Bull Pan Am Health Organ 14(4), 1980.

FROM CONCEPTS TO PROGRAMS: THREE DECADES OF PROGRESS FOR VETERINARY PUBLIC HEALTH AND ANIMAL HEALTH IN LATIN AMERICA AND THE CARIBBEAN

Pedro N. Acha[1]

Veterinary public health activities play a key role in promoting animal health, human health, and economic development. This article reviews the basic rationale behind veterinary public health activities in Latin America and the Caribbean. It also describes the major role PAHO has played in developing that rationale and helping to improve the quality of those activities.

Introduction

Veterinary public health has traveled a long road in Latin America and the Caribbean, having been transformed from a subject on the periphery of veterinary medicine to a key discipline critically and intimately linked to both animal and human health and socioeconomic development. The key to this progress has been not merely development of appropriate concepts but incorporation of those concepts into national programs and an international infrastructure capable of promoting them throughout the Hemisphere.

The purpose of this article is twofold: to review the concepts of animal health and veterinary public health, as well as their interrelationships; and to trace the development of national prevention and control programs—and of a correlated international infrastructure—that have made and will continue to make important contributions to closing the existing socioeconomic gap in the Americas.

Concepts

The development of a veterinary public health action program depended upon acceptance of three major concepts. These concepts were:

1) Animal health is a key factor in socioeconomic development.

2) There is a crucial interrelationship between human and animal health that becomes evident in veterinary public health programs.

3) Veterinary public health plays an important role in focusing the attention of health and livestock authorities on communicable disease problems and in pioneering new programs in the fields of animal health and veterinary education.

Animal Health and Socioeconomic Development

To fully understand the support that development of veterinary public health programs has received in Latin America and the Caribbean, we must first appreciate the unique role that the livestock industry plays in this region. The area is blessed with favorable climates; but of the approximately 500 million hectares of agricultural land, 80 per cent are suitable only for pastures and livestock raising. Thus Latin America and the Caribbean, with roughly the same amount of agricultural land as the United States (55 per cent of which is used for pasture), have more than twice the head of livestock (448 million food animals versus 192 million). In 1978 the nations of the Americas, excepting Canada and the United States, had 247 million cattle, 109 million sheep, 63 million pigs, and 29 million goats *(1)*. Even considering differences in prices and

[1] Special Adviser to the Director-General, Inter-American Institute of Agricultural Sciences, Washington, D.C.

slaughter cycles, this represents about US$45 billion in cattle alone.

However, the herd is constantly at risk from diseases—both those endemic to the Hemisphere and exotic diseases. The livestock industry's productivity is only 67 per cent of what it is in Australia and 32 per cent of what it is in the United States *(2)*. It follows that the United States, with only half the livestock, produces almost twice the supply of meat and meat products. Moreover, animals in developing countries generally grow more slowly, mature later, and produce less than animals in developed areas. Nevertheless, notwithstanding the risks and reduced potential, such animals still represent an economically important agricultural product and a major source of income—in both local and international trade.

Animal Diseases

The economic losses and waste of energy caused by animal pests and diseases are so enormous that intensive control efforts must be made. Obviously, for purposes of socioeconomic development, it is imperative to reduce the risks, reverse the disease trends, and maximize the area's livestock potential.

Besides posing a major obstacle to increased productivity, animal diseases also create a major barrier to international trade in livestock products. They thus constitute a key negative factor in the socioeconomic development of Latin America.

Meanwhile, the productivity of US agriculture and livestock products depends partly on heavy expenditures of energy resources. That is, the US consumes 10-15 petroleum calories to produce a calorie of food *(3)*. From the point of view of energy requirements, this is the least efficient of all systems of production. Consequently, in a world suffering critical and ever-accelerating shortages of energy as well as food, increased productivity in developing countries—where fewer energy resources are used in meat production—will prove both economically sound and essential for world trade.

In this vein, it should be kept in mind that ruminants and other food-producing animals can convert the bioenergy of crop-harvest waste directly into food and fiber for the welfare of humanity. And if Latin America's livestock output could be raised merely to the level of Australia's, while the number of head increased only 5 per cent each year, total production would double within 5 years *(2)*.

In the 1960s, animal diseases accounted for approximately one-third of the livestock productivity losses in Latin America. For example, foot-and-mouth disease, hog cholera, babesiosis, and Newcastle disease together caused an estimated 11,701 metric tons of meat, eggs, and milk to be lost per year from 1962 to 1964. The control of these diseases alone could have a significant effect on animal productivity in the region. When foot-and-mouth disease is eradicated from Latin America, it is expected that 350,000 more tons of meat and 500,000 more tons of milk will be obtainable from the same number of cattle in today's herd *(4)*.

International Trade and Economics

Latin America today provides one-fourth of the world trade in meat products, but its share has been declining due to animal diseases that could be spread by international movements of animals and animal products *(5)*. For example, before World War II Argentina accounted for 14 per cent of the mutton and lamb in the world market and 53 per cent of the beef exports; today the corresponding rates are 4 and 19 per cent *(6)*. The leadership role has been assumed by Australia with 32 per cent of the export trade *(6)*. Although the United States has emerged as the world's leading meat importer since World War II, Latin America has not been able to capture this neighboring market because of the barriers raised to thwart animal diseases.

Despite these circumstances, however, Latin America's livestock industry plays a

critical role in development. Besides providing a source of employment and food for local populations, it still yields important amounts of the foreign currency needed for economic development. In recognition of this fact, the Inter-American Development Bank (IDB) has mobilized large sums for animal disease control projects. To date 13 countries have received 15 IDB loans for animal health totaling US$110 million, of which US$60 million, or 54 per cent, has been disbursed. The total cost of these projects (including counterpart financing by the countries themselves) is estimated at about US$400 million *(7)*. The various projects have involved the following activities:

1) Providing an infrastructure for diagnosing animal diseases and conducting disease control activities in the field;
2) Training skilled manpower;
3) Implementing long-term control efforts;
4) Integrating and coordinating national and international efforts.

In addition, the World Bank, the IDB, and the United States Agency for International Development have lent the Latin American countries approximately US$1,300 million to promote and improve livestock production, as part of projects costing a total of US$2,300 million.

The justification for these international agencies' capital outlays is based on recognition of the livestock industry's importance for Latin America and the need for its future development. Seen in this light, the proper role of veterinary medicine in the area is to simultaneously protect these investments and make a major contribution to Latin America's socioeconomic development.

The magnitude of the task at hand can be seen from the following figures: In 1976 the total world trade in fresh, chilled, and frozen beef amounted to US$3.9 billion, in live cattle amounted to US$2 billion, and in canned meat amounted to another US$1.5 billion. In terms of exports, developing countries had 35-40 per cent of this trade in the early 1970s, but by 1976 that share was down to 22 per cent *(8)*.

In a world beset by critical energy and protein shortages, a crucial element of survival strategy is to shift animal production to the developing world by increasing productivity and removing the animal disease barrier to international trade. In the interest of achieving this in the Western Hemisphere, national animal health programs have been implemented and an international animal health infrastructure has been established.

Animal Health and Veterinary Public Health

Protein deficiency is perhaps the most widespread public health problem of our time. Malnutrition has been a major contributor, directly or indirectly, to infant mortality. The Inter-American Investigation of Mortality in Childhood found it to be an associated cause of 60.9 per cent of the deaths from infections and 32.7 per cent of the deaths from all other causes *(9)*. It has been estimated that 19 per cent of all children 0-4 years of age in Latin America experience moderate or severe forms of protein-calorie malnutrition. If mild forms of malnutrition are included, an estimated 50 per cent of the children under 5 are affected. Overall, malnutrition appears to be a direct or indirect cause of half of all deaths among children in Latin America *(9)*.

