of livestock and bats, processed by the official laboratories of the Ministries of Agriculture, attribute a greater risk to bovines in Argentina (0.86), Panama (0.67), Peru (0.64) and Brazil (0.42) (REDIPRA 16, 2017). The Region of the Americas has diagnostic capacity in 195 laboratories of national and accre-dited veterinary services where the main diagnostic techniques used are direct immunofluorescence (DIF), isolation in mice, and RT-PCR.

1.4. AXES OF THE NATIONAL PROGRAMS

The structure of the program should be based on 9 axes consisting in 6 core execution pillars and 3 cross-cutting components (Figure 5).

The 6 core pillars encompass legislation to support the actions of the official service, surveillance strategies, diagnostic capacity and a coordinated laboratory network, prevention and control actions, assistance to focal areas with occurrence of rabies, and an information system for action management. The cross-cutting components are shared by all core pillars and cross the whole process of the national program: regular training of professionals, health education and integration with the public health, environment, research, and private sectors.

The means for rabies control should be designed to firstly prevent cases and, if prevention fails, to act in assistance to focal areas to mitigate damages in the affected region (Figure 6).

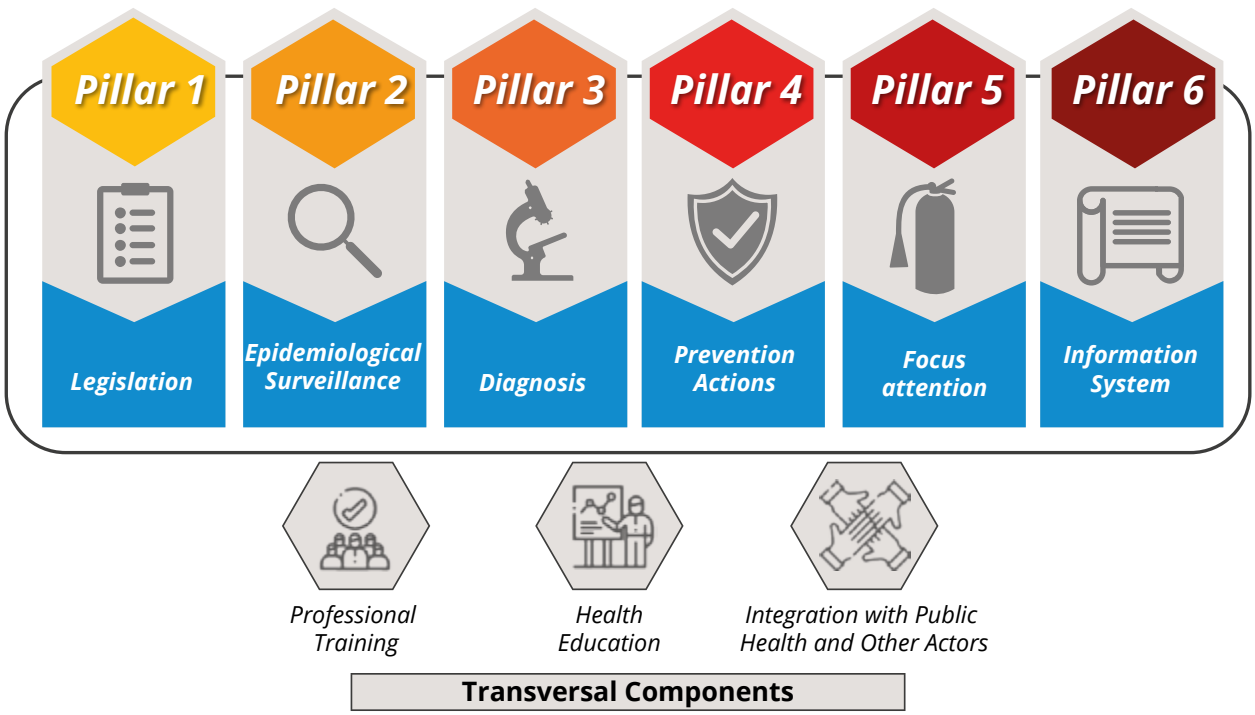


FIGURE 5. The 9 axes pillars (core pillars and cross-cutting components) for a national rabies control program in livestock.

PILLAR 1. Legislation

Specific legislation on the topic is necessary to support the actions envisaged for the program, including surveillance, control and prevention as well as the activities at rabies focal areas, based on technical guidelines, on the structure and organization of the official veterinary service and on current scientific knowledge.

PILLAR 2. Epidemiologic surveillance

Surveillance should identify signs prior to the emergence of focus of rabies and then, when the case occurs, it should identify it as soon as possible to orient actions and minimize damages. Therefore, surveillance should identify attacks to livestock caused by *D. rotundus* and constantly monitor registered roosts to make a follow-up of these bats and identify their growth or stabilization. At the same time, it should be alerted to identify suspected cases of livestock with nervous signs and symptoms in order to collect samples for laboratory confirmation. Namely, surveillance should monitor attacks on livestock, roosts of *D. rotundus*, and suspected cases. Among these, attacks are the key indicator since they allow to identify the existence of roosts and the increase of the *D. rotundus* population, and to predict areas where rabies focal areas may appear in the future.

PILLAR 3. Diagnostic

The program should determine sample shipping methods, as well as the network of official laboratories accredited according to quality management criteria (established by PAHO/WHO Collaborating Centers and OIE Reference Laboratories) to comply with the requirements of the Program, and to guarantee that each sample reaches the nearest laboratory. The existence of laboratories that implement diagnostic techniques, strategically distributed in different areas of the country is essential for better attention to suspected cases. Likewise, and according to the availability of local resources and infrastructure, diagnosis should be considered for the antigenic and genetic characterization of the virus circulating in endemic areas of rabies transmitted by the *D. rotundus* to livestock which allows, in turn, to differentiate it from variants or lineages transmitted by terrestrial carnivores. If this is not feasible, request the support of PAHO/WHO Collaborating Centers and OIE Reference Laboratories.

