III INTER-AMERICAN MEETING ON

FOOT-AND-MOUTH DISEASE AND ZOONOSES CONTROL

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION

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ADDRESS BY THE DIRECTOR OF THE PAN AMERICAN SANITARY BUREAU

DR. ABRAHAM HORWITZ

We tend nowadays to talk in terms of decades rather than of centuries, such is the speed and range of events in the modern world. We are also better informed than in the past, and hence we make bold to predict the future with greater assurance. That during the 1960's events of vast significance took place which have left their mark on the Americas is an indisputable fact. There are those who raise the query whether the political declarations and the enterprises to which they gave rise attained their object, in other words, whether the outcome was a success or a failure. It might seem wishful thinking to try to change the face of a continent in a single decade; but it is perfectly reasonable to try to alter radically the course of events in the countries belonging to that continent, and this is in fact what has happened. Not only have people become aware; there have been achievements which justify the optimism felt in some quarters in regard to the 10-year period beginning with the present year.

With regard to the prevention and cure of disease, vital and health statistics reveal steady progress, in spite of the notable underregistration of morbidity and mortality. There is likewise a sense of realism which is prompting Governments, professionals, and experts of public and private services to make productive use of the human and material resources at their disposal. Notwithstanding the political and social ups and downs—which are to be expected, since higher income brings higher aspirations—we are confident that this trend will continue to benefit an increasing number of human beings in this Hemisphere.

The forecasts made concerning the feeding of the world population from this year onward are therefore not surprising. The introduction of high-yield, improved varieties of wheat, corn and rice, resistant to disease and highly responsive to the action of fertilizers, gives grounds for an optimistic view of this grave problem, as a result of this so-called "green revolution." If the trend should spread, some predict that it is not the production of food that will be the major problem but its distribution and preservation to ensure proper consumption and utilization. This is a matter of proper organization and administration of a series of complex mechanisms in individual countries and communities. It may be pertinent to recall that there are those who hold that the most serious crisis of our time is the institutional crisis. They maintain that the traditional institutions have been unable so far to adapt themselves to the speed of change in human beings. The institutions established now and in the future must give careful thought to ways and means of satisfying vital needs which are a feature of a more just society, and these needs include nutrition.

There can be no efficient organization which is not the outcome of a rational policy. To draw up such a policy for food and nutrition in the Americas has become a pressing need. Prevention and treatment of the ravages of malnutri-

tion and other deficiency diseases is a hopeless task without a knowledge of food availability and quality, and the organization of food production without regard for the health and sickness requirements of the inhabitants, as well as their economic needs, would appear to be equally futile. The dissociation of functions created artificially by men does not exist in nature; we can therefore understand why agriculture and health specialists are convinced today that they must take joint action and pursue a single policy for the common good. The Ministers of Health have favored this policy. They have also favored the establishment of a Nutrition Data Retrieval and Analysis Center for the countries of the Americas. This information would be useful for the formulation, execution, and evaluation of programs for the production, consumption, import, and export of protective and energy-giving foods. The Government of the Republic of Argentina has expressed interest in having the headquarters of this undertaking in its territory, and is sponsoring a project on the subject with the collaboration of the United Nations Food and Agriculture Organization and our own Organization. It is noteworthy that agrometrics has not yet attained the same degree of development in Latin America as biometry. In other words, demographic and vital and health statistics, and procedures for analyzing them, are more widely and more frequently used than statistics on agriculture and livestock-raising. The scheme in question might well have the immediate effect of inducing Governments to organize or extend their services for collecting and effectively using data connected with their agricultural policies.

We look forward during the present meeting to a wide-ranging debate on this whole complex question, in the course of which the Ministers of Agriculture or their representatives will no doubt enlighten us concerning the feasibility, or the present status, whichever applies, of the process of providing the population with the minimum balanced diet. This is, of course, a multisectoral and multidisciplinary operation, and there are traditions and conventions which are not easy to bypass; but we cannot remain unmoved in the face of a mortality rate in children under 5 years which represents 44 per cent of all deaths in Latin America and the Caribbean area. Malnutrition contributes in large measure to this death rate and helps to increase it.

An important component in this whole problem is the loss of essential proteins through diseases in certain animal species. But it is a matter of even greater concern when these diseases are transmitted to men. I should like to express to the Government of Argentina, on behalf of the Pan American Health Organization and the World Health Organization, our profound gratitude for making it possible to establish the Pan American Zoonoses Center as a successful going concern. In response to Resolution VIII of your II Meeting held in Rio de Janeiro in May 1969, you will be hearing the report of the Special Mission which so far has visited 15 countries in the Hemisphere to seek your views on regional extension of the activities of the Center. Everyone is agreed as to the need for controlling the zoonoses in cattle, reducing infection in human beings, and increasing the protein intake of vulnerable groups. This implies an intensification of the education and training programs, and of research and advisory services to Governments, all with a view to reducing the incidence of these problems. It is gratifying to note the readiness of the Inter-American Development Bank and the International Bank for Reconstruction and Devel-

opment (World Bank) to consider applications for credits for livestock promotion, including zoonoses control.

The other items on your agenda merely corroborate the great significance of the present meeting. I should like to make special mention of the panel on vaccines for foot-and-mouth disease control, the mere mention of which indicates its tremendous practical importance. I should like once again to thank the Government of Brazil, on behalf of the Organization, for the excellent facilities it has provided for the Pan American Foot-and-Mouth Disease Center since its inception. Since it is financed today by Governments, its program and budget will come up for discussion at one of the working sessions.

A second panel will discuss health and food problems connected with imports and exports of animals and animal products. Here again, the mere mention of the subject reveals its implications for nutrition and for the economy. I am sure that the debates will suggest lines of action which public and private bodies, as well as the international organizations, will endeavor to put into practice. This is our feeling in regard to all the resolutions which you see fit to adopt here. They will enable us to make our contribution to the well-being and the development of the Hemisphere.

We propose to set up at the Headquarters of the Organization a department to handle relations between health and agriculture, which have taken on a special importance in the Americas and are a matter of great concern to us. The justification for this new departure will be more patent to the extent that Governments formulate and implement a food and nutrition policy. We shall thus be better able to direct and organize the cooperation of the Pan American Health Organization in dealing with problems which by their nature and the consequences that derive from them are among the most vital.

Nothing seems impossible today in the Americas; this is the most positive lesson to be drawn from what has occurred during the 1960's. Albert Camus expressed this, much more poetically, when he said that we must mend what has been torn, we must make justice once more conceivable in a manifestly unjust world, we must give a new meaning to happiness for peoples poisoned by the unhappiness of our times. No doubt it is a superhuman task; but the fact is that what are described as superhuman tasks can be and are accomplished by men in the fullness of time.

ADDRESS BY THE EXECUTIVE DIRECTOR OF THE INTER-AMERICAN DEVELOPMENT BANK

MR. ILDEGAR PÉREZ SEGNINI

It is my great privilege to bring you greetings from the Inter-American Development Bank—from its Board of Executive Directors and more particularly from its President, Felipe Herrera, who until the very last moment had been hoping to be present personally at this important meeting. This turned out to be impossible because of commitments in connection with the preparation of the forthcoming meeting of the Board of Governors of the Bank, which is about to open in Punta del Este, Uruguay. He has asked me to assure you of his personal interest in the purposes and objectives which bring us together here, and of his firm conviction that the development of the countries of our Hemisphere and the well-being of its inhabitants are bound to be enhanced by the implementation of the conclusions and recommendations that emerge from this meeting.

For three years running—thereby establishing a noteworthy tradition—the Pan American Health Organization has brought together the Ministers of Agriculture and senior government experts of our countries for joint discussion of problems relating to foot-and-mouth disease and other livestock diseases, realizing as it does that they affect all the countries, directly or indirectly, and call for comprehensive solutions likewise based on joint action.

The Inter-American Development Bank has attended all these meetings, voicing the opinion of its member countries, fully appreciative of the problems involved, and working with others for their solution.

I should like to thank the Pan American Health Organization for its kind invitation, and indeed to thank all of you for this excellent and timely opportunity to express the interest and concern of IDB in regard to the discussions which take place here and to assure you of its firm intention to support the technical measures and decisions adopted. We regard the present meeting as highly important. We feel that it could be invaluable for this Hemisphere, many of whose problems and difficulties could be overcome if we could confirm our decision to face them in a comprehensive, united fashion.

Action by IDB in the Agriculture and Livestock-Raising Sector

The economy of our countries continues to be based essentially on agriculture and livestock-raising. It is this sector that has primary responsibility for providing the wherewithal to feed a growing population, while at the same time it constitutes a fundamental source of employment. Nevertheless, serious shortcomings have restricted its development, and unless we succeed in giving it the benefit of the latest technological advances, we shall face the serious difficulties

already hinted at by the international organizations concerned with food and agricultural development.

During the 10 years since its inception, IDB has made a substantial contribution to the valiant efforts of the Latin American countries to improve their agriculture. No doubt its concern in this direction explains the fact that the first two loans of the Fund for Special Operations earmarked a considerable portion of the financing for development programs in this sector.

Now that we have reached the end of our first decade, we have encouraging results to show, with an agricultural portfolio which is the highest in IDB, representing 24.3 per cent of the total. Up to 31 December 1969, IDB's contribution to the achievement of progress in the Hemisphere amounted to $3.5 billion, of which $834 million represent assistance in introducing improved techniques into agriculture. To appreciate this contribution fully, let us recall that every dollar lent by IDB mobilizes two dollars of the domestic resources of the different countries, likewise for agriculture. As a result of this collaboration, 6.5 million persons have seen their living conditions improved, and 1.5 million hectares have been added to the cultivated areas or have increased their productivity. The activities reflected in these figures show that the Inter-American Development Bank continues to be the public organ which has contributed most to agricultural financing in Latin America.

Appreciable indirect contributions have also been made by way of road-building and rural housing, support for the teaching of agronomy or veterinary medicine and for rural health programs.

The close relationship between health and agriculture and the active and cooperative participation of these sectors in a food and nutrition policy for the Americas will be examined at this meeting. IDB has likewise given its support to health programs. This field, along with education and other fields, has been given special attention by our President, Felipe Herrera, who was awarded the Bronfman Prize by the American Public Health Association in recognition of his work for the protection of public health in Latin America.

The complexity of the agricultural sector, in the development of which non-human factors are frequently involved, makes its financing subject to special problems and features which IDB has helped to resolve in conjunction with the various countries. The traditional fields of financing such as agricultural or irrigation credits have been given attention, but as these programs have developed others have arisen which likewise need encouragement, so that we find ourselves financing new items such as the marketing of agricultural and livestock products or animal health programs involving foot-and-mouth disease control.

Importance of Animal Health in Livestock Development

Livestock-raising has received something like $72 million in direct loans, or 8.6 per cent of the whole of the agricultural portfolio. At the same time, IDB has helped to finance other projects which indirectly benefit livestock-raising or which imply livestock development programs, to the tune of approximately $47 million, making the total IDB contribution under this heading approximately $119 million.

The experience gained with livestock projects indicated the need to give

thought not only to the quality of livestock and to feeding and management, but particularly to animal health.

Losses caused by foot-and-mouth disease, estimated at some $500 million, are not the only factor which worries individual countries and seriously affects the economy of the Region. In quite a few of the Latin American countries we find a decline of more than 30 per cent in livestock production as a consequence of infectious and parasitic diseases. If these diseases are to be controlled, they must be combated at all levels—the farm, the country, or in the case of diseases with a marked tendency to spread, such as foot-and-mouth disease, even at the regional or continental level.

A control process not carried out at the level of the entire region affected is as useless as it is costly. It is this technical need which gives foot-and-mouth disease and other animal health campaigns their status as a multinational integration program. This has been IDB's approach ever since it made its first loans for foot-and-mouth disease control to Paraguay and Chile in 1968 and to Argentina in 1969, totaling $15.6 million.

In a recent report on the livestock situation in the Region, the Economic Commission for Latin America points out the favorable prospects and the very extensive possibilities of zonal integration and complementation for the countries of the Latin American Free Trade Association. But it also points out that the countries must unify and coordinate their activities, improve their research and technical assistance services, and undertake joint action against foot-and-mouth disease, the endemic nature of which in the South American countries is hampering sales of meat in certain international markets.

Significance of the Action Taken against Foot-and-Mouth Disease and the Improvement in Animal Health

With the effective assistance of the countries of the Region, of the Pan American Health Organization, and particularly the Pan American Foot-and-Mouth Disease Center, as well as other bodies, IDB has given vigorous support to a campaign to combat this and other livestock diseases. In addition to the foot-and-mouth disease campaigns in Argentina, Chile, and Paraguay now under way with the financial support of the Bank, Bolivia has in preparation a health project which will include campaigns against foot-and-mouth disease, brucellosis, and paralytic bovine rabies. Brazil has already placed before the Bank a project, now at an advanced stage of discussion, covering as a first stage the control of foot-and-mouth disease in seven Brazilian states where livestock production is most heavily concentrated. The program will make use of the experience acquired in the campaigns in Rio Grande do Sul and other states. Colombia, with the help of the Pan American Foot-and-Mouth Disease Center, has just completed an animal health program including the control of this disease and of brucellosis. Ecuador is due to conclude in the second half of 1970 an animal health project for the organization of which it obtained a technical assistance loan from the Bank on a contingent repayment basis. Peru, with technical advice from the Foot-and-Mouth Disease Center and technical assistance from IDB, is hoping to complete the formulation of its project in the first half of 1970 and to be in a position to submit it for

financing. Uruguay is using preinvestment funds to prepare a foot-and-mouth disease, hydatidosis, and brucellosis project to supplement its current campaign. Venezuela is likewise completing the formulation of a project for a health campaign.

Thus, in response to the recommendations and the strategy approved at previous meetings, IDB has pledged full support to this program, and the prospects are favorable, since all the countries of South America have projects of this nature either in progress or at an advanced stage of preparation.

Toward a Solution of Animal Health Problems

It is an undoubted fact that the measures aimed at livestock promotion will all fail to achieve real results or will be seriously and constantly in jeopardy unless the livestock diseases, especially foot-and-mouth disease, are brought under control or eradicated. The meat deficit in Latin America also means a shortage of proteins, an essential element in human nutrition; this calls urgently for sustained, systematic action at the regional level with a view to increasing the livestock population, the main source of this valuable element.

The experience of the campaigns now under way—the outcome of criteria and guidelines for the preparation and study of projects formulated with the help of the individual countries, the Pan American Health Organization, and various scientific centers to which recourse has been had—leads us to believe that this target is feasible. We have the means of attaining it; all we need is the will to do so.

The Bank is prepared to support these programs resolutely as part of the policy it has established, and it looks to the individual countries to proceed with the preparation of soundly-designed programs based on proper technical advice and with due attention given to multinational considerations and the efficient use of technological and scientific resources. There will be a need for sustained and constant effort, for effective coordination between countries, financing bodies and technical centers, for a continuing evaluation of results, as well as for efficient institutions endowed with adequate resources and technical personnel, the active participation of stockmen and farm workers, good-quality vaccines in sufficient quantities, and other factors of like importance. Use will have to be made of the permanent advisory services of the Pan American Health Organization, the Pan American Foot-and-Mouth Disease Center, FAO, scientific centers, and other assistance; and it will be necessary to strengthen scientific institutions such as the Foot-and-Mouth Disease Center, to help them with their research, to promote an interchange of technical information, and to encourage multinational and regional coordination.

The Inter-American Development Bank will continue to work in close cooperation with the Ministers for the elimination of foot-and-mouth disease and other livestock diseases. It is reassuring to see you assembled here once again, with the same firm resolve, evaluating the progress you make and adopting appropriate decisions to confirm proposals and to detect or rectify mistakes. The Bank is happy to be present here and it will continue to attend whenever it considers this necessary, since its *raison d'être* is and will continue to be to serve the countries of the Hemisphere.

Finally, I should like to send a greeting and say a word of thanks to the Argentine people and Government for their hospitality and for the facilities given us. They will assist us in conducting our discussions and provide an atmosphere propitious for fruitful resolutions.

ADDRESS BY THE SECRETARY OF STATE FOR AGRICULTURE AND LIVESTOCK OF ARGENTINA

DR. LORENZO A. RAGGIO

The Government of the Republic of Argentina wishes to express, through me, the honor it feels in welcoming its eminent visitors from the sister republics of the Americas and those countries of Europe that will share our concern to present a united front in the fight against some of the factors causing the inadequate food intake in many parts of the world.

My country is anxious that all of you should feel at home here in these working sessions, in the knowledge that you have the fellow-feeling of all the Argentine citizens, who are genuinely interested in learning the results of your deliberations, begun two years ago under the auspices of the Pan American Health Organization and continued today at this III Meeting. It is evident that this sentiment is shared by all your countries, since they have sent to attend this meeting the outstanding figures in one or another aspect of health, agriculture, and the economy.

The demand for more and more food, both to meet the spiraling growth of the population and to improve the standard of living of the new peoples joining the community of nations, is increasing at a prodigious rate everywhere in the world. We have a tremendous responsibility, as chiefs of technical bodies which take the lead in obtaining this food, not only to meet the internal needs of our countries, but to help as far as we can in the solution of the problem at the world level.

The extent to which we can do so is determined in a sense by the natural conditions and the geographic area of our countries, and also by a concern to improve quality and intensify production capacity.

Here is where our great responsibility begins, where the unquestionable goal of our duty lies—in the acquisition of agricultural technology with a view to higher productive capacity and the safeguarding of this production through the adoption of the necessary preventive measures to ensure that pests and diseases do not destroy the whole or part of it.

The diseases affecting livestock are today taking a considerable toll of the animal population in terms of head of cattle and tonnage of meat and derivatives lost. I need not quote the figures on the cost which this represents; the statistics at the disposal of all of us are a reliable indication that, except for occasional fluctuations, the percentage level of livestock production is falling, even though the over-all quantities may appear to indicate the contrary.

There is daily evidence to show that countries which hitherto could boast of self-sufficiency in food production are today faced with the imminent prospect of having to call upon other producing countries to make up their deficit. In the face of this prospect we cannot remain impassive, otherwise we incur the

charge of willful negligence. That is why the community of effort we are building up through these meetings is not a mere pious hope, but a very positive means of coordinating the technical efforts of the countries and the international organizations to achieve a precise and positive goal.

We must also remember that countries like ours, anxious to advance in the direction of industrialization so as to achieve a standard of living in keeping with the possibilities of modern technology and science, must do everything possible to increase and sustain food production. This will not only enable us to keep our manpower efficient, healthy, and physically vigorous, but will also provide an exportable balance to help satisfy the needs of other countries and at the same time allow us to meet the costs which this industrialization involves.

We must also remember that the livestock producers are aware of the vital role they play in this world crusade against hunger, and they have the right to insist that the agencies in charge of the economic policy of the various countries devote their efforts to legislation which will allow them to earn a fair remuneration and thus make it possible for them to continue to share the responsibilities of the health campaigns with their Governments.

The official bodies should devote their best efforts to planning and organizing these campaigns, not only with a deep concern for health but with a genuine practical outlook. This will encourage producers to redouble their efforts, expending on this task their enormous traditional stock-in-trade of knowledge of livestock exploitation and plowing back their profits in the interests of increased production.

Although it will be a basic issue in the papers to be read here, I feel I should mention the tremendous concern felt in countries such as Argentina, which are traditional livestock producers, about the disease which plays most havoc with production, namely, foot-and-mouth disease.

The campaigns against this disease have been in progress for some years, and it is evident that considerable progress has been made. This is borne out clearly in my own country by the figures, which show that out of a total of 404,000 livestock establishments subject to control, with an approximate total of 50 million head of cattle and 40 million sheep, the number of foci recorded in 1969 was 1,957, many of them consisting of a single animal. Moreover, we have succeeded in eradicating the disease from a large section of the territory, covering practically the whole of Patagonia.

But although progress has been made in this direction, the very fact that the disease is still with us brings us within the health legislation of the importer countries, which considerably restricts our exports.

Argentina, like other Latin American countries, has never denied the existence of foot-and-mouth disease, a disease brought into our Continent from outside, but we do feel that recognition should be given to the vigorous campaigns we are waging. In its plans for the next five years, Argentina proposes to invest approximately 200 million pesos (US$50 million), including a loan from the Inter-American Development Bank, and we also have the strong support of the producers. We hope to achieve control of this disease and thus to be able to look forward confidently to its final eradication.

Before concluding, I should like to make special mention of the Pan American Health Organization together with its subsidiary agencies, the Pan American Foot-and-Mouth Disease Center and the Pan American Zoonoses Center,

which have done such admirable work in ensuring that technical activities at the expert level in our countries constantly enjoy the benefit of advisory services. They have likewise organized training courses for laboratory technicians and maintained a vigorous interchange with technical offices of the Governments; and in their laboratories the two Centers have studied and solved many problems arising in individual countries and in regional groups of countries.

That these meetings are sponsored by the Pan American Health Organization is an eloquent comment on the continuing concern about the health problems affecting the countries of the Americas.

I repeat, gentlemen, please feel at home here, and I trust that your work will be fruitful and your efforts crowned with success.

FINAL REPORT OF THE MEETING

FINAL REPORT

The III Inter-American Meeting, at the Ministerial Level, on Foot-and-Mouth Disease and Zoonoses Control was held at the San Martín Theater in the city of Buenos Aires, Argentina, from 14 to 17 April 1970. The meeting was convened by the Director of the Pan American Sanitary Bureau pursuant to Resolution XIX [1] approved by the Directing Council of the Pan American Health Organization at its XVII Meeting, and Resolution XV [2] of the II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control.

OFFICERS

The heads of delegations met on 14 April to elect the officers of the meeting. The following were elected:

President:	Dr. Lorenzo A. Raggio, Secretary of State for Agriculture and Livestock (Argentina)
Vice-Presidents:	General Jorge Barandiarán Pagador Minister of Agriculture and Fisheries (Peru)
	Hon. Lionel M. Robinson Minister of Agriculture, Land and Fisheries (Trinidad and Tobago)

Dr. Abraham Horwitz, Director of the Pan American Sanitary Bureau, served as Secretary ex officio.

PARTICIPANTS

The following Governments were represented at the meeting: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, France, Guatemala, Guyana, Honduras, Jamaica, Mexico, Kingdom of the Netherlands, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, United Kingdom, United States of America, Uruguay, and Venezuela. The Government of Canada sent an official observer. Observers from the following international organizations were also present: Inter-American Development Bank, International Bank for Reconstruction and Development, United Nations Development Program, United Nations Children's Fund, Inter-American Institute of Agricultural Sciences, International Office of Epizootics, and Food and Agriculture Organization of the United Nations.

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[1] *Official Document PAHO* **82**, 74–76.
[2] *Scientific Publication PAHO* **196**, 16.

PLENARY SESSIONS

Dr. Abraham Horwitz, Director of the Pan American Sanitary Bureau, opened the meeting and in his address referred to the importance of the prevention and cure of animal diseases as a means of improving the food supply and nutrition of the peoples of the Americas. He stressed that one immediate consequence of the agreement concluded by the Ministers of Health [3] to establish a Nutrition Data Retrieval and Analysis Center would be to encourage the organization or expansion of the services devoted to the compilation and use of data relating to the agricultural policies of the Governments. Moreover, recognizing the need for specialists in the fields of agriculture and health to work closely together, the Organization proposed to establish at its Headquarters a department charged with coordinating all matters relating to those activities. Dr. Horwitz then reviewed briefly the agenda and stressed the importance of all the topics for the health and the economy of the countries.

Next, Dr. Lorenzo A. Raggio, Secretary of State for Agriculture and Livestock of Argentina, welcomed the participants and expressed the hope that the meeting would contribute to the solution of problems arising from the extraordinarily fast growth of the world demand for food. He extended his wishes for the success of the meeting and stressed the need to establish closer bonds of cooperation between the countries and the international organizations concerned with animal health problems in the Hemisphere.

At the first plenary session, Mr. Juan F. Yriart, Regional Representative for Latin America and Assistant Director-General of the Food and Agriculture Organization, spoke on "The Role of the Agricultural Sector," under the topic "Bases for a Food and Nutrition Policy in the Americas." He described the existing collaboration between his Organization and the Pan American Health Organization, which work together to improve the relationship between agricultural production and food and nutrition. He enumerated certain fundamental measures that could be adopted by the Governments of the countries to increase the production and supply of food, and strongly urged that a veritable crusade of human solidarity be launched to improve nutrition among the peoples.

Dr. Roberto Rueda-Williamson, Regional Adviser in Nutrition of the Pan American Sanitary Bureau, presented a paper on "The Responsibility of the Health Sector," as the second part of the above-mentioned topic. He drew attention to the seriousness and magnitude of malnutrition and other deficiency diseases in large groups of population in Latin America, and to their adverse effects on the economic and social development of the countries. He gave special emphasis to the need for multisectoral action—encompassing health, agriculture, and education plans—in order to formulate and implement a sound national food and nutrition policy in each country.

In connection with this topic, the Representative of Colombia presented a draft resolution on food availability and consumption indexes, and the Representative of Peru submitted another draft resolution on national food and nutrition policies.

At the second plenary session, Mr. Ildegar Pérez Segnini, Executive Director of the Inter-American Development Bank, referred to the Bank's activities in the agricultural and livestock sector of Latin America, and particularly to the

[3] *Official Document PAHO* **89**, 40.

importance of animal health to livestock development. He reviewed the financial assistance granted not only for foot-and-mouth disease control campaigns in Argentina, Chile, and Paraguay and for the preparation of similar campaigns in other countries, but also for programs against other zoonoses of economic and social importance such as brucellosis, rabies, hydatidosis, and tuberculosis. Lastly, he recommended that the countries draw up well-conceived animal health programs, which should be supported by suitable technical advice and take into account multinational aspects.

Following this address, the Representative of Paraguay expressed his country's appreciation for the aid it had received from the Inter-American Development Bank for the development of its foot-and-mouth disease control program, and presented a draft resolution requesting the Bank to help finance demonstration and training programs at the Pan American Foot-and-Mouth Disease Center. The Representative of Brazil also presented a draft resolution dealing with international cooperation in animal health programs.

The second part of this plenary session was devoted to country reports on the status of vesicular diseases and to the prevention and control activities under way. Following the order of registration of speakers, reports were submitted by the following participants and countries: Dr. Teodorico Terry Elejalde (Peru), Dr. Lautaro Gómez Ramos (Chile), Dr. Ezelino Arteche (Brazil), Dr. Gabriel Baraya (Colombia), Dr. José Luis Roca García (Bolivia), and Dr. Pablo T. Quinteno Pinzón (Panama).

The first speaker at the third plenary session (15 April) was Dr. Ramón Rodríguez, Head of the Department of International Affairs of the University of Chile, who presented the report of the Scientific Advisory Committee on the "Research Program of the Pan American Foot-and-Mouth Disease Center and the Pan American Zoonoses Center." He expressed the Committee's satisfaction at the progress made in the field of research, which had attained a truly academic level, and stressed that the activities of both Centers, adequately coordinated with the national universities, would be an important factor that would benefit the countries and the international organizations. He pointed out that both Centers are in a unique position to give research training in connection with animal health problems common to the Americas, and asserted that the activities carried out by the Centers cannot be substituted by individual action.

Following that statement, the Representative of Peru presented a draft resolution, which was unanimously approved.

Next, Dr. Enrique García Mata presented the "Report on Zoonoses Control as an Integral Part of Agriculture and Livestock Development and the Role of the Pan American Zoonoses Center," containing the findings of the study entrusted by PASB to the speaker, in conjunction with Drs. Juan T. Bowler and Rubén Lombardo, pursuant to Resolution VIII [4] of the II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control. He reviewed the current status of the principal animal diseases in the Americas, examined their economic effects, and summarized the views expressed during his interviews with Ministers and Government officials with reference to the most important problems in their respective countries and the advice and assistance they would like to receive from the Pan American Zoonoses Center. Finally,

[4] *Scientific Publication PAHO* **196**, 12–13.

he stressed the need for granting increased financial assistance to the Center in view of the growing demands made on it by the problem of animal diseases in the Americas.