The livestock industry has proven itself to be man's best tool for harvesting roughage and agro-industry waste materials and for producing a balanced amino acid combination that will meet specific dietary protein needs in a way that most plant proteins cannot. For every kilogram of wheat, rice, and corn produced there remains a kilogram of usable plant parts that could be used by ruminants. Moreover, in the process of providing for the world's 4 billion people, it has been estimated that 150 pounds of cellulosic waste per person are produced daily. If only 5 per cent of this were used, it would provide ruminants with enough energy to meet all of the world's protein needs *(10)*. Overall, using vegetable waste

products for animal food is the best way of converting those products into high-quality protein and eliminating nutritional diseases such as kwashiorkor.

At the same time, however, some animal diseases—the zoonoses—can be transmitted to people. Some of these, in addition to their economic consequences, have important public health implications. Zoonoses considered among the most important are rabies, brucellosis, bovine tuberculosis, hydatidosis, the equine encephalitides, leptospirosis, and anthrax.

Vampire bat-transmitted bovine rabies afflicts some 500,000 cattle per year in Latin America and causes losses of up to US$50 million annually. Canine rabies also poses serious problems. Though progress has been made in controlling the latter, it continues to be widespread in the Americas. During the period 1970-1979 there were 2,412 registered human rabies cases (Table 1).

Brucellosis continues to be one of the world's most prevalent zoonoses. In Latin America, estimated economic losses caused by brucellosis run as high as US$600 million per year *(11)*. To date, relatively few developing countries have been able to control the infection, and fewer still have managed to eradicate it.

Table 1. Reported cases of rabies in man and animals in the Americas, 1970-1979.[a]

Country	Human cases	Animal cases in:			
		Dogs	Cats	Cattle	All Animals
Argentina	77	15,895	1,558	3,717	21,170
Belize	3	64	—	27	91
Bolivia	30	3,424	84	406	3,914
Brazil	977	18,167	1,422	18,943	38,532
Canada	1	1,009	849	4,041	5,899
Chile	2	72	2	27	101
Colombia	117	38,125	2,331	623	41,079
Costa Rica	1	139	9	32	180
Cuba	12	926	298	60	1,284[b]
Dominican Republic	27	1,023	94	20	1,137
Ecuador	151	6,148	360	157	6,665
El Salvador	94	496	93	596	1,185
French Guiana	—	—	—	1	1
Grenada	1	16	13	96	125
Guatemala	36	2,151	75	96	2,322
Guyana	—	—	—	112	112
Haiti	14	426	—	—	426[c]
Honduras	39	1,349	87	426	1,862
Mexico	608	62,703	2,072	3,457	68,232
Nicaragua	18	1,486	78	138	1,702
Panama	2	61	5	112	178
Paraguay	—	2,238	102	401	2,741
Peru	119	6,553	306	230	7,089
Suriname	—	—	—	24	24[d]
Trinidad and Tobago	—	5	—	109	114
United States of America	19	1,309	1,011	2,579	4,899[e]
Venezuela	64	3,961	295	3,196	7,452
Total	2,412	167,746	11,144	39,626	218,516

Source: E. Escobar *(17)*.
[a]The cumulative figures for 1979 are provisional.
[b]No information available for 1979.
[c]No information available for 1978-1979.
[d]No information available for 1976-1977.
[e]No information available for 1977-1979.

Available information indicates there were 3,049 human brucellosis cases in 1977 in selected countries of the Americas (Table 2). Goat brucellosis has been the main source of human infection in Argentina, Mexico, and Peru, where the goat infection rate in some areas is very high. Porcine brucellosis also constitutes a serious human health problem.

Bovine tuberculosis, endemic and widespread in most of the countries, has been known to afflict as many as 4.7 per cent of the 4 million animals slaughtered by one country in a single year. The highest prevalence rates occur in South American dairy sheds, where positive reactions to the tuberculin test have been as high as 30 per cent in some herds (Table 3). Annual Hemisphere-wide losses from this disease are estimated at over US$100 million.

Hydatid disease, a zoonotic infection of man caused by the cystic stage of the tapeworm *Echinococcus granulosus,* is a major public health and economic problem in Argentina, Brazil (Rio Grande do Sul), Chile, Peru (the central Sierra), and Uruguay, where the dog-sheep cycle is predominant. A total of 1,008 human cases were reported in 1977. Hydatid disease also seems to be endemic in the high plateau region of Bolivia, where at least 6 human cases with hydatid cysts are treated every year. The disease has also been reported in Ecuador, Guatemala, and Mexico.

Besides its implications for human health, hydatidosis has a major economic impact because of the large number of condemned viscera involved *(6).* Large dog and sheep populations—together with unsanitary free disposal of parasite-infected wastes, uncontrolled home slaughter, uninspected commercial slaughterhouses, and inadequate dog control—have contributed to the maintenance of the disease cycle.

Three types of equine encephalitides are present in the Americas in epizoodemic and cyclical forms; these are eastern equine encephalitis, western equine encephalitis, and Venezuelan equine encephalitis. The diseases pose major problems for human health and livestock raising in the affected countries (Table 4).

With regard to leptospirosis, more than 50 leptospira serovars from 15 serotypes have been isolated in Latin America and the Caribbean. Several of these serovars are autoch-

Table 2. Human cases of brucellosis in selected countries of the Americas, 1973-1977.

Country	1973	1974	1975	1976	1977
Argentina	986	1,123	1,293	1,569	1,727
Canada	8	27	30	38	39
Chile	4	3	1	2	—
Colombia	25	69	—	—	—
Costa Rica	6	5	7	8	2
Cuba	18	10	34	14[a]	14
Dominican Republic	—	—	10	12	13
Guatemala	—	—	1	3	—
Honduras	3	4	4	1	1
Mexico	735	557	550	565	382
Panama	1	4	—	5	7
Peru	607	554	592	610	630
United States of America	202	240	310	296	214
Uruguay	2	6	7	4	1
Venezuela	72	13	18	15	19
Total	2,669	2,615	2,857	3,142	3,049

Source: Animal health questionnaire, with supplemental data from *Report of the Director, Quadrennial 1974-1977, Annual 1977.* Washington, D.C., Pan American Health Organization, 1978.

[a]Incomplete data.

Table 3. Numbers of animals tested with tuberculin and the percentages of positive reactors, suspects, and positive herds in 15 countries of the Americas, 1977.

Country	No. of animals tested	Reactors (%)	Suspects (%)	Positive herds (%)
Barbados	2,225	1.3	0.3	5.7
Brazil	101,261	2.5	0.8	11.5
Canada	532,200	0.2	—	0.6
Colombia	350	10.6	—	66.7
Costa Rica	9,176	0.2	0.3	0.6
Dominican Republic	100,645	1.0	0.2	6.5
Honduras	144,011	0.7	0.7	20.8
Jamaica	17,292	0.1	—	—
Mexico	485,643	0.3	0.1	3.3
Nicaragua	725	0.5	—	50.0
Peru	81,691	0.9	—	2.7
Suriname	400	8.0	—	100.0
United States of America	2,358,604	0.1	0.2	0.1
Uruguay	109,376	0.03	0.1	—
Venezuela	319,779	0.4	0.1	9.7

Source: E. Escobar *(17)* and country reports to the Pan American Zoonoses Center, 1977.

Table 4. Geographic distribution of eastern equine encephalitis (EE), western equine encephalitis (WE), and Venezuelan equine encephalitis (VE) and the dates of the most recent known outbreaks in the countries of the Americas, 1969-1978.