PILLAR 4. Preventive actions

Prevention of rabies cases is based on two actions: vaccination of livestock in areas where hematophagous bats of the *D. rotundus* species are found and their control. Vaccination will prevent the occurrence of rabies in livestock, but it will not control the persistence and dissemination of the disease in reservoirs. Therefore, the control of hematophagous bat populations is necessary to reduce the population of *D. rotundus*, thus decreasing the risk of rabies transmission between colonies of *D. rotundus* bats and to domestic animals. For the control of the population of hematophagous bats, monitoring and recording roosts on an ongoing basis is essential, including coordinates and characteristics of roosts so that the technical teams can easily find them and assess the outcome of control activities. When the location of the roost is not possible to be identified, control should be conducted at feeding sources. It is imperative that this activity is controlled and performed only by the veterinary authority of the country; the control of the *D. rotundus* population is a strategic action conducted in specific conditions with own materials and a team of professionals trained to that end.

PILLAR 5. Assistance to focal areas

Once the rabies case is confirmed, actions at the focal area should start. Vaccination of the herd at the focal area should be implemented to protect the affected animals of that zone and animals in nearby farms, and surveillance and preventive actions in the surrounds of the focal area should be monitored. Topographic and environmental factors should be considered as well as the distribution of flocks and roosts for a better understanding of the focal (area of influence) and perifocal areas (up to 10 km surrounding the focal area – surveillance area).

PILLAR 6. . Information system

A functional information system is important to identify patterns of disease behavior and to interpret the data that orient field actions regarding surveillance, prevention and attention to focal areas. The objective of the information system is to record disease evolution by checking the outcome of the program, and to evaluate its execution, to optimize and increase the efficiency of actions. Data such as the coordinates of registered roots and the number of *D. rotundus* bats, attacked farms, farms within focal areas, number of livestock attacked, rate of attacks, data of implemented actions, among others, are examples of the information that can support the orientation of actions.

Cross-cutting components are those shared by and present in all core components. It is not possible, for example, to implement the core components of surveillance, diagnosis, prevention actions, attention to focal areas and management of the information system without professionals trained to implement these activities. Therefore, cross cutting components, to a greater or lesser extent, are present in all core components and are essential for the continuity of those components, for communication to the population and for an intersectoral approach:

CROSS-CUTTING COMPONENT 1. Professional training

Keeping the team of field professionals of the rabies program for livestock, as well as laboratory professionals, updated regarding new technologies and scientific knowledge is essential. Besides, staff turnover occurs and it should be replaced by trained professionals, with the same quality of service rendered.

CROSS-CUTTING COMPONENT 2. Health education

Obtaining the support of producers for the actions of the official service is important. Well-informed producers will report attacks and suspected cases, thus reducing underreporting of cases and the risks for public health. Moreover, producers are in direct contact with ill animals and, therefore, they are also at risk of rabies. Health education is also important for health promotion and dissemination among rural producers. Countries should consider their own social, cultural and economic characteristics to identify the best alternatives to raise awareness in and build engagement with the private and productive sector to support the program, either by means of seminars, advertising campaigns, meetings with farm producers cooperatives, distribution of information material, etc.

CROSS-CUTTING COMPONENT 3
Integration with Public Health and other actors

This component refers to the "One Health" approach. Infected livestock with rabies are manipulated by rural workers, who may be therefore exposed to the risk of infection. Likewise, technicians of the official service are also in constant contact with suspected and positive cases. Therefore, the public health system should be aware of pre- and post-exposure protocols, which should be implemented by assessing risk. Environmental-related factors exist that are directly linked to the behavior of *D. rotundus* bats, as well as with their frequency and presence in areas of animal exploitation. Integration with the environmental services could support the identification of these environmental factors and orient control actions.