The Representatives of Costa Rica, Paraguay, the United States of America, and Venezuela commended both the report and the Pan American Zoonoses Center on its work. The Representative of Colombia presented a draft resolution on the future programs and financing of the Center, which was adopted by 18 votes in favor, none against, and 3 abstentions.

During the second part of the session the draft resolutions presented at the second plenary session were put up for discussion and, there being no comments, were voted on and unanimously approved.

Dr. Mário Fernandes, Director of the Pan American Foot-and-Mouth Disease Center, then presented the proposed program and budget estimates for the Center for 1971 and the provisional drafts for 1972 and 1973. After various comments and explanations, the Representative of Brazil submitted a draft resolution, which was unanimously adopted.

At the fourth plenary session, in the absence of the President and of both Vice-Presidents, the Hon. Robert J. Jordan (Guyana) was elected Provisional President. The session was devoted to reports on the status of vesicular diseases and other zoonoses presented by the following Representatives: Mr. Rubén Espinosa R. (Ecuador), Hon. Robert J. Jordan (Guyana), Dr. Carlos H. Aguilar Avila (Honduras), Dr. Leonard V. Butcher (Trinidad and Tobago), Dr. Amador P. Nita (Kingdom of the Netherlands), Dr. Humberto Olmos (Venezuela), Dr. Cedric L. Bent (Jamaica), Dr. Nelson Magallanes Pastorino (Uruguay), Dr. Malcolm B. Proverbs (Barbados), Dr. José Luis Solano Astúa (Costa Rica), Mr. Ricardo R. Granada Pineda (El Salvador), Dr. Juan F. Urguizú Gutiérrez (Guatemala), Dr. Parisio Pineda Ayala (Paraguay), Dr. Gustavo Reta Pettersson (Mexico), Dr. Frank Mulhern (United States of America), Dr. Luis María Cuevas (Dominican Republic), Dr. Jorge Borsella (Argentina), Dr. John Reid (United Kingdom), Dr. Albert E. Lewis (Canada), and Dr. Louis R. Perpère (France).

After concluding his presentation, the Representative of the Kingdom of the Netherlands submitted a draft resolution on the cooperation rendered by the Food and Agriculture Organization of the United Nations (FAO), which was unanimously adopted.

The fifth plenary session (16 April) discussed the topic assigned to Panel A: "Vaccines for Foot-and-Mouth Disease Control."

Dr. Jacob G. van Bekkum, Director of the Amsterdam Central Veterinary Institute (Kingdom of the Netherlands), in presenting his paper on "Use and Experiences with Frenkel-Type Vaccine," referred to the excellent results obtained in his country with one yearly application of that vaccine to cattle, and the enforcement of strict supplementary animal health measures, including the slaughter of diseased or contaminated cattle. He stated that over 50 million vaccinations had been applied in his country since 1953, and that not a single outbreak of foot-and-mouth disease had been recorded in the past two years.

Dr. John B. Brooksby, Director, Animal Virus Research Institute of Pirbright (United Kingdom), then discussed the topic "Tissue Culture Vaccines (BHK) in Foot-and-Mouth Disease Control." He reviewed the advantages of cell

lines in virus cultures for the production of vaccines and drew attention to their importance when planning large-scale vaccination campaigns.

In presenting the third topic, "Study of Live Virus Vaccine against Foot-and-Mouth Disease," Dr. Carlos A. Palacios, Director of the Veterinary Research Center (Venezuela), summarized the history, results, and prospects of these types of vaccines, and referred particularly to the research work carried out in Venezuela and at the Pan American Foot-and-Mouth Disease Center.

The next speaker was Professor Manfred W. Mussgay, President, Federal Research Institute for Animal Virus Diseases of Tübingen (Federal Republic of Germany), who presented the topic "Accidents and Reactions Observed in Foot-and-Mouth Disease Vaccinations." In his concluding remarks he called attention to the fact that the studies made in the Federal Republic of Germany showed that allergic postvaccinatal reactions were infrequent; consequently, while such reactions can occasionally pose some problems, this should not be a deterrent to the use of the vaccines to control the disease, particularly in view of the fact that there are technical means available, if needed, to reduce those reactions.

Panel A discussions closed with the presentation by Dr. Jerry J. Callis, Director of the Plum Island Animal Disease Laboratory (United States of America), on "New Vaccines and Future Prospects in Foot-and-Mouth Disease Immunization." He emphasized the research under way to improve inactivated vaccines by testing new inactivants and adjuvants and by virus concentration and purification techniques. He also referred to the possibilities of interferon in controlling the disease.

A discussion followed during which questions, views, and information were exchanged by the Representatives of Argentina, Colombia, Jamaica, United Kingdom, United States of America, and Uruguay, at the end of which three draft resolutions were presented. All three resolutions—one presented by Chile on foot-and-mouth disease vaccines, and two presented by Venezuela on the strengthening of animal health services and application of health measures in the control of foot-and-mouth disease—were unanimously approved.

The sixth plenary session opened with a report on Cuba, presented by Dr. Pedro Roca. Following this, the meeting proceeded with the discussion of the topics assigned to Panel B: "Health Aspects of the Import and Export of Animals and Animal Products for Consumption," which included papers by Drs. José J. Cañón, Director of the Joint FAO/ECLA Agricultural Division; Fernando Quevedo, of the Pan American Zoonoses Center; Teodorico Terry Elejalde, Assistant Director for Animal Health, Ministry of Agriculture and Fisheries (Peru); H. Königshöfer, of the Food and Agriculture Organization of the United Nations (presented by Dr. Frank J. Peritz, Regional Veterinarian of FAO), and Ernest E. Saulmon, Director, Animal Health Division, Agricultural Research Service, Department of Agriculture (United States of America).

In his report on the "Present Status of the Production and Consumption of Animal Products in the Hemisphere and Prospects in the Next Ten Years," Dr. Cañón stressed the need for considering livestock problems with a broad outlook and for solving them through soundly conceived interdisciplinary action. During the presentation of the second topic, "Health Problems Involved in the Import and Export of Foodstuffs of Animal Origin," Dr. Quevedo called

attention to the need for Latin American countries to adopt measures at the hemispheric level and to standardize food control methods in order to increase their exports and meet the growing demands of importers with regard to quality.

In referring to "Disease Problems Associated with the Import and Export of Animal Products Intended for Consumption," Dr. Terry made some interesting remarks on the movement of cattle for consumption and recommended that multinational programs be carried out for the control of communicable and parasitic diseases.

Dr. Peritz presented the topic "Need for Uniform Animal Health Guidelines and Regulations Governing the Import and Export of Animals Intended for Consumption and Breeding," and Dr. Saulmon presented the paper entitled, "Present and Future Problems Associated with the Import and Export of Animals and Animal Products, and Their Effect on the Economic Development of Countries." Both speakers concurred on the need for joint efforts to exchange knowledge and attain goals that will be reflected in the economic development of the Hemisphere. The importance of the concepts contained in these papers led Dr. Carlos Ruíz Martínez, President-Counselor, National Council of Agricultural Research, International Office of Epizootics (OIE), to review the activities of that organization in the field of international legislation; he then called attention to the International Animal Health Code, and expressed his warmest congratulations to the Pan American Sanitary Bureau for its work in this field.

Next, Dr. Roberto Goic Martinic, Chief, Field Advisory Services, Pan American Foot-and-Mouth Disease Center, presented the topics "Epidemiological Surveillance of Foot-and-Mouth Disease" and "Reference Guide for Evaluation of Foot-and-Mouth Disease Control Programs." He stated that probably during the current year a definitive system of epidemiological surveillance of vesicular diseases would be established in the Americas, and that this Guide was a valuable contribution to the evaluation of the progress and results of foot-and-mouth disease prevention and control campaigns.

Finally, Dr. Boris Szyfres, Director of the Pan American Zoonoses Center, presented the topic, "Epidemiological Surveillance of Rabies." He reviewed the work carried out by the Center in this field and also drew attention to the need to increase the production of vaccines and exercise stricter quality control.

During this session, several draft resolutions were examined and unanimously approved.

At the seventh plenary session (17 April), the Minister of Agriculture and Fisheries of Peru, General Jorge Barandiarán Pagador, reported that in April 1971 the VI Meeting of Ministers of Agriculture of the Americas, sponsored by the Organization of American States, would be held in Lima. He would therefore be pleased if the Pan American Sanitary Bureau would consider the possibility of holding the IV Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control in that city. The Representative of Nicaragua supported the proposal and the Representative of Uruguay requested that it be approved by acclamation. However, the Technical Secretary of the Meeting, Dr. Pedro Acha, requested that the Pan American Sanitary Bureau be permitted to consult with the Organization of American States since the holding of two meetings of different organizations might create certain inconveniences.

The Final Report was then read and approved unanimously without change.

The Technical Secretary explained that the Director of the Bureau had had to return to Washington unexpectedly for reasons beyond his control and had requested him to greet the representatives on his behalf and to present his regrets for having to be absent from the closing session. Speaking for the Director, he expressed appreciation for the collaboration rendered by the consultants, as well as for the valuable participation of the Ministers and representatives, and requested that they send to the Headquarters of the Organization any and all suggestions they deemed necessary with reference to the meeting. Lastly, he especially thanked the Government of Argentina for its cooperation, which had made it possible to hold the discussions without difficulty and had led to their complete success.

The meeting was closed by General Barandiarán Pagador, who, on behalf of his country, thanked the representatives for having elected him Vice-President, and on behalf of all the representatives, thanked the Government of Argentina for their many courtesies. After praising the work of the Pan American Health Organization in behalf of the countries of the Hemisphere, he stated in closing: "The great significance of this meeting can be seen in the important topics selected for consideration, the valuable analysis made of the status of problems vital to the Hemisphere, and the resolutions adopted, based on a realistic approach to the activities that should be undertaken or accelerated in the field of animal health for the benefit of economic and social development of the countries."

RESOLUTIONS APPROVED

The following resolutions were approved in plenary sessions:

Resolution I

Vote of Thanks to the Scientific Advisory Committee

THE III INTER-AMERICAN MEETING,

Considering the importance of the scientific and technological activities of the Pan American Foot-and-Mouth Disease Center and the Pan American Zoonoses Center to the understanding and control of these diseases;

Bearing in mind the variety of functions and the skills of the professional staff of the Centers;

Having made a thorough appraisal of the report of the Scientific Advisory Committee on the work of the two Centers; and

Recognizing the excellent scientific qualifications of the members of the Committee,

RESOLVES:

1. To express its satisfaction with the comprehensive in-depth analysis contained in the report on the activities and achievements of the Centers.

2. To call attention to the recommendations for broader, more complex future

endeavors in research, technical assistance, and training in problems relating to these diseases.

3. To express its appreciation to the Scientific Advisory Committee for its efforts, as reflected in this annual analysis, and to support its recommendations.

(Approved at the third plenary session, 15 April 1970)

Resolution II

Program and Future Financing of the Pan American Zoonoses Center

THE III INTER-AMERICAN MEETING,

Having studied the Report on Zoonoses Control as an Integral Part of Agriculture and Livestock Development and the Role of the Pan American Zoonoses Center, which contains the results of a study requested in Resolution VIII of the II Inter-American Meeting;

Aware of the serious danger caused by the major zoonoses to human and animal health, as well as their harmful effect on economic growth and the development of the livestock industry;

Recognizing the essential role of the Pan American Zoonoses Center in education, research, and advisory services for the purpose of assisting the Governments in promoting, expanding, and improving national programs to control and prevent zoonoses;

Having taken note of the recommendations of the Scientific Advisory Committee of the Pan American Zoonoses Center concerning the need for expanding its activities to provide broader services for zoonoses control on a regional basis, which will require additional financial support from Governments and the United Nations Development Program;

Noting the favorable reception accorded the mission of Drs. Juan T. Bowler, Enrique García Mata, and Rubén Lombardo and the support expressed by the respective Ministries of Agriculture for continuing and expanding the work of the Center; and

Bearing in mind the importance to the future of the Center, as a regional project, of obtaining an extension of the support of the United Nations Development Program, as well as of providing increasing financial support within the regular budget,

RESOLVES:

1. To express appreciation to the members of the mission for their valuable services and excellent report.

2. To approve the program recommendations contained in the report, in which Governments are requested to give special attention to programs for control and prevention of brucellosis, rabies, bovine tuberculosis, and hydatidosis, as well as the recommendations on the activities of the Center in education, research, and advisory services.

3. To support a proposal to the United Nations Development Program for extension of financial assistance to the Center as a regional project and to request the Pan American Health Organization to collaborate with the Governments in the submission of the proposal.

4. To recommend to the XVIII Pan American Sanitary Conference that it approve an additional appropriation of $300,000 for 1971 to meet the requirements of the Center as presented in Document RICAZ3/14, in the understanding that the Ministries of Agriculture of the Governments of the Organization will increase their financial support in accordance with the scale of assessments.

(Approved at the third plenary session, 15 April 1970)

Resolution III

Food Availability and Consumption Indexes

THE III INTER-AMERICAN MEETING,

Taking into account that although food balance sheets constitute important over-all indicators of the food situation, many Latin American countries do not prepare them regularly, or these contain incomplete or inaccurate data;

Considering that the setting of goals for availability of food for human consumption will make it possible to give biological orientation to the plans for food production, imports, and exports; and

Considering that food consumption surveys carried out in different specific population groups, classified according to various criteria (geographic, socioeconomic, biodemographic), make it possible to determine the actual consumption of food by the population,

RESOLVES:

1. To recommend to the Governments that they make a special effort to prepare and publish the food balance sheets annually on the basis of reliable data, and to adjust future goals for availability of food for human consumption in accordance with the nutritional needs of the population.

2. To recommend to the Governments that they conduct periodic food and nutrition surveys in order to determine the magnitude and characteristics of the nutritional problems and food consumption levels in the different strata and specific groups of the population and to ascertain the progress made in the fields of food and nutrition in Latin American countries.

(Approved at the third plenary session, 15 April 1970)

Resolution IV

National Food and Nutrition Policies

THE III INTER-AMERICAN MEETING,

Considering that food and nutrition problems are widely prevalent in Latin America and have an adverse effect on health, education, agriculture, and the economy, thereby hindering the development of the countries;

Bearing in mind that food and nutrition problems are caused by a number of complex factors involving different sectors of economic and social development; and

Considering that food and nutrition programs call for the implementation of coordinated, simultaneous intersectoral plans responding to a definite food and nutrition policy,

RESOLVES:

1. To recommend to the Governments that they formulate and implement national food and nutrition policies, organizing for this purpose technical committees or groups at the national planning level, which would assume the responsibility of formulating, encouraging, coordinating, and evaluating the development of those policies.

2. To recommend to the countries that they include food and nutrition programs in their respective sectoral plans for agriculture, economy, health, and education.

3. To request the Pan American Sanitary Bureau, the Food and Agriculture Organization of the United Nations, and the United Nations Children's Fund to promote in all the countries of Latin America the formulation and development of national food and nutrition policies, to which end it is suggested that a standing committee of these organizations be established, which would formulate and coordinate the activities of the proposed plan.

(Approved at the third plenary session, 15 April 1970)

Resolution V

Assistance of the Inter-American Development Bank for the Pan American Foot-and-Mouth Disease Center

THE III INTER-AMERICAN MEETING,

Considering that the control of foot-and-mouth disease in South America depends on the correct application of the most efficient techniques for the manufacture, control, and application of vaccines;

Bearing in mind the increasing demand for specialized personnel to develop the foot-and-mouth disease control programs envisaged in the Hemisphere;

Recognizing the accelerated progress of foot-and-mouth disease control techniques and the need to put them into practice promptly;

Considering that the Pan American Foot-and-Mouth Disease Center operates as a regional reference, education, and training organization for the countries; and

Considering that with the Center's existing facilities and equipment it is not possible to develop techniques and methods for the production of various types of vaccines on a basis comparable to private industry, nor can their quality be controlled on a large scale,

RESOLVES:

To request the Inter-American Development Bank to supplement its firm support to the countries in their foot-and-mouth disease control programs by granting the Pan American Foot-and-Mouth Disease Center the financial assistance required to establish a demonstration unit for the control of foot-and-mouth disease. This unit would be devoted primarily to training personnel of the Hemisphere in industrial production of various types of vaccines and quality control systems; field methods of application of vaccines; and techniques for evaluating foot-and-mouth disease control programs.

(*Approved at the third plenary session, 15 April 1970*)

Resolution VI

International Cooperation in Animal Health Programs

THE III INTER-AMERICAN MEETING,

Recognizing that an essential function of international organizations in the health, economic, and agricultural fields is to achieve increased coordination and development of the animal health programs in the Hemisphere;

Aware of the importance and magnitude of foot-and-mouth disease control programs, for which financial assistance is made available by international credit institutions, particularly the Inter-American Development Bank;

Bearing in mind the wishes expressed by the representatives of Governments at this meeting, as set forth in the report of the Special Mission of PAHO (Document RICAZ3/14), that national zoonoses control programs be initiated, particularly for brucellosis, tuberculosis, and bovine rabies, with financial assistance from international credit agencies; and

Considering that this effort to promote animal health programs should be supported by the most efficient technical coordination at the multinational level,

RESOLVES:

1. To express its gratitude to the Inter-American Development Bank for the financial support it is granting to the countries to enable them to carry out their foot-and-mouth disease control campaigns, and for its decision to extend

this support to the control of other animal diseases such as those mentioned, which cause serious economic and social problems to the countries of the Hemisphere.

2. To recommend to countries which are in the planning stage of national campaigns against foot-and-mouth disease and other animal diseases that they consider the possibility of supplementing the financing of these campaigns by making use of the credit facilities afforded by the Inter-American Development Bank.

3. To request the Pan American Health Organization to prepare, as soon as possible, standard techniques applicable, at the multinational level, to the programs for the control of the principal zoonoses, particularly brucellosis.

4. To request the Pan American Health Organization and the Food and Agriculture Organization of the United Nations, as well as other regional organizations, to provide all possible technical assistance to the countries for the development and coordination of their campaigns against foot-and-mouth disease and other zoonoses.

(Approved at the third plenary session, 15 April 1970)

Resolution VII

Program and Budget Estimates of the Pan American Foot-and-Mouth Disease Center for 1971 and Provisional Draft for 1972

THE III INTER-AMERICAN MEETING,

Bearing in mind the serious and harmful repercussions of foot-and-mouth disease in the affected countries on nutrition, the livestock industry, and economic progress, and the constant threat to countries free of the disease;

Recognizing that the Pan American Foot-and-Mouth Disease Center plays an essential and effective role in the struggle to control and prevent the disease;

Having made a detailed study of the program and budget estimates for 1971 and the provisional draft for 1972;

Noting that the program continues along the lines approved but with increased emphasis on technical assistance and training in support of national programs for control and prevention;

Recognizing that the Scientific Advisory Committee pointed out that the quality of the proposed programs would make it possible to meet the expanded services requested by the countries, and recommended that these activities receive adequate financial support;

Noting further that the proposed budget increases are modest and that the major portion will be required to meet increasing costs,

RESOLVES:

1. To express its full support to the Pan American Foot-and-Mouth Disease Center and the program which it is carrying out.

2. To reaffirm the need for the Center to continue and increase its activities

to provide the Governments with personnel training and technical advisory services essential for the planning, execution, and coordination of national and regional programs for the prevention and control of foot-and-mouth disease.

3. To emphasize the importance of the Center's applied research programs on the laboratory and field aspects of foot-and-mouth disease and the significance of these programs to the technical assistance provided to the countries in order to achieve ultimate control and prevention of the disease.

4. To recommend to the XVIII Pan American Sanitary Conference that it give favorable consideration to the approval of the proposed program and budget estimates of the Center for 1971 as set forth in Document RICAZ3/7.

5. To recognize that the provisional draft of the program and budget estimates for 1972 include activities that are scientifically and operationally sound, which will make it possible to provide vital assistance to the countries, and that the draft will be subject to further study in 1971 by the IV Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control and by the Executive Committee and the Directing Council of the Pan American Health Organization.

(*Approved at the third plenary session*
15 April 1970)

Resolution VIII

Cooperation with the Food and Agriculture Organization of the United Nations

THE III INTER-AMERICAN MEETING,

Considering that the countries of Latin America are making special efforts to develop their livestock programs and to ensure the acceptability of their products in foreign markets; and

Considering that the Director-General of FAO has repeatedly demonstrated his interest in obtaining technical and scientific resources from outside the Region to strengthen the development of these programs,

RESOLVES:

To recommend to the Director of the Pan American Sanitary Bureau that he study the best possible means to take advantage of FAO's offer, which will benefit the countries in the Region.

(*Approved at the fourth plenary session*
15 April 1970)

Resolution IX

Foot-and-Mouth Disease Vaccines

THE III INTER-AMERICAN MEETING,

Considering that foot-and-mouth disease vaccines are fundamental and indispensable for the success of campaigns against the disease;

Realizing the great importance of research on new techniques for the production of vaccines and of the development of such techniques in order to obtain an increasingly effective product at a low cost;

Bearing in mind that, whatever the technique used in their production, foot-and-mouth disease vaccines are delicate biological products that require special care in their preservation until they are used; and

Emphasizing the need for and significance of using standardized biologicals for vaccine production and effective quality control,

RESOLVES:

1. To recommend to the Governments that they adopt the necessary measures to ensure that vaccine-producing laboratories are equipped with adequate facilities and properly trained personnel to guarantee the production of an effective vaccine.

2. To request the Pan American Foot-and-Mouth Disease Center to intensify its research work on the development of new techniques for the production and control of vaccines, and to cooperate with national laboratories or institutes engaged in research in this field.

3. To recommend to the countries that, as a fundamental element of their foot-and-mouth disease control programs, they establish official laboratories and services for controlling the production and efficacy of every batch of vaccine, as far as possible, including the distribution and application phases.

4. To request the Pan American Foot-and-Mouth Disease Center that, in collaboration with the Governments, it establish a commission for the preparation and adoption of standardized regulations and techniques for vaccine quality control that will be acceptable to animal health authorities of the Hemisphere.

(*Approved at the fifth plenary session, 15 April 1970*)

Resolution X

Strengthening of Animal Health Services

THE III INTER-AMERICAN MEETING,

Considering that foot-and-mouth disease and zoonoses control calls for the organization of veterinary medical services capable of making administrative decisions and taking action; and

Recognizing the need for strengthening official animal health services in order to place them on a level compatible with such responsibility,

RESOLVES:

1. To recommend to the countries that they give to the animal health services of their respective Ministries of Agriculture the hierarchical position commensurate with the importance of the problems under their responsibility.

2. To recommend furthermore that such services be provided with the

stability, adequate financing, and administrative flexibility necessary for the efficient development of programs of prevention and control of foot-and-mouth disease and other animal diseases.

(*Approved at the fifth plenary session, 16 April 1970*)

Resolution XI

Application of Health Measures in the Control of Foot-and-Mouth Disease

THE III INTER-AMERICAN MEETING,

Considering that foot-and-mouth disease control programs are at varying stages of development in most countries of South America and in the preparatory phase in others;

Bearing in mind the need for obtaining a high degree of immunity in the animal population exposed to risk of the disease;

Recognizing that the success of the programs depends not only on systematic vaccination of the animals but also on the strict and proper application of animal health control measures; and

Bearing in mind that health problems are common in some border areas and can extend into other areas,

RESOLVES:

1. To recommend to the Governments that during each stage of vaccination against foot-and-mouth disease they endeavor to immunize as many animals as possible.
2. To recommend to the Governments that they establish supervision systems that will enable them to suitably check vaccinations made by private persons or by personnel employed in the official program.
3. To recommend to the foot-and-mouth disease control authorities that they intensify the enforcement of animal health control measures designed to prevent the spread of the disease.
4. To request the countries to coordinate their foot-and-mouth disease control programs in border areas, with the cooperation of the Pan American Health Organization, through the Pan American Foot-and-Mouth Disease Center.

(*Approved at the fifth plenary session, 16 April 1970*)

Resolution XII

International Trade in Animals and Animal Products

THE III INTER-AMERICAN MEETING,

Bearing in mind that international trade in animals and animal products for human consumption is an economic factor of major importance to the countries of the Americas;

Considering the increase in intraregional and interregional trade in animals and animal products resulting from the expansion of livestock development programs;

Recognizing that foot-and-mouth disease and other zoonoses are an obstacle to the development of such trade;

Considering the need for having uniform standards and criteria for health regulations in the different countries, in order to facilitate the solution of problems relating to international trade; and

Bearing in mind that the Regional Technical Animal Health Commission (Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay) and the International Regional Organization for Health in Agriculture and Livestock (Panama, the Central American countries, and Mexico) have already taken steps to standardize import and export regulations,

RESOLVES:

1. To recommend to the Governments that they intensify their efforts to achieve the standardization and coordination of rules, regulations, and control procedures for the import and export of animals and animal products.

2. To request the Pan American Health Organization, through the Pan American Zoonoses Center and the Pan American Foot-and-Mouth Disease Center, to promote international coordination in this field, with the cooperation of the United Nations Food and Agriculture Organization and the regional animal health organizations, by providing personnel training and technical assistance to the countries.

3. To recommend to the Governments that they support and sponsor periodic meetings of animal health authorities, for the purpose of making a constant review and evaluation of health problems that affect intraregional and interregional trade in animals and animal products. For these meetings, it would be advisable to have the participation of the agencies of the Latin American Common Market.

(Approved at the sixth plenary session, 16 April 1970)

Resolution XIII

Food Hygiene

THE III INTER-AMERICAN MEETING,

Realizing that contaminated food products of animal origin cause serious health problems in the Hemisphere resulting in an unfavorable effect on protein sources in a region where protein deficiencies already constitute a major concern;

Considering the importance of intra- and interregional trade in food of animal origin, and the need to facilitate it through the use of standard procedures and techniques that permit adequate control of such foods;

Bearing in mind the increasing importance and requirements of health regula-

tions in the countries relative to international commerce in animals and animal products for human consumption; and

Considering that for the organization of efficient food control services it is necessary to have adequate numbers of specialized professionals in microbiology, food technology, and hygiene,

RESOLVES:

1. To recommend to the Pan American Health Organization that it promote the coordination of activities developed by the national agencies in the field of food control, with a view to establishing uniform criteria for control applicable to the domestic and international food commerce.

2. To recommend to the countries that they prepare and enforce codes of sanitary procedures governing the production, processing, storage, transportation, and distribution of food.

3. To request the Pan American Zoonoses Center that, as part of its expanded program, it include gradual increases in advisory services to the countries and the training of professional personnel in the fields of microbiology and food hygiene.

4. To recommend to the universities and other scientific centers of the countries of the Hemisphere that they increase their food science training programs for personnel at all levels.

(*Approved at the sixth plenary session, 16 April 1970*)

Resolution XIV

Epidemiological Surveillance of Foot-and-Mouth Disease

THE III INTER-AMERICAN MEETING,

Considering the report presented by the Pan American Foot-and-Mouth Disease Center (Document RICAZ3/17) on the activities carried out in the inter-American epidemiological surveillance program for foot-and-mouth disease that is being implemented pursuant to Resolution I [5] of the II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control;

Bearing in mind that the success of this program will depend largely on the cooperation it receives from the governmental organizations responsible for obtaining the information and promptly submitting it to the Center for compilation and subsequent distribution; and

Recognizing that it is necessary to have the highest degree of cooperation between the countries and the Center in reporting the cases of the disease in order to obtain the information that will permit the control and prevention of foot-and-mouth disease in the Hemisphere,

RESOLVES:

1. To request the Pan American Foot-and-Mouth Disease Center to intensify its activities for improving the inter-American system of epidemiological surveillance of foot-and-mouth disease.