	EE		WE		VE	
Country	Countries with epidemic outbreaks in the last 10 years	Year of last known outbreak	Countries with epidemic outbreaks in the last 10 years	Year of last known outbreak	Countries with epidemic outbreaks in the last 10 years	Year of last known outbreak
Argentina	X	1972	X	1972		—
Barbados		—		—		—
Bolivia	X	1975		—		—
Brazil	(X)	—		—		—
Canada	X	1972	X	1977		—
Chile		—		—		—
Colombia		—		—	X	1973
Costa Rica	(X)	—		—	X	1971
Cuba	X	1972		—		—
Ecuador		—		—	X	1972
El Salvador		—		—		1969
Guatemala		—		—	X	1969
Guyana	X	1977	X	1977	X	1977
Haiti		—	X	1974		—
Honduras		—		—	X	1978
Jamaica	(X)	(1962)		—		—
Mexico		—		—	X	1972
Nicaragua		—		—	X	1970
Panama	X	1973		—	(X)	—
Paraguay		—		—		—
Peru		—		—		—
Suriname		—		—		—
United States of America	X	1978	X	1978	X	1971
Uruguay		—	X	1973/1974		—
Venezuela	X	1976			X	1973

Source: E. Escobar *(17)* and Pan American Zoonoses Center, *Encephalitis Epidemiologic Surveillance.* Annual Reports 1-6, 1973, 1974, 1975, 1976, 1977, and 1978.

Note: (X) refers to outbreaks in the 1960s.

thonous and have not been described in other geographic areas *(12)*. Little is known about the distribution and importance of these serovars—owing to shortages of data, diagnostic facilities, and personnel trained to diagnose the disease.

Anthrax continues to be endemic in Haiti, where human outbreaks affecting several persons have periodically occurred in association with animal cases. In 1977 about 150 cases of human anthrax were reported from Les Cayes, Haiti, and 162 were reported from other parts of Latin America.

Hemispheric Control Efforts and Veterinary Public Health

Once the key importance of the interrelationships between animal and human health had been established, it became essential to have action programs that would bring together agricultural and public health interests and would direct the resources of the veterinary and scientific communities at problem areas. This pioneering task was undertaken by PAHO's Veterinary Public Health Program. Establishment of that program became possible because medical leaders understood the public health importance of the nutritional diseases and zoonoses. Its ultimate success in attracting large-scale funding and international support was due to recognition by the Hemisphere's agriculture ministries that control of the zoonoses and vesicular diseases had great socioeconomic importance.

Agriculture ministries have traditionally been among the strongest of Latin American government ministries, and governmental cooperation and support throughout Latin America has always been a key factor in the program's development. At the same time, PAHO's Veterinary Public Health Program has itself proved instrumental in promoting, establishing, and giving technical support to all phases of national animal health programs.

However, animal disease control measures are costly, and the results are sometimes unpredictable. In this vein, national animal health programs are an expensive proposition because they require long-range planning, highly-trained veterinarians, qualified animal scientists, and an array of assistants. Expensive technology is often needed to make biological and chemical products for disease diagnosis, prevention, and treatment. And sophisticated diagnostic facilities are required for accurate monitoring of specific diseases. Clearly, such programs must be founded upon a political commitment to provide appropriate financing and resources.

The United Nations Food and Agriculture Organization has estimated that over the decade of the 1960s animal diseases caused the loss of over 30 million tons of milk per year—enough to provide almost 200 million children with two glasses of milk a day. How tragic that the technology of disease prevention has not kept pace, through either development or adaptation, with the technology of production.

In our own Latin American and Caribbean area, until major diseases can be controlled there will be little incentive for livestock breeders to introduce large-scale improvements; for the expense in time, labor, and feed can be negated quickly by disease outbreaks. Moreover, the prevalence of established diseases often effectively blocks importation of new and improved breeding stock that has not been exposed to diseases indigenous to the areas involved *(4)*.

Promotion and Implementation of Control Programs

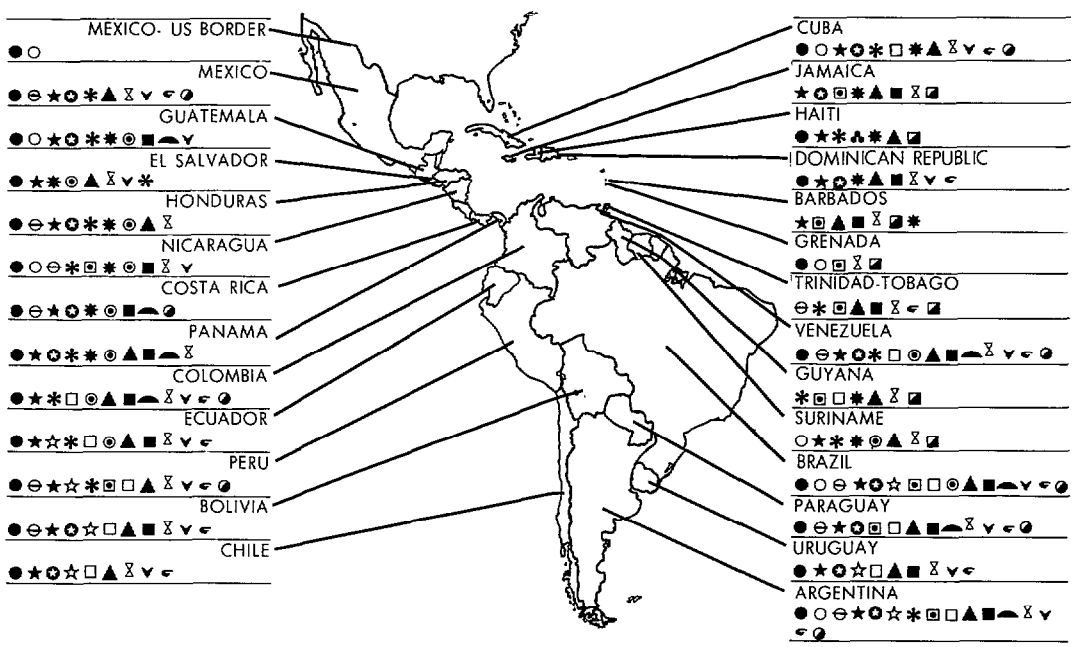
Since 1949 the Pan American Health Organization has collaborated with its Member Countries in planning, developing, implementing, and evaluating veterinary public health and animal health programs. These tasks have been performed by regional, area, and country advisers—and by the scientific staffs and laboratories of the Pan American Foot-and-Mouth Disease Center (est. 1950) and the Pan American Zoonoses Center (est. 1956).

There are presently 54 country projects related to animal health and veterinary public health (see Figure 1) in Latin America and the Caribbean area. Through its Special Program of Animal Health, PAHO provides technical assistance for these projects—assistance supported by financing from the regular PAHO budget or by grants from various national organizations, countries, and international organizations. The approved budget for this program in the 1980-81 period is over US$18 million.

The established goals of the Special Program of Animal Health are to reduce the prevalence of foot-and-mouth disease and the most important zoonoses in the Americas; to expand the areas declared free of them; to promote and strengthen animal health and veterinary public health services; to strengthen surveillance systems; to improve diagnostic methods; to establish new laboratories; to increase vaccine production and supply; to develop new and effective immunizing agents; and to raise the number and technical capabilities of veterinary medical service personnel.

By using consultants with world reputations and expert scientific committees, the Veterinary Public Health Program has been able to

Figure 1. PAHO animal health and veterinary public health projects and activities in Latin America and the Caribbean, 1965-1979.