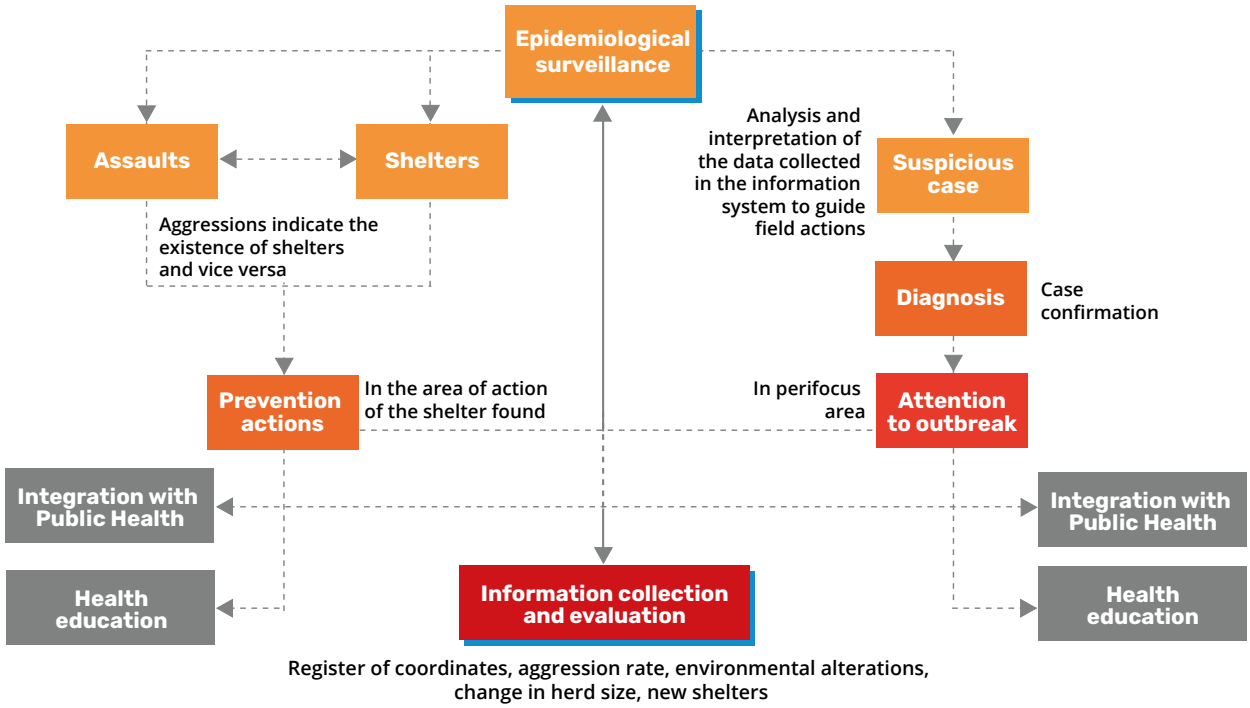


FIGURE 6. Operation flow of a national program for the control of rabies in livestock.

1.5. IMPORTANCE OF THE DIFFERENTIAL DIAGNOSIS OF RABIES

Since rabies is endemic and fatal in the region, it is reasonable to consider rabies as a target disease in the surveillance of diseases with nervous symptoms. The acute condition of this disease is different, for example, from chronic conditions of prion illnesses. Therefore, it is totally accepted and understood that all the samples negative for rabies are tested for bovine spongiform encephalopathy (BSE) as well as other differential diagnoses of nervous syndromes that comply with the inclusion criteria for the surveillance of BSE and other nervous syndromes (to be considered in the differential diagnosis of diseases consistent with rabies), that may be diagnosed not only by histopathology but using other techniques to this end.

The differential diagnosis of rabies compared to other pathologies that evolves with nervous syndromes is fundamental for the confirmation of suspect cases and, moreover, contributes to the surveillance of other diseases, for example, the BSE. The international recognition by the OIE (OIE 2019) requires demonstration of the detection capacity of the disease through the analysis of a minimal number of animal samples with compatible clinic, from which the efford to collect samples for rabies, and collect for BSE too, optimizing time and resources. Therefore, the effort made for rabies surveillance will contribute to the surveillance of other diseases with nervous symptoms.

2.

DESCRIPTION OF **THE REGIONAL PROGRAM**

2.1. RATIONALE

Rabies transmitted by the *D. rotundus* bat to livestock is a significant disease that affects at least 22 countries of the Americas, thus becoming a multinational regional issue. The Regional Program of Rabies in Livestock (PRRH) is important to support standardized and shared policies as well as to orient national policies in order to combat and control the disease. Besides, a regional program develops objectives, goals and results, including indicators, to identify the evolution of regional public policies and the achievements of national programs.

Control, prevention and attention to focal areas of rabies in livestock represent a relevant contribution to development since they reduce the loss of animals due to the disease, with an increase in the primary production of animals and their products. Attacks of *D. rotundus* to susceptible livestock result in other indirect damages that represent indirect economic losses, as well as poor development of attacked animals and secondary infections at the site of the lesions.

Thus, rabies control activities increase the sanitary level and improve the productive capacity of the herds in agricultural communities of family and subsistence farmers, with an increased participation in the provision of the domestic market, which improves their income and their socioeconomic conditions and welfare and contributes to the settlement of these communities in the rural environment. Furthermore, since rabies is a zoonosis, rabies in livestock also represents a public health risk, and therefore, the development and implementation of a program for control and prevention will reflects positively in the health system and in the society.

2.2. PURPOSE

a. To strengthen rabies control in the region, supporting the countries for the creation and development of their programs, as well as for updating those already established.

b. To support and strengthen the political management of national programs.

c. To support the harmonization of actions and practices, harmonizing methodologies.

d. To act as mediator in the communications and the flow of information between countries, and to foster and support actions in bordering areas.

e. To develop mechanisms to help, share and facilitate the provision of supplies and materials for the control actions established by national programs.

2.3. STRATEGIC GUIDELINES

2.3.1. Political and Institutional Guidelines

a. Establishment of clear and decisive political commitments of the countries with the objectives of the PRRH for the prevention and control of rabies transmitted by the ***D.*** *rotundus* to livestock.

b. Strengthening of the participation of the agricultural community in the responsible health management of its herds in support to the actions of the official service.

c. Strengthening of communication and joint actions at regional level, particularly at bordering areas, in a coordinated fashion and with the participation of all stakeholders, strengthening and encouraging all regional and sub-regional instances of cooperation and coordination.

d. Strengthening of the PANAFTOSA/VPH-PAHO/WHO technical cooperation management and coordination of the PRRH in order to assess the regional health situation, with a critical and constructive view, endowed with autonomy and technical capacity.

e. Promotion of interinstitutional involvement by means of the joint cooperation of International Organizations that pursue the same ends in order to avoid non-harmonized efforts and to improve the efficient use of resources.

f. Establishment of PANAFTOSA/VPH-PAHO/WHO as the Regional Program coordinator at the level of the Americas.

g. Continuous exchange and share of all data from the Regional Program coordinated by PANAFTOSA/VPH-PAHO/WHO with the countries.