[5] *Scientific Publication PAHO* **196**, 8.

2. To recommend to the countries that they establish a reporting and statistical service as part of their foot-and-mouth disease control programs, with a view to extending it to all animal health activities.

3. To recommend to the countries that they give their strongest possible support to the development of those services to enable the most rapid collection, analysis, and distribution of the basic information required for the epidemiological surveillance of foot-and-mouth disease.

4. To request the Pan American Foot-and-Mouth Disease Center to consider, among its future activities, the possibility of holding a meeting of specialists in animal disease reporting to examine the methods currently used and the progress being made in foot-and-mouth disease control.

(Approved at the sixth plenary session, 16 April 1970)

Resolution XV

Reference Guide for Evaluating Foot-and-Mouth Disease Control Programs

THE III INTER-AMERICAN MEETING,

Having considered the "Reference Guide for Evaluating Foot-and-Mouth Disease Control Programs" (Document RICAZ3/15), prepared by the Pan American Foot-and-Mouth Disease Center pursuant to Resolution XIII [6] of the II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control; and

Bearing in mind that the Guide contains the basis for evaluating the development and results obtained in foot-and-mouth disease campaigns and the measures that are indispensable for the planning of future activities in the control of this disease, at both the national and multinational levels,

RESOLVES:

1. To recommend to the countries that they establish an evaluation unit as soon as possible within the structure of their national foot-and-mouth disease control services, and that this unit apply the procedures and indicators outlined in the above-mentioned Guide.

2. To recommend to the Pan American Foot-and-Mouth Disease Center that it organize a meeting of the officials responsible for the evaluation units cited above for the purpose of reviewing and analyzing the results of experience obtained in applying the Reference Guide.

(Approved at the sixth plenary session, 16 April 1970)

[6] *Ibid.*, pp. 15–16.

Resolution XVI

Epidemiological Surveillance of Rabies

THE III INTER-AMERICAN MEETING,

Considering the report presented by the Pan American Zoonoses Center on the operation of an epidemiological surveillance service for rabies in the Americas pursuant to Resolution VII [7] of the II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control;

Recognizing that this report contains up-to-date epidemiological information on rabies which is indispensable for carrying out efficient programs for the prevention and control of the disease;

Bearing in mind the economic importance of bovine rabies and the need for having available as much epidemiological information as possible in order to determine more precisely the magnitude of the losses and to promote a better development and evaluation of control programs;

Realizing that it is necessary to improve case-reporting systems and the collection and shipment of samples to laboratories, and to have a larger number of diagnostic laboratories located in strategic areas of the affected countries; and

Bearing in mind that in various countries the cases reported include both those diagnosed clinically and those diagnosed by laboratory methods only,

RESOLVES:

1. To express its satisfaction at the establishment by the Pan American Zoonoses Center of an epidemiological rabies surveillance service for the Americas, recognizing its usefulness for rabies control programs, both in the field and in the laboratory.

2. To recommend to all the Governments of the Americas that they participate in this important disease-reporting system by forwarding rabies information regularly to the Pan American Zoonoses Center.

3. To recommend the installation, expansion, or improvement of laboratories for diagnosing rabies, according to the needs of each country.

4. To recommend to the countries that they improve their rabies-reporting system, including the collection and shipment of samples to laboratories.

5. To request the countries to report all cases of bovine rabies whether diagnosed clinically or by laboratory methods.

6. To recommend that the Pan American Zoonoses Center continue and expand its service of epidemiological surveillance of rabies, and examine periodically its development and gradual improvement with the Governments.

(Approved at the sixth plenary session, 16 April 1970)

[7] *Ibid.*, p. 12.

Resolution XVII

Control of Vaccines against Bovine Rabies

THE III INTER-AMERICAN MEETING,

Bearing in mind that vaccination against bovine rabies is an essential weapon in the fight against the disease and that its value depends on the quality of the vaccine used;

Recognizing the desirability of standardizing the methods of quality control for rabies vaccine used in various countries, and for improving and coordinating research in methods used in field and laboratory tests; and

Considering the need to submit each batch of vaccine for examination by official control methods for potency, innocuity, and purity, according to standard requirements,

RESOLVES:

1. To recommend that the countries establish a systematic method of control over vaccines against bovine rabies, both domestic and imported, adopting the necessary measures so that the official control services will have an adequate supply of trained personnel, equipment, and resources to control these examinations.

2. To request that the Pan American Zoonoses Center, in addition to providing training, reference services, and biologicals through its expanding programs, cooperate with the countries in the verification and periodic standardization of laboratory tests for the control of vaccines against bovine rabies as well as in evaluating the efficacy of the vaccine under field conditions.

(*Approved at the sixth plenary session, 16 April 1970*)

Resolution XVIII

Education and Training

THE III INTER-AMERICAN MEETING,

Considering the interest shown by the Governments in the development and conduct of campaigns against foot-and-mouth disease, brucellosis, tuberculosis, bovine rabies, and other zoonoses;

Bearing in mind that the implementation and development of such campaigns entail heavy investments by the Governments and the international credit organizations, as well as the support and backing of technical and administrative structures that will permit the effective control of these diseases; and

Recognizing the need to increase the number of trained professional personnel required for the various stages of the implementation of animal health programs in the Americas,

RESOLVES:

1. To recommend to the countries that they intensify the training of personnel at all levels to assure the successful development of animal health campaigns.

2. To request the Pan American Health Organization to consider the possibility of increasing its cooperation with the countries in the training of veterinarians in the planning, administration, and evaluation of animal health programs.

(*Approved at the sixth plenary session, 16 April 1970*)

Resolution XIX

Equine Encephalomyelitis

THE III INTER-AMERICAN MEETING,

Considering that the reports presented by the representatives of several countries reveal the frequent appearance of cases of equine encephalomyelitis;

Recognizing that the disease has spread to various countries of Central and South America and has caused fatal cases among human beings; and

Bearing in mind that epizootic outbreaks among horses can cause extremely high losses,

RESOLVES:

To recommend to the Pan American Health Organization that it appoint a working party to examine this problem, consider possible solutions, and propose action to be taken.

(*Approved at the sixth plenary session, 16 April 1970*)

Resolution XX

Technical Assistance in Equine Encephalomyelitis and Vesicular Stomatitis

THE III INTER-AMERICAN MEETING,

Considering that the zoonoses cause serious economic losses in important geographic areas, with serious risks of spread of the disease and public health hazards, such as occur in the case of equine encephalomyelitis;

Bearing in mind that in addition to causing economic losses, other diseases interfere with the development of control and eradication programs for foot-and-mouth disease, thereby hindering the detection of the disease, such as occurs with vesicular stomatitis,

RESOLVES:

To request the Pan American Foot-and-Mouth Disease Center and the Pan American Zoonoses Center, in close cooperation with other international agencies, to provide technical assistance to the affected countries in order to study essential aspects such as epidemiology, vector identification, and reservoirs, and carry out vaccine production for the control and/or eradication of the above-mentioned diseases.

(*Approved at the sixth plenary session, 16 April 1970*)

Resolution XXI

Vote of Thanks to the Government of Argentina

THE III INTER-AMERICAN MEETING,

Bearing in mind the wholehearted collaboration of the Government of Argentina in the holding of the present meeting, and the generous support and active participation of that Government in its organization, which contributed in great measure to the successful outcome of its deliberations,

RESOLVES:

To express its thanks to the Government of Argentina for its cooperation in the conduct of this III Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control.

(*Approved at the sixth plenary session, 16 April 1970*)

PART I

BASES FOR A FOOD AND NUTRITION POLICY IN THE AMERICAS

PARTICIPATION OF THE AGRICULTURAL SECTOR

MR. JUAN F. YRIART *

I wish first to extend to the delegates the warmest greetings from the Director-General of FAO, Mr. Addeke H. Boerma, and his best wishes for the success of this meeting.

I would also like briefly to explain my own presence at the meeting. The Pan American Health Organization and FAO have always maintained close relations to ensure that both are duly informed of each other's activities in the field of animal health in Latin America. These relations have been strengthened and coordinated during recent months. I had the honor of joining FAO at an opportune time and have been able to work closely with the Director-General in strengthening our links with the institutions of the Inter-American System to effect closer coordination and collaboration or joint action in activities of common interest to all of us.

As far as cooperation with the Pan American Foot-and-Mouth Disease and Zoonoses Centers is concerned, a number of personal contacts have taken place between the Directors as well as the technicians of the two Organizations to coordinate our activities and determine the most efficient manner for FAO to attract resources from outside the Hemisphere to support PAHO projects in these fields. I believe that I can say, without fear of contradiction, that we are reaching a level of consultation and coordination that is nearly free from duplication and overlapping of effort, and instead we are seeing complementary action and mutual support.

Livestock Development in Latin America

Before dealing with the subject of food and nutrition I would like to define our Organization's interest in livestock problems, in relation to which the control of foot-and-mouth disease and other zoonoses is a principal consideration.

FAO, with the goodwill of the Governments, is concentrating its efforts within five areas of action: development of high-yielding varieties of basic food crops; filling the protein gap; war on waste; mobilization of human resources for rural development; and improving the foreign exchange situation.

Livestock merits a high priority in our Latin American programs, and in particular as it relates to these areas of concentration. The protein deficit and the war on waste are especially relevant in our livestock programs. The losses we suffer from epizootics, for example, not only constitute waste of food for domestic consumption, but also represent a loss to the foreign trade sector of many countries.

The FAO Regional Office for Latin America has adopted a new working pattern in order to more effectively assist the Governments in the multidisciplinary study of livestock development problems. In the integrated and global approach, now em-

* Assistant Director-General of the Food and Agriculture Organization of the United Nations, Regional Representative for Latin America.

ployed, problems of animal production and health, marketing, financing, international commerce, etc., can be effectively dealt with at the request of, and in cooperation with, the various Governments so as to help them formulate their livestock policies and to define their needs for technical and financial assistance.

I would also like to remind you that in August 1970 here in Buenos Aires, we shall hold the Second *Ad Hoc* Consultation on Meat and Poultry within the framework of our Committee on Commodity Problems. As in the case of the First Consultation held at our Headquarters in 1969, the problem of international markets will be analyzed with a view to considering possible mechanisms which FAO could establish to collaborate with Governments in regulating the trade in meat.

Livestock Production and Food and Nutrition Policies

The subject of meat production links us closely with the work of PAHO in striving to improve the relationship between food and nutrition in the various countries. During this last year a new link has been forged between our two Organizations for that purpose.

In accordance with FAO's Constitution, the programming of livestock production must take into consideration the food and nutrition requirements of mankind. Conversely, we cannot consider the needs for food and nutrition without also taking into consideration the programming of livestock production. The interest that PAHO has in the problems of livestock production, given its responsibilities in the field of food and nutrition, is the link that unites us. I believe that the meeting we held in 1969 at the expert level, and which UNICEF and ECLA also attended, fully demonstrated the new spirit of collaboration between PAHO and FAO. This also explains why the Director of PASB wished to draw to your attention the topic "Bases for a Food and Nutrition Policy in the Americas," and why he has honored me by asking me to place this subject before you. The attention we shall give to these problems during the coming days will be one more step in a program of action which we shall follow up with subregional meetings to consider food and nutrition policies for groups of countries.

I should like to add that I have been associated with the Pan American Foot-and-Mouth Disease and Zoonoses Centers since their establishment, and it has always been a source of satisfaction for me to work with institutions of the Inter-American System. This, and the affectionate respect I have held for Dr. Horwitz, arouses deep feelings as I now consider the responsibilities facing me in working toward strengthening the cooperation between our two Organizations in order to offer to the Governments and their peoples effective assistance in solving some of their more pressing problems.

Latin America is facing serious and profound problems which can, and do, affect the biological picture of its human resources. These are demonstrated by the high rate of infant mortality and morbidity, attributable in great part to the prevalence and incidence of undernourishment and malnutrition throughout vast sectors of the population. This is particularly apparent in those zones characterized by high demographic growth and low economic development and has direct repercussions on human production capacity, with a consequent increase of social and political tensions.

If careful note is taken of the future food requirements of Latin America, in the light of the rates of economic development and population growth, it is readily apparent

that a most difficult period lies ahead. This impending crisis can be avoided only if urgent and adequate measures are promptly taken in the sectors of production, marketing, and consumption of foodstuffs. These measures should be embodied in an integrated policy which, on a short-term basis, would overcome the more acute phases of the problem, without losing sight of the longer-term necessity of integrating the food and nutrition objectives at the governmental decision-making levels and in the national plans for social and economic development.

In this brief analysis of the nutrition problems facing Latin America, it is also necessary to comment on the current demographic situation in order to more effectively analyze and evaluate the urgent continental problems relating to the supply and consumption of foodstuffs. This is a prerequisite for policy formulations.

Food and Demographic Growth

As you undoubtedly know, in Latin America there are more than two hectares of farmland available for each person, whereas in Europe the figure is 1.3 hectares and in Asia only 0.4. In addition, Latin America possesses great areas of undeveloped but potentially productive lands. Unfortunately, this otherwise favorable situation is offset by the low productivity of both the land and agricultural labor. This is readily illustrated by the statistics of agricultural production using wheat as an indicator. In Latin America approximately 350 kilograms of wheat are produced per hectare, whereas in the United States 880 kg are produced. As to productivity per capita, we find the gap between the regions even greater: the figure is 300 per cent higher in the United States than in Latin America. Such is the situation in which Latin American agriculture finds itself. During the decade of the '60s, over-all production in Latin America has grown at a cumulative annual rate of 2.2 per cent per capita, which is considerably below the 4 per cent level considered as optimum for agricultural policy and proposed for the Region.

The accelerated rate of population growth in Latin America, the highest of any region in the world, makes this picture even more bleak. As a result of a combination of high birth rates and declining mortality rates, it now amounts to 3 per cent per annum. At this rate the population will be doubled within the next 20 years.

As a consequence of the prevailing low agricultural productivity and accelerated demographic growth, the availability of foodstuffs within the Region as a whole can at best be considered as barely adequate in both quantity and quality. This is so notwithstanding the abundance of natural resources. Of the two, the qualitative situation is more critical than the quantitative. For example, whereas the current supply of calories is 20 per cent above its pre-war level, the supply of animal proteins has declined by a like amount.

Thus, given the demographic forecasts for Latin America during the next 30 years, it will be necessary to double the total supply of foodstuffs and nearly triple the production of animal proteins in order to satisfy the projected demand and attain adequate nutritional targets.

This calls for bold efforts in reorienting and reorganizing livestock and fish production. Changes and innovations that will improve the productivity of agricultural resources are essential. More rational use must be made of the land, taking advantage of the current advances in science and technology. All this must be done within cohesive and comprehensive food and nutri-

tion policies and should be included in the general development plans.

Analysis and Evaluation of the Current Latin American Position in the Light of the Establishment of National Policies for Food and Nutrition

At the Eighth FAO Regional Conference (Viña del Mar, Chile, 1965), where the basic principles of agricultural development were reviewed, the consensus was that the primary objective of livestock programs should be to satisfy the nutritional requirements of the various sectors of the population. Nevertheless, this objective has not been realized so far and even as a policy does not appear to be included in the agricultural programming in the Region. Therefore, I believe it expedient to present some ideas and points of view dealing with the aims and objectives that such policies should attain during the next few years.

1) The majority of Latin American countries have prepared sectoral plans for the development of agriculture as integral parts of national development plans but without, unfortunately, giving nutrition objectives the priority they deserve. Consequently, the opportunity exists to reconsider this aspect and formulate lines of action that will increase the quantity and improve the quality of food for human consumption and result in a more satisfactory intake of energy-giving and protective foods.

2) At a time when policies and plans for agrarian reform and land settlement are being promoted, food and nutrition considerations should be included in their technical programs to ensure an improvement in the productive capacity of the beneficiaries.

3) Given the inflationary process existing in many countries of the Region, as well as the levels of economic development, Governments should take strict measures to avoid a deterioration of the relationships between food prices and personal income, and also between food prices and other commodity prices, with the object of allowing for an adequate as well as a more balanced diet. The price relationships of energy-giving and protective foods should be given special attention in order to encourage more balanced and adequate diets and thus better enable the individual to develop to his full mental and physical potential.

4) It is estimated that approximately 25 per cent of the economically active population in Latin America is unemployed, and that hardly 25 per cent of the land classified as suitable for the production of foodstuffs is under cultivation. Furthermore, it is also known that manufacturing installations are worked at about half of their capacities. From this we can conclude that the resources, both human and physical, are available which could be used for development and the elimination of undernourishment among our peoples. It is thus obvious that not only are there economic, social, and human justifications for our winning the food and nutrition battle within the Region, but we also have the potential resources with which to do so.

5) One of the most effective means of increasing the availability of foodstuffs is the application of new concepts and technology. This will not only help to decrease high losses of foodstuffs, which in some countries amount to 30 per cent of total production, but will also create reserves that can be used for the enhancement of nutritional value, improved marketing and price policies, and better distribution. At the same time, foreign trade policies should be carefully reviewed to ensure that imports benefit the population's nutritional status

and that exports do not drain the country of highly nutritious foods.

Thus, because of the prevailing conditions in Latin America, it is urgent that cohesive interdisciplinary policies and actions be formulated to cope with the situation. That is to say, it is essential to establish rational food and nutrition policies that will serve the needs of all strata of society.

The aforementioned technical meeting of FAO and PAHO, held in May 1969 with the participation of UNICEF and ECLA, was called for the purpose of establishing guidelines for the formulation and execution of food and nutrition policies in the Latin American countries. After considerable deliberation and a discussion of governmental measures connected with selective production of foods, marketing, and consumer guidance, as well as the technical and institutional aspects of the problem, the meeting agreed to define food and nutrition policy as a complex of measures that would contribute to the optimum nutritional status of the whole population through an adequate supply of food and accompanied by induced changes in consumption patterns. Such a policy should be included as an integral part of the national social and economic development plans, and should be executed by means of coordinated sectoral programs.*

We are thus able to see the manner in which food and nutrition policy at the national and regional levels is closely tied in with the general problem of underdevelopment, and that the effectiveness of such policies is dependent upon the degree to which the structural causes of underdevelopment and the low efficiency in the production of foodstuffs are dealt with.

Consequently, we can also see the necessity of reviewing and developing some fundamental measures that can be put into action by the Governments of Latin America to expand the production and the supply of foodstuffs. In this manner, the planning process involves not only the formulation of plans but also putting them into action.

Among the measures to be taken into consideration are the following:

- Economic and social stimulus for the processing and marketing of foodstuffs in order to ensure their widest possible distribution, and when necessary use of price controls to safeguard the interests of the lower-income groups; promotion of a desirable balance of trade between exported and imported foodstuffs; and recourse to tax and price incentives when necessary.
- Investments and the financing of programs related to the extension of industrial and agricultural credits and the creation of social infrastructure for the production, marketing, and distribution of foodstuffs.
- Application of technology for the reorientation of livestock and fishery research and their respective extension services; particular attention should be given to the study and promotion of those foodstuffs nutritionally important in habitual diets.

Such measures, within national food and nutrition policies, will facilitate the production and distribution of a more adequate supply of foodstuffs. Nevertheless, the picture would be incomplete unless, at the same time, food consumption targets were also fixed. In order to do this, it is necessary to take into account demographic patterns and increases; recommended daily intake per person for each group of foods; data from surveys of food consumption and dietary habits; and available supplies of energy-producing and protein foodstuffs, both animal and vegetable. On the basis

* *Elements of a Food and Nutrition Policy in Latin America.* Scientific Publication PAHO 194. Washington, D. C., 1970.

of such studies, a comparison can be made between the data on availability of foods and the findings of food consumption surveys in the different socioeconomic groups, in order to determine whether there is a sufficiency, an oversupply, or a deficit of the various types of foods, at both the national and the zone levels.

Targets in regard to the availability and consumption of foodstuffs, which must serve as the basis of any food and nutrition policy, are dependent on the following variables:

a) Production and consumption trends for foodstuffs and the forecasts over a given number of years.

b) Forecasts of demographic growth as well as distribution of population and variations in family size.

c) Forecasts of income growth and its relation to the consumption of foodstuffs.

d) Relationships of prices within the different groups of foodstuffs and between these and other consumer goods.

The methodology to be employed in this type of analysis is that in common usage in general planning activities and thus is the direct responsibility of the national planning offices. In order to assure a balance in the planning process, close cooperation must exist between the nutrition specialists and those charged with planning national livestock development. Executing the plan will involve decisions being made at the governmental level, which will be embodied in specific projects with adequate financing.

The private sector, with its potential resources of capital, organization, and productive capacity, also has an important role and should be involved in this process. The fulfillment of the aims and objectives set within a food and nutrition policy requires a minimum technical and administrative structure staffed by specialized and well-trained personnel in the field of human nutrition and closely associated with the national planning agency. At the same time, it is necessary to strengthen the food and nutrition units in the principal executive agencies that are directly involved in this field, particularly those in the ministries of health, agriculture, and education. Although significant advances along these lines have been made, the efforts have been unisectoral and much remains to be done to complete this essential infrastructure in most of our ministries of agriculture and education. FAO is keenly interested in offering technical assistance to the Latin American Governments to aid them in implementing these vital projects.

I may have gone into too much detail in analyzing some of the factors involved in the establishment of food and nutrition policies in Latin America. Nevertheless, my interest is to demonstrate the need to approach the problem in a planned, coordinated, and interdisciplinary manner. This is the only sure way of ensuring concrete action to cope with the problems of the supply and consumption of foodstuffs. This is imperative in both nutritional and human terms; for mankind's betterment is the purpose of all our activities and we accept the fact that all share the birthright of an adequate and balanced diet. I firmly believe that our Governments, together with public and private organizations, should give overriding importance to the achievement of this goal.

Food and Nutrition Policy in the Decade of the '70s

I do not believe I am mistaken in forecasting that during the seventies, at the decision-making levels of the Latin American Governments and among the various socioeconomic bodies, high priority will be

given to the struggle against undernourishment and malnutrition as an integral element of the social and economic development programs. During the decade that has just ended, FAO, through the Freedom from Hunger Campaign, as well as the Pan American Health Organization, the World Health Organization and others, have already provided a strong stimulus in this direction. Now we must consolidate our efforts, mobilizing national and international resources to integrate food and nutrition objectives into the development plans in order to effect a more rational employment of all the factors destined to achieve that end.

In order to contribute to the attainment of this objective, FAO and PAHO, in association with the Argentine Government, plan to set up a Nutrition Data Retrieval and Analysis Center for Latin America. The role of the Center will be to:

1) Collect, analyze, and interpret data relating to the availability of food and the nutritional status of the population.

2) Offer advice to Governments on the formulation of food and nutrition policy.

3) Develop effective methodologies and procedures, and train various categories of national personnel to execute food and nutrition programs suited to national, subregional, and regional conditions.

We also hope to continue to hold Latin American meetings on food and nutrition policies with the cooperation of UNICEF and the participation of ECLA, so that those directly concerned with agriculture, health, education, economics, and planning may benefit from a mutual exchange of ideas and experiences in this wide field and develop adequate policies for the future.

Before closing I would like to appeal to all the Governments of Latin America, and in particular to those present here at this meeting, to unite in the undertaking of a crusade for the attainment of higher levels of food and nutrition for our peoples; a crusade that will enable us to more fully appreciate the present and future needs of our fellowmen as they relate to a modern society wherein a minimum of well-being and the basic necessities of food, health, nd productive work are assured. In such a community can a spirit of humanism operate alongside and together with science and technology for the well-being of the individual and the community as a whole.

THE RESPONSIBILITY OF THE HEALTH SECTOR IN PLANNING AND CONDUCTING NATIONAL FOOD AND NUTRITION POLICIES

DR. ROBERTO RUEDA-WILLIAMSON *

Malnutrition and Social and Economic Development

Although malnutrition and other deficiency diseases have been very prevalent in large segments of the population in Latin America for several centuries, it is only in the last 10 years that international agencies and the Governments have become fully aware of the size and importance of nutrition problems. Thus, the Declaration of the Presidents of the Americas, signed at Punta del Este, Uruguay, in 1967, stated that one of the goals of the continental policy of economic and social development would be the improvement of the nutritional conditions of the population.

To bring out the importance of this Declaration some preliminary considerations are in order concerning the obstacles that nutrition problems put in the way of the economic and social progress of developing and industrializing countries.

Many studies have shown that there is a direct correlation between substandard nutritional status in the individual and his low resistance to disease. Protein-calorie malnutrition in children completely changes their defense mechanisms, the result being that malnourished infants are not only more frequently attacked by infectious disease but are also more subject to complications or secondary diseases, and their convalescence is more prolonged. This explains why protein-calorie malnutrition in children is coupled with high mortality and morbidity, especially in those under 5 years of age. They are a very vulnerable group because of their high nutritional needs stemming from their rapid growth and the key periods of nutritional and environmental adaptation through which they are passing.

It is therefore not surprising that vital statistics in the Region show that mortality in children under one year of age is five to 10 times higher than it is in developed countries; and that mortality in the 1-4 years group, which is most directly related to protein-calorie malnutrition, is 10 to 30 times higher than in the industrialized countries. Furthermore, preliminary data from the Inter-American Investigation of Mortality in Childhood, sponsored by PAHO, show that in a great many instances protein-calorie malnutrition is the underlying or associated cause of death in children under 5 years of age, even though death certificates do not explicitly say so.

However, these figures do not fully express the seriousness of the nutrition problem in Latin America. From the standpoint of the educational and economic development of the countries of the Region, the grave consequences of malnutrition in the children who survive its harmful effects are perhaps its most serious aspect. It has been

* Regional Adviser in Nutrition, Pan American Sanitary Bureau.

shown that malnutrition in children is essentially characterized by a lag in the normal processes of physical growth and development, frequently coupled with mental retardation. The malnourished child ceases to grow normally because he lacks the essential raw materials for the formation of his tissues; he is inactive, tires easily, and manifests changes in his psyche, becoming irritable and apathetic. The malnourished child does badly in school, is less receptive to teaching, and makes less progress than well-fed children who pay greater attention to the teacher. There is good reason to believe that malnutrition is in part responsible for poor scholastic performance in underdeveloped countries.

Finally, nutritional status has a specific effect on the capacity of the individual for physical work, both with respect to its duration and its intensity. The human organism is frequently compared to a machine that needs fuel and continuing repair of its tissues and organs to ensure that it functions correctly; however, that fact is even more frequently forgotten. The association between nutrition and health, on the one hand, and work, on the other, is not a new idea; but only in recent years have serious observations been made confirming that undoubted correlation. In Germany, Indochina, Costa Rica, and other countries studies of miners and agricultural and construction workers have shown that it is possible to achieve a significant increase in the output of workers and in productivity rates by adding to their deficient diet the calories and nutrients necessary to make it balanced and adequate in terms of their age, the climate in which they live, and the activity they perform.

If to these observations we add the synergistic relationship between malnutrition and infection, which results in a higher prevalence of diseases in malnourished populations and thus in the loss of thousands of hours of work due to illness, the impact of malnutrition and illness on productivity rates in a country and consequently on its economy is even more obvious. A recent study on health manpower in Colombia, made by the Association of Medical Schools, in cooperation with the Ministry of Public Health (*1*), showed that workers lose 96 million days a year as a result of illness; assuming an average wage of 20 pesos a day, this absenteeism represents a financial loss of about 2 billion pesos, or approximately US$100 million a year—a figure that would represent US$1 billion in terms of the minimum salary in the United States. In addition, there is the high cost of medical care, the loss in the efficiency of the worker, the residual disability, and the years of life lost by premature death.