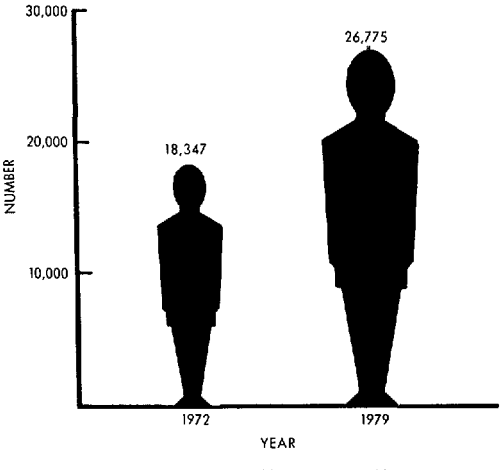
extend the range of its activities and keep up with scientific knowledge while dealing with practical problems of the developing world. It has also enabled PAHO to initiate unique programs for Latin America—including ones in the fields of veterinary education and manpower development, epidemiology and disease control, vaccine production methodologies, food protection, and laboratory animal medicine.

Veterinary Education and Manpower Development

A major obstacle to improvement of veterinary public health services in Latin America has been the scarcity of trained manpower at all levels. This problem is only compounded by the existing manpower's prevailing geographic distribution within each country. Overall, 65 per cent of the veterinarians are still located in capitals and large cities. The main community services rendered by veterinarians are food hygiene inspection, research, prevention and control of animal diseases (including zoonoses), and environmental sanitation. However, the service of inspecting meat and milk does not extend into rural communities. In addition, since rural areas are the most exposed to zoonoses and food-borne diseases, veterinary services capable of solving these problems are needed in order to provide appropriate health assistance to rural dwellers.

Overall, there was a significant improvement in the manpower situation between 1972 and 1979. To begin with, there were only 18,347 veterinarians in Latin America and the Caribbean in 1972 as compared to 26,775 in 1979 (Figure 2). In 1972 only 37.4 per cent of these veterinarians were in government services (doing administrative work or employed by government agencies concerned with animal or human health). As a result of substantial growth of animal disease control programs, this percentage had risen to 47 per cent as of 1979. Elsewhere, of the total veterinarians, 30 per cent were in private practice in 1979, as compared to 44 per cent in 1972; 17 per cent (versus 16 per cent in 1972) were

Figure 2. Growth in the number of veterinarians in Latin America and the Caribbean from 1972 to 1979.



Source Pan American Health Organization (1), H Malaga and P Acha (13), and P Acha (19)

engaged in education or research, and the remaining 5 per cent (2.6 per cent in 1972) were employed in industry (Figure 3).

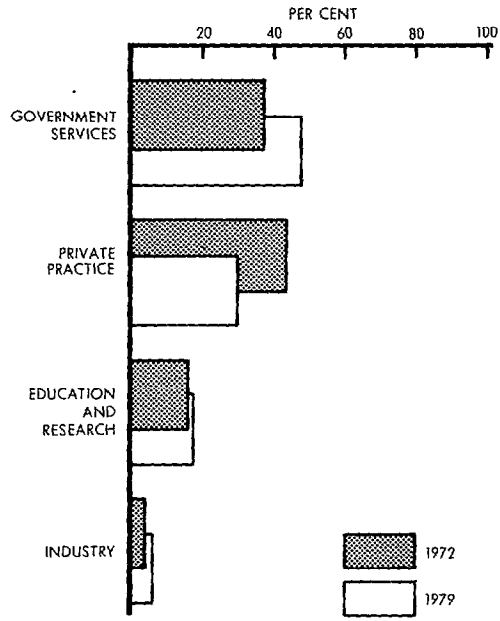
Of the veterinarians in government service in 1979, 66.5 per cent were working for agriculture ministries or similar agencies, approximately 12.7 per cent had entered the public health services, and 20.8 per cent were working for other government services (Figure 4).

The number of individuals wishing to enter the veterinary profession has increased notably over the past 7 years, and consequently the number of those who have completed the degree program has likewise risen (Figure 5). There has also been a substantial increase in the number of veterinary schools in Latin America and the Caribbean—the total increasing from 53 in 1972 to 90 in 1979.

Despite the increased numbers, however, there is still a tremendous need to train veterinarians in the various areas of animal health and veterinary public health—including the areas of program planning and administration. Most Latin American and Caribbean countries do not have the infrastructure needed for effective development of veterinary public health and animal health programs.

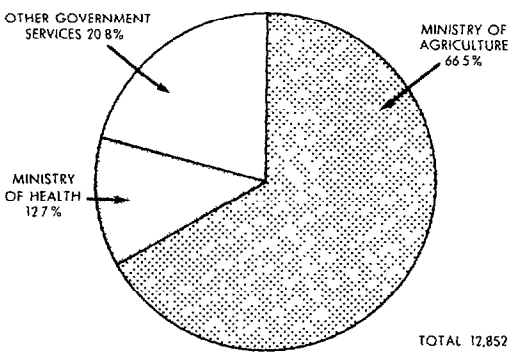
The essential goals of PAHO's Veterinary

Figure 3. The percentages of Latin American and Caribbean area veterinarians engaged in different types of activities in 1972 and 1979.



Sources Pan American Health Organization (1), H. Malaga and P Acha (13), and P Acha (19)

Figure 4. A chart of government agencies employing veterinarians in Latin America and the Caribbean that shows the percentages employed by ministries of agriculture, ministries of health, and other government services in 1979.



Sources Pan American Health Organization (1) and P Acha (19)

Public Health Program in entering the field of education and training were to help upgrade the quality of the existing schools of veterinary medicine, to train teachers, to promote introduction of newer curricula and courses, and to provide specific short courses for technicians and practitioners already in the field. One of the most serious problems in most of the countries was the limited number of veterinarians with adequate preparation and experience in health-related disciplines—specifically epidemiology, biostatistics, and administration.

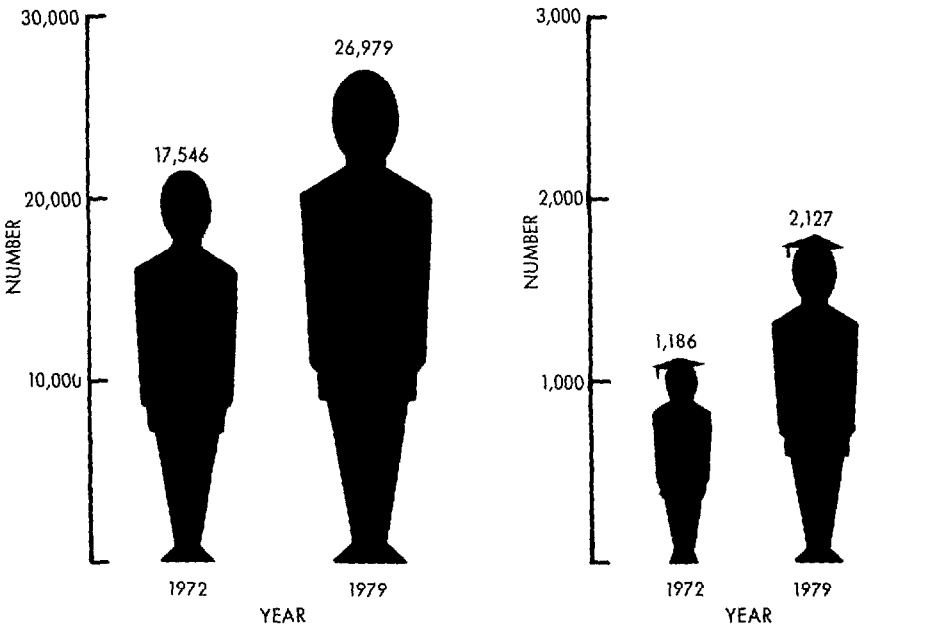
Considerable progress has been made since the First Seminar on the Teaching of Public Health and Preventive Medicine in Schools of Veterinary Medicine in the Americas was held under PAHO auspices in Kansas City (U.S.A.) in 1959. Since then, regional seminars in veterinary education have been held in Mexico City, Mexico (1963); Lima, Peru (1967); Minnesota, U.S.A. (1968); Belo Horizonte, Brazil (1972); and Valdivia, Chile (1979).