2.3.2. Technical-epidemiological Guidelines

a. Zoning of the countries according to the risk of rabies in livestock based on the detection of attacks and presence of *D. rotundus* colonies. As a result of this, the following territories

have been identified: i. Risk zone, encompassing the territories (countries and areas) with presence of colonies of *D. rotundus* bats or attacks to livestock; ii. Low risk zone, encompassing territories (countries and areas) where the establishment of colonies of *D. rotundus* have not been identified or attacks to livestock;

b. Use of epidemiological characterization of production systems, ecosystems of rabies in susceptible livestock and risk factors of the epidemic process of the disease, as guiding framework of prevention strategies and attention to focal areas, thus implementing a combination of tools that have proven to be more efficient for the control of the disease in the region;

c. Establishment of follow-up plans and assessment of the PRRH using indicators to measure the progress according to the parameters established for the different regions of the countries according to their epidemiological situation;

d. Maintenance and strengthening of sub-regional plans, fostering integration and coordination of the actions of different programs between the countries that envisage joint actions at the level of shared bordering territories;

e. Adaptation and strengthening of the structure of veterinary care based on the identification of performance critical factors, according to operational strategic requirements and the legal and regulatory framework supporting the (regulatory) public good actions that need to be executed in the program; and

f. Organization of national programs for rabies prevention, control and attention to focal areas in livestock, adapted to the needs for action based on strategic guidelines and epidemiological conditions.

2.4. OBJECTIVES

2.4.1. General Objective

To develop regional harmonized policies to orient national programs for the prevention and control of rabies transmitted by hematophagous bats (*D. rotundus*) to livestock, defining goals and results, assessed by means of indicators.

2.4.2. Specific Objectives

Specific objectives are developed according to the components of national programs:

- To develop and implement or review national programs, guidelines, and specific technical standards for this topic.
- To improve the epidemiological surveillance of attacks, roosts of *D. rotundus* and suspected cases of rabies.
- To strengthen diagnostic capacity for rabies in the countries.

- To reinforce control and prevention actions at focal areas.
- To strengthen timely attention to areas of foci and the occurrence of positive cases.
- To establish a mechanism for the flow of information of the results of national programs and the exchange of data.
- To ensure the availability of field and laboratory technical professionals trained and updated in the program of rabies in livestock.

2.5. GOALS, ACTIVITIES AND INDICATORS

The objectives set in this program will be considered complied with when a certain number of milestones are accomplished. That is, each objective has its goals, with the activities required to achieve them and the respective indicators showing the implementations of the activities (Figure 7).

The implementation indicators of the PRRH are based on the combination of national efforts through the execution of activities developed for their national programs according to their epidemiological situations, the organization of their official animal health services, and the actions outlined in the legislation for the control and prevention of rabies. Therefore, the necessary data for the as-

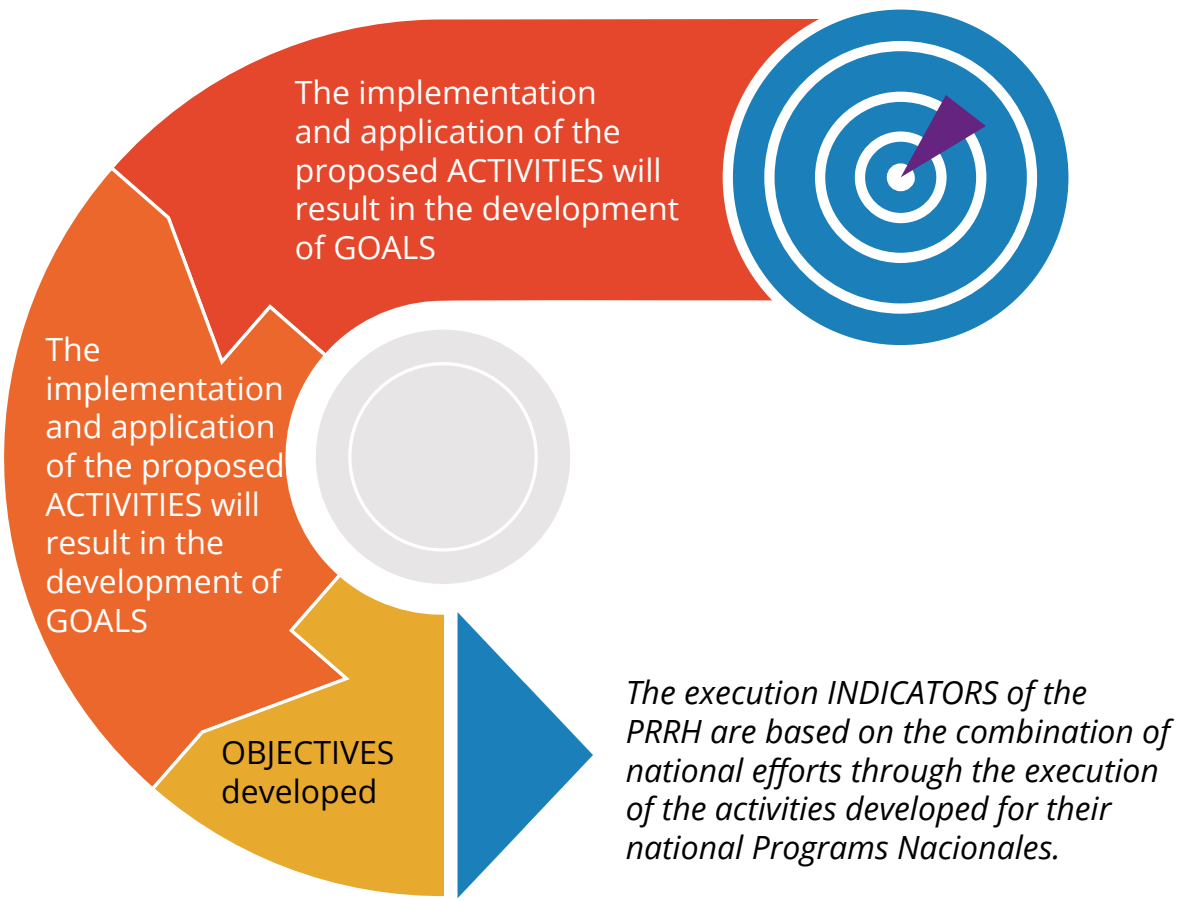


FIGURE 7. Logical flow of objectives, goals, activities and indicators of the PRRH

sessment of the PRRH will depend on the data of national programs, which will generate information as the proposed goals are developed and fulfilled.