What has been said above shows that a high level of nutrition and health in the agricultural and the industrial worker of Latin America will help increase production in that area, and also that programs to control malnutrition and disease should not be regarded as expenditures but highly profitable investments.

The above-mentioned observations and studies also clearly demonstrate the close interdependence between nutrition, health, and the social and economic development of the country and establish the fact that malnutrition and other nutritional diseases affect not only the health sector but also the educational and agricultural sectors and the economy in general.

I should now like to add a few considerations on the place of the various factors causing malnutrition in the different development sectors, in order to indicate what the bases should be for preventive activities in the field of nutrition in the countries of the Region.

Determining Factors in Malnutrition

The specific objectives of programs to prevent malnutrition might be summarized as follows: to make sufficient food available for the whole population; to ensure that the entire population consumes foods that satisfy its nutritional needs; to prevent diseases that may interfere with the utilization or cause excessive loss of nutrients. However, this very simple picture, which includes the three components of the epidemiological constellation of deficiency diseases—agent, environment, and host—becomes much more complicated when we take a closer look at the determining factors related to the availability, consumption, and use of foodstuffs.

The *availability* of foodstuffs at the local level depends on a number of favorable circumstances connected with agricultural production, such as quality of the soil, water, climate, rainfall, irrigation, land tenure patterns, seeds, animal and vegetable diseases, fertilizers, breeds of animals, kind and quality of animal feeds, agricultural mechanization, credit systems, manpower skills in these fields, etc. Furthermore, the productivity of human beings is directly related to their nutritional status and their health, which accounts for the low output of industrial and agricultural workers in areas where malnutrition is widespread.

Animal diseases cause a substantial loss of foodstuffs of animal origin, which are precisely those that have the highest nutritional value. Losses are calculated on the basis of the destruction of meat, milk, eggs, or in net production losses directly due to disease. It has been calculated that in Latin America the loss in animal products due to cattle diseases exceeds 35 per cent of the total production (*2*). Among these diseases, foot-and-mouth disease and certain zoonoses such as rabies, brucellosis, bovine tuberculosis, and hydatidosis are responsible for the loss of thousands of tons of animal protein, a loss that seriously aggravates the malnutrition problem in Latin America and also impedes livestock development in the countries.

Proper control of animal diseases could bring about a significant increase in the availability of animal protein in relation to the present rates of production. Pertinent studies have estimated that this increase might be as much as 4.4 grams of animal protein per day per capita in the countries of the Region (*2*); this would be the equivalent of a 50 per cent increase in the present supply of animal protein for the Region, which, according to FAO, is 9 grams per person per day (*3*). This meeting will hear a full report on the control of zoonoses as an integral part of agricultural development, prepared by a PAHO mission, including estimates of the animal protein losses due to livestock diseases and their impact on the economies of the countries.

There are other factors involved in the availability of foodstuffs, namely, those relating to various links in the food chain from producer to consumer. They include the warehousing, storage, processing, and packaging of foodstuffs as well as transportation and distribution to the local market or to the corner shop.

An adequate level of *consumption* of food by each and every one of the members of a family or of a community also depends on another set of factors of an economic or sociocultural nature. On the one hand, capital and levels of employment and salaries determine the purchasing power of a family unit; and on the other, food customs and habits, beliefs and taboos relating to food, and health and child-rearing practices determine individual and family preferences and feeding practices, that is to say, the characteristics of individual diets, both in

quantity and quality, and the extent to which they satisfy nutritional requirements.

Adverse sociocultural factors connected with food and nutrition more frequently affect the most vulnerable groups of the family, i.e., children under 5 years of age, pregnant women, and nursing mothers; this means that although a family may have enough food, this fact may not be reflected in good infant feeding, since taboos and cultural blocks often prevent them from receiving the foods eaten by the adult members.

Finally, there are a number of factors that determine the correct *utilization* of the foods consumed and the losses of certain nutrients. Infectious and parasitic diseases are determining factors in malnutrition, for they result not only in a loss of nutrients but also in a loss of appetite, and frequently patients are subjected to food restrictions by reason of ignorance or incorrect food patterns and practices. Furthermore, as has been mentioned, malnutrition reduces the defenses of the organism against diseases and establishes a vicious circle due to this synergistic action.

It is therefore evident that a number of the development sectors of a country are directly affected by the nutrition problems of its population, and also that the factors giving rise to such problems are situated especially in the economic, agricultural, health, and educational sectors. There is thus a twofold reason for stating that if we wish to prevent and successfully control malnutrition and other deficiency diseases we must undertake coordinated multisectoral programs aimed at eliminating the various determining factors.

National Food and Nutrition Policies

The United Nations—being fully aware of the need for multisectoral activities and programs to solve the nutrition and food problems of the countries—has undertaken, through PAHO/WHO, FAO, and UNICEF, to promote and offer technical and financial assistance for the organization and operation of applied nutrition programs in various countries. These programs are definite efforts to coordinate the sectors of economic and social development that are more directly responsible for the solution of food and nutrition problems. Although the development of applied nutrition programs has been slow and has encountered the difficulties inherent in a shortage of trained personnel, they have been initiated as pilot projects in small areas and subsequently converted into larger-scale programs whose expansion and consolidation have been achieved through intersectoral coordination. Applied nutrition programs have been under way in eight countries of the Region for five or more years, and their area of operation has been progressively extended; programs are also being organized in two other countries. However, it has now become necessary to view the problem from a broader standpoint.

If we examine the food and nutrition programs conducted in Latin America, we see that in the past they have not been the outcome of national policies. In the last 10 years, however, the countries have become aware of the need to establish and implement a clearly-defined national food and nutrition policy as a basis for coordinating sectoral plans, and they have accepted the fact that coordinated efforts make it possible to tackle all the various aspects of the problem at the same time, and thus obtain more than a piecemeal solution.

A food and nutrition policy has been defined as the formulation and implementation of a set of measures that ensure an optimum nutritional status for the whole population through an adequate supply of foods and the necessary changes in con-

sumption patterns. This policy must be established as an integral part of the national plans for economic and social development and be carried out through coordinated sectoral programs. Each country must be encouraged to set up a multidisciplinary technical committee, situated at the highest administrative level in the national planning office, to assume responsibility for establishing a food and nutrition policy.

The technical committee on food and nutrition policy should comprise representatives of the sectoral planning offices of the various ministries or government departments that are directly or indirectly responsible for planning and executing specific projects in this field. It should be responsible not only for the formulation of a national food and nutrition policy but also for studying material, manpower, and financial resources for the simultaneous conduct of coordinated activities. This group would have to supervise the initiation and institution of the measures established and recommend the necessary administrative decisions for ensuring that they are correctly organized and executed and for periodically evaluating the progress made.

The execution of the national food and nutrition policy is the responsibility of the different sectoral agencies involved. Each is responsible for executing that part of the program which directly concerns it. Among these agencies are the national planning office; the ministries of agriculture, health, and education; agricultural research, agrarian reform, industrial development, credit, agricultural marketing, and food technology agencies; associations of producers; agencies regulating food standards and retail prices; universities and middle-level training centers; and finally, the institute of nutrition or the technical group specializing in nutrition, generally under the authority of the ministry of public health. The components of a food and nutrition policy in Latin America were discussed by an expert group that met in Washington, D.C., in 1969 under the auspices of PAHO/WHO and FAO (*4*).

Responsibility of the Health Sector

Let us now look at the responsibility of the health sector in planning and conducting a national food and nutrition program in a given country.

Planning the program. As is well known, the first stage of planning is the diagnosis of the situation. With respect to the health and nutrition situation, this diagnosis is based primarily on three indicators: the net availability of food for human consumption, the actual consumption of food in the various socioeconomic strata, and the nutritional status of the population. The net availability of food is expressed in terms of per-capita amount of each of the various groups of foods (cereals, meats, fats, vegetables, fruits) and also the caloric and protein value of each of them individually and as a whole. To obtain this information, food balance sheets and pertinent demographic data are used. However, food balance sheets reflect only the apparent consumption and do not enable us to ascertain the actual consumption of food, that is, the actual amount ingested by individuals of different population groups or strata. To overcome this drawback, systematic surveys of the consumption of food in specific population groups classified according to different criteria (geographic, socioeconomic, biodemographic, etc.) must be made. These studies are the responsibility of the nutritionists or nutritionists-dietitians who are members of the health team.

The availability and consumption of food in a country, as established by means of

food balance sheets and consumption surveys, must be compared with the nutritional needs of the population in the light of the recommended daily intake of calories and nutrients for the country concerned; those recommended standards must, of course, be established by the nutrition experts of the health team, using appropriate methods and principles.

On the basis of these recommendations, it will be possible to evaluate the results of the consumption surveys and determine whether or not the various groups have sufficient nutrients. Food consumption targets can then be established; that is, the amount of food necessary to enable the population to satisfy its caloric and nutrient needs. They are established, taking into account the population structure in each country, the daily per-capita recommended caloric and nutrient intakes, the average caloric and nutrient content of each group of foods, the availability of foods in each country, regional consumption and food-habit surveys, the desirable distribution of the caloric contribution by source, as well as the relative contribution of energy and protein foods by source. Food consumption targets are a useful reference point for agricultural and economic planners, who, in the light thereof and taking other factors into consideration, can establish a clearly defined policy governing food production, importation, and exportation; and imports and exports, regardless of their origin, must be adjusted to that policy. The comparison and analysis of the above-mentioned data calls for coordinated and joint efforts by the nutrition experts of the health sector and the experts in economics and agriculture.

I have already pointed out that the per-capita availability of foods in a country is an average value and thus does not reflect actual consumption by different socio-economic sectors of the population or their nutrition problems. Therefore, to make a more accurate diagnosis of the problems, nutrition surveys that include data on food consumption must be conducted, as well as surveys on dietary habits and chemical and biological analyses that indicate the nutritional status of the population.

Virtually all the countries of the Region have been able to make a basic diagnosis of the food and nutrition program, for which purpose PAHO has provided consultant services. Furthermore, through the research carried out by the Institute of Nutrition of Central America and Panama (INCAP) and by the Caribbean Food and Nutrition Institute, which is also supported by FAO, and through collaborative or individual studies made in various countries, PAHO has helped to ascertain the prevalence of nutritional diseases as well as their extent and characteristics. As a result of studies on protein-calorie malnutrition, nutritional anemias, hypovitaminosis A, and endemic goiter, which have provided information supplementary to that derived from nutrition surveys in the countries, it has been possible to give better guidance to nutrition programs.

As soon as the food and nutrition situation in a country has been diagnosed, the technical groups belonging to the sectors involved must prepare coordinated sectoral plans of operations after first determining the resources available in each sector—institutional, material, economic, technical, legislative, etc.—for conducting activities, projects, and programs aimed at the common objective of ensuring the optimum nutritional status for the population of the country.

Conduct of the program. In each multisectoral program, the health sector should undertake specific activities in line with the national food and nutrition policy of the country.

General health activities. Public health agencies and organizations conduct two types of activities through the general health services. The first are those that help to improve the population's nutritional status but that cannot be regarded as being specifically for that purpose. They include activities for the restoration of health undertaken in hospitals, health centers, and outpatient departments; general preventive and curative activities aimed at protection of mothers and children, such as prenatal care programs, education on nutrition during pregnancy and lactation; care of the newborn; care in delivery and the postpartum period; family counseling on the spacing of children and family planning; preventive and curative health services for infants and preschool-age children; school hygiene programs; adult hygiene programs including screening for diabetes, control of obesity, and investigation of other diseases related to nutrition; and finally, environmental sanitation activities of fundamental importance to the nutritional status of the individual and the community. Among the last-mentioned activities special mention may be made of the prevention of waterborne diarrheal diseases by means of in-house water connections, proper sewage and garbage disposal, improved housing, periodic spraying of houses with insecticides in areas where malaria or Chagas' disease is endemic, rodent control, since rodents help to reduce the availability of foodstuffs, and measures to prevent the contamination and infestation of foods and reduce the foodborne infections.

Specific nutrition activities. To these general activities must be added the second group, more specific to nutrition, which are part of a health program and therefore carried out by health personnel at the national, intermediate, or local level.

I have already mentioned how the health sector shares at the national level with other sectors the responsibility for establishment of a national food and nutrition policy in each country. The health sector must actively assist in formulating a national nutrition program in line with that policy; it must ensure that the necessary funds are assigned to it from its own budget; and it must also play a key role in coordinating and promoting economic and technical assistance, multilateral and bilateral, incorporating it into the national nutrition program and thus avoiding separate programs that frequently lead to incomplete utilization of existing resources.

The national nutrition program, the general object of which is to achieve an optimum nutritional status for the whole population, has the following specific objectives: to develop manpower for nutrition; to promote the availability and proper consumption of protein-rich foods; to conduct nutrition education and food supplementation programs for the most vulnerable population groups (pregnant women and nursing mothers, children under 5 years of age, school-age children); to ensure the nutritional rehabilitation of children with advanced malnutrition; to establish and implement food and nutrition regulations and standards; to undertake research on nutrition problems in order to correctly orient programs designed to solve them; and in general, to help formulate and implement the national food and nutrition policy.

It is up to the health sector at the national level to inform the highest governmental decision-making levels of the extent and importance of the nutrition problems affecting the population, so as to ensure that nutrition programs are given the priority they deserve in the country's social and economic development plans.

At this level, the health sector must also give advice on and assist in the establish-

ment of procedures, regulations, techniques, teaching programs, food standards, and handbooks for operating various services related to food and nutrition, whether in the health, education, or agricultural sector.

The research and teaching programs in these fields must also be coordinated and directed by the nutrition groups of the health sector. In Latin America the training of personnel specialized in nutrition (nutritionists and nutritionists-dietitians) is of very special importance, since the present shortage of such professional personnel is one of the factors that has limited the expansion of programs.

Some activities of nutrition programs must be incumbent on the health authorities at the central level; for example, requests for multilateral or bilateral technical or economic assistance for food supplementation programs and the subsequent distribution of equipment or food supplies to intermediate or local levels; the conduct of nationwide nutrition education programs through radio, television, or the press; the preparation of publications and distribution of educational material to be used at the local level.

At the intermediate level the health sector is responsible for the formulation and intra- and intersectoral coordination of the nutrition program for the province or state and for administering and directly supervising it. Intersectoral coordination enables maximum use to be made of the technical and economic resources available and simultaneous complementary activities to be carried out.

The health team at the intermediate level plans the nutrition component in the health plan; defines the part to be played by each member of the technical team in nutrition activities; gives advice to and supervises the local and district level; and adapts national standards for the conduct of nutrition programs to local conditions.

At the local level it is responsible for the execution of food and nutrition programs. These are carried out through health services, elementary schools, and agricultural extension agencies. These services are the basic structures through which the community receives direct attention from the professional and auxiliary personnel in charge of the various activities of the program in their particular sector. These activities are described in the PAHO publication dealing with nutrition activities at the level of the local health services (*5*).

In the area of health the basic operational units are the districts, the centers, and the health posts. The nutrition activities they conduct include the diagnosis of the problem in individuals and in the community, the promotion of a good nutritional status, specific protection against nutritional diseases, and treatment of nutritional deficiences.

The diagnosis comprises the study of indicators of nutritional problems such as vital statistics, anthropometric values, cliniconutritional and food surveys, as well as of the causative factors.

The promotion of a good nutritional status includes educational activities for persons benefiting from the services and for the community in general; promotion of and assistance in activities to increase the availability and consumption of food with a high nutritional value; encouragement of early participation in maternal and child health programs; promotion of intersectoral coordination at the local level; and training of nursing auxiliaries in food and nutrition.

Specific protection activities include periodic supervision of the health of vulnerable groups and counseling with respect to feeding; the supply of iron to pregnant women and of vitamin A, iodine, and other

nutrients in areas where their deficiency is endemic; food supplementation programs, high priority being given to the most vulnerable groups; promotion of the increasing consumption of traditional foodstuffs rich in proteins, new protein mixtures, and enriched foods.

The treatment of nutritional diseases includes hospitalization of advanced cases of malnutrition, organization and operation of nutrition rehabilitation centers, treatment of anemia and vitamin deficiencies, and periodic supervision of children undergoing rehabilitation.

In the education sector the basic operating unit is the elementary school. The school nutrition program includes five correlated and complementary activities: teaching of basic ideas about food and nutrition as part of the regular elementary curriculum; operation of a school dining room; organization and operation of a school garden, school cooperative, and school nutrition club.

In the agricultural sector the local basic operating unit is the agricultural extension service. Through this service agricultural engineers, veterinarians, and intermediate-level personnel promote and provide guidance in the conduct of agricultural and livestock projects aimed at increasing production and the availability of foodstuffs, orienting their consumption, and improving economic and living conditions. The agricultural team gives technical assistance to farmers as well as specialized services such as supervised credit, supply of seeds and improved varieties; it organizes them into groups and gives them informal training in agriculture and animal husbandry, preparation and storage of foods, nutrition, hygiene, and home economics, including training in various types of handicrafts to enable them to improve the financial conditions of their families.

The responsibility of the health sector in these community programs carried out by the education and agriculture sectors is primarily the food and nutrition training of schoolteachers and home economists and expert advisory services in the organization and conduct of school and rural nutrition programs.

Conclusions

A rapid review of the components of the national food and nutrition program and especially of the responsibility of the health sector in conducting it at the national, intermediate, and local levels leads to the following general conclusions which are considered of major importance for this meeting:

1. Nutritional diseases are one of the major obstacles to the acceleration of the economic and social development of Latin America.

2. To ensure the whole population the optimum nutritional status, each country must formulate and implement a clearly defined food and nutrition policy, whereby the availability, consumption, and use of food is brought into line with the needs of the population.

3. To implement the national policy, it is necessary to conduct a national food and nutrition program made up of sectoral programs included in the health, education, and agricultural plans.

4. As part of the national food and nutrition program, it is necessary for the agricultural and health sectors to undertake joint activities to control animal diseases, primarily the zoonoses which greatly reduce the availability of protein foods essential for the population of the Hemisphere.

5. Programs undertaken by the countries of the Region to control malnutrition and disease must be given a high priority as part of economic and social development plans

and must be considered as highly productive investments.

6. To extend the coverage and increase the effectiveness of the national food and nutrition program in the country, it is essential to make maximum use of governmental health, agricultural, and education services and resources.

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PART II

FOOT-AND-MOUTH DISEASE VACCINES

USE AND EXPERIENCES WITH FRENKEL-TYPE VACCINE

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The Frenkel vaccine as we know it now was developed in the years after the Second World War (*1*).

The method is based on older observations by Maitland and Maitland, which showed that vaccinia-virus would multiply in fragments of tissue kept in survival suspended in a fluid medium. To grow foot-and-mouth disease virus in vitro, Frenkel used epithelium harvested from the tongues of slaughter cattle. The development of antibiotics made it possible to apply this principle on a large scale. The tissue is collected shortly after slaughter. It is harvested by peeling off the epithelium after the tongue has been fixed on a drum and is then collected in a buffer solution. If maintained at refrigeration temperature, it will remain suitable for use for one or more days. The virus multiplies only in the deep epithelium layers, but the presence of non-producing hornified tissue does not seem to affect the multiplication process adversely. Epithelium from both susceptible and immune cattle has been found suitable for large-scale virus production, although in the latter case the quantity of seed virus needed to infect the cultures may be larger.

At first the tissue, which was collected in the form of cell sheets, was cut into small fragments prior to cultivation. This step is now in most instances omitted.

Virus culture takes place in stainless steel containers with a useful content of 30 to 100 liters. Seed virus may be obtained by cattle passage and subsequent adaptation by a few transfers in Frenkel or other cultures. Up to now all virus strains tested have been found to multiply sufficiently in the Frenkel system, although some may give better antigen yields and more potent vaccines than others.

Different types of culture vessels have been developed, but the principle is always the same. The tissue is kept in suspension by stirring during incubation at about 37°C., while oxygen or an oxygen-nitrogen mixture is led through the fluid. This aeration serves two purposes, i.e., to supply oxygen to the actively metabolizing tissue and to remove the CO_2 formed in the course of the process.

The culture medium is usually a Tyrode buffer, supplemented with amino acids, vitamins, etc. The solutions used in different laboratories may vary with regard to their glucose, bicarbonate, and amino-acid contents.

Antibiotics are used in all instances, but here again different producers may use various mixtures on account of differences in the bacterial flora encountered and experiences with allergic reactions after vaccination. Cultures reach their maximum yield 20 to 24 hours after seeding, depending on the virus strain used. According to our experience, both epithelium and culture fluid contain large quantities of virus and should therefore be collected. Cultures are harvested by grinding up the tissue; remaining

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tissue fragments are removed by centrifugation; and a bacteria-free suspension is eventually obtained by centrifugation, filtration, or treatment with chloroform. Filtration, if carried out carefully, need not lead to appreciable losses. Sterile virus suspensions can be kept at refrigerator temperature for several weeks and may in the meantime be tested for virus type, virus content, sterility, etc.

Vaccine is prepared by adsorption of the virus on aluminum hydroxide and inactivation with formaldehyde at 25–26°C. The processes employed in different laboratories may vary, e.g., in the dry matter content of the aluminum hydroxide, the concentration of formaldehyde, and the duration and pH of inactivation. In many instances saponin is added.

The final dosage in which the vaccine is employed may vary from 1 to 10 ml per type. A reduction of the volume is usually easily obtained by separating the hydroxide, to which the antigen is adsorbed, from the supernatant fluid.

The innocuity and potency tests used for Frenkel vaccines are those employed for other foot-and-mouth disease vaccines. As the routine innocuity test, the intradermolingual injection of susceptible cattle is generally preferred. The potency test too may be done in cattle, but for many laboratories the technique is too expensive for routine use.

Frenkel vaccines have been in use in the Netherlands since 1952. Initially only types A and O were used. In 1953 type C was added and an annual vaccination of the cattle was introduced.

In May 1967 the Dutch livestock population showed the following composition:

	No. of animals	*No. of farms*
Cattle	3,970,000	162,000
Swine	3,920,000	95,000
Sheep	560,000	24,000

The country's total surface area is 32,600 km^2. The cattle are of the dairy type, kept in herds averaging 25 head. The average farm is about 14 hectares. A complete registration of the cattle is maintained, the apparatus for which is in the hands of the farmers' organizations.

The annual vaccination is carried out by administering one dose of trivalent vaccine to all cattle more than 4 months old in a 10-week period in the spring. Vaccination is carried out by veterinary surgeons and is not compulsory. Unvaccinated stock can only be sold for slaughter. In practice about 99 per cent of the animals aged more than 4 months are vaccinated.

The policy not to vaccinate young calves is based on laboratory evidence (*2*). Cows that have received several doses of vaccine excrete large quantities of antibodies with their colostrum. When taken up by their calves in the first one or two days of life, these antibodies will protect the calves against the disease, but they also prevent an effective vaccination. The four-month period is an average; some calves may be expected to respond earlier to vaccination, although young stock do not immunize as readily as adult cattle.

Since Frenkel vaccine first came into use in the Netherlands in 1953, a number of minor changes have been made in the production process. The foot-and-mouth disease control policy applied in the field also underwent repeated modifications.

The vaccine at first was used in a 15 ml dose per type. This has since been reduced to 5 ml, and a further reduction to about 1.5 ml is in preparation. Other changes took place in the production process itself. Virus culture is done in vessels with an effective volume of about 40 liters. As antibiotics we usually employ penicillin, neomycin, and chloromycetin. The present need, equivalent to 5 to 6 million trivalent cattle doses

per year, is covered by processing about 130,000 cattle tongues, or 3,500 kgs of tissue.

In general, the policy should be to adapt the vaccine as far as possible to the field by using field strains for antigen production. Since a general vaccination policy was introduced in Holland in 1953, such a changeover had to be made only once. This is probably due to the high level of immunity of the cattle population, which reduces virus circulation to a negligible level and thus prevents the development of variant strains.

Cattle that have repeatedly been vaccinated may also develop an immunity to virus strains that differ appreciably from those incorporated in the vaccine. This was, for instance, shown in the course of the 1967 outbreak, when cows that had received several annual doses of O_2-vaccine proved resistant to challenge with the O_1-strain.

Some specifications of the vaccine now in use are the following: Vaccines are prepared monovalently and contain at least $10^{8.3}$ mouse ID_{50} of virus per dose and type. The aluminum hydroxide content of the final product is 2 per cent dry matter. Inactivation is carried out for 48 hours at a pH of 8.2 with a formaldehyde concentration of 0.03 per cent. Vaccines of the above composition are routinely tested for innocuity by intradermolingual injection into susceptible cattle. Immediately after preparation no infective virus can be detected in them by this route. The batch size is usually 2,000 liters, 400,000 doses. The potency test is done by measuring a PD_{50} in groups of 15 cattle, two weeks after vaccination. The number of PD_{50} per 5 ml dose varies between 6 and 15. In 1967, 1,500 imported susceptible cattle were used for the innocuity and potency testing of about 15 million monovalent cattle doses. This number is reduced as other control techniques become available.

The routine control measures employed in the field consisted up to 1955 of mass vaccination supported by the routine veterinary police measures. In that year a slaughter policy was introduced, and all vaccinated cattle showing foot-and-mouth disease symptoms, as well as unvaccinated cattle, sheep, and swine found on infected farms, were removed and destroyed.

This program has proved effective, as the following figures show, and has since been adopted in a number of other European countries.

Foot-and-mouth disease incidence in the Netherlands

Year	No. of cases (farms) reported
1951	20,750
1952	7,654
1953	308
1954	34
1955	48
1956	47
1957	47
1958	7
1959	6
1960	3
1961	183
1962	5,470
1963	2,103
1964	146
1965	1,426
1966	2,193
1967	196
1968	0
1969	0

In the period between 1961 and 1967 the disease occurred mainly in pigs. This caused a number of secondary cases in cattle, which varied in different years. In the winter epizootic of 1966–1967 cattle were involved in about 10 per cent of the outbreaks. As a rule only unvaccinated calves or young stock that had been vaccinated only once were affected. This was the reason for taking additional measures.

Prior to 1967 there existed a supplementary vaccination program for young stock which were moved in the autumn. Its re-

sults were rather incomplete, and only about 15 per cent of the individuals of the age groups at risk were treated. In 1967 a general autumn vaccination of all cattle that had not previously been vaccinated or had received only a single dose of vaccine was introduced.

Laboratory investigations have provided further information on the effect of foot-and-mouth disease vaccination on the resistance of cattle against the disease.

Cattle develop virus neutralizing antibodies after vaccination. Following administration of a single dose of vaccine, the serum antibodies attain a maximum value after three to four weeks. The titer then drops off, but reaches a stable level after three to four months, which is maintained for a long period (*3*). The duration of the immunity that develops after one vaccination is not more than four to six months, when intradermolingual challenge is used. Repeated vaccination is therefore judged an essential part of any long-term program using these vaccines.

Every annual revaccination results in an increase of the serum antibody level (*4*). These antibodies persist for many years, even when vaccination is not continued. Such repeatedly vaccinated cattle have a solid immunity against both field exposure and infection by intradermal inoculation as often practiced in the laboratory.

There is a clear-cut relationship between the serum titer and resistance to infection in both animals vaccinated recently and those vaccinated long ago (*5*). The levels of antibody necessary for 50 per cent protection against generalization after intradermolingual challenge are, however, different for both groups. Nearly all cattle develop tongue lesions if this challenge is carried out nine or more months after vaccination but they will not develop generalized lesions. Experience shows that such animals will not develop disease when exposed under field conditions.

A slaughter policy now constitutes an essential part of the foot-and-mouth disease control programs in most West European countries. When such a method was first used in the Netherlands, there was no information with regard to the occurrence of virus carriers. As a consequence, only individuals showing clinical symptoms were slaughtered. We know now that many cattle that remain clinically normal after exposure may become virus carriers, but up to the present these have not been known to cause new outbreaks of the disease.