The curricula of most veterinary medical schools in Latin America today provide a basic knowledge of subjects such as epidemiology, biostatistics, food protection, and public health administration. In addition, over the past few years some schools have made serious efforts to adapt their curricula to the needs of national programs in animal health and veterinary public health.

Nevertheless, there is still a great need for specialized education in veterinary medicine in Latin America. In order to prepare veterinarians responsible for activities related to planning and executing animal disease control programs, the teaching of disciplines such as epidemiology and biostatistics, surveillance and information systems, diagnosis of animal diseases, laboratory animal medicine, and food protection will have to be strengthened. Moreover, the universities will need to establish special educational programs with a sizable continuing education component.

In this regard, PAHO's Special Program of Animal Health and its Division of Human Resources and Research are helping to im-

Figure 5. Charts showing the numbers of students enrolled in Latin American and Caribbean veterinary medical schools and the numbers graduated in 1972 and 1979.



Students of Veterinary Medicine in Latin America and the Caribbean 1972-1979.

Students who completed the degree program in Schools of Veterinary Medicine in Latin America and the Caribbean 1972-1979

Sources: P. Acha and H. Malaga (18) and P. Acha (19).

prove curricula by developing specific instructional areas and by providing support to individual veterinary schools to advance their academic programs. Specific PAHO activities include participating in curriculum reform, selecting and providing textbooks, designing interdisciplinary studies, coordinating curricula among schools, and lending direct teaching assistance through consultants and staff members.

Also, at the request of the countries, PAHO has developed an infrastructure within the Pan American Foot-and-Mouth Disease and Zoonoses Centers which has trained almost 2,000 veterinarians in the forementioned specialized disciplines over the last 20 years. The demand for this type of education has increased so much recently that the Centers' resources—in terms of space and staff—are now being overwhelmed. Continued efforts to strengthen this type of training are essential for improvement of the veterinary contribution being made to human and animal health programs in Latin America.

With the establishment of national disease control programs, a special need arose to train veterinarians in project planning, evaluation, and administration. Since 1971, PAHO has been conducting a yearly seven-month course in animal health planning at the Pan American Zoonoses Center (CEPANZO). Staff members from CEPANZO and the Pan American Foot-and-Mouth Disease Center, as well as outside consultants, provide the instruction to between 15 and 20 veterinarians from different national animal health agencies who are admitted annually.

Postgraduate veterinary education at the

master's or doctoral level has developed only recently in Latin America and is still limited to five schools. Latin American veterinarians usually pursue this type of advanced training in the United States, Canada, or Europe.

PAHO also helps with the training of assistants in animal health and veterinary public health. In 1976 the Regional Training Center for Animal Health Assistants (REPAHA) opened in Georgetown, Guyana. This center was established through the collaborative efforts of PAHO, the World Bank, the United Nations Development Program, and the Government of Guyana for the purpose of training auxiliary veterinary personnel for the English-speaking Caribbean countries and territories. Since then the center has trained and graduated over 100 animal health and veterinary public health assistants.

Animal Disease Control, Epidemiology, and Vaccine Production

Over the last 15 years, PAHO's animal health and veterinary public health work in Latin America and the Caribbean has been aimed mainly at assisting Member Governments in planning, developing, and executing programs to control the Hemisphere's more important zoonoses.

Rabies. Projects or activities directed against urban rabies have been conducted in practically every country of the region. Studies of wildlife rabies have been performed in the Mexico—U.S. border area, Guatemala, Nicaragua, Cuba, Grenada, and Brazil. Programs to combat paralytic rabies in cattle have been organized successfully in Mexico, Central America, Peru, Venezuela, and Brazil.

Beyond that, owing to CEPANZO's influence and work, every Latin American country has been able to improve diagnostic procedures and to organize a system for producing and distributing good-quality rabies vaccine. In turn, this has resulted in successful anti-rabies campaigns (undertaken jointly by agriculture and public health agencies) throughout the Continent.

Also, special projects have been organized against paralytic cattle rabies caused by vampire bats. These projects have entailed vaccination of cattle and use of anticoagulants to reduce vampire bat populations. Finally, a special project to control canine and wildlife rabies at the Mexican-American border was instituted in 1966; and although eradication has not yet been achieved, the situation has been brought under control.

Encephalitis. Another example of a joint binational effort was the campaign against Venezuelan encephalitis that included vaccination of 12 million horses in Mexico and the United States. Systematic vaccination in several countries of Central and South America has kept this disease quiescent, and has also served as a model of how health and agriculture ministries can control an important zoonosis by sharing responsibilities for diagnosis, field work, and vaccine production. At present Venezuelan equine encephalitis vaccination programs are being conducted in Colombia, El Salvador, Guatemala, Mexico, Peru, and Venezuela. Regarding western and eastern equine encephalitis, control activities are only being performed in countries where the diseases are enzootic—such as Argentina, Brazil, Cuba, and Guyana.

Hydatidosis. Effective hydatidosis control programs are underway in Peru, Argentina, Chile, and Uruguay. PAHO projects in the three latter countries are concentrating on administering drugs to affected dogs. In addition, a number of national projects have succeeded in using standardized diagnostic reagents to identify the geographic areas involved and to plan control efforts.

Bovine tuberculosis and leptospirosis. Regarding national efforts, it should be noted that Costa Rica, Cuba, Honduras, Mexico, and Panama now have programs for eradication of bovine tuberculosis, and that leptospirosis studies have been performed in Argentina, Brazil, Peru, Venezuela, Trinidad and Tobago, Cuba, Barbados, Grenada, and Jamaica.

Brucellosis. Great strides have also been made in standardizing the procedures used to

diagnose human and animal brucellosis cases and to control the quality of *Brucella abortus* strain 19 vaccines. A few decades ago, complete chaos reigned with respect to diagnostic procedures and the quality of antigens used in different countries. Brucellosis vaccines were produced and used without any official quality control.

This situation has changed, partly because PAHO (through CEPANZO) has come to distribute *Brucella* strains used for vaccine and antigen production, standard reference antigens, and technical guidelines. PAHO is also performing reference quality control of these biologicals at the governments' request.

Most countries now have regional or national control programs against bovine brucellosis, and some have programs against goat and swine brucellosis. PAHO's Veterinary Public Health Program, which was instrumental in promoting these efforts, acted as a preinvestment technical agency to obtain international credits for national control programs.

Foot-and-mouth disease. The greatest number of PAHO country projects have been concerned with foot-and-mouth disease. Every South American country has now built an infrastructure to control and eradicate this animal scourge, and the Hemispheric effort against it probably constitutes one of the largest animal health campaigns in the world.

The South American program covers a cattle population of 198 million head—including 89 per cent of the total cattle population in the affected countries. Overall, 63 per cent of the South American herd (117 million animals) was vaccinated in 1979 (Table 5). Average annual vaccine production by the South American countries currently exceeds 500 million doses. Argentina has instituted a national vaccine quality-control project that has resulted in a substantial decrease in foot-and-mouth disease cases. Meanwhile, the countries of Central America and the Caribbean are maintaining an active program to prevent foot-and-mouth and other exotic diseases—a program that includes continual surveillance of vesicular stomatitis.

In addition, some South American coun-

Table 5. Percentages of cattle included in South American foot-and-mouth disease control programs and vaccinated against the disease, by country, 1979.