Tables 1 to 6 depict, individually, the core pillars, with the specific activities to achieve the goals and the respective indicators to demonstrate the execution of the proposed activities. The goals classified as "Operational" or "Partially operational" will be measured through the data provided by the indicators. Hence, under "Current situation", the goal is classified as "Operational", when all the proposed activities are carried out as part of the routine of the official service; as "Partially operational", when only one or some, but not all, the proposed activi-ties are carried out as part of the routine of the official service; or as "Not operational", if none of the proposed activities are carried out as part of the routine of the official service. In sequence, the management of the official program can fulfill the expectation of complying with a goal in the subsequent years (up to 5 years), that is, what the 5-year expectation would be. In this case, the program management must consider the operation capacity, the availability of resources, and the political commitment to achieve the goals as well as the time within which the country might achieve them.

Annex 1 presents the development matrix of national programs, with the consolidated goals of each pillar for a general overview of the program, and a self-evaluation regarding whether a goal is currently "Operational", "Partially operational" or "Not operational". Operational means that the goal was achieved and is still ongoing; Partially operational means that the goal is partially developed and only some activities are operational; Not operational means that none of the activities were developed. Through the goal matrix, the countries will be able to estimate and commit to the development and the operation of the goal to reach it within a period of time in years. Annex 2 shows the execution matrix of national programs, with the consolidated activities of each goal, for a general overview of the proposed activities.

TABLE 1 - Pillar 1: Legislation

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
1.To develop a specific legislation based on current scientific knowledge.	1.1 Specific legislation to support the actions for the control of rabies in livestock developed.						

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
1. To develop a specific legislation based on current scientific knowledge.	1.2. Specific legislation to support the actions for the control of rabies in livestock developed.	- Elaborating, reviewing and approving a specific legislation on rabies in livestock, based on technical guidelines, on the structure and organization of the official veterinary service and on current scientific knowledge.	- The country has specific legislation based on current scientific knowledge or not.

TABLE 2 - Pillar 2: Epidemiological surveillance of attacks, *D. rotundus* roosts and suspected cases of rabies

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
2. To strengthen the epidemiological surveillance of attacks, roosts of hematophagous bats and suspected cases of rabies	2.1. Occurrence of attacks caused by *D. rotundus* monitored						
	2.2. Searching, recording, and monitoring of the *D. rotundus* roosts implemented						
	2.3.. Monitoring of the suspected cases of rabies in livestock implemented						

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
2. To strengthen the epidemiological surveillance of attacks, roosts of *D. rotundus* and suspected cases of rabies	2.1. Occurrence of attacks caused by *D. rotundus* monitored	- Having a reporting system of attacks; - Having a reliable record of farms/productive units; - Having trained professionals for the identification of bites.	- Number of reporting farms with attacks to livestock caused by *D. rotundus*
	2.2. Searching, recording, and monitoring of the *D. rotundus* roosts implemented	- Having a system for recording roosts; - Having trained professionals for the identification and search of roosts of *D. rotundus;* - Carrying out a systematic monitoring of registered roosts;	- Number of new roosts of *D. rotundus* recorded - Total number and regional distribution of roosts recorded - Number of roosts monitored
	2.3. Monitoring of the suspected cases of rabies in livestock implemented	- Having a reporting system of suspected cases; - Having trained professionals for sampling; - Having materials available for sampling and shipping; - Having a reliable record of farms/ productive units.	- Number of suspected farms reports assisted - Number of trained professionals for sampling - Number of samples sent for laboratory analysis

TABLE 3 - Pillar 3: Diagnostic capacity for rabies

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
3. To strengthen diagnostic capacity for rabies in the countries	3.1. Capacity to diagnose rabies in livestock implemented						
	3.2. Capillarity of the official and accredited laboratory network enhanced						
	3.3. Execution of interlaboratory study implemented/ optimized						
	3.4. Surveillance for the differential diagnosis of rabies implemented						

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
3. To strengthen diagnostic capacity for rabies in the countries	3.1. Capacity to diagnose rabies in livestock implemented	- Determining the flow of samples for official/ accredited laboratories - Having the structure, materials, equipment, and trained professionals to perform diagnostic tests for rabies	- Number of official and accredited laboratories that perform diagnostic tests for rabies in livestoc - Number of diagnostic tests performed in samples of livestock - Total positive samples for rabies - Number of trained professionals for the execution of diagnostic tests for rabies
	3.2. Capillarity of the official and accredited laboratory network enhanced	- Establishing and mapping the network of official and accredited laboratories	- Distribution of official and accredited laboratories
	3.3. Execution of interlaboratory study implemented	- Laboratories with standardized protocols and procedures to manipulate, process and diagnose rabies at national level	- Number of laboratories with standardized protocols and procedures for the manipulation, processing and diagnosis of rabies in livestock - Number of official laboratories that perform interlaboratory tests
	3.4. Surveillance for the differential diagnosis of rabies implemented	- Systematizing the flow of differential diagnosis of nervous diseases in samples of animals with nervous symptoms negative for rabies - Having the structure, equipment, materials, supplies and trained professionals to perform tests for the differential diagnosis of nervous syndromes	- Nervous diseases diagnosed - Number of samples for the differential diagnosis of rabies - Number and list of positive results for the differential diagnosis of nervous syndromes

TABLE 4 - Pillar 4: Actions for the control and prevention of rabies

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
4. To strengthen the actions for the control and prevention of rabies in livestock	4.1. Control of the populations of the vector responsible for the dissemination of rabies in livestock implemented						
	4.2. Level of immune protection against rabies in livestock increased						