Carriers have been found as late as two years after infection, but the condition is essentially self-limiting (*6*). After the 1965–1966 type C outbreak, the last virus isolations from carriers were made in 1968. Since April 1967 the country has been free of clinical foot-and-mouth disease, although the last O_1 carriers from the 1966–1967 outbreaks only became negative in the course of 1968. Especially late carrier viruses have been found to differ markedly from isolates recovered from outbreaks.

Since 1953 more than 50 million Dutch cattle have been vaccinated with Frenkel vaccine. These were mainly valuable production stock. In this period the vaccine proved its efficacy and innocuity. Every year a few cases of anaphylactic reactions of the immediate type are reported. These are usually mild and respond readily to treatment with antihistamine preparations. Losses are less than one per million.

In the Netherlands as well as in various other European countries, control of the disease is based on annual vaccination of the cattle. These programs are supported by a slaughter policy and the application of further police measures, such as quarantine, disinfection, etc.

Sheep are not routinely vaccinated. The

vaccination of this species poses no particular problems, and only a fraction of the vaccine dosage used for cattle is needed to afford a satisfactory level of protection.

From 1961 onward a series of outbreaks occurred which mainly affected pigs. In some years these became quite extensive. Initially they were combated only by stamping out and by the application of police measures, as experience indicated that the normal vaccines had a low efficacy in swine.

In 1961–1962 more than 300,000 pigs were destroyed in the course of a single eradication campaign. As this policy proved expensive and it often took a long time to attain the objective of eradication, vaccination was finally resorted to.

Most satisfactory results were obtained by vaccinating all pigs in endangered zones. Preferably vaccines with three or more times the antigen content used for cattle were employed. Such vaccines give pigs a reasonably good protection against contact exposure, which is, however, of a short duration. The results obtained in the field are generally better than one would deduce from laboratory evidence.

Aluminum hydroxide adsorbed antigens are quite effective in pigs when administered repeatedly, as can occasionally be done in breeding stock. The immunity so obtained in sows may be sufficient to give passive immunity to their offspring for two or more months (*7*).

The problems related to the protection of pigs against foot-and-mouth disease are not specific for a given vaccine. New vaccines containing antigens emulsified in oil have been reported by several authors to give a protection of longer duration than aluminum hydroxide adsorbed antigens; but with such vaccines the protection given to the swine population as a whole will not be more than three or four months, as the average life immunity in swine is not more than six months.

Protection of the individual farm is possible but demands an almost continuous vaccination. The application of such a policy to the whole swine population would prove too costly.

It should be realized that foot-and-mouth disease in pigs is often secondary to the disease in cattle. There are several examples of the disappearance of the disease from swine after the outbreaks in cattle had been brought under control. As far as we know, pigs do not become virus carriers.

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TISSUE CULTURE VACCINES (BHK) IN FOOT-AND-MOUTH DISEASE CONTROL

DR. JOHN B. BROOKSBY *

The advantages of a cell line for the cultivation of virus for vaccine production are well known. With modern methods of cell storage, a constant supply of a uniform host cell is available for regular routine production of virus. This host cell can be subjected to rigorous tests to prove the absence of adventitious viruses; it will give reproducible results; and from the practical point of view it means that the producing unit is free from the difficulties frequently found in arranging the supply of material from slaughterhouses. To be satisfactory, however, the cell line must multiply readily to a high cell concentration; it must be fully susceptible to the virus and must produce virus to a high titer. Moreover, the cell products must have no adverse effects on the inoculated animal either in possible tumor production or in the production of anaphylactic effects. Criticism of the BHK cell for foot-and-mouth disease vaccine production is centered mainly on these last two points, because in all other respects the cell is clearly very efficient for vaccine production.

Our present knowledge suggests that these two points of criticism can be met. Extensive experiments have failed to show production of tumors by anything other than the intact BHK cell, and then only in the homologous species, the hamster. Even living cells implanted in domestic animals have never given rise to any oncogenic effect. As far as the cells being a source of allergen is concerned, the situation at present is that reaction to BHK protein can be produced in the same way as to many other constituents of the vaccine, but the problem can be overcome largely by a change of inactivant used in the vaccine. Further studies on purification of the product may also be of value in this direction.

The purpose of this paper is to describe the present situation in regard to BHK-derived vaccines, indicating the progress that has been made since the susceptibility of the cell was established in 1962 by Mowat and Chapman and the first demonstrations of its usefulness in vaccine production were made by Capstick *et al.* and by Mowat *et al.* in the same year. Observations on the usefulness of the cell have been made in many European countries, the highest rate of commercial production in Europe having been achieved in Italy (Nardelli, 1969).

This paper does not propose to go into detail on the methods of virus production and vaccine formulation but rather to discuss the principles involved. Details are in any case available in a number of publications (see Bibliography).

Cell and Virus Production

BHK cells can be stored indefinitely in a master bank. Sufficient cells have been laid

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down in this to provide directly for the next 30 years and for a further period by derivation from any one of these seeds, which are held in liquid nitrogen at −196°C. For routine runs, production banks at −70°C with larger quantities of cells are held, and revival from storage for production from these takes from four to six weeks. Cascade systems of vessels are arranged so that cell culture in increasing volume can be carried out in entirely closed systems. Extensive quality controls are maintained on cells for cell size, growth, growth rate, chromosome number, virus susceptibility, and screening for mycoplasma and for microbial contamination.

The method of choice for cultivation of cells is in suspension culture, and the line derived by the workers at Pirbright is available for this purpose. New lines can be derived from cells hitherto grown in monolayer, but the initial line appears to be the most satisfactory of those which have been derived.

An alternative method of proceeding to cell cultivation is by growing seed in suspension culture and transferring into monolayer rolling bottles. Very high cell concentrations can be achieved in the rolling bottle system, which does not require quite the sophisticated equipment needed for suspension cell culture work. Nevertheless, suspension cell equipment is much more convenient in operation, requiring less labor and less space. The cell density achieved in suspension cultures is now 3×10^6 cells/ml or greater.

Virus Production

Seed virus for BHK vaccine production is usually satisfactory if the field strain is passaged in BHK-21 monolayer cells for 3–6 passages, then transferred to suspension culture. There is thus no question of the strain having been subjected to a long series of passages which might modify it in some way. In suspension culture, the virus/cell input ratio is now normally something of the order of 1:10 or 1:100, but a ratio of 1:1000 has been satisfactory when tested. The culture period may vary with the strain, although in general it is about 48 hours. Maximum virus titers will be reached earlier than the time at which the virus should be harvested, and it has been the practice to harvest at a point between maximum virus titer and maximum complement-fixing titer. The virus culture is then filtered to remove cell debris in two stages, through a prefilter of pure cellulose and then through a nitrocellulose membrane with a pore diameter of 0.2μ.

Virus Inactivation and Formulation of Vaccine

Virus inactivation is by 0.05 per cent acetylethylenimine for 30 hours at 26°C. Each cattle dose contains 5 mgm of saponin.

Safety Testing of Vaccine

The safety testing of the BHK vaccine is carried out before the saponin adjuvant is added. The subject has recently been investigated by Anderson *et al.*, and it has been demonstrated that the most efficient method is by the inoculation of large volumes onto monolayer tissue cultures. This method is more sensitive than the use of cattle for the detection of possible failure of the inactivation procedure. Acetylethylenimine inactivation is free from the terminal tail in the inactivation curve that accompanies inactivation with formalin.

Vaccine for field use at the present time, however, is also tested by inoculation of the tongues of cattle in the same manner as for aluminum hydroxide Frenkel vaccines.

Potency of BHK Vaccines

Table 1 presents an example of data on 50 per cent protective dose determination of a vaccine prepared in the manner described. This method of determination of vaccine potency by the dilution technique has been employed as standard at Pirbright for the experimental evaluation of vaccines. Throughout these tests, various laboratory tests are employed in parallel. These include complement-fixation tests on total complement-fixing antigen and on the 25 nm antigen; serum tests on the sera of cattle which have been vaccinated, taken at the pre-exposure stage; and finally, guinea pig protection tests using the same vaccine to immunize guinea pigs. For the purposes of this table, the complement-fixing antigen content is the total antigen and, of course, is diluted out in proportion to the vaccine dilution given. The serum titers are on color tests; a significant titer in terms of protection is of the order of 1:45. The higher titers produced are approaching those which would be given in convalescent animals. Reaction is assessed on the basis of protection against the appearance of secondary lesions. As can be seen in the table, a number of animals are protected even against the development of clinical reactions on the tongue after intradermal challenge, but this is less reproducible than the demonstration of secondary lesions on the feet. This has been chosen as a realistic endpoint which compares more with contact challenge and therefore possibly with a severe field exposure.

Table 2 presents the data, including those from Table 1, for six typical batches of vaccine produced in the same way. The number of PD_{50} per dose of vaccine was estimated at 21–28 days after vaccination and can be seen to be much above the minimum requirement of 6 PD_{50} per dose. The total complement-fixing units per dose of vaccine are not precisely correlated with the number of PD_{50} per dose and would appear to vary from strain to strain. The antibody titers refer to those of the groups

TABLE 1—Results of an experiment to determine the potency for cattle of a type C (strain Norville) vaccine prepared with antigen produced in BHK deep suspension culture and with saponin as adjuvant.

Steer No.	Vaccine dilution	CF antigen content	Prechallenge serum titer	Clinical reaction after i/d tongue challenge	No. protected / No. vaccinated
HH 52	1:64	0.8 cfu	1:8	Tongue and feet	1/4
HH 53	1:64	0.8 cfu	1:22	Tongue and feet	
HH 54	1:64	0.8 cfu	1:66	Tongue and feet	
HH 55	1:64	0.8 cfu	1:22	Tongue only	
HH 56	1:16	3.1 cfu	1:2048	Nil	4/4
HH 57	1:16	3.1 cfu	1:2048	Nil	
HH 58	1:16	3.1 cfu	1:128	Tongue only	
HH 59	1:16	3.1 cfu	1:90	Tongue only	
HH 60	1:4	12.5 cfu	1:708	Tongue only	4/4
HH 61	1:4	12.5 cfu	1:708	Nil	
HH 62	1:4	12.5 cfu	1:708	Nil	
HH 63	1:4	12.5 cfu	1:512	Nil	
HH 64	1:1	50 cfu	1:8192	Nil	4/4
HH 65	1:1	50 cfu	1:5600	Nil	
HH 66	1:1	50 cfu	1:178	Tongue only	
HH 67	1:1	50 cfu	1:4096	Nil	

PD_{50} value = 40.6 per 2 ml vaccine dose.

cfu = complement fixing unit.

TABLE 2—The response of cattle to BHK-produced antigens formulated with saponin 5 mgm/dose as adjuvant and given by subcutaneous injection.

Type	Strain	Total cfu per 2 ml dose vaccine	No. of PD_{50} per 2 ml dose vaccine i/d tongue challenge 21–28 days post-vaccination	Peak antibody titers (C.M.I.) prior to challenge from groups of cattle given the field dose of vaccine
O_1	BFS 1860	210	> 30	1:595
O_1	Swiss 1/6	150	27	1:295
A_5	Eystrup	130	—	1:457
A_5	Eystrup	130	> 64	1:537
A_5	Eystrup	130	416	—
C	Norville	Harvested as 90 Diluted for vaccine test to 50	40.6 (equiv. to 73 for undiluted harvest)	1:2818

C.M.I. = Cells metabolic inhibition.

of animals receiving the field dose of undiluted vaccine. It is clear that the response in all these cases has been completely satisfactory.

Table 3 shows the laboratory results on five vaccines given to swine. In this case the adjuvant was the water-in-oil emulsion, and the vaccine was given by subcutaneous injection. In this instance we do not have challenge results, and the estimate of protection is given by the pig antibody titers of groups of 10 pigs or more up to 28 days postvaccination. Challenge results exist in the laboratory for groups of pigs up to nine months after vaccination and are extremely good.

Field Use of BHK Vaccines

Although Pirbright was responsible for pioneer work in developing BHK vaccines, the pilot plant at the Institute was not converted from Frenkel production until 1967; since that time the program has centered on research into methods of BHK vaccine production. Vaccine from the Institute has therefore been issued only for relatively minor field trial studies, the main production capacity being employed in the production of Frenkel-type vaccine against strains of virus exotic to Europe. Working in a building adjacent to the Institute, however, the Wellcome Foundation has developed and applied the BHK production technique, and in many of its overseas laboratories it has carried it through to a high level of production. I am indebted to the Wellcome Foundation for the information in Table 4, which sets out the use of BHK vaccines in a number of areas during the last four or five years. As can be seen, there has been considerable production in this period, and there is no question that the vaccine has now passed the experimental stage. There are no data which can support in a fully scientific manner the claim that the vaccine is efficient, but it appears to have met with general acceptance, and in some areas where campaigns have been perhaps a little more closely supervised, notably in Kenya, there has been gratifying evidence of the failure of the virus to spread from surrounding areas into areas in which vaccination has been carried out. In view of

TABLE 3—The response of swine to BHK-produced antigens formulated as primary water-in-oil emulsions and given by subcutaneous injection.

Type	Strain	Total cfu per 2 ml dose vaccine	Peak antibody titers (C.M.I.) up to 28 days p.v. mean from 10 pigs
O_1	Swiss 1/66	117	1:645
A_{22}	Iraq 24/64	200	1:346
A_5	Eystrup	108	1:851
C	997	200	1:186
SAT-2	Ken. 3/57	60	1:457

TABLE 4—The field use of BHK Vaccines. (*Data from the Wellcome Foundation*)

Country	Vaccine	Adjuvant	Vaccination Regime	Duration of campaign	Number of doses applied
Brazil	BHK formalin Monolayer 1965–1968 Suspension 1967–1970	Aluminum hydroxide	3 times yearly	3 years	2–20 million per annum
Uruguay	BHK Frenkel mixture (50–50) formalin BHK suspension cells grown in bottles	Aluminum hydroxide Saponin	3 times yearly	5 years	Up to 8 million per annum
Spain	BHK formalin, now AEI, suspension cells	—	—	2 years	—
Kenya	BHK formalin, now AEI, suspension cells	Aluminum hydroxide Saponin	2 times yearly, then annually	2 years	1½ million cattle have had 3 doses
Botswana	BHK AEI suspension cells	Aluminum hydroxide Saponin	Annually	4 years	300,000 doses per annum

the paper to be given at this meeting by Dr. Mussgay, it may be appropriate to mention that reports of anaphylactic reactions following vaccination have been limited to eight farms in Brazil, none in Uruguay, none in Spain, a limited number in Kenya, and none in Botswana. Apart from the Wellcome experience, the major use of BHK-produced vaccine has been in Italy. In 1969 Nardelli described the production processes in use at the Institute at Brescia. There the procedure depends on the growth of seed cells in suspension and the transference of these cells to rolling bottles. The group at Brescia has continued to develop suspension culture, but its main production remains in the rolling bottle monolayer. In recent years several million doses have been prepared annually and used in northern Italy. Although some cases of anaphylaxis have been reported, they are not considered numerous enough to interfere with the successful use of the vaccine.

Conclusion

The production of BHK vaccine is a relatively simple process, and the application of the vaccine in the field has not given rise to greater problems than are usually associated with new immunizing agents. BHK vaccines produce as good an immunity as earlier foot-and-mouth disease vaccines. Because of the production advantage in having cells readily available, BHK vaccine should be given most serious consideration when plans are made for increased foot-and-mouth disease vaccine production.

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STUDIES ON LIVE VIRUS VACCINES FOR FOOT-AND-MOUTH DISEASE

DR. CARLOS A. PALACIOS *

Background

The research carried out in Europe on the adaptation of foot-and-mouth disease virus to embryonated eggs following Peragallo's description in 1937 was confirmed by Traub and Schneider in 1948. Skinner's discovery concerning the susceptibility of suckling mice in 1951, and the work of Gillespie in 1954, describing the technique of adapting the virus to day-old chicks, established the initial guidelines for new studies in the Americas and throughout the world. These studies demonstrated that through the technique of continuous passage of the foot-and-mouth disease virus through different hosts (such as embryonated eggs, suckling and adult mice, rabbits of various ages, day-old chicks, and tissue cultures), strains of virus can be produced that can be used as modified live vaccines for cattle, owing to their low pathogenicity and high immunogenicity.

The first reports of these studies and the use of modified live virus vaccines to combat foot-and-mouth disease in South America were published by Rubino and Tortorella in 1940 (cited by Palacios, *7, 8*). Between 1933 and 1939, foot-and-mouth disease viruses were submitted to a series of passages in guinea pigs. The test animals showed only slight pathogenicity and good immunity in laboratory tests. The same viruses were then submitted to passages in sheep in order to obtain sufficient quantities to carry out field experiments. On various farms in Uruguay, 7,300 head of livestock were vaccinated. Only 30 animals (0.4 per cent) showed any post-vaccinal reactions. In 20 of the 27 experiments, adequate protection resulted. The conclusions of this study indicate that contagiousness was not present and that the modified virus likewise showed a notable reduction in pathogenicity for sheep.

The bibliographic researches of Bachrach (1968), Palacios and collaborators (1966), and Palacios (1968) give a historical description of almost all the scientific works prepared on this subject.

Application of the Live Virus Vaccine in Various Parts of the World

The principal countries in which the large-scale application of the modified live virus vaccine has been studied in relation to various types of foot-and-mouth disease viruses (A and O Vallée, C Waldmann, SAT-1, SAT-2, and Asia-1) are Israel, Kenya, South Africa, Transvaal, South-West Africa, Guyana, Brazil, Colombia, Ecuador, Chile, and Venezuela.

Israel

Kemron, cited by Bachrach (*2*) and Palacios (*7, 8*), reports that using live virus vaccines of the Asia-1 type modified in embryonated eggs, he was successful in con-

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trolling the spread of the disease to non-infected areas from 8-10 days after the application of the vaccine. No undesirable postvaccinal reactions were observed among the 86,000 head of cattle involved.

In more limited experiments, Kemron and Goldsmit found that vaccination with the type of virus mentioned produced a 100 per cent immunogenic response. They also observed that a considerable difference existed in responses according to the different groups of animals and that the older the animal, the better the response. They reported that following a booster dose at 14 months, there was a significant increase in the level of antibodies.

The importance of subtypes is pointed out by Bachrach (*2*) when he states that in 1965 Kemron's modified A_{10} vaccine was ineffective against subtype A_{22}. A residual pathogenicity formerly unnoticed in the vaccine was observed; it produced lesions in the teats of the udders of pedigreed Friesian animals, leading to secondary mastitis.

Kenya

Galloway (*6*) reports on the use of live virus vaccine of the modified Rho-1 strain belonging to the SAT-2 type. Vesicular material received in Pirbright in July 1960 confirmed that an outbreak occurring during the previous month in the Nanyuki District in Kenya belonged to the SAT-2 type. This was the first time that this type of virus had appeared outside of the native reserves and it produced a great deal of anxiety among officials and farmers. It was believed that the infection had been introduced by game animals from the Mukogodo Reserve. Two infection foci were established and an intensive vaccination program was carried out around them and on all farms in the populated area of Nanyuki. Some cattle from the native reserves were also vaccinated. In all, about 80,000 animals were inoculated. In addition to the native Boran breed and its crosses with Friesian, Ayrshire, and Guernsey, vaccinated animals came from a large number of pure breeds such as Guernsey, Friesian, and Red Poll. Following vaccination, there was no sign of spread of the infection.

Reports on postvaccinal reactions indicated that these were very benign in character and limited to approximately 10 per cent in the European breeds and their crosses with the autochthonous breeds. Reactions were much less pronounced in animals of the Boran breed, amounting to a mere 2 per cent. Galloway confirms that out of a herd of 500 Guernseys, 12 animals showed the most extensive and severe lesions produced by the use of this type of vaccine. He also points out that in a farm in the middle of a focus, where 1,003 cattle had been vaccinated, one animal was found to have severe lesions three days after vaccination; upon examination of the vesicular material, it was found that the virus had no subtype relation with the virus used in the vaccine. The author believes that this observation is extremely interesting, since certain severe reactions may be erroneously attributed to the vaccination, when they are really due to an infection with wild virus.

Subsequently, it was shown that the field virus was a different subtype from that used in the vaccine, but even under these circumstances it was possible to limit and control the spread of the SAT-2 virus by application of the modified live virus vaccines.

South Africa

Galloway, using modified live virus vaccine of the Rho-1 strain belonging to the

SAT-2 type, reports on its application in South Africa in an area comprising 80,580 cattle. An outbreak of foot-and-mouth disease had been raging in the central zone of this area for about three weeks, and was showing a pronounced tendency toward expansion.

A wide sanitary cordon was established and the cattle were fire-branded to stop their irregular movements; in addition, an intensive vaccination campaign covering close to 44,000 head of cattle was carried out in the area surrounding the focus. Results indicate that out of the 44,000 head vaccinated in the area not initially infected, only 320 (0.7 per cent) contracted the disease; 18,000 of these cattle were administered a second dose when cases of foot-and-mouth disease were noticed in certain farms among cattle that had been vaccinated six to eight weeks earlier. Within 25 days of the second dose, there was a reduction and total disappearance of these cases. The infected zone had a population of about 43,600 animals, of which 7,954 were vaccinated. Field exposures were conducted on these animals and it was established that 66 per cent of the unvaccinated animals and 37 per cent of the vaccinated animals contracted the disease in the center of the focus.

The results also indicate that although the strain of the virus that was present in the field belonged to a different subtype, it was possible to control the rapid spread of the disease. This categorically proves the extraordinary value of the modified live virus vaccine even under such adverse conditions as those in which it was administered in this case.

Transvaal

Martin and Edwards (cited by Palacios, 7) report that during a field experiment in Transvaal that involved using a live virus vaccine modified by passage in mice (Rho-1 of SAT-2/1 type) and that included 3,400 vaccinated cattle, very slight lesions were observed in only 0.35 per cent of the animals. These researchers did not observe abortions or other reactions that might have been attributed to the vaccine. Although the animals were vaccinated without distinction to sex or age, the virus apparently did not spread to the unvaccinated cattle used as controls. Experiments carried out by the same team (cited by Bachrach, *2*) show that this modified live virus vaccine produced a 91 per cent immunity to its homologous virus in cattle and gave partial protection to an additional 7 per cent. In two experiments carried out with Afrikander and Cebu Kenya cattle vaccinated with the Rho-1 strain (SAT-2/1) intramuscularly and intradermolingually and exposed to the field virus SAT-2/2 and SAT-2/3, it was observed that 70 per cent of the 3,400 Afrikander animals (SAT-2/2) and 63 per cent of the 2,000 Cebu Kenya cattle (SAT-2/3) were protected. These experiments indicate that the modified viruses used would be capable of conferring a high degree of protection from foot-and-mouth disease viruses to adult animals, provided, of course, that the field strain employed did not differ in its antigenic structure from the Rho-1 strain.

South-West Africa

Galloway describes a large outbreak of foot-and-mouth disease diagnosed in Pirbright in July 1961 as belonging to the SAT-1 type. This was the first outbreak diagnosed in South-West Africa (with the exception of a few along the borders of the country) which affected livestock districts in the central region having highly susceptible populations. The hope that sanitary measures and field exposures might control

the disease, as had occurred on other occasions, prevented them from considering vaccination until more than a month after the initial outbreak. By this time, the number of farms affected had increased considerably, complicating the epidemiological picture of the infection of game animals. Because of the grave danger of the spread of the disease, a good deal of anxiety was generated in neighboring countries, especially in South Africa, which was importing some 250,000 to 300,000 cattle on the hoof from South-West Africa.

When vaccination with the RV11 modified strain was begun, almost two months had passed since the initial outbreak and more than 170 farms had been affected. There was an average of 20 new cases daily and this figure promised to soon reach 30 or 40 a day. For initial control of the epizootic, 678,000 doses of modified live virus vaccine were used; in the area bordering around the zone vaccinated with modified live virus, 2,630,000 doses of inactivated vaccine were administered. In spite of the tremendous difficulties met with during the vaccination campaign—such as farms with an area of 6,000 to 7,000 hectares, the impossibility of bringing together all the animals for vaccination, the persistent drought, the spread of the virus by wild animals, the implementation of field exposures, and the difference between the subtypes of the vaccine and the field virus (a difference established by cross-immunization tests in cattle) —a protection of 90 per cent was achieved with the modified live virus vaccines in the areas nearest the outbreak and of 95 per cent with the inactivated vaccine in the areas surrounding that in which the modified live virus vaccines were used.

Dr. J.H.B. Viljoen, Deputy Director of the Veterinary Services of South-West Africa, in an interesting document presented to the International Office of Epizootics in 1964 (*9*), reports on the campaign against foot-and-mouth disease carried out in his country. He states that some 4,490,645 doses of inactivated and modified vaccines were used on cattle, sheep, and goats on a total of 4,798 farms. Of these, some 1,237,000 doses were modified virus vaccines, used particularly for cattle and goats. This was the most extensive campaign to be realized anywhere in the world with this type of vaccine at that particular time (1961-1962). Dr. Viljoen points out that the sanitary control measures implemented included the construction of a 2.59 m barrier to control the movement of animals. This measure, however, was only effective in certain areas, while in others it was useless, possibly because it was constructed very near the known zones of infection. The writer also emphasized the importance of wild animals in the spread of this epidemic and the use of field exposures, which had been useful on other occasions to control outbreaks of foot-and-mouth disease in combination with animal health measures.

The inactivated vaccine was used in the peripheral zone and the modified live virus vaccine near the affected area. Although there were gaps in the immunization, the fight against the disease was completely successful owing to a repetition of the vaccination several times in necessary cases. The epizootic was halted and the disease was completely eliminated in the latter part of 1962. Proofs were obtained that the use of vaccines on infected farms interrupted the course of the disease.

Certain cases of neuromuscular disturbances in sheep, which circumstantial field tests attributed to the application of the modified virus vaccine SAT-1, were discovered. The practice of field exposures, still used in highly contaminated areas, is to be condemned in the fight against foot-and-mouth disease, owing to the impossi-

bility of containing or isolating all susceptible animals, particularly game animals. It is believed that the field exposures put into practice since 1931 have increased the infectiousness of the SAT types of the foot-and-mouth disease virus among game animals.

Guyana

In September 1961 an outbreak of foot-and-mouth disease (type A Vallée virus) occurred in the Rupununi savanna. Ten thousand doses of inactivated vaccine were administered in the affected zone and 5,000 cattle were vaccinated with a modified live virus vaccine (67th passage of the strain of type A_{24} Cruzeiro) in the central area of the outbreak. This measure was taken after preliminary testing of this vaccine with 20 cattle, which showed no postvaccinal effects. Eight hundred of the 5,000 animals vaccinated were individually observed without any reaction whatsoever being discovered.

The modified live virus vaccine, both by itself and in combination with inactivated vaccine, gave the vaccinated cattle excellent protection. Not only did it prevent the spread of the disease, but until the present—eight years later—not a single outbreak of foot-and-mouth disease attributed to type A Vallée has been discovered.

In 1969 Guyana experienced a new outbreak of foot-and-mouth disease diagnosed as belonging to the type O Vallée virus.

Brazil

The headquarters of the Pan American Foot-and-Mouth Disease Center is located in this country, and the following is a summary of the most important studies carried out by that institution and the Biological Institute of São Paulo. Also included are some of the studies conducted jointly with the Veterinary Research Center in Venezuela, particularly as regards the study and application of modified live virus vaccines for type A Vallée virus.

In results obtained with the 66th and 67th passages in rabbits of a type C Waldmann virus (Cunha *et al.*, cited by Palacios, *7, 8*) a low degree of pathogenicity (3/96) and good immunity (91/106) in cattle was observed. In contrast, all swine inoculated contracted generalized foot-and-mouth disease (10/10) and seven of the animals died. While there was no contagiousness among the cattle, it was quite high among the swine.