Country	No. of cattle (in thousands)	Cattle included in the program		Cattle vaccinated against foot-and-mouth disease	
		No. (in thousands)	% of all cattle in the country	No. (in thousands)	% of all cattle in the country
Argentina	59,957	59,957	100	47,032	78
Bolivia	4,000	548	14	238	6
Brazil	97,500	76,645	79	52,043	53
Colombia	24,275	24,275	100	7,346[a]	30
Chile	3,468	3,468	100	462[b]	13
Ecuador	2,505	2,505	100	634[c]	25
Paraguay	5,916	5,916	100	3,999[a]	68
Peru	3,735	3,735	100	1,094	29
Uruguay	10,235	10,235	100	—[d]	—[d]
Venezuela	10,269	10,269	100	4,632[e]	45
Total	221,860	197,553	89	117,480	53[f]

Source: Report on the Epidemiological Surveillance on Foot-and-Mouth Disease and other Vesicular Diseases in the Americas, 1980 *(20)*.

[a]First vaccination round in 1979.

[b]Doses applied during the first round in 1979, within a vaccination zone containing 674,494 cattle.

[c]Doses applied in 1979 divided by 3.

[d]Data not available.

[e]Doses applied in 1979 divided by 2.

[f]Not including Uruguay.

tries have started to use their foot-and-mouth disease infrastructure against other problems—such as brucellosis, tuberculosis, and rabies in Bolivia, Brazil, Paraguay, and Peru. Chile, which is about to be declared free of foot-and-mouth disease after a campaign that began in 1969, is now shifting its eradication infrastructure to control hog cholera, brucellosis, and hydatidosis.

Other activities and considerations. The United Nations Development Program, the Canadian International Development Agency, and other international agencies have provided resources to several Caribbean countries to improve their animal health infrastructures, to control brucellosis and bovine tuberculosis, and to prevent the introduction of new diseases through construction of quarantine facilities.

One important effect of all these national programs, with or without international support, has been to demonstrate that the Governments of Latin America and the Caribbean, as well as international agencies, trust the veterinary profession and are willing to invest capital in veterinary programs. Millions of dollars of the countries' budgets have now been invested in disease prevention or control activities at the national and local levels. It is important that this confidence in the profession be maintained.

Animal Disease Diagnostic Laboratories

In assisting countries with animal health planning, a primary aim of PAHO's Veterinary Public Health Program has been to provide national programs with an adequate infrastructure for field and laboratory activities.

Most of the Latin American and Caribbean countries lack an integrated system of laboratories and instead operate through a central laboratory. The major exceptions are Argentina, Colombia, and Mexico (each of which has a laboratory network) and Brazil, Honduras, and Venezuela (each of which is developing such a network with PAHO project assistance). Nevertheless, over the past decade the countries' veterinary service infrastructure—including diagnostic laboratories—has improved considerably.

In 1976-1978 the animal disease diagnostic laboratory services in the Americas were inventoried. Overall, information was obtained from 26 Latin American and Caribbean countries *(1,14)*. According to this information, there were a total of 258 animal disease diagnostic laboratories in those countries (see Table 6) in 1978. Most of these (82.5 per cent) were under the Ministry of Agriculture. The ratio between head of livestock and the number of diagnostic laboratories is shown in Table 7. Overall, Latin America and the Caribbean appeared to have about one laboratory for every 1,937,844 head of livestock (including horses, cattle, sheep, goats, and pigs).

The inventory also showed that the animal disease diagnostic laboratories were providing important public health services in addition to their specific veterinary functions. Data from 17 countries indicated that 91 laboratories were making water quality-control examinations and 89 were performing food quality-control examinations. In 1977 some 10,000 specimens from human patients were examined by 139 animal health laboratories in 13 of the 17 countries. This diagnostic work was all the more significant because it was performed in rural areas without public health laboratories. Hence it is clear that many animal health laboratories are providing services that are indispensable to the primary health care of rural populations *(15)*.

At present PAHO's Special Program of Animal Health is providing the countries with reference and advisory services, biological reagents, laboratory animals, small amounts of equipment, and training in diagnosis and vaccine production for the control of vesicular and zoonotic diseases. Most of this work is performed by CEPANZO and PANAFTOSA.

Since these are the only two international centers dealing principally with animal diseases, other diagnostic centers used by the countries are primarily national laboratories of rec-

Table 6. *The distribution of animal disease diagnostic laboratories in Latin America and the Caribbean area and the types of agencies responsible for their administration, 1978.*

Country	No. of laboratories	No. of laboratories under different types of agencies							
		Agriculture ministries							
		Operate at national level	Operate at state level	Autonomous laboratories	Health ministries	Universities	Private organizations	Municipal agencies	The armed forces
Argentina	31	12	7	7	—	3	—	1	1
Barbados	1	1	—	—	—	—	—	—	—
Bolivia	4	4	—	—	—	—	—	—	—
Brazil	29	11	18	—	—	—	—	—	—
Chile	10	4	—	—	1	3	2	—	—
Colombia	26	—	—	26	—	—	—	—	—
Costa Rica	1	1	—	—	—	—	—	—	—
Cuba	10	3	6	—	1	—	—	—	—
Dominican Republic	14	8	—	—	1	1	4	—	—
Ecuador	8	3	1	—	2	2	—	—	—
El Salvador	4	3	—	—	—	—	1	—	—
Grenada	1	1	—	—	—	—	—	—	—
Guatemala	4	1	—	—	1	1	1	—	—
Guyana	1	1	—	—	—	—	—	—	—
Haiti	—	—	—	—	—	—	—	—	—
Honduras	2	2	—	—	—	—	—	—	—
Jamaica	1	1	—	—	—	—	—	—	—
Mexico	62	62	—	—	—	—	—	—	—
Nicaragua	1	1	—	—	—	—	—	—	—
Panama	10	10	—	—	—	—	—	—	—
Paraguay	6	2	—	—	1	1	2	—	—
Peru	13	3	—	—	2	7	1	—	—
Suriname	1	1	—	—	—	—	—	—	—
Trinidad and Tobago	1	1	—	—	—	—	—	—	—
Uruguay	4	2	—	—	1	1	—	—	—
Venezuela	13	10	—	—	1	—	2	—	—
Total	258	148	32	33	11	19	13	1	1
Per cent	100	57.3	12.4	12.8	4.3	7.4	5.0	0.4	0.4

Source: Diagnostic of the Animal Health Situation in the Americas, Vol. 2. Pan American Health Organization, 1978 *(1)*.

Table 7. The ratios between head of livestock and numbers of animal disease diagnostic laboratories in countries of Latin America and the Caribbean, 1978.