OBJETIVE	GOAL	ACTIVITIES	INDICATOR
4. To strengthen the actions for the control and prevention of rabies outbreaks in livestock	4.1. Control of the populations of the vector responsible for the dissemination of rabies in livestock implemented	- Having a database of registered roosts - Carrying out a systematic monitoring of registered roosts - Having trained professionals for captures in roosts and feeding sources - Having a system for recording the population control performed - Having materials and equipment for the execution of population control of *D. rotundus*	- Number of roosts with actions taken for the control of *D. rotundus* populations - Number of captures at feeding sources - Number of *D. rotundus* captured - Number of trained professionals for the search, monitoring and control of *D. rotundus* populations
	4.2. Level of immune protection against rabies in livestock increased	- Analyzing the indication and recommendation to vaccinate animals in risk areas	- Number of vaccinated animals in areas of *D. rotundus* attacks

TABLE 5 - Pillar 5: Timely assistance to focal areas

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
5. To strengthen timely assistance to focal areas and the occurrence of positive cases	5.1. Current damages caused by rabies in the focal areas mitigated						

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
5. To strengthen timely assistance to focal areas and the occurrence of positive cases	5.1. Current damages caused by rabies in the focal areas mitigated	- Having trained professionals for sampling and for the assistance to focal areas with occurrence of rabies - Having a reliable register of farms/productive units - Establishing criteria to define focal and perifocal areas - Having materials and vaccines available for vaccination - Having the operational capacity to implement surveillance and prevention actions in the perifocal areas	- Number of confirmed focal areas assisted - Number of animals attacked - Number of animals in the focal areas - Number of animals in the perifocal areas - Number of animals vaccinated by the official service - Number of training courses / meetings / producer meetings / producer's cooperatives / producer's centers for the awareness about rabies in livestock

TABLE 6 - Pillar 6: Sistema de información

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
6. To establish a mechanism for information management in national programs	6.1. Information system for the collection and consultation of surveillance data, results of diagnostic test and of actions for prevention, control, and assistance to focal areas of rabies in livestock implemented						

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
6. To establish a mechanism for information management in national programs	6.1. Information system for the collection and consultation of surveillance data, results of diagnostic test and of actions for prevention, control, and assistance to focal areas of rabies in livestock implemented	- Having an information system for storing and consulting quantitative and qualitative information about roosts of *D. rotundus*, reports of attacks and suspected cases, laboratory results, preventive and control actions, and assistance to focal areas with rabies	- Data reporting rate for Components 2, 3, 4 and 5

2.6. EXPECTED RESULTS

As countries, through their national programs or plans for the control of rabies transmitted by *D. rotundus* to livestock, develop the activities to achieve the goals and objectives set forth in this document, the Americas will benefit as a whole, achieving the expected results (Table 7).

TABLE 7 - Expected results at regional level for the development of national programs.

OBJECTIVE	GOAL	EXPECTED RESULT
1. To develop a specific legislation on the topic	1.1. Specific legislation to support the actions for the control of rabies in livestock developed	100% of countries with presence of *D. rotundus* have specific legislation on the topic
2. To strengthen the epidemiological surveillance of attacks, roosts of hematophagous bats and suspected cases of rabies	2.1. Occurrence of attacks caused by *D. rotundus* monitored	100% of countries with operational surveillance systems of attacks in livestock
	2.2. Searching, recording, and monitoring of the *D. rotundus* roosts implemented	100% of countries with operational surveillance systems of roosts of *D. rotundus*
	2.3. Monitoring of the suspected cases of rabies in livestock implemented	100% of countries with operational surveillance systems of suspected cases
3. To strengthen diagnostic capacity for rabies in the countries	3.1. Capacity to diagnose rabies in livestock implemented	100% of countries with capacity to perform diagnostic tests for rabies in livestock
	3.2.Capillarity of the official and accredited laboratory network enhanced	100% of countries with standardized laboratory procedures for the diagnosis of rabies in livestock
	3.3. Execution of interlaboratory study implemented	100% of countries ensure the quality of their service for the diagnosis of rabies in livestock
	3.4. Surveillance for the differential diagnosis of rabies implemented	100% of countries with capacity to conduct differential diagnostic tests
4. To strengthen the actions for the control and prevention of rabies outbreaks in livestock	4.1. Control of the populations of the vector responsible for the dissemination of rabies in livestock implemented	100% of countries with actions oriented toward the control of *D. rotundus* populations
5. To strengthen timely assistance to focal areas and the occurrence of positive cases	5.1. Current damages caused by rabies in the focal areas mitigated	100% of countries with operational capacity for attention to focal areas of rabies
6. To establish a mechanism for information management in national programs	6.1. Information system for the collection and consultation of surveillance data, results of diagnostic test and of actions for prevention, control, and attention to focal areas of rabies in livestock implemented	100% of countries with operational information systems for surveillance and data collection

3.

INTERSECTORAL COLLABORATIONS AND **JOINT ACTIONS**

Rabies is a highly complex disease regarding its biology and epidemiology. Therefore, the "One Health" approach, which links inter-institutional groups of the Agriculture, Health and Environment sectors, adds to the control objectives of this disease and to the research for the evaluation of joint strategies and the coordinated attention of events in which they have technical and legal authority for the prevention and control of rabies in agricultural species, people and wild fauna.

The technical cooperation organisms of sub-regional, regional and global levels, together with PAHO, should participate and contribute to the control and prevention of the rabies transmitted by hematophagous bats to livestock. This participation requires coordinated actions between the different organisms so that their respective cooperation programs are aligned with the objectives and strategies adopted by national programs and plans. For their national programs, the Region of the Americas counts with the support of the Pan American Health Organization/World Health Organization Collaborating Centers (CC) for rabies and the OIE Reference Laboratories.