Other studies were conducted on survival and carriers of this modified type C virus (utilized in a bivalent vaccine with type A Vallée virus, avianized). In these studies, type C Waldmann virus was recovered in almost all the cattle vaccinated, and in some contacts, in various organs and tissues. These observations led to other experiments to study the biological characteristics of this virus. Preliminary results indicate that some of the viruses isolated from carriers (submitted to three serial passages in suckling mice) produced relatively high titers in cattle, accompanied by generalized and vesicular lesions (5/8).

Cattle inoculated with vaccine virus and viruses isolated from postvaccinal reactions could transmit and produce serious vesicular foot-and-mouth disease lesions in swine contacts; swine inoculated with the same virus samples and showing serious lesions did not, however, infect the two cattle that were kept in contact with them (Bernal *et al.*, Augé de Mello *et al.*, cited by Palacios, *7, 8*).

At the Pan American Foot-and-Mouth Disease Center, Bernal and collaborators are studying new strains of type C Waldmann virus, subtype C_3, modified in em-

bryonated eggs and cell cultures at low temperatures. So far, results are encouraging since they show extremely low pathogenicity for swine and cattle, good immunity for cattle, and partial immunity for swine.

The results of studies by Bernal *et al.* (cited by Palacios, *7, 8*) with O Campos strain (type O Vallée, subtype O_1) modified by serial passages in 14-day-old embryonated eggs reveal that pathogenicity decreases progressively, while good immunity is maintained for bovines, even at the 99th passage.

Using data obtained at the 67th, 80th, and 92nd passages of the A Cruzeiro strain (type A Vallée, subtype A_{24}) in 14-day-old embryonated eggs (*3*) Cunha *et al.* and Palacios (cited by Palacios, *7, 8*) indicate that the pathogenicity of this virus for highly susceptible cattle (from zones free of foot-and-mouth disease in Venezuela, Colombia, Ecuador, and Chile) was 16/32 for the virus at the 67th passage, 13/32 at the 80th passage, and 16/104 at the 92nd passage. At the last level, pathogenicity was very low, and in susceptible cattle from an epidemic zone (Brazil) it was even lower: 4/18 and 0/66 for the 67th and 92nd passages, respectively. Good immunity was obtained in all cattle vaccinated, even when the trial inoculation was effected with an antigenically dissimilar virus (subtypes A_{18} and A_{19}). There was no indication of the spread of the infection from vaccinated cattle to susceptible contact animals. This virus still maintains a high pathogenicity for swine at the 113th passage. In a limited experiment with sheep, no postvaccinal reactions were observed at the 92nd passage and the animals were immune.

Duration of immunity in 1- to 2-year old cattle inoculated with a monovalent vaccine (strain A_{24} Cruzeiro, passage 92). Eighty cattle were used in this study, described in the reports of the Pan American Foot-and-Mouth Disease Center (*8*). They were divided into four groups and given the following treatment:

I. One dose of vaccine (30 cattle).
II. Two doses of vaccine at an interval of 30 days (22 cattle).
III. Two doses of vaccine at an interval of 240 days (16 cattle).
IV. Cattle not vaccinated and in contact (12 cattle).

Of all the animals vaccinated for the first time, only one presented a benign postvaccinal reaction. After revaccination no signs of pathogenicity were detected.

In Group I, which received only one dose of vaccine, the following was observed:

Ten cattle showed complete immunity by the 30th day; six out of 10 showed immunity by the 120th day; and five out of 10 also showed immunity by the 180th day. In this last test four contact animals (without vaccination) presented generalized lesions. All four control animals of each experiment reacted and presented generalized lesions.

The curve of antibody levels is represented by the arithmetic mean of the indices obtained from the animals used in the challenge test, which decreases after 30 days, staying close to the immunity level considered to be acceptable up to the sixth month.

The cattle of Group II, tested seven months after revaccination, showed good immunity (8/8), while the four controls generalized. In the test performed one year after revaccination, seven out of nine vaccinated animals remained immune, while the four controls, as well as the unvaccinated contact animals, contracted the disease.

Regarding the cattle of Group III, all showed immunity (7/7) 210 days after revaccination, while the unvaccinated contacts and the four controls presented gen-

eralized lesions. An identical result was obtained one year after revaccination in the test performed with eight vaccinated animals.

In Group II the antibody level stayed above the indicative limit of protection up to seven months after revaccination, diminishing slowly until the 12th month of this test.

Regarding the antibody level, it is interesting to point out that, by coincidence, two curves with marked differences were found referring to the animals used in the challenge test of Group III. One, relating to animals challenged in the 15th month, stayed well above the immunity line; the second one, relating to cattle that were challenged in the 20th month, stayed below the same line. Both groups reacted very well to revaccination in the eighth month and stayed above this line up to 20 months, when this test was finished.

Duration of immunity in calves inoculated with a monovalent vaccine (strain A Cruzeiro, passage 92). The experiment was carried out in 187 calves (3-6 months of age) submitted to two different treatments (report of the Pan American Foot-and-Mouth Disease Center cited by Palacios, *8*).

Group I: 83 calves vaccinated three times, intramuscularly, at 30-day intervals.

Group II: 79 calves vaccinated four times; the first three doses at seven-day intervals and the fourth dose, 90 days after the first.

A third group of 16 calves were kept as contact controls without vaccination. The immunity tests were performed by the inoculation of homologous virus and by studying the seroprotection indices in suckling mice.

The results of postvaccinal reactions showed that 3 per cent of the vaccinated cattle presented benign lesions.

Regarding the immunity measured by the serum antibodies, there was a pronounced increase in the arithmetic mean in the two groups of vaccinated calves.

In both groups the arithmetic mean of the sera studied remained the same up to the 12th month, very near to the line established as indicative of protection.

In Group I it was observed that the antibody levels were at or above the 1.7 line for the sixth and eighth month, thus coinciding with the results of the challenge tests. At the test performed at the 12th month, seven out of the eight cattle used showed antibody indices below 1.5, which could explain the discrepancy between the arithmetic mean of the antibody level of all the remaining animals and the challenge test, which showed only a 1/8 protection level.

In Group II the curve of antibody levels and the challenge test were closely related.

In Group III (unvaccinated calves) the antibody levels were never above 1.7, and in the challenge tests all cattle were unprotected.

Use of bivalent vaccines. An experiment on the duration of immunity in cattle revaccinated with modified A Vallée and C Waldmann virus seems to indicate that immunity lasts up to 360 days, independently of the time between vaccination and revaccination, whether this is a 30- or a 180-day period.

Experiments carried out at the Pan American Foot-and-Mouth Disease Center and the Veterinary Research Center in Venezuela seem to indicate that bivalent vaccines do not present a cumulative effect of pathogenicity nor a decrease in the immunogenic properties of the virus used.

Carriers and survival of some modified live virus in vaccinated cattle. Esophagopharyngeal material from cattle vaccinated and revaccinated with modified live virus

(A avianized and C lapinized) at different intervals (30 and 180 days), as well as a small non-vaccinated group left in contact, were studied for virus isolation through inoculation of suckling mice and cultures of BHK-21, C-13 cells, and their typing by complement fixation.

The data obtained indicate that, although there was a tendency for the number of carriers to be reduced (which after the first vaccination was 16/32 for the group revaccinated in 30 days and 15/49 for the revaccinated group in 180 days), it was possible to isolate the virus up to the 270 days after vaccination (1/49) and apparently revaccination at 30 or 180 days did not increase the number of carriers.

The virus isolated in all cases was C Waldmann, with the exception of a case at the 90th day and another at the 240th day, in which virus A Vallée was isolated.

In experiments performed in order to study three virus isolation methods—inoculation of swine, suckling mice, and tissue culture—the data obtained show that suckling mice and BHK cells seem to be more susceptible than swine and that it was necessary to use these two methods because otherwise it would have been impossible to isolate virus from three or four out of the nine known positive cases.

Some of the calves coming into contact with animals inoculated with bivalent vaccine utilized in this experiment (*1*) became carriers for 180 days. It must be pointed out, however, that this occurred only with type C Waldmann. Another interesting observation made during these studies was the apparent absence of any reciprocal relationship between the concentrations of antibodies and the isolation of virus from carrier animals. Augé de Melo also reports in his study that he succeeded in isolating type C Waldmann virus from unvaccinated calves born of cows immunized during the gestation period and after the birth of the young with trivalent modified live virus vaccines which included the type C Waldmann lapinized strain. The antibody levels of these animals were always below 1. The results obtained with the C Waldmann virus described above, which illustrate the recuperation of pathogenicity of the C virus, its prolonged persistence in carriers, in organs and in tissues, and its contagiousness without clinical signs in cattle and with lesions in swine, led to the elimination of this strain from later research and its complete rejection for field use. The shortcomings of this virus stand out particularly when compared to A Vallée virus, Cruzeiro strain, which, insofar as carriers are concerned, could only be detected in two animals at 90 and 240 days and which was apparently absent in the organs and tissues utilized in the survival studies. Moreover, in various studies carried out by the Pan American Foot-and-Mouth Disease Center, this virus has shown no contagiousness for cattle (both adults and young) or swine.

Table 1 shows the pathogenicity resulting from the application of monovalent and polyvalent vaccines to cattle in the field. This information was gathered by detailed examination of groups of vaccinated animals, as well as by the observation of these animals to determine which of them showed clinical symptoms of the disease.

A great variety of postvaccinal vaccination responses resulted. This variety is explained by the variables existing in the cattle utilized with respect to breeds, ages, state of immunity, etc. Apparently, the number of cattle showing reactions does not increase considerably with the polyvalent virus. In other words, the latter does not appear to produce cumulative pathogenicity. Cunha *et al.* and Palacios *et al.* discovered that the effectiveness of the polyvalent modified live virus vaccines is not

TABLE 1—Pathogenicity resulting from the application of monovalent and polyvalent live virus vaccines against foot-and-mouth disease in cattle in Brazil.

Year	Virus/modification	Vaccinated cattle	Reactors	
			Individual [a]	General [b]
	Monovalent vaccines			
1956–1965	O/Col11	26,685	103/1,434	7/1,159
1963–1965	O/E52-65	4,917	85/ 508	27/1,083
1961–1962	A/E67	669	19/ 103	—
1962–1964	A/E92	11,422	35/ 592	—
1963–1964	O/Co67	2,699	50/ 419	—
	Polyvalent vaccines			
1964	A/E92 O/Col11	2,309	14/ 113	3/ 919
1965	A/E92 C/Co67	7,255	33/ 730	0/1,133
1965	A/E92 O/E106 C/Co67	6,489	31/ 446	5/5,440

[a] All the cattle were carefully examined to detect reactions in the mouth, feet, and so forth.
[b] Field observation to detect any animal which could be clinically affected.

inferior to that of the respective monovalent vaccines.

Observations of a small group of young cattle during a natural foot-and-mouth disease outbreak in one of the farms where previous experiments had been carried out revealed an obvious antigenic difference between O strain modified in rabbits and the same strain modified in chick embryos. At the end of nine months, the former still protected 40 per cent (5/13) of the inoculated animals; the latter protected 70 per cent (9/13). The 70 per cent immunity level was similar to that observed in a group of cattle that had contracted the disease nine months earlier (15/24).

The Biological Institute of São Paulo, Brazil, has carried out research with three modified viruses in monovalent and polyvalent vaccines corresponding to types A and O Vallée and C Waldmann, all modified by passages in embryonated eggs (L. Pustiglione *et al.*, cited by Palacios, *8*).

From 1964 to 1966, type A monovalent vaccine was applied on 120 dairy farms with 30,000 head of cattle formerly vaccinated with inactivated vaccines. The seroprotection indexes were 3.5 to 4.5 over an eight-month period. In 1966 and 1967, bivalent (A and O) and trivalent (A, O, and C) vaccines were administered to 15,000 cattle. No adverse postvaccinal effects were observed and not a single case of foot-and-mouth disease was reported. Antibody concentrations are being studied.

Colombia

Foot-and-mouth disease has been present in Colombia in 1950, when an epizootic of O Vallée virus affected Venezuela and swept from the Apure plains to the Arauca lowlands, spreading rapidly through the entire country. Subsequently, in 1951, a Vallée virus was discovered in the Valle del Cauca Department, Cali district, and again, quickly spread through the country.

At the request of the Government of Colombia, and after testing, it was found that the modified live virus vaccine of the A_{24} Cruzeiro strain was sufficiently attenuated for the cattle of this country; moreover, it gave them excellent protection against the type A Vallée viruses that were present in the countryside. Consequently, it was decided to carry out a limited and controlled vaccination program in the Bogotá savanna with approximately 5,000 to 6,000 cattle forming part of a bovine population of 120,000 Holsteins basically used for milk production.

The results of the five-year application (1963-1967) indicated that when an individual review was made of the animals, postvaccinal reactions, all very benign, were found in 24 out of 296 cattle in 1963 and 50 out of 295 in 1964. Animals with manifest signs formed an extremely low percentage which varied from 0.1 to 0.05 per cent (4/4,499 in 1963 and 2/4,727 in 1964).

In the Bogotá savanna experiments have been made with a vaccine prepared with a strain of O_1 virus (Campos) modified by serial passages in embryonated eggs to the 71st and 100th passage level (*7, 8*). A summary of the results of these tests indicates that the postvaccinal reactions were 31/550 at the 71st passage and 0/396 at the 100th.

During 1966 and 1967, bivalent vaccines were applied to 5,000 and 6,000 cattle, respectively. The results of this application are not yet all available for analysis.

Ecuador

Foot-and-mouth disease, type A, was diagnosed in Ecuador for the first time in 1956 in the so-called Litoral. In this region there are approximately 600,000 head of cattle, mostly of a mixed Cebu-criollo type.

The Andean part of Ecuador, where most of the country's high-grade cattle breeding regions are located, was kept free from the disease until 1967 by means of strict quarantine and sanitary control measures, except for three outbreaks of virus type O Vallée, in 1962, 1965, and 1967, and another of type A Vallée in 1965. The first occurred in the Province of Carchi, and was introduced by cattle that came from Colombia. The second outbreak of type O occurred in the southern Provinces of Loja, Azuay, and El Oro. The third outbreak occurred in the Provinces of Pichincha (Sierra) and Guayas, Los Rios, and Manabí (Litoral).

The outbreak of type A Vallée was detected in Carchi Province in the north of the country. These outbreaks were, however, quickly brought under control by means of mass vaccination in the northern districts with inactivated vaccines and with modified live-virus vaccine type O_1 Vallée (Campos) in the south, coupled with rigorous measures of control on cattle movements.

The Government of Ecuador decided to use a modified live virus vaccine for the control of the outbreaks in view of the encouraging results obtained in Guyana, in Venezuela, and in experiments performed by the Pan American Foot-and-Mouth Disease Center in Brazil.

In cooperation with the Center, steps were taken to obtain the necessary knowledge for both production of the vaccine and its use in the field. The first step was a potency test of the A_{24} Cruzeiro vaccine (90th passage) in a small number of cattle, at the Foot-and-Mouth Disease Institute in Guayaquil. Twelve fully susceptible young steers were vaccinated. Four others were left without vaccination in close contact with the vaccinated animals. None of the vaccinated animals showed lingual or hoof lesions. Three weeks after vaccination all animals were inoculated intradermolingually with $4 \times 10{,}000$ $LD_{50/rl}$ of a pathogenic virus strain isolated in Ecuador. None of the vaccinated animals showed signs of generalization, but the four contact animals presented generalized lesions.

After this preliminary and successful test, controlled and limited field trials were made.

These field trials were performed first on a small scale at the farm called "La Paz" and later in the areas of Barranca Chica and Hacienda El Recreo, where vaccination against foot-and-mouth disease had never been applied.

The total of animals found with reactions was 44. However, only three of those

animals were reported by the farmers. All other reactors were found only after careful inspection of the mouth and hoofs; they had been undetected by the farmers because of the absence of significant salivation or lameness.

The percentage of animals with lesions in the Barranca Chica area (43/312) was greater than that observed in El Recreo (1/126). The explanation for this must be the fact that the farms in Barranca Chica were stocked mainly with cattle from the disease-free Andean region, whereas at the Hacienda El Recreo outbreaks of the disease had been reported a year previous to the vaccination. There were also two farms in Barranca Chica in which type A virus was diagnosed a year previous to the vaccination. No reactors were found on these farms.

Although theoretically the group of animals between 6 months and 1 year old must be without maternal or any other antibody, the animals vaccinated within this age group were the ones that showed the lowest rate of reactors (0/38). Unfortunately, the small number of calves that were actually inspected on the farms in the Barranca Chica area was too small to warrant a definite conclusion regarding the relative unsusceptibility of this group to the vaccine, compared with older cattle. There was no drop in milk production, and no abortions or deaths occurred. Of all reacting cattle, only three animals were indicated by the farmers as having lesions.

In February 1967 an outbreak of virus type O Vallée appeared in Pichincha Province (near Quito) and spread to other farms in the Province of Cotopaxi and in Cayambe (Sierra).

New outbreaks appeared later in the Litoral in the Provinces of Guayas, Los Ríos, and south of Manabí. Faced with this emergency, the Ecuadorian animal health authorities applied the plan of action previously used successfully in the 1965 outbreak in Loja, Azuay, and El Oro Provinces. This plan covered three zones:

1. The infected zone, where cattle were vaccinated with modified live virus vaccine (avianized strain O Campos, passages 101-106).

2. The suspected zone, surrounding the first zone, where cattle were vaccinated partially with modified live virus and partially with inactivated vaccine (Waldmann type) followed by modified live virus vaccine.

3. The protection zone, surrounding the second zone, where cattle were vaccinated with inactivated vaccine, followed by modified live virus vaccine.

The first outbreak was diagnosed on 8 February 1967 on a farm in Pichincha Province (infected zone); the second appeared at a distance of 45 km from the first. The disease spread rapidly to other farms and about 50 new outbreaks were reported in the first 28 days (nearly two farms infected every day). This infected zone has excellent conditions for rapid propagation of the disease: cattle with no previous history of infection; an extensive network of roads with heavy circulation of vehicles for transport of animals and animal products; and the existence of small country roads between farms, allowing a heavy circulation of people and animals.

During the vaccination of cattle within the infected zone, it was impossible to determine exactly the number of farms in which the cattle were in the incubation period of the disease, or were infected during the period when the vaccine was not yet protecting them adequately. For this reason it was impossible to determine which of the animals were infected by the field virus and which really had postvaccinal reactions.

In the suspected zone (in which there

were fewer outbreaks than in the first zone), the use of the modified live virus vaccine produced a small number of postvaccinal reactions, ranging from 3 to 7 per cent. This acceptable percentage is completely different from the one found in the infected zone, where the average varied between 5 and 45 per cent in some cases. The unusual proportion of affected cattle following vaccination in the latter zone, as compared with that in the suspected zone, was due to the conditions previously described for both zones. In the remaining parts of the suspected zone and in the protection zone where similar treatments were applied, postvaccinal reactions were not significant.

The situation in the provinces of the Sierra indicated that the use of the vaccines, together with the sanitary measures, resulted in the rapid control of the disease and prevented its spread.

Sixty-seven outbreaks were reported between 7 March and 29 April in the Litoral provinces, and about 30,000 head of cattle are estimated to have been infected before the administration of modified live virus vaccine. Vaccination of these cattle was delayed by the floods produced by heavy rains (Lombardo *et al.*, cited by Palacios, *8*).

During 1967, 1,099,902 doses of vaccine, particularly modified live virus vaccine, were applied and the immediate spread of the disease to the Provinces of El Oro, Esmeralda, and the remainder of Manabí was prevented.

In the course of 1968 outbreaks of type O Vallée subtype O_1 and type A Vallée subtype A_{27} appeared in Manabí, Pichincha, Cotopaxi, Los Ríos, and Imbabura. A Vallée virus was diagnosed in Carchi, Esmeralda, and Guayas.

It is noteworthy that owing to various circumstances, Ecuadorian authorities could carry out only 32 per cent of the vaccination program in 1968, and only 845,211 doses of vaccine were administered.

Because of these events, there was a nationwide epizootic for the first time in 1969, and a great deal of anxiety was generated at all levels. The Pan American Foot-and-Mouth Disease Center (*11*) conducted a study which was presented to the corresponding officials in July 1969, in which the following observations were made:

1. In the cases examined in well-cared-for herds that had undergone systematic vaccination with some type of vaccine (modified or inactivated) a low incidence and only slight losses were observed.

2. Higher morbidity, more lesions, and greater losses were observed in herds subject to deficient handling and irregular and/or incomplete vaccinations.

3. Total serious attacks (frequently 100 per cent morbidity), with high mortality and large economic losses, were observed on farms that, according to cattle raisers and veterinarians, were not vaccinated.

4. Cases were recorded in which vaccines (inactivated or modified) were administered when the cattle were already sick or in the middle of the incubation period. This was shown by the appearance of vesicular lesions in the days immediately following application of the vaccine.

5. No indications were found that the modified virus had produced outbreaks of the disease or any other adverse effects.

Chile

In light of the interest that the modified live virus vaccines could have for Chile, the encouraging results of other countries, and the experimental trials previously carried out, in which domestic cattle showed excellent immunity to local viruses and only slight pathogenicity, a field application pro-

gram was planned for the Province of Llanquihue.

Modified live virus vaccine prepared with A_{24} Cruzeiro strain, passage 92, was administered in 5,587 red and white Holstein cattle; it was complemented three weeks later with inactivated bivalent vaccine against O Vallée virus and C Waldmann virus. Out of 670 individually controlled animals, 14.1 per cent were found to have postvaccinal lesions; 4.1 per cent of these had vesicular characteristics, while the other 10 per cent were of the desquamative type.

Seven cases of benign anaphylactic reactions and two abortions occurring between the 4th and 6th days after vaccination were also observed. These animals, however, showed no lesions that could be attributed to the vaccine applied.

TABLE 2—Annual distribution of foot-and-mouth disease outbreaks in Venezuela, 1950–1969.

Year	Type of virus		Total
	O	A	
1950	38	—	38
1951	58	5	63
1952	21	—	21
1953	6	1	7
1954	5	6	11
1955	—	—	—
1956	53	10	63
1957	31	48	79
1958	28	12	40
1959	30	—	30
1960	72	4	76
1961	32	7	39
1962	94	88	182
1963	41	31	72
1964	43	12	55
1965	33	4	37
1966	77	8	85
1967	46	21	67
1968	63	5	68
1969	33	48	81
Total	804	310	1,114

Venezuela

Foot-and-mouth disease (type O Vallée) made its first appearance in Venezuela in 1950, spreading rapidly through most of the midwestern portion of the country. It has maintained its enzootic character in this region up to the present.

Type A Vallée virus was discovered in two zones, in the north (Puerto Cabello, 1951) and along the border with Colombia (Táchira, 1954). It spread from the border to the midwest following an epizootic outbreak in late 1956 and during 1957. From that time forward, the presence of both types of virus has become normal. Until recently there was a zone subject to sporadic outbreaks, comprising the eastern states, and another area free of the disease, made up of Bolívar State and the Amazon and Delta Amacuro Territories. Table 2 shows the number of outbreaks reported from 1950 to 1969, which total 1,114 for both types: 804 of O virus and 310 of A virus. The years in which the greatest number of outbreaks of O type occurred were 1950, 1951, 1956, 1960, 1962, 1966, 1967, and 1968. Until 1967 only subtype O_3 was known, and in that year subtype O_1 made its appearance.

The greatest incidence of A Vallée virus occurred in 1957, when it spread through the enzootic zone; in 1962, when the new subtype A_{18} Zulia appeared; and in 1969, when new areas were infected, almost certainly due to the appearance of a new subtype (Venezuela 1970).

Venezuela undertook a campaign against the disease in 1950. Production of vaccine began in 1951 with the use of inactivated Waldmann type. In that year, vaccinations totaled 2,411,600 doses.

In June 1962 an epizootic outbreak of A Vallée virus affected the southern part of Zulia State. The information obtained seems to indicate that it was the continuation of a focus found some months earlier in the Perijá district of the same state. The characteristics of this outbreak showed that the Waldmann vaccine, produced until that

time from the A Vallée Táchira strain, did not provide adequate protection against the new virus. A survey cited by Palacios (*7, 8*) covering approximately 6,000 animals (vaccinated several times during 1961 and 1962) revealed that 79 per cent of them contracted the disease, with a range of from 44 to 94 per cent on the different farms. This observation was confirmed by immunity tests done at the Veterinary Research Center of Venezuela. Serologic studies carried out at the Pan American Foot-and-Mouth Disease Center and the Venezuelan Center demonstrated a great difference between the strain of virus used in the production of the vaccine and the one found in the field. These results were confirmed by the World Reference Laboratory at Pirbright, England, and the new subtype was classified as A_{18} (Zulia).

Because of the danger of spread of the disease through the techniques used for the preparation of the Waldmann-type vaccine (inoculation of cattle in slaughterhouses located in the center of the country), the possibility of using a modified live virus vaccine was considered. Studies performed at the Pan American Center and at the Venezuelan Center had shown promising results with strains modified through serial passages in chick embryos and day-old chicks. Strain A Cruzeiro (subtype A_{24}) modified by Zahran and Bernal (cited by Palacios, *7, 8*) was selected for the first trials. Good protection was obtained with the use of this virus against strain A_{18} (Zulia), as well as an acceptable degree of postvaccinal reactions.

In December 1962 a total of 500,000 doses were administered to the major dairy cattle herds, in the central and western areas of the country (Villegas, cited by Palacios, *7, 8*). Later on, when more experience had been gained in the laboratory, it was found that, in order to obtain good immunity with virus from the 92nd passage, it was necessary to inoculate more than $10^{7.0}$ $LD_{50/rl}$, a requirement that made it very expensive to produce the vaccine using embryonated eggs. Further studies with fewer passages showed that it was possible to obtain good immunity with virus from the 67th and 80th passage levels, titers ranging from $10^{5.6}$ to $10^{6.7}$ $LD_{50/rl}$ per vaccinating dose.

Postvaccinal reactions with passages 92 and 80 were studied by Villegas and found to be, respectively, 0.81 per cent (297/36,663) and 2.33 per cent (99/4,243). In general, these reactions were mild.

The administration of this vaccine controlled the new epizootic, confining it to Zulia State, which has a cattle population of about 1,000,000 animals. Through mass vaccination in the enzootic area, it was possible to prevent the disease from spreading to the rest of the country, where the cattle population amounted to 5.5 million head.

There have been very few outbreaks of type A Vallée since 1963 and subtype A_{18} has not been found since 1962.

In 1967 the virus subtype A_{27} was diagnosed in Colombia. Fearing the possibility of infection in Venezuela, a joint study was undertaken by the Pan American Foot-and-Mouth Disease Center and the Veterinary Research Center to determine the degree of protection afforded cattle by the modified A_{24} Cruzeiro virus against the new subtype.

Bernal, Balestrini, *et al.*, in studies not yet published, found that the 80th passage is capable of conferring acceptable protection in cattle 30 days after vaccination with titers of $10^{6.6}$ and $10^{7.4}$ $LD_{50/rl}$, respectively, while at the 92nd passage the specific immunity induced against the new subtype was inadequate (Table 3). Both passages produced highly effective specific immunity against their homologous subtype. Studies on the duration of immunity were also con-

TABLE 3—Pathogenicity and immunity results in cattle using two passage levels of modified A_{24} Cruzeiro live virus.