Country	No. of various kinds of livestock					Total national herd	No. of diagnostic laboratories	No. of head per laboratory
	No. of cattle	No. of sheep	No. of goats	No. of swine	No. of horses			
Argentina	55,354,669	34,691,426	4,580,263	4,126,742	3,005,240	101,758,340	31	3,282,527
Barbados	7,082	27,054	5,436	27,515	952	68,039	1	68,039
Bolivia	2,406,941	8,112,932	3,680,848	1,188,000	1,334,665	16,723,386	4	4,180,846
Brazil	92,495,364	19,760,643	6,416,964	34,192,028	8,539,784	161,404,783	29	5,565,682
Chile	3,417,003	6,690,280	933,007	1,021,594	536,051	12,597,935	10	1,259,793
Colombia	23,858,508	1,920,770	626,071	1,897,374	2,526,052	30,828,775	26	1,185,722
Costa Rica	1,346,222	—	—	246,802	106,576	1,699,600	1	1,699,600
Dominican Republic	1,471,967	25,565	259,758	730,218	412,145	2,899,653	10	289,965
Ecuador	2,446,055	1,096,640	221,354	1,127,745	556,404	5,448,198	8	681,025
El Salvador	960,774	112	—	11,160	104,674	1,076,720	4	269,180
Grenada	6,000	9,000	5,500	10,000	—	30,500	1	30,500
Guatemala	1,712,851	667,766	53,576	659,031	165,174	3,258,398	4	814,599
Guyana	200,000	62,000	20,000	80,000	22,500	384,500	1	384,500
Honduras	1,685,487	2,863	16,938	511,124	264,753	2,481,165	2	1,240,582
Jamaica	278,710	9,000	263,000	66,013	—	616,723	1	616,723
Mexico	25,123,756	5,320,070	8,487,822	11,720,843	10,720,699	61,373,190	62	989,890
Nicaragua	2,864,198	—	—	207,059	149,446	3,220,703	1	3,220,703
Panama	1,358,360	—	—	179,000	130,019	1,667,379	10	166,738
Paraguay	5,537,200	370,400	108,300	1,102,000	325,400	7,443,300	6	1,240,550
Peru	4,251,800	14,117,600	2,276,154	2,141,600	1,326,350	24,113,504	13	1,854,885
Suriname	26,000	—	—	—	—	26,000	1	26,000
Uruguay	10,383,773	15,647,170	—	226,265	507,948	26,765,156	8	3,345,645
Venezuela	9,409,443	90,035	1,262,300	1,117,215	882,699	12,761,692	13	981,669
Total[a]	246,602,163	108,621,326	29,217,291	62,589,328	31,617,531	478,647,639	247	1,937,844

[a]Not including Cuba or Trinidad and Tobago.

Source: Diagnostic of the Animal Health Situation in the Americas, Vols. 1 and 2. Pan American Health Organization, 1978 *(1)*.

ognized international standing. These include the U.S. Agriculture Department's Plum Island Animal Disease Center, which provides invaluable assistance in diagnosing and controlling exotic disease outbreaks—such as the recent outbreaks of African swine fever in some countries of the Americas. The U.S. Agriculture Department's Animal Disease Center in Ames, Iowa, is also used by many Latin American and Caribbean laboratories. Other centers employed include the U.S. Public Health Service's Center for Disease Control in Atlanta, Georgia; PAHO/WHO's Caribbean Epidemiology Center (CAREC) in Port-of-Spain, Trinidad; the Animal Virus Research Institute in Pirbright, Great Britain; the Central Veterinary Laboratory in Weybridge, Great Britain; the National Livestock Research Institute in Palo Alto, Mexico; and the Laboratory Animal Diseases Research Institute in Ottawa, Canada.

Food Protection

Most veterinary public health and animal health services in Latin America and the Caribbean are directly responsible for the quality control of foods of animal origin. In some countries—such as Colombia, Costa Rica, Guatemala, Trinidad and Tobago, and Venezuela—the veterinary public health units are in charge of all food protection activities within the purview of the health sector.

Since its creation, PAHO's Veterinary Public Health Program has provided Member Countries with active cooperation in this field. These activities have always been closely coordinated with related PAHO Veterinary Program activities in such areas as food-borne disease epidemiology, laboratory diagnosis, veterinary education, and the training of auxiliary personnel. Among other things, this PAHO effort has included direct technical assistance in planning and organizing food protection programs in the ministries of health and agriculture. This assistance has been designed to help develop or improve local and national food protection programs and services through enactment of up-to-date legislation, preparation of qualified personnel, and provision of adequate support for food analysis laboratories.

As Figure 1 indicates, several PAHO food protection projects or activities were underway in the 1970s. During that period a regional training center for food inspectors was established in Caracas, Venezuela, in cooperation with the School of Public Health of the Ministry of Health and Social Welfare of that country. This project, which was later transferred to Medellín, Colombia, has trained over 150 food inspectors from practically all the Latin American countries. The Central American countries, Colombia, Venezuela, Barbados, and Jamaica have also received assistance in training personnel in meat hygiene and meat technology. In addition, with the cooperation of the Adolfo Lutz Institute in São Paulo, Brazil, PAHO has prepared and published over 350 food health standards. These have been adopted by the Central American countries and are also being used by several South American countries. Finally, with the cooperation of Guatemala's Ministry of Health and the United Nations Development Program, a National Food Analysis Laboratory has been established in Guatemala City. This fully-equipped laboratory, operated by PAHO personnel and well-qualified Guatemalan staff members, uses the most sophisticated available technology to analyze chemical and pesticide residues in meats and other foods of both plant and animal origin. Besides serving an important public health function, it has provided the Central American countries with analytical certificates for all the meats and other agricultural products exported to the United States and Europe.

A large part of PAHO's assistance to food protection programs has been provided by CEPANZO's Food Microbiology Department, and over the years that center has become a focal point for training personnel in food analysis. CEPANZO has been very active in the fields of milk hygiene and milk technology and has performed extensive re-

search on the contamination of animal and food products. In this same vein, CEPANZO has published several training and laboratory manuals on food protection.

Laboratory Animal Medicine

Since the development of this discipline, PAHO's Veterinary Public Health Program has provided assistance to Member Governments for training veterinarians in animal care and management and in laboratory animal pathology. Several Latin American veterinarians have received U.S. and European training in this field at the master's and doctoral levels. PANAFTOSA and CEPANZO have provided assistance at both the professional and technical levels for training people from several animal health and public health laboratories in how to develop, maintain, and manage laboratory animal colonies. The two centers have also published and distributed a series of manuals on diseases of laboratory animals, appropriate breeding methodologies for several species, and proper design and operation of animal colonies.

Through its Special Program of Animal Health, PAHO is also collaborating with the Government of Peru in development of a breeding center for subhuman primates used in biomedical research. Agreements have been signed for development of similar centers in Brazil and Colombia. These projects are being financed through a contract between PAHO and the United States National Institutes of Health.

Conclusion

The establishment and subsequent success of PAHO's Veterinary Public Health Program throughout Latin America has depended on a number of factors. These include:

1) Development of sound concepts relating to the program's importance and to the socioeconomic gains (as well as the health gains) involved.

2) Establishment of procedures for bringing together top scientific experts and leading agriculture and health authorities to determine the most appropriate control procedures.

3) Establishment of a sound infrastructure of services and functions well-suited to meeting the needs of PAHO Member Countries.

4) Generation of constructive pressure capable of promoting program development and justifying program costs by estimating concrete benefits to be produced.

These were the methods by which veterinary medicine was brought into the forefront of current interest and concern with socioeconomic development. In this same vein, the Veterinary Public Health Program has provided supportive assistance in procuring Inter-American Development Bank funds—funds needed by Member Countries to improve disease control and diagnostic laboratory services. All in all, the program's impact on veterinary medicine in the Americas has been out of proportion to its limited staff and budget, for it has proved a decisive stimulus to growth and development over the past three decades.

At the present juncture, society has shown confidence in the veterinary profession and has invested heavily in animal disease prevention and control. But it is also true that new kinds of veterinarians are needed in Latin America—veterinarians with new skills in management, economics, computer sciences, epidemiology, and so forth—who can carry these programs to a successful conclusion. Not enough present veterinarians have these skills, so it is important that appropriate numbers with such skills be prepared quickly. Otherwise, it may take generations before veterinary medicine will get the social support needed for its work.

This is the present challenge to the veterinary medical program in Latin America as the century comes to a close. Meeting that challenge successfully can result in reestablishment of Latin America as the world's "meat basket"—a development that would help the region provide nutritious food, employment for its people, and a key source of funds for socioeconomic development.

SUMMARY

The purpose of this article is twofold: to review the basic rationale behind veterinary medical activities in Latin America and the Caribbean and to describe the role PAHO has played over the last three decades in promoting and helping to improve the quality of these activities.