The collaboration of the academia and scientific research institutions has an essential role in the development of knowledge and technology for the improvement of new practices and execution protocols for national programs. The technical groups participating in the activities for the prevention and control of vampire-transmitted rabies can be coordinated with and integrated to scientific research teams (such as the academia and research groups) in order to promote the development of increased knowledge of the disease dynamics and the relationship of the vector with agricultural, urban and natural environments where the hematophagous bat lives.

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5. GLOSSARY

- **Assistance to area of focus:** Set of actions and measures to mitigate the effects of a positive focus of rabies transmitted to susceptible livestock.
- **Confirmed case:** Case of rabies confirmed by clinic and laboratory testing.
- **Control:** Set of zoosanitary measures aimed at reducing the cases of rabies in animals at a defined geographical area.
- ***Desmodus rotundus:*** Mammal of the order Chiroptera that feeds on the blood of animals. From the three known species of hematophagous bats, the *Desmodus rotundus* is the most relevant species, and the one considered for the components of this program.
- **Diagnosis:** Study conducted by a veterinary doctor based on the analysis of a set of clinical signs observed in animals, that allows to rule out or confirm the suspected case, in the latter case, by laboratory test for rabies virus.
- **Endemicity:** Regular presence of rabies in a population.
- **Epidemiological surveillance:** Set of activities that allow to collect essential information to identify and assess the behavior of rabies, detect and prevent any change that may occur as a result of changes in the factors, conditions or determinants in order to provide timely science-based recommendations on the measures indicated for rabies prevention, control and eradication.
- **Focal area of rabies:** A defined and circumscribed locality/area where livestock, their products and by-products are manipulated, commercialized and/or exploited, in which the presence of one or more cases of rabies in susceptible livestock is identified.
- **Information system:** Tool capable of collecting and storing relevant information and make it available, as necessary, for the management of national programs.
- **Legislation:** Legislative process that elaborates a set of laws with legal value at national and international level in order to ensure the responsibilities of the official service regarding prevention

and control of the rabies transmitted by hematophagous bats (*D. rotundus*). It may be a guideline, a standard, a program of actions or a technical note, supporting the actions and responsibilities of the official service.

- **Livestock:** Susceptible production animals. For the purpose of this document, they are cattle, buffaloes, goats, sheep, horses, mules, camelids and, including swine.
- **Perifocus:** Area (around 10 km) around the focal area of rabies. This distance will depend on the geographic and ecological characteristics and the distribution of livestock.
- **Prevention:** Set of health procedures devoted to protect humans and animals from an infection caused by the rabies virus.
- **Report:** Informative document about the detection, follow-up and conclusion of a case of rabies transmitted by *D. rotundus*.
- **Risk factors:** Any trait, characteristic or exposure of an individual that increases the probability of disease.
- **Sample:** Brain tissue including the two hemispheres of the brain, the cerebellum and the medulla, obtained to be analyzed by laboratory testing to diagnose the presence or absence of the rabies virus.
- **Suspected animal:** Ill animal with clinical signs suggestive of rabies.
- **Vaccination:** Administration of rabies antigens in the proper dose in order to induce the production of antibodies against rabies at protective levels.
- **Vampiricide:** Chemical product elaborated with anticoagulant substances used for the control of bat populations. Vampiricides should have an official record indicating the type of vehicle and dosage.
- **Zoonosis:** Diseases naturally transmitted between vertebrate animals and humans, by direct contact or by vectors.
- **Zoosanitary measures:** Provisions to prevent and control rabies transmitted by *D. rotundus* to livestock.

6. ABBREVIATIONS

BSE	Bovine spongiform encephalopathy
CC	Collaborating Centers
COSALFA	South American Commission for the fight Against Foot-and-Mouth Disease
DIF	Direct immunofluorescence
IM	Isolation in mouse
OIE	World Organisation for Animal Health
PAHO/WHO	Pan American Health Organization/World Health Organization
PANAFTOSA/VPH-PAHO/ WHO	Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health of the Pan American Health Organization/World Health Organization
PRRH	The Regional Program of Rabies in Livestock
RNA	Ribonucleic acid
RT-PCR	Reverse transcription polymerase chain reaction in real time
WHO	World Health Organization

7.

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8. ANNEXES

ANNEX 1 - Development matrix of national programs.

OBJECTIVE	GOAL	CURRENT SITUATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
1. To develop a specific legislation based on current scientific knowledge	1.1. Specific legislation to support the actions for the control of rabies in livestock developed						
2. To strengthen the epidemiological surveillance of attacks, roosts of hematophagous bats and suspected cases of rabies	2.1. Occurrence of attacks caused by *D. rotundus* monitored						
	2.2. Searching, recording, and monitoring of the *D. rotundus* roosts implemented						
	2.3. Monitoring of the suspected cases of rabies in livestock implemented						
3. To strengthen diagnostic capacity for rabies in the countries	3.1. Capacity to diagnose rabies in livestock implemented						
	3.2. Capillarity of the official and accredited laboratory network enhanced						
	3.3. Execution of interlaboratory study implemented/ optimized						
	3.4. Surveillance for the differential diagnosis of rabies implemented						
4. To strengthen the actions for the control and prevention of rabies outbreaks in livestock	4.1. Control of the populations of the vector responsible for the dissemination of rabies in livestock implemented						
	4.2. Level of immune protection against rabies in livestock increased						
5. To strengthen timely assistance to focal areas and the occurrence of positive cases	5.1. Current damages caused by rabies in the focal areas mitigated						
6. To establish a mechanism for information management in national programs	6.1. Information system for the collection and consultation of surveillance data, results of diagnostic test and of actions for prevention, control, and assistance to focal areas of rabies in livestock implemented						