Passage	No. of cattle	$LD_{50/r1}$ inoculated [a]	Pathogenicity	Immunity to: Virus A_{24} Vaccinated	Virus A_{24} Controls	Virus A_{27} Vaccinated	Virus A_{27} Controls
80	8	6.6	1/8	—	—	6/8	—
	8	7.4	5/8	—	—	6/8	—
92	8	6.5	0/8	—	—	1/8	—
	8	7.2	1/8	—	—	3/8	0/4 [b]
80	8	6.6	1/8	7/7	—	—	0/4
	8	7.6	4/8	8/8			
92	8	6.5	0/8	8/8			
	8	7.5	0/8	8/8	0/4		

[a] Log. 10 of the $LD_{50/r1}$ inoculated per vaccine dose.
[b] Cattle in contact during the 30 days of vaccination. Exposure with 10,000 $LD_{50/r1}$ intradermolingually.

ducted by the same researchers, and it was shown that eight months after revaccination 50 per cent of the animals used in the test were immune to the heterologous subtype (8/16) and 75 per cent were immune to the homologous virus (12/16).

These tests apparently explain why the A_{27} virus has not posed a serious threat to zones such as Aragua State which are well vaccinated twice a year.

In the early months of 1970, A Vallée virus was diagnosed in samples taken in various states (Bolívar, Apure, Monagas, Zulia, and Amazon Federal Territory). When the samples were sent to the Pan American Foot-and-Mouth Disease Center for subtyping, a new subtype for South America, which we shall call Venezuela 1970 until the World Reference Laboratory assigns it a number, was discovered. Research was immediately begun to determine what protection the modified vaccines would give cattle against the new subtype. As some of the zones affected by the new virus were freed or are free of foot-and-mouth disease, it was thought advisable to import a small batch of 10,000 doses of inactivated bivalent vaccine.

Immunity was tested by direct intradermolingual challenge in cattle, 21 days

TABLE 4—Studies on immunity in cattle induced by bivalent modified live virus vaccine (A_{24} Cruzeiro, passage 80, and O_1 Campos, passage 73).

Vaccines	$LD_{50/r1}$ or ml [a]	Immunity against: Virus A Venezuela 70 Protection [b] Vaccinated	Controls	Virus A_{24} Cruzeiro Protection Vaccinated	Controls
Bivalent modified live virus $A_{24} - O_1$	$A_{24}^{6.8}$ $O_1^{6.4}$	2/9	0/4	7/8	0/4
Inactivated bivalent A-C (imported)	10 ml subcut.	4/10		—	—
	50 ml subcut.	3/3	0/4		

[a] In suckling mice, applied in doses of 4 ml of vaccine (2 ml each virus).
[b] Number protected. Number vaccinated.

TABLE 5—Results of pathogenicity, immunity, and contagiousness tests in cattle and swine inoculated with foot-and-mouth disease vaccine (modified through serial passages in chick embryo and in day-old-chicks, virus type O Vallée, subtype O_3, strain O Lara).

Preparation of vaccines		Testing							
		Cattle				Swine			
Passage No.	Material used	LD_{50} p/dose	Pathogenicity	Immunity [a]	Contagiousness	LD_{50} p/dose	Pathogenicity	Immunity	Contagiousness
101–103	Embryo, day-old chick heart, gizzard [b]	5.2–7.3	43/174	124/143	0/14	5.9	6/6	9/10	4/6
162–163	Day-old chick-heart	5.4–8.3	0/ 54	42/ 51					
182	Day-old chick-heart	6.0–7.5	0/ 12	12/ 12					
202	Day-old chick-heart	6.2–8.3	2/ 24	16/ 24			6/6		
301	Day-old chick heart	5.8–7.6	0/ 6	5/ 6			6/6		

[a] Tested by inoculation of 2 × 10,000 LD_{50} (pathogenic virus, suckling mouse).
[b] By seroneutralization tests.

after vaccination, using the modified Henderson-Galloway technique.

The results, given in Table 4, show that while the modified live virus vaccine continued to confer adequate protection against its homologous virus, as shown by the protection from generalized lesions (7/8), the protection in this experiment against the Venezuela 1970 virus (2/9) was deficient. This seems to confirm the serologic results obtained by the Pan American Foot-and-Mouth Disease Center.

The inactivated vaccine was not tested against its homologous virus since the latter was not available, but it is believed that it may contain the subtype A_{27}.

The results obtained using this vaccine at the normal dosage of 10 ml, administered subcutaneously in cattle, were very similar to those produced by the modified live virus vaccine. Protection from generalized lesions was 4/10. In testing the innocuity of the inactivated vaccine, four cattle were used to obtain 80 negative results to the intradermolingual inoculation as a minimum requirement for vaccine innocuity. Moreover, they were inoculated subcutaneously with 50 ml, i.e., five times the normal dosage. Three of these cattle, which were in good health, were also inoculated with the Venezuela 70 virus. They were all protected from generalized lesions and had no local lingual lesions whatsoever.

Research will go on in order to find the degree of protection of modified live virus vaccines with a greater antigenic content ($10^{7.5}$ and $10^{8.5}$ $LD_{50/rl}$), as well as the effects of revaccination and the duration of immunity.

Table 5 refers to the results obtained by Palacios *et al.* (cited by Palacios *7*, *8*) using the O Lara strain (type O Vallée, subtype O_3) modified by serial passages in embryonated eggs and day-old chicks. At passages 162 and 163, a marked decrease in pathogenicity for cattle was recorded. Good immunity in cattle inoculated with virus from all the passages studied, with the exception of passage 202, was obtained. Susceptible cattle in contact with vaccinated animals did not contract the disease. The patho-

TABLE 6—Experimental field application of foot-and-mouth disease in cattle in the enzootic zone of Calabozo, Venezuela (passages 101–103 in embryonated eggs and day-old chicks, virus type O Vallée, subtype O_3 strain O Lara).

Year	No. of cattle vaccinated	LD_{50}	Pathogenicity	Contagiousness	Remarks
1961	3,729	6.7	3/ 3,729	0	No contagiousness noted
1962	6,417	6.0	7/ 6,417	0	No contagiousness noted
1963	10,928	6.7	0/10,928	0	One bovine showed symptoms of anaphylactic shock
Total	21,074	6.0-6.7	10/21,074	0	

genicity of this virus for swine is very high, even at passage 301.

Table 6 summarizes data obtained by Palacios *et al.* (*7, 8*) in the experimental application of the viruses of passages 101-103 in natural conditions in an enzootic zone in Venezuela. Only 10 cattle, or 0.05 per cent of the 21,074 animals vaccinated showed foot-and-mouth disease lesions. This remarkably reduced pathogenicity, in comparison with the percentage mentioned in the previous table, appears to be related to the fact that these animals had been previously inoculated with inactivated vaccine, from one to three years prior to the application of the modified live virus vaccine.

The production of modified live virus vaccine using the Lara strain of the O Vallée virus (modified by serial passages in day-old chicks and embryonated eggs) was begun at the end of 1964, using virus of passages 101-103. The use of this vaccine on a large scale was followed by some post-vaccinal reactions. While the percentages recorded (0.3 to 1.5) were quite low in comparison with the total number of animals vaccinated, they were higher than expected in some farms, particularly among purebreed animals. Consequently, after studies made by the Veterinary Research Center of Venezuela (mentioned previously, Table 5), a vaccine was administered in 1965 which was prepared with virus from passages 162 and 163 in day-old chicks. Since that time, no adverse reactions have been reported in vaccinated cattle.

To maintain immunity, vaccination is effected in Venezuela every six months. Field observations, conducted since 1962, with the application of 39,706,042 doses of A_{24} Cruzeiro vaccine and 33,470,602 of type O, subtype O_3 (Lara) and O_1 (Campos) (Table 7) seem to confirm that this interval is adequate. It has been observed that outbreaks occurring during the 1962-1969 period in areas or farms where animals had been vaccinated every five to seven months generally have given evidence of good resistance to the disease. The same has held true in laboratory experiments in which animals revaccinated with the O_1-Campos strain have shown immunity for up to 10 months.

The most serious problem related to the application of modified live virus vaccine in cattle was the appearance of anaphylactic shock. Preliminary data from a survey

TABLE 7—Vaccine doses against type A and O Vallée of foot-and-mouth disease used in cattle in Venezuela, 1962-1969.

Year	Vaccine doses Type of virus A	O	Total
1962	801,640	—	801,640
1963	3,663,445	—	3,663,445
1964	4,135,510	2,067,755	6,203,265
1965	4,716,355	4,716,355	9,432,710
1966	4,222,550	4,519,900	8,742,400
1967	8,444,677	8,444,677	16,889,354
1968	6,369,200	6,369,200	12,738,400
1969	7,352,715	7,352,715	14,705,430
Total	39,706,042	33,470,602	73,176,644

covering 18,275 animals revealed that the percentage of anaphylactic shock was 1.5. In various areas, a considerable increase was observed between the first and second doses of vaccine. According to a study of 13 farms in the central region, the incidence rose from 0.03 per cent (2/5,739) to 2.1 per cent (114/5,394) during the second vaccination, an increase of about 70 times (Goic, cited by Palacios, *7, 8*).

The studies carried out jointly at the Pan American Foot-and-Mouth Disease Center and the Venezuelan Veterinary Research Center resolved this problem by discovering that the anaphylactic reactions were due to the antibiotics used in the vaccine (penicillin and streptomycin) (Quiroz *et al., 7, 8*).

Once the vaccines were used without these antibiotics, no anaphylactic reactions were observed during the administration of some 35,000,000 doses of modified live virus vaccine A_{24} Cruzeiro and 33,400,000 doses of type O in the years 1964-1969.

In 1965-1966, outbreaks of type O Vallée virus which principally affected swine were reported. When a higher incidence than was expected was produced in cattle in 1966, more thorough serologic studies of the natural strain were conducted. These studies revealed that the field virus was a different subtype from that commonly found in Venezuela since 1950, and it was classified as subtype O_3. This new virus had the serologic characteristics of the subtype O_1.

The information obtained at the Veterinary Research Center (Bello, cited by Palacios, *8*) indicated that the vaccine prepared with O Lara strain (subtype O_3 modified by passages 162 and 163 in day-old chicks) provided from 80 to 100 per cent protection against the homologous virus in various experiments with 25 head of cattle. These results confirmed once more those obtained previously by Palacios *et al.* The same vaccine, challenged with the heterologous virus (new O_1 strain), provided only 28 per cent protection in experiments carried out with 32 head of cattle.

The Pan American Foot-and-Mouth Disease Center sent the O Campos strain (subtype O_1) modified in embryonated eggs to Venezuela for study. Research covered passages 101, 74, and 72. From Table 8 it can be seen that only passages 72 and 74 con-

TABLE 8—Results of immunological studies in Venezuela in cattle inoculated with different vaccines of type O modified live virus.

Vaccine	$LD_{50/r1}$ per dose	Pathogenicity	Immunity
O CaR14 B2 E101	$10^{7.7}$/5ml	1/6	1/6
	$10^{6.9}$/5ml	0/6	3/6
	$10^{6.3}$/5ml	1/6	3/6
O CaR14 B2 E72	$10^{7.7}$/5ml	2/6	4/5
	$10^{6.8}$/5ml	2/6	4/6
	$10^{6.4}$/5ml	2/6	5/6
O CaR14 B2 E74	$10^{7.7}$/5ml	4/10	7/9
O CaR14 B2 E101 + O Lara P163	$10^{7.7}$/5ml + $10^{7.5}$/5ml } 10ml	1/10	2/10
O CaR14 B2 E101	$10^{7.4}$/5ml × 2	2/8	3/8
O Lara P163	$10^{7.7}$/5ml × 2	0/8	0/8
Control animals	—	—	0/8

Note: Test inoculation LD: 4×10^3, 4 LD_{50} pathogenic virus modified in successive passages in suckling mice.

ferred adequate protection against the new natural strain. Likewise, it was apparent that neither the vaccine prepared with a mixture of the O Lara (O_8, passage 163) and the O Campos (O_1, passage 101), nor revaccination at two-week intervals with one or the other strain, offered sufficient protection against the natural strain (*4, 5*).

According to information obtained from the Ministry of Agriculture and Livestock of Venezuela, no significant postvaccinal reactions were produced by the administration of 22,000,000 doses of bivalent modified vaccine prepared with O Campos virus (passage 74) and Cruzeiro virus (passage 80) from 1967 to 1969. Solid immunity, however, was obtained when the vaccine was correctly applied and contained the necessary minimum amount of antigen (about $10^{6.5}$ $LD_{50/rl}$ per dose).

Observations made in 1967 in Aragua State, a dairy-farming area well controlled by means of periodic vaccination against foot-and-mouth disease (Romeda Rada, cited by Palacios, *8*), indicated that the new vaccine applied to 19,744 head of cattle produced very slight postvaccinal reactions in 32 animals belonging to four farms whose bovine population was 1,578 head (2 per cent). At the same time, it was noticed that during outbreaks of foot-and-mouth disease (type O) on two farms that raised both cattle and swine (the former vaccinated), the disease affected only the swine.

In a study currently in preparation on the duration of immunity, Bernal, Balestrini, and collaborators report that in cattle revaccinated with bivalent modified live virus, Campos strain, passage 74, highly satisfactory immunity could be conferred for up to 10 months. This is based on the high percentage of protection (24/32) conferred against intradermolingually challenged pathogenous virus.

Summary and Conclusions

Research on the various modified live virus vaccines and their large-scale application in various parts of the world has shown them to be one more weapon for use in the fight against foot-and-mouth disease in cattle, independently or in conjunction with inactivated vaccines.

Applications in the Middle East, Africa, and South America have shown that in spite of some postvaccinal reactions in cattle, their application in active foci has succeeded in halting the disease or interfering with its spread.

Some modified live virus vaccines have even shown an ability to immunize cattle against heterologous subtype viruses. A truly interesting case is that of the A_{24} Cruzeiro strain which, at least in this study, has conferred protection against three different subtypes (A_{18}, A_{19} and A_{27}). Revaccination produces a better and longer lasting immunity, which may endure almost one year against homologous viruses. The application of polyvalent vaccines does not seem to increase pathogenicity nor to interfere with the production of antibodies.

So far, there is no proof for attributing any outbreak of foot-and-mouth disease in cattle to the modified vaccines; nevertheless, it is important to point out that subtype A_{24} has been applied in Venezuela since 1962 without that virus ever having been diagnosed in the field. It is interesting to note that when O_1 virus appeared in the country in 1966, a vaccine produced with O_3 virus was being used. As for swine, Venezuela has had three cases of transmission of the O_3 modified virus to that species, which lives in close contact with the cattle, one of which was corroborated by laboratory tests. Three cases, however, do not represent a very significant figure in a vaccination campaign that administered

39.7 million doses against type A Vallée virus and 33.4 million doses against type O Vallée.

Immunity in young cattle continues to be a problem even with this vaccine, but studies mentioned here seem to indicate that monthly vaccinations (three times) could extend immunity up to five or six months.

Although the live virus vaccine constitutes a useful weapon, this does not mean that there are not many other aspects that require serious study. Perhaps the most important is the development of a method that permits a rapid, short-term modification of field strains which, because they are so different from the subtypes in the vaccines administered, break the immunity imparted by the modified vaccines. Outstanding examples are of those of Israel, where animals were vaccinated with the modified A_{10} strain and the A_{22} strain appeared, and Venezuela, where subtype O_1 emerged when animals were vaccinated with O_3. Another solution might be the establishment of an international center or organization that would have a bank of modified strains with a wide range of protection such as is the case with the A_{24} Cruzeiro virus.

More thorough studies should be undertaken in connection with the problems of carriers and the survival of modified viruses in tissues. The modified strains should also be looked at more closely, since it appears that their behavior differs.

A certain number of markers for each strain are necessary in order to discover its behavior with regard to carriers and other epidemiological problems. It is also necessary to increase research in order to better understand the behavior of these modified strains when they are utilized on other species of animals such as swine and sheep.

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ACCIDENTS AND REACTIONS OBSERVED IN FOOT-AND-MOUTH DISEASE VACCINATIONS

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A discussion of the accidents and reactions that may be observed after vaccination of cattle against foot-and-mouth disease demands a short description of the kinds of vaccines most frequently used in the field. Table 1 offers a schematic survey. In principle, we must distinguish between "inactivated vaccines" and "live vaccines." The latter were discussed in detail by Dr. Palacios. I shall restrict my contribution to the "inactivated vaccines." These are based on the classical Waldmann-Köbe-Pyl vaccine which consists of virus harvested from tongue lesions of infected cattle; the virus is adsorbed onto colloidal aluminum hydroxide and is then inactivated by formalin and heat. Later, Frenkel replaced the costly source by growing the virus in surviving fragments of bovine tongue epithelium. With the development of cell monolayer cultures in which virus can propagate, it became possible to use them also for the production of foot-and-mouth disease virus. At present, permanent cell lines, mostly BHK-21 cells cultivated on glass surfaces or in suspension, and primary cultures derived from calf kidney are used. Furthermore, some industrial houses and laboratories changed the inactivation procedure; inactivation in these places is performed by using acetylethylenimine, β-propiolactone, or hydroxylamine. Finally, an attempt was made to replace aluminum hydroxide by saponin or—as is done frequently—to enhance the adjuvant effect of aluminum hydroxide by the addition of saponin. Considering the accidents and reactions, it should be mentioned that foot-and-mouth disease

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TABLE 1—Types of foot-and-mouth disease vaccines most frequently used for vaccination of cattle.

	Type	Virus source	Inactivation	Adjuvants, adsorbents
Inactivated vaccines	Waldmann-Köbe-Pyl	Aphthae of cattle	Formalin and heat	Aluminum hydroxide
	Frenkel	Cultured tongue epithelium of cattle	Formalin and heat	Aluminum hydroxide Saponin
	Tissue culture: Permanent cell lines	Baby hamster kidney (BHK)	Acetylethylenimine Formalin β-propiolactone Hydroxylamine	Aluminum hydroxide Saponin Oil adjuvants
	Primary cultures	Calf kidney		
Live vaccines	Attenuated by passages in: Suckling or adult mice; rabbits; eggs; eggs and chicken; calf kidney cell cultures.			

vaccines, besides their three main ingredients (virus, substance used for inactivation, and adjuvant), contain organic matter derived from the tissue or cells used for virus propagation, and they may also contain admixtures such as antibiotics, tissue culture fluid, glycerol, vitamins, polyglycols, methyl cellulose, Tween-like compounds, and silicons.

Postvaccinal complications can generally be classified into three main groups, as listed in Table 2 (*3*). Complications in groups 1 and 2 occur very rarely, provided that innocuity and immunizing potency of the vaccines are controlled by forceful regulations before their use in the field. Most accidents and reactions are due to so-called vaccinal damages; they include allergic reactions, disturbances of pregnancy, local reactions at the site of inoculation, stress caused by the mere act of vaccination, and changes in milk quality. Considering first the influence of a foot-and-mouth disease vaccination on the quantity and quality of milk, it can be stated (*6*) that vaccination usually does not lead to a reduction of the quantity, but that there may be an increase in the fat concentration, a prolongation of the lab-coagulation time, and a decrease of protein and sodium contents in the first two milkings after vaccination. Local reactions at the site of inoculation occur regularly and are mainly caused by the aluminum hydroxide (*4*). These tissue reactions may on rare occasions become infected and result in the formation of local abscesses, or phlegmons, but they usually disappear within weeks with no complications. Stress caused by the act of vaccination is a small risk associated with any injection whatsoever and thus warrants no comment. The most severe vaccinal damages are due to allergic reactions and to abortions.

TABLE 2—Postvaccinal complications.

1) Disease due to unsafe vaccine, i.e., vaccine which still contains residual infectious virus.
2) Foot-and-mouth disease infections due to incomplete immunity.
3) Vaccinal damages.

Considering the allergic reactions, we must distinguish between reactions of the immediate type and of the delayed type.

Allergic reactions of the immediate type appear within seconds to minutes or with a delay of six to eight hours after vaccination (*3*). They are clinically characterized by restlessness, sweating attacks, trembling, asthmatic coughs, angino-neurotic edemas developing at eyelids, lips, the vagina, lungs, the brain, and joints; furthermore, salivation, acute circulatory insufficiency, shock, and local or generalized swelling of the skin with a nettle-rush-like urticaria are observed. The urticaria is often overlooked because it frequently disappears after one to two hours. Usually, all low- to high-grade skin reactions fade away five to six hours after their appearance, without any medical treatment. Animals showing the shock syndrome may suddenly die. If therapy is necessary, antihistaminics, cortisone, circulation drugs, and sodium bicarbonate may prove beneficial.

The clinical picture of the delayed-type reactions is characterized by weeping eczema, which may be local or generalized (*3*). These eczemas appear from several days up to three weeks after vaccination and may persist for a number of weeks. They are seen at the neck, dorsum, vulva region, udder, hind extremities, and mouth region. In the latter case, the first symptoms may be confused with foot-and-mouth disease, mucosal disease, and malignant catarrhal fever.

A significant increase in the frequency of allergic reactions after foot-and-mouth disease vaccination was observed in 1967 and 1968 in the Federal Republic of Germany. In 1967 a program was begun in which all

cattle more than six weeks old were vaccinated once a year with trivalent vaccines composed of inactivated foot-and-mouth disease virus types O, A, and C. In the course of this program, 14 to 15 million cattle are to be vaccinated each year. First reports (*3*) on the increase of allergic reaction came from Bavaria in 1967 and were soon confirmed from other states of the Federal Republic (*5*). It was noticed that allergic reactions occurred more frequently in cattle vaccinated with BHK-type vaccines than in those immunized with Frenkel-type vaccines. This is illustrated in Table 3. It can be seen that in Bavaria in 1967 3,021,758 cattle were immunized with a BHK-type vaccine; 33 out of 100,000 vaccinated animals responded with an allergic reaction of the immediate type, i.e., 996 animals. Nine out of 100,000 showed symptoms of a delayed-type reaction; in this group, 1,238 cases of abortion were reported, i.e., 41 cases in 100,000 vaccinated animals (*3*). By comparison, vaccinal damages were less frequently encountered in the group of animals immunized with a Frenkel-type vaccine. In the following year, 1968, the number of animals responding with a delayed-type reaction increased. The data from the other states of the Federal Republic (*5*) are based on an upper estimate and demonstrate, as in Bavaria, that the percentages of vaccinated animals showing symptoms of allergic reactions were higher in the two groups of animals immunized with BHK-type vaccines than in the two groups of animals immunized with one of the two Frenkel-type vaccines. By 1969 most of the animals had been vaccinated with Frenkel-type vaccines; as a result, the incidence of allergic reactions dropped by a factor of about 10 as compared with the groups of animals vaccinated with BHK-type vaccines in 1967 and 1968 (*5*). Summarizing the data presented, it is evident from Table 3 that immunization with BHK-type vaccines was followed by a significantly higher incidence of allergic reactions than was immunization with Frenkel-type vaccines. Allergic reactions after BHK-type vaccination occurred in the range between 0.07 and 0.09 per cent; reactions of the delayed-type were predominant, reaching values between 0.05 and 0.08 per cent.

The observations mentioned raise three main questions:

TABLE 3—Allergic reactions and disturbances of pregnancy after foot-and-mouth disease vaccination.

State	Year	Types of vaccines	Number of vaccinated animals used for statistical evaluation	Allergic reactions (number of affected animals in 100,000 vaccinated animals)		Disturbances of pregnancy (number of affected animals in 100,000 vaccinated animals
				Immediate type	Delayed type	
Bavaria	1967	BHK I	3,021,758	33	9	41
		Frenkel I	1,192,502	2	0	25
	1968	BHK I	3,093,650	13	79	17
		Frenkel I	1,169,084	6	0	14
Fed. Rep. Germany (excluding Bavaria)	1 Sept. 1967 to May 1968	BHK I	1,203,968	24	48	80(?)
		BHK II	1,615,803	4	17	2
		Frenkel I	730,022	1	2	12
		Frenkel II	221,807	3	2	5
	1 Dec. 1968 to Aug. 1969	Frenkel I	3,660,781	4	3	4
		Frenkel II	1,840,705	5	4	5

1. Is there a relationship between allergic reactions and disturbances of pregnancy?

In my opinion, this question cannot be answered at present, nor can a definite decision be made whether disturbances of pregnancy and abortions occur more frequently after vaccination with Frenkel-type vaccines than after immunization with BHK-type vaccines. Furthermore, it cannot be determined whether disturbances of pregnancy are due to the foot-and-mouth disease vaccines themselves or to the manipulations in the course of vaccination.

2. Why did a significant increase of allergic reactions in animals vaccinated with BHK vaccines occur in Germany, whereas in other countries which also used this type of vaccine on a regular schedule such an increase was not reported?

I must confess that I have no explanation for this situation. Several speculations have been put forth, but none is based on the results of clear-cut experiments.

3. What is the cause of the allergic reactions?

Experiments were performed (*3*) in which substances used for the production of foot-and-mouth disease vaccines were tested for their potency to induce allergic reactions of the immediate type. The compounds tested included antibiotics, emulgators, suspension stabilizing substances, antioxidants, and heterologous as well as formalin-treated homologous bovine proteins. Guinea pigs, goats, and calves were sensitized with these substances and were then used for active systemic anaphylaxis and active cutaneous anaphylaxis tests. Moreover, passive cutaneous anaphylaxis and a precipitation test in a liquid medium were applied. Sensitized cattle of the field were also subjected to active cutaneous anaphylaxis tests with the substances mentioned and to purified foot-and-mouth disease virus, extracts of primary calf kidney cells, and BHK cells, respectively (*3, 2*).

Table 4 summarizes the results. The experiments clearly demonstrated (*3, 2*) that animals repeatedly sensitized by BHK vaccines responded frequently with an immediate-type reaction after administration of formalin-treated calf serum. In some cases an immediate-type reaction was observed after injection of extracts of BHK cells and of formalin-treated extracts of primary calf kidney cell cultures. Antibiotics, saponin, and suspension stabilizing substances are able to act as inducers of an allergic state of the immediate type (*3*), but in the incidences observed in Germany they played only a minor role. An interesting observation is that both BHK- and Frenkel-sensitized animals showed manifestations of reaction after the application of infectious as well as inactivated purified type O foot-and-mouth disease virus (*3, 2*). Cutaneous reactions using animals sensitized by BHK vaccinations and performed with extracts derived from primary calf kidney cell cultures and from BHK cells demonstrated that BHK-type vaccines induce hypersensitivity of the delayed type to components of BHK cells but not to material of primary calf kidney cell cultures. In animals sensitized with Frenkel-type vaccine an allergic response could be elicited neither with

TABLE 4—Inducers for allergic reactions of the immediate and delayed types.

Preparations used in the experiments	Immediate type reaction	Delayed type reaction	Comments
Calf serum	—	—	—
Calf serum Formalin-treated	+	—	Strong inducers
Antibiotics	+	+/—	Infrequent
Emulgators (cremophor, methylcellulose, sodium carboxymethyl cellulose, carbowax)	+	—	Infrequent
Purified foot-and-mouth disease virus	—	+	Frequent
Extracts of:			
Primary calf kidney	—	—	—
Primary calf kidney formalin-treated	+	—	Occasional
BHK cells	+/—	+	Strong inducers
BHK cells chloroform-treated	+	—	Occasional

extracts of BHK cells nor with native material of primary calf kidney cell cultures.

Concerning the components of BHK cells able to induce hypersensitivity, we obtained evidence that the extracts of BHK cells contain at least two active substances, one of which can be eliminated by a combined treatment with chloroform and arcton and which is therefore considered to be a lipoprotein in nature (*2*). BHK vaccines with a weak capacity for sensitization can be obtained if the virus is precipitated with polyethylene glycol, leaving about 90 to 95 per cent of the protein impurities—including the nonviral inducers for allergic reaction—in the supernatant (*1*).