In essence, development of a strong veterinary public health program in the region has depended upon acceptance of three major precepts. These are:

1) Animal health is a key factor in socioeconomic development.

2) There is a critical interrelationship between human and animal health that becomes evident in veterinary public health programs.

3) Veterinary public health plays an important role in focusing attention on communicable disease problems and in pioneering new programs in animal health and veterinary education.

Clearly, animal health in Latin America and the Caribbean is inextricably linked to socioeconomic development. Livestock represents an important agricultural product and a major source of revenue. It is therefore essential to reduce economic losses wrought by animal diseases such as the zoonoses, foot-and-mouth disease, hog cholera, piroplasmosis, and Newcastle disease. The resulting increased productivity and freer international trade would help alleviate the critical shortages of energy and protein that beset the world today.

A key interrelationship between human and animal health relates to man's need of protein. Malnutrition, which continues to plague the populations of developing countries, was recently shown to be the indirect or direct cause of half of the deaths among children under 5 years of age in Latin America. The livestock industry is a principal tool for alleviating this problem by providing essential protein. In addition, some of the more prevalent human diseases—rabies, brucellosis, tuberculosis, hydatidosis, the equine encephalitides, leptospirosis, and anthrax—are acquired directly or indirectly from animals.

Given these important linkages between animal and human health, it is appropriate that national and international programs should have been instituted to promote well-being and prevent disease, capitalizing on the resources of veterinary and scientific communities. In the Americas, PAHO's Special Program of Animal Health has spearheaded these pioneering efforts. That program has proved instrumental in promoting, establishing, and providing technical support for all phases of national and regional animal health activities. Numerous PAHO-supported country projects have been successfully completed, and many others are still underway, in such crucial areas as: veterinary education and development of human resources; animal disease control, epidemiology, and vaccine production; animal disease diagnostic laboratories; food protection; and laboratory animal medicine.

All in all, it is now evident that this Program's past and present endeavors have made a major contribution to human and animal health. But it is also true that solution of the problems confronted partly through that Program will require a continuing political commitment to provide appropriate financial and human resources—and that failure to employ sufficient resources of this kind could have a serious adverse impact on animal health and human well-being in the Americas.

BIBLIOGRAPHIC REFERENCES

(1) Pan American Health Organization. *Inter-American Study on the Animal Health Situation, 1978* (vols. 1-4). Publication of the Special Program of Animal Health. Washington, D.C., 1980.

(2) Cáceres, F. Statement by the Observer for the Inter-American Development Bank. In Pan American Health Organization, *Animal Disease Control in the Americas, 1977.* Scientific Publication 358. Washington, D.C., 1978, pp. xiii-xvi.

(3) Bergland, R. Address by the Secretary of Agriculture of the United States of America. In Pan American Health Organization, *Animal Disease Control in the Americas, 1977.* Scientific Publication 358. Washington, D.C., 1978, p. viii.

(4) Poppensiek, G. C., and K. T. Marash. Biological Energy and the Plant Animal Trade-off, I Inter-American Meeting at the Ministerial Level on Animal Health. PAHO Document RIMSA 1/10. Washington, D.C., Pan American Health Organization, 1980.

(5) Hubbard, H. B. Impact of Animal Diseases on Protein of Animal Origin. In Pan American Health Organization, *Animal Disease Prevention in Developing Countries: Its Relationship to Health, Nutri-*

tion, and Development. Scientific Publication 380. Washington, D.C., 1979, pp. 36-41.

(6) de las Carreras, A. Foot-and-Mouth Disease and the World Meat Trade. In Pan American Health Organization, *Marketing of Animals and Their Products and Animal Health.* Scientific Publication 374. Washington, D.C., 1979, pp. 59-72.

(7) Herman, M. Statement by Observer of the Inter-American Development Bank, I Inter-American Meeting at the Ministerial Level on Animal Health. PAHO Document RIMSA 1/18. Washington, D.C., Pan American Health Organization, 1980.

(8) Rivero, N. Barriers to the World Beef Trade. In Pan American Health Organization, *Marketing of Animals and Their Products and Animal Health.* Scientific Publication 374. Washington, D.C., 1979, pp.149-155.

(9) Horwitz, A. Worldwide Perspective on Animal Disease Losses and Their Impact on Nutrition, Health and Development. In Pan American Health Organization, *Animal Disease Prevention in Developing Countries.* Scientific Publication 380. Washington, D.C., 1979, pp. 1-8.

(10) Pritchard, W. R. The Role of Animals in Providing for Man's Nutritional Needs. In Pan American Health Organization, *Animal Disease Prevention in Developing Countries.* Scientific Publication 380. Washington, D.C., 1979, pp. 28-35.

(11) Acha, P. N., and B. Szyfres. *Zoonoses and Communicable Diseases Common to Man and Animals.* Scientific Publication 354. Washington, D.C., Pan American Health Organization, 1980.

(12) Szyfres, B. Leptospirosis as an Animal and Public Health Problem in Latin America and the Caribbean Area. In Pan American Health Organization, *VIII Inter-American Meeting, at the Ministerial Level, on Foot-and-Mouth Disease and Zoonoses Control.* Scientific Publication 316. Washington, D.C., 1976, pp. 115-130.

(13) Málaga, H., and P. Acha. The Function of the Veterinarian in Community Health in Latin America. In Pan American Zoonoses Center, *II Seminar on Education in Veterinary Medicine in Latin America, Belo Horizonte, Brazil, 21-31 August 1972.* Series on Education in Veterinary Medicine, 1. Ramos Mejía, Argentina, 1973, pp. 59-72.

(14) Szyfres, B. Animal Disease Diagnostic Laboratories in the Americas. In Pan American Health Organization, *Animal Health in the Americas, 1979.* Scientific Publication 391. Washington, D.C., 1980, pp. 75-88.

(15) Orozco, R. The Animal Health Laboratory of San Rafael, Veracruz, Mexico, and Its Support for Medical Care Programs in Rural Areas. In Pan American Health Organization, *Animal Health in the Americas, 1979.* Scientific Publication 391. Washington, D.C., 1980, pp. 89-96.

(16) Pinto Cohen, G. Address by the Minister of Agriculture and Livestock Breeding of Venezuela. In Pan American Health Organization, *Marketing of Animals and Their Products and Animal Health.* Scientific Publication 374. Washington, D.C., 1979, pp. xii-xiii.

(17) Escobar, E. Animals and Zoonoses, General Bases for Zoonoses Control, I Inter-American Meeting at the Ministerial Level on Animal Health. PAHO Document RIMSA 1/7. Washington, D.C., Pan American Health Organization, 1980.

(18) Acha, P., and H. Málaga. Some Aspects of Teaching Veterinary Medicine in Latin America. In Pan American Zoonoses Center, *II Seminar on Education in Veterinary Medicine in Latin America, Belo Horizonte, Brazil, 21-31 August 1972.* Series on Education in Veterinary Medicine, 1. Ramos Mejía, Argentina, 1973, pp. 19-58.

(19) Acha, P. Algunos hechos y conceptos sobre la enseñanza de la medicina veterinaria en América Latina. Informe V, Jornadas Médico Veterinarios, 8-10 de noviembre de 1979. Valdivia, Chile, Universidad Austral de Chile, 1979, pp. 62-100.

(20) Pan American Foot-and-Mouth Disease Center. Report on the Epidemiological Surveillance on Foot-and-Mouth Disease and Other Vesicular Diseases in the Americas, I Inter-American Meeting at the Ministerial Level on Animal Health. PAHO Document RIMSA 1/15. Washington, D.C., Pan American Health Organization, 1980.