Current situation: Complete with "Operational"; "Partially operational"; or "Not operational". YEAR 1 to 5: Mark the cells with "Operational" if the current situation was classified as "Operational", indicating that for the subsequent years the goal will continue being executed. For the goals classified as "Partially operational" or "Not operational" under current situation, over time, the program may indicate the estimate time in years to reach the goal and turn it operational, switching from "Not operational" to "Partially operational" when part of the activities is developed, and finally to "Operational" with the expected times in years for the goal to reach the classification of "Operational"

ANNEX 2. Execution matrix of national programs

OBJECTIVE	GOAL	ACTIVITIES	INDICATOR
1. To develop a specific legislation based on current scientific knowledge	1.1. Specific legislation to support the actions for the control of rabies in livestock developed	- Elaborating, reviewing and approving a specific legislation on rabies in livestock, based on technical guidelines, on the structure and organization of the official veterinary service and on current scientific knowledge.	- The country has specific legislation based on current scientific knowledge or not
2. To strengthen the epidemiological surveillance of attacks, roosts of hematophagous bats and suspected cases of rabies	2.1. Occurrence of attacks caused by *D. rotundus* monitored	- Elaborating, reviewing and approving a specific legislation on rabies in livestock, based on technical guidelines, on the structure and organization of the official veterinary service and on current scientific knowledge.	- The country has specific legislation based on current scientific knowledge or not
	2.2. Searching, recording, and monitoring of the *D. rotundus* roosts implemented	- Having a system for recording roosts; - Having trained professionals for the identification and search of roosts of *D. rotundus* ; - Carrying out a systematic monitoring of registered roosts; - Having specific materials and equipment	- Number of suspected farms reports assisted - Number of trained professionals for sampling - Number of samples sent for laboratory analysis
	2.3. Monitoring of the suspected cases of rabies in livestock implemented	- Having a reporting system of suspected cases; - Having trained professionals for sampling; - Having materials available for sampling and shipping; - Having a reliable record of farms/productive units.	- Number of official and accredited laboratories that perform diagnostic tests for rabies in livestock - Number of diagnostic tests performed in samples of livestock - Total positive samples for rabies - Number of trained professionals for the execution of diagnostic tests for rabies
3. To strengthen diagnostic capacity for rabies in the countries	3.1. Capacity to diagnose rabies in livestock implemented	- Determining the flow of samples for official/ accredited laboratories - Having the structure, materials, equipment, and trained professionals to perform diagnostic tests for rabies	- Number of official and accredited laboratories that perform diagnostic tests for rabies in livestock - Number of diagnostic tests performed in samples of livestock - Total positive samples for rabies - Number of trained professionals for the execution of diagnostic tests for rabies
	3.2.Capillarity of the official and accredited laboratory network enhanced	- Establishing and mapping the network of official and accredited laboratories	- Distribution of official and accredited laboratories
	3.3. Execution of interlaboratory study implemented/ optimized	- Laboratories with standardized protocols and procedures to manipulate, process and diagnose rabies at national level	- Number of laboratories with standardized protocols and procedures for the manipulation, processing and diagnosis of rabies in livestock - Number of official laboratories that perform interlaboratory tests
	3.4. Surveillance for the differential diagnosis of rabies implemented	- Systematizing the flow of differential diagnosis of nervous diseases in samples of animals with nervous symptoms negative for rabies - Having the structure, equipment, materials, supplies and trained professionals to perform tests for the differential diagnosis of nervous syndromes	- Nervous diseases diagnosed - Number of samples for the differential diagnosis of rabies - Number and list of positive results for the differential diagnosis of nervous syndromes

4. To strengthen the actions for the control and prevention of rabies outbreaks in livestock	4.1. Control of the populations of the vector responsible for the dissemination of rabies in livestock implemented	- Having a database of registered roosts; - Carrying out a systematic monitoring of registered roosts; - Having trained professionals for captures in roosts and food sources - Having a system for recording the population controls performed - Having materials and equipment for the execution of population control of hematophagous bats	- Number of roosts inspected for the control of hematophagous bat populations - Number of captures at food sources - Number of hematophagous bats captured - Number of trained professionals for the search, monitoring and control of hematophagous bat populations
	4.2. Level of immune protection against rabies in livestock increased	- Analyzing the indication and recommendation to vaccinate animals in risk areas	- Number of vaccinated animals in areas of hematophagous bat attacks
5. To strengthen timely assistance to focal areas and the occurrence of positive cases	5.1. Current damages caused by rabies in the focal areas mitigated	- Having trained professionals for sampling and for the assistance to focal areas with occurrence of rabies - Having a reliable register of farms/productive units - Establishing criteria to define focal and perifocal areas - Having materials and vaccines available for vaccination - Having the operational capacity to implement surveillance and prevention actions in the perifocal areas	- Number of confirmed focal areas assisted - Number of animals attacked - Number of animals in the focal areas - Number of animals in the perifocal areas - Number of animals vaccinated by the official service - Number of training courses / meetings / producer meetings / producer's cooperatives / producer's centers for the awareness about rabies in susceptible livestock
6. To establish a mechanism for information management in national programs	6.1. Information system for the collection and consultation of surveillance data, results of diagnostic test and of actions for prevention, control, and assistance to focal areas of rabies in livestock implemented	- Having an information system for storing and consulting quantitative and qualitative information about roosts of *D. rotundus*, reports of attacks and suspected cases, laboratory results, preventive and control actions, and assistance to focal areas with rabies	- Data reporting rate for Components 2, 3, 4 and 5

* The goals classified as "Operational" in green and as "Partially operational" in yellow can be measured through the proposed indicators, so that the program can assess the implementation of activities.

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PAHO Pan American Health Organization
World Health Organization Regional Office for the Americas
PANAFTOSA
Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health

PAHO Pan American Health Organization

World Health Organization Americas

PANAFTOSA
Pan American Center for Foot-and-Mouth Disease and Veterinary Public Health