In conclusion one can say that allergic reactions of the immediate and delayed types can occur after vaccination with both BHK-type and Frenkel-type vaccines. The over-all frequency of the complications is usually not high; such complications occur more frequently in animals vaccinated with BHK-type vaccines than in those immunized with Frenkel-type vaccines. In 1967 and 1968, in the Federal Republic of Germany an unusual increase of allergic reactions was observed in cattle immunized with BHK vaccines, necessitating efforts to diminish their application. As a consequence of the investigations immediately performed, the following proposals can be made:

1. Vaccines used for a vaccination program on a regular schedule should be purified with regard to nonviral proteins. This consideration applies mainly to vaccines prepared with virus grown in permanent cell line cultures.

2. Inactivation by formalin should be replaced by other means.

3. Vaccine admixtures should be tested before use in order to eliminate substances inducing an allergic state or anaphylactoid reactions.

4. Under special circumstances it may become necessary in the course of systematic vaccinations to change the kind of cells used for vaccine production. There is some evidence that even differences between various BHK cell lines exist with regard to induction of an allergic state.

Finally, I would like to comment briefly on reactions in pigs after foot-and-mouth disease vaccination.

Inactivated foot-and-mouth disease vaccines used for immunization of cattle do not commonly induce a sufficient immunity in pigs. However, recent investigations with vaccines containing an oil adjuvant have shown that a high degree of protection can be induced in pigs. Unfortunately, such vaccines often produce a lesion at the site of injection, and this makes their routine application for animals used for meat production unacceptable at present. Work is in progress to overcome this drawback. In our Institute, we found (*7*) that the oil adjuvant can be replaced by DEAE-dextran, which does not produce such severe tissue reactions as those observed after the application of an oil adjuvant.

Although several kinds of accidents and reactions may occur after foot-and-mouth disease vaccination, there is no reason to refrain from the use of this preventive measure in combating the disease. Continuous efforts to improve the vaccine quality may lead to a situation in which such accidents and reactions will be virtually negligible.

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NEW VACCINES AND FUTURE PROSPECTS IN FOOT-AND-MOUTH DISEASE IMMUNIZATION

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It gives me particular pleasure to speak to you at this III Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control. I am grateful to the Pan American Sanitary Bureau for the opportunity to present to the delegates of the countries represented at this meeting information on foot-and-mouth disease vaccines and future prospects on immunization and vaccine testing. Many of you are no doubt considering changes in some aspects of your program, and all of us present here are hopeful that our comments and the discussion to follow will be useful.

Foot-and-mouth disease must be considered a world problem if progress is to be made in controlling its spread. No country or region may maintain an isolationist policy, for the virus does not respect national boundaries. A campaign against it is handicapped if it is waged piecemeal and if each country or part thereof acts as though it were a self-contained unit. International collaboration is essential for the effective control of this disease (*1*).

In the Americas, the necessity for coordinated action for the prevention and control of the disease on an extensive territorial basis was recognized and implemented by the initiative of certain member countries of the Organization of American States. This resulted in 1951 in the creation of the Pan American Foot-and-Mouth Disease Center as a project of the Pan American Sanitary Bureau. Thus at that time the Bureau, through its Center located near Rio de Janeiro, joined other international organizations such as the International Office of Epizootics, the Food and Agriculture Organization of the United Nations, and the European Commission for the Control of Foot-and-Mouth Disease—all of which were formed to take international action in regard to this problem.

The virus has the ability to spread rapidly and, as a consequence, causes economic problems in the country in which it exists because of its effect on meat, milk, and butter. It therefore interferes with trade wherever it occurs, and it is safe to say that the price of almost every animal product on the world market is in some way affected by the disease. Perhaps the greatest loss results from interference with the normal import and export trade of animals and products of animal origin and other farm products. Such interference takes the form of rigid restrictive measures that must be applied for control or eradication or of actions adopted by disease-free countries against products from infected countries (*2*).

In countries where the disease exists sporadically, control is brought about by eradication of the infected animals. Generally speaking, countries with land boundaries have to contend with a different set of cir-

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cumstances and, in these instances, even if it were possible to control the disease through slaughter, there is a question of whether the countries' neighbors would allow them to remain free. Thus, the disease incidence in these countries is usually controlled by procedures that include vaccination. For this reason, it is apparent that the problem of developing an improved, cheaper, and more rapidly produced vaccine must receive continuing attention. All the Governments and international organizations involved in the control of the disease are generally agreed on the urgent necessity of more effective control leading to lower incidence of the disease, with the hope of ultimate eradication.

There are generally two types of foot-and-mouth disease vaccines in use today: inactivated and modified live virus. The latter is used routinely in only a few countries that do not export meat. Those countries that have a surplus of meat use inactivated virus vaccines because many meat-importing countries will not accept meat from countries where modified live virus foot-and-mouth disease vaccines have been used, for fear that such products may be harboring the modified virus.

During the last calendar year, according to estimates, more than 500 million doses of inactivated foot-and-mouth disease vaccine were produced and used throughout the world. It is further estimated that 300 million doses were used in South America. In addition to the inactivated vaccine, another 5 to 10 million doses of living virus vaccine were applied in a limited number of countries.

Several types of modified live virus vaccines have been developed. Two have been used more widely than the others. One, developed by modifying the infectivity of the virus by passage in suckling mice, was used in some of the African nations. The other, which is being routinely used, is produced in day-old chickens or embryonated chicken eggs. A description of this product is given elsewhere in this program (*3*).

Although modified or live virus foot-and-mouth disease vaccines have never been used widely, research is continuing on such products in a limited number of places. For virus infections in general, live virus vaccines stimulate a longer-lasting immunity and protection against a wider antigenic spectrum than do inactivated vaccines. This factor is important when a virus as variable as that of foot-and-mouth disease is considered. Live virus vaccines may also offer considerable cost advantages over inactivated virus vaccines. Unfortunately, however, the foot-and-mouth disease live virus vaccines thus far developed have not fully measured up to the goals that were set and therefore have never been widely used.

In spite of these disappointments, research is continuing in an effort to develop modified strains of the virus which, when inoculated into animals naturally susceptible to foot-and-mouth disease virus, will replicate sufficiently to stimulate a high level of immunity, yet not produce clinical signs of the disease. Work is continuing along the classical lines of serially passaging viruses in various mediums in the hope that a nonvirulent but immunogenic strain can be developed. Newer techniques are being tried, including the isolation of virus populations that grow in the cold, the selection of viruses that produce characteristic plaques in tissue culture systems, and the induction of mutagenesis by chemical and physical means. Even though the prospects for success are not bright, efforts are continuing and should be encouraged because of the benefits which would accrue from the use of such products in some areas of the world where the costs of inactivated vaccines might be prohibitive.

Inactivated foot-and-mouth disease vaccines have been in use for more than 30 years. The methods of production have been changed at frequent intervals to encompass new techniques. Most of the inactivated vaccine in use today contains virus which is propagated by the Frenkel technique, in explants of surviving bovine tongue epithelium. Generally, the virus is inactivated with formalin and adjuvanted with aluminum hydroxide. In some instances, saponin is added for its reported immune-enhancing properties. When properly prepared, tested, and applied, vaccines of this type are capable of reducing the disease incidence to the point of eradication.

Several changes are being suggested and considered in the formulation of the inactivated foot-and-mouth disease vaccine. Of the several methods available for virus production, it appears that propagation in a tissue culture system may be used increasingly, especially in those countries where the demand for vaccine may exceed the available tongue tissue supply and where the technology for virus production exists. Virus produced by this method may be readily incorporated into a vaccine with little additional processing other than centrifugation and inactivation. This method contrasts with the mincing, extraction, and filtration steps which are necessary with virus produced by the Frenkel method.

Traditionally, formaldehyde has been used to inactivate foot-and-mouth disease virus, either before the virus is adjuvanted or more often after adjuvanting with aluminum hydroxide. The kinetics of inactivations of formaldehyde have been studied thoroughly and, because of variability of the rate, it is difficult to predict when inactivation is complete. The time of inactivation is generally thought to be longer than that taken into account by most vaccine producers. In these instances, the virus that is not inactivated by the formaldehyde is probably masked by the aluminum hydroxide. Because of the variability of the rate of inactivation by formalin and the possible interaction of formalin and aluminum hydroxide on the virus, a search for a better inactivant goes on constantly. Among those being studied, acetylethylenimine seems to be the current new inactivant of choice because of its first-order inactivation curves without a secondary or tailing effect (*4*). Ethyl-ethylene imine is also being widely researched and appears promising (*5*). These inactivants seem to be free of reactions which affect the immunizing properties of the virus. Recently, formaldehyde has become suspect as one of the causes of postvaccinal complications which have been observed with some products. Two types of reactions occur—the immediate anaphylactic type and the delayed cutaneous type (*6*). These reactions are being studied, and if formaldehyde continues to be implicated as the cause, a change to other inactivants will be made, perhaps sooner than otherwise would have happened.

Aluminum hydroxide has been the adjuvant of choice for foot-and-mouth disease vaccine for more than 30 years. The enhancing effects of this colloidal adjuvant have been well demonstrated. Recently, incomplete Freund's adjuvant, consisting of pharmaceutical-grade mineral oil and Arlacel, has been used with good results in swine (*7*). There are, however, some problems with this adjuvant which must be resolved before it can be placed in wide-scale use. Methods must be developed for production of the emulsion on a commercial scale; the reactions which develop in some vaccinated animals must be diminished; or the animals must be vaccinated where the reaction is not objectionable. Aside from these problems, this adjuvant seems to enhance the immunizing properties of some

antigens better than aluminum hydroxide does and over a longer period of time. It has been especially useful in swine. Quite recently DEAE-dextran has been used as an adjuvant with good results, from the standpoints of both enhancement of immunity and freedom from local reaction in the vaccinated animal (*8*).

Concentrated and purified foot-and-mouth disease virus (*9*) is now being produced by various methods, and virus developed by these means seems to offer several advantages over that contained in tissue culture fluid (*10*). Perhaps most importantly, it permits accurate quantitation of viral mass, and as soon as more information is obtained it should be possible to relate this to the antigenic mass necessary to immunize against a given type of virus. It is also possible to include a large antigenic mass in a small volume, thus reducing the problems associated with handling large volumes of a vaccine. This procedure should diminish the problems which might be caused by the adjuvant, as well as the allergic problems being encountered as a result of the interaction of formaldehyde and proteins in the tissue culture fluid. Use of purified antigens in vaccines must, however, await development of economical means of production by one of the several methods being researched. Such methods include precipitation with ammonium sulfate, differential centrifugation, treatment with sodium deoxycholate, sucrose gradient centrifugation, precipitation with polyethylene glycol, and foaming.

Methods for producing milligram quantities of concentrated and purified foot-and-mouth disease virus were necessary before the chemical, physical, and immunological properties of the virus could be assessed. The virus has been determined to be about 23 millimicrons in diameter and is made up of 32 capsomeres, which appear to form a symmetrical capsid for the ribonucleic acid core of the virus (*11*). Studies are now being made on the peptide and amino-acid composition of foot-and-mouth disease virus, and although these studies have barely gotten under way, significant differences have been demonstrated in the amino-acid compositions of virus types A, O, and C (*12*). Work is being carried forward to find methods for the preparation of artificial antigens, which give rise to antibody production against natural protein antigens such as those of simple viruses. Synthesis of an artificial antigen against foot-and-mouth disease virus is a hope for the future.

The primary structure of the protein coat of the virus is being studied, and it remains to be seen whether any of the peptides have immunological activity. It is hoped that one of them will have the same antigenicity as the intact virus. In this event, knowledge about the amino acids and their arrangements would be a prerequisite to attempts at synthesis.

This discussion would not be complete without considering the role or potential of interferon in control of foot-and-mouth disease (*13*). Its use as a possible means of protecting animals against a number of virus infections is now attracting the attention of many scientists throughout the world. Interferon, a substance normally produced by cells in response to virus infection or stimulation by nonviral agents, is capable of protecting other cells against infection by a variety of viruses. It differs from specific antibody in that its effect is not restricted to one virus type, it does not affect the virus directly, and it is produced earlier during infection than antibody. However, the effectiveness of interferon is measured in days, or at most a few weeks, whereas antibody is effective for months and even years.

Several interferon inducers are being used

against viruses. These are synthetic polyanions, double-stranded RNA, other viruses, bacteria, endotoxins, rickettsiae, fungal extracts, and mutagenic agents. The problems that remain to be resolved before these agents can be useful against foot-and-mouth disease virus include demonstration of products that (1) are nontoxic and noninfective, (2) are not permanently incorporated into animal cells, (3) will stimulate enough interferon for sufficient duration, (4) have no carcinogenic potential, (5) have acceptable costs, and (6) possess overall safety. All products under investigation fall short on one or more of these criteria. However, there is sufficient hope of resolving these problems to warrant more research.

In addition to stimulating interferon, some of these compounds, especially the polynucleotides, have had the capacity of repairing or stimulating the immune response. The stimulatory effects of these products on foot-and-mouth disease antigens are being tested, and the preliminary results are encouraging. In one instance, a noninfective component of foot-and-mouth disease virus has been complexed with bovine serum albumin and shown to invoke antibody response against foot-and-mouth disease virus in rabbits. Similar work is under way on using Poly I:C and Poly AU for enhancing inactivated vaccines. These products are being investigated to learn whether preliminary findings from laboratory animals will prevail when the principles are applied in animals naturally susceptible to foot-and-mouth disease.

The importance which this group attaches to the testing of foot-and-mouth disease vaccines is amply demonstrated by the fact that a subcommission on foot-and-mouth disease of the regional technical commission on animal health was convened in Buenos Aires during March 1969 to make recommendations on this general subject. It will be neither possible nor necessary to repeat their recommendations here; nevertheless, some important points should be amplified. The provision of means to determine antigen content, vaccine innocuity, and potency is the first step that those responsible for organizing or improving campaigns should consider. Innocuity and potency tests should be conducted on each and every batch of vaccine produced. It is highly desirable that such tests be conducted in the species of animal which the product is intended to protect. The potency tests should be carried out in such a way as to ensure that the vaccine provides protection against the type and subtypes of virus occurring in the field and is of adequate potency to produce a high degree of production. The tendency among vaccine producers (*14*) is to evaluate the potency in terms of protective doses. When these steps are followed systematically, the duration of immunity will become more prolonged with each subsequent vaccination. An inherent part of vaccine control is a separation of responsibility through the establishment of laboratories whose responsibility is to certify vaccines, not to become involved in the production or application of the products being tested.

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PART III

HEALTH ASPECTS OF THE IMPORT AND EXPORT OF ANIMALS AND ANIMAL PRODUCTS INTENDED FOR CONSUMPTION

PRESENT STATUS OF THE PRODUCTION AND CONSUMPTION OF ANIMAL PRODUCTS IN THE HEMISPHERE AND PROSPECTS IN THE NEXT TEN YEARS

JOSÉ J. CAÑÓN *

Despite the vast natural resources existing in Latin America for a greater development of the livestock industry, production in this basic sector of the economy is visibly stagnated in most of the countries. This is particularly true in the case of beef and milk, whose production per inhabitant has been deteriorating year after year, as a result of which consumption levels have dropped and the participation of Latin American meat on the international market has decreased. Considering Latin America as a whole, this stagnation of the livestock sector constitutes a serious obstacle to agricultural development and to economic development in general. Studies carried out by the Food and Agriculture Organization of the United Nations (FAO), the Economic Commission for Latin America (ECLA), and other international agencies have pointed out the factors responsible for the slow growth of livestock production, and at the same time the great possibilities existing in Latin America for stepping up that production to meet both domestic requirements and the continuously expanding overseas demand.

The purpose of this article is to present a summarized general analysis of the situation as well as of past trends of supply and demand for beef and milk products and the prospects over the next 10 years. The limitations of this study make it necessary to restrict it to a predominantly regional analysis.

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Situation and Trends

Livestock Area

It is estimated that Latin America's pasture land includes 535 million hectares, but that only 12 per cent of this area is under artificial or cultivated pastures while most of it (470 million hectares) is covered by natural pastures whose productivity is much lower. Considering grazing capacity in the proportion of 1 to 3, the total pasture area would be approximately 200 million hectares, in terms of artificial pastures; thus, the density of the cattle population would be about one head per hectare of artificial pasture, plus the grazing corresponding to the equine, sheep, and goat species. Needless to say, the capacity of pastures varies greatly from country to country and from one livestock zone to another; it is of two or more head per hectare on the extensive improved pastures in the Argentine Pampa, in certain livestock zones in Uruguay and Brazil, and in tropical pastures of higher quality. A very low grazing capacity is registered in the Andean regions of Bolivia, Ecuador, and Peru and an even lower one in the eastern plains of

Colombia, the Venezuelan plains, and the arid zones of Mexico, where as many as five and even 10 hectares are required per animal. It is true that the low productivity of the tropical pastures of Bolivia, Brazil, Colombia, Peru, and Venezuela is due not only to the predominance of natural pastures, but also in great measure to extreme conditions of draught or rains that frequently cause seasonal pasture crises; these also occur with certain frequency in Argentina, Chile, and Uruguay.

It is often said, and with good reason, that Latin America possesses an immense potential for livestock development. In fact, in addition to other advantages, the region has a great proportion of new land suitable for meat and milk production, such as the large land reserves existing in most of the tropical countries, especially Bolivia, Brazil, Colombia, Mexico, Peru, Venezuela, and those of Central America. On the other hand, the use of natural instead of artificial pastures provides an ample margin for expending grazing capacity, and at the same time a much greater productivity can be achieved in existing pastures through improved management practices and better utilization. In general terms, the region's forage potential does not present any insurmountable obstacles to attaining a much greater development of livestock production.

Livestock Population

Despite the deficiencies of available statistical information, it can be estimated, on the basis of livestock censuses and other sources, that Latin America's present cattle population is approximately 230 million head, the proportion being 90 head per 100 inhabitants. The ratio is 94 head per 100 inhabitants in the countries of the Latin American Free Trade Association (LAFTA), 55 in the Central American Isthmus, and 51 in the rest of Latin America. The proportion has been declining in the last 30 years, as the mass of bovine livestock has increased at a slower rate than the population. The highest proportion of bovines per inhabitant is found in Argentina, Paraguay, and Uruguay, which is in line with their high consumption levels and their tradition as meat-exporting countries. However, it should be pointed out that in the case of Argentina and Uruguay the cattle-population relationship has experienced an appreciable decrease, in spite of low demographic growth in those two countries. The lowest proportion is registered in Chile and Peru, which are strong livestock and meat importers.

The 11 LAFTA countries have a total of 213 million head of cattle, representing 93 per cent of the bovine population in Latin America; Brazil has the largest herd, followed by Argentina, Mexico, Colombia, Uruguay, Venezuela, Cuba, Paraguay, Peru, and the remaining countries. It is important to note that Argentina, despite having a much smaller herd than Brazil, produces 71 per cent more meat, which is due to a higher slaughter rate and a greater yield of carcass meat. But at the regional level, it is important to remember that although Latin America's herd is double that of North America, the latter produces nearly three times as much meat and five times as much milk as the Latin American countries.

Beef and Milk Production

Beef. Latin America's beef production in 1968 was estimated at approximately 6.2 million tons (carcass weight), representing 18 per cent of world production, which amounted to approximately 34.9 million tons according to preliminary FAO esti-

mates. Out of the region's total (excluding exports of live cattle) 41 per cent corresponds to Argentina, 24 per cent to Brazil, 14 per cent to Mexico and Colombia whose production yields are very similar, 4 per cent to Uruguay and 17 per cent to the remaining 15 countries. The LAFTA countries produce 94 per cent. Out of the total of 8.1 million tons of red meats (beef, pork, and mutton) produced in 1968, 77 per cent corresponds to beef and nearly 20 per cent to pork.

Beef production in kilograms per inhabitant for the same year was estimated as follows:

Argentina	109.3	Costa Rica	16.2	Cuba	24.3
Bolivia	10.4	El Salvador	6.2	Dominican Republic	5.2
Brazil	17.1	Guatemala	10.0	Haiti	2.4
Chile	18.4	Honduras	9.1		
Colombia	20.4	Nicaragua	24.7		
Ecuador	7.3	Panama	23.5		
Mexico	9.0				
Paraguay	51.4	Central American Isthmus	12.7		
Peru	6.0				
Uruguay	85.8				
Venezuela	19.1				
LAFTA	25.6				

From the above list it may be seen that the highest production levels correspond to Argentina, Uruguay, and Paraguay while the lowest are those of Haiti, El Salvador, Peru, Ecuador, Mexico, and Bolivia. Brazil, Chile, Colombia, and Venezuela hold an intermediate position.

Milk. Latin America production of cow's milk in 1968 was 22.5 million tons, which is equivalent to only 6 per cent of world production. Within the region, the greatest volume corresponded to Brazil, with 31 per cent of the production, followed by Argentina with 22 per cent, Mexico 13 per cent, Colombia 10 per cent, Chile 5 per cent, Ecuador and Peru jointly 4 per cent, and the remaining South American countries—except Bolivia and Paraguay, which show the lowest production figures—and Cuba contributed with 3 per cent each; a subregional total of 4 per cent corresponds to the Central American Isthmus.

The highest production per inhabitant corresponds to Uruguay, with 217 kilograms, closely followed by Argentina; production fluctuates between 90 to 108 kg in Cuba, Ecuador, Costa Rica, Nicaragua, Colombia, and Chile, in an ascending order, and is below 80 kg in the remaining countries.

Production Trends

In contrast to the greater development of agricultural production as such, the total physical volume of animal production has over the long term increased at a lower rate than the population growth. In fact, during the last 20 years the population increased by 76 per cent, i.e., a cumulative annual rate of 2.9, while livestock production only increased at a rate of 2.2, which is clearly inferior to demographic growth (Table 1 and Figure 1). The development rate, of course, shows notable differences between countries and between one item and another. Production of poultry (meat

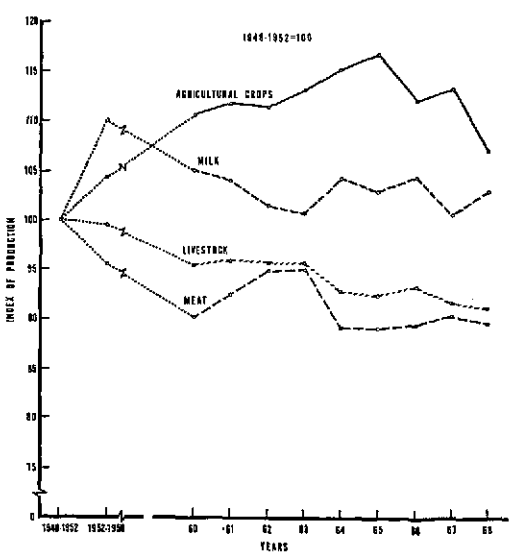

FIGURE 1—Index of agricultural and livestock production in Latin America, 1948–1952 to 1968.

TABLE 1—Bovine yields in Latin America, average 1962 to 1966.

Country	Beef			Milk	
	Slaughtering rate	Kg per slaughtered animal	Kg per head	Kg per cow in production	Kg per cow
Argentina	24.6	209	51	425	298
Bolivia	...	...	...	...	...
Brazil	8.8	192	17	426	...
Chile	18.8	234	45	1,700	763
Colombia	12.9	200	26	995	303
Ecuador	12.4	153	22	500	...
Mexico	9.7	186	18	2,000	...
Paraguay	11.2	178	20	536	...
Peru	13.6	134	22	680	...
Uruguay	16.6	218	36	410	...
Venezuela	13.2	177	23	685	179
LAFTA Total	*13.6*	*199*	*27*	*840*	...
Total Central American Isthmus	*11.5*	*170*	*23*	*1,205*	*124*
Total, rest of Latin America	*13.0*	*170*	*22*	*625*	...
Total, Latin America	*13.8*	*197*	*27*	*850*	...

Source: Studies by the Joint ECLA/FAO Agricultural Division and FAO Production Yearbook (1968).

and eggs), pork, and milk has been increasing at a greater rate, which has brought about an improvement of the production level per inhabitant. On the other hand, deterioration of production has been evident in the case of beef and mutton production. During the period under study, total poultry and egg production was doubled and milk and pork production increased approximately 70 per cent. Beef production only increased by 41 per cent during this long period, at a yearly rate of only 1.7 per cent. Wool and mutton production per inhabitant decreased considerably.

Even though briefly, it is advisable to consider trends by countries, especially those in Argentina, since it is the most important beef producer and exporter and fluctuations in its livestock production are reflected in considerable changes in the regional totals. Even if trends in this country reveal an increment in beef production in absolute terms, at a cumulative yearly rate of 1.4 per cent between the pre-war years (1935-1939) and the 1948-1950 period, and of 1.5 per cent between this period and 1966, these increases were inferior to the population growth and the result was a decrease of availabilities for national consumption and export. It is important to note that a new period of prosperity in livestock production started in Argentina in 1964; livestock population, which was estimated at 42.3 million head that year, reached nearly 51.5 million head in 1968, which is equivalent to a cumulative increment of 5 per cent a year; meat production increased considerably during the same period, at a yearly rate of 5.8 per cent. During the 1958-1968 decade production increased more than population only in Bolivia, Nicaragua, Panama, and Venezuela; it was almost equal to demographic growth in Colombia, Costa Rica, El Salvador, and Mexico; in Chile, Ecuador, and Guatemala it increased at a rate of 2 per cent; and Brazil, Cuba, Haiti, Honduras, Paraguay, Peru, and Uruguay showed increases of less than 1 per cent. The most important increases in pork production were registered in Brazil and Mexico. Im-

portant and sustained increases of milk production per inhabitant were obtained only by Venezuela, while a notable decline was registered in most of the Latin American countries. In the region as a whole, production per inhabitant decreased from 91 kg in 1958 to 87 kg in 1968.

Productivity Levels

Meat and milk yield per animal and physical productivity of livestock in general not only vary from country to country, and even within one zone, but are also subject to important changes of a seasonal and cyclic character. It is for this reason that average figures over a sufficiently representative period (1962-1966) are used in this study.

It is an undeniable fact that the evolution of livestock production in Latin America and its productivity levels compare very unfavorably with those in countries with a greater economic development. Basically, this disadvantageous situation must be attributed principally to the slowness with which the livestock industry is absorbing the progress of science and technology. Outdated livestock management systems still prevail in many areas and there is a marked backwardness with respect to breeding efficiency, health control, genetic improvement of animal breeds, pasture improvement and feeding practices and, in general, management and administration methods. This is confirmed by some examples.

Under predominant conditions of mixed bovine production, the proportion of cows suitable for breeding within the herds barely reaches an average of 45 per cent, except in Argentina and Uruguay and in isolated although numerous cases of herds with a high reproduction efficiency in other Latin American countries. It is evident that the limited availability of suitable breeding cows is caused, in relative terms, by the defective composition of the herds which frequently have a high proportion of adult steers for fattening. On the other hand, the calving rate in relation to the number of breeding cows reaches a regional average of only 50 per cent and maybe less; to this should be added the death rate of calves on very large farms, which make up the majority.

Regarding the slaughtering rate and the yield of meat per carcass, figures are notably low in most of the countries; the highest levels are those of the Argentine beef industry, with a slaughtering rate double that of many other countries, followed by Uruguay and Chile. The highest meat yields per hectare and per live head of cattle correspond precisely to these three countries with a temperate climate.

Productivity levels in dairy farms also leave much to be desired. Frequently only between 50 and 70 per cent of the cows are milked, while in other countries with advanced dairy industries this figure is often as high as 85 and 90 per cent and the milking period is longer, as may be observed in Holland, Denmark, the United States, and Canada, for example. Although in Latin America higher milk yields are obtained in the three temperate countries, the fact is that the average for the region (850 kg per cow in production) and all of the national averages are between five and six times below the yields obtained in North America and Western Europe. The numerous difficulties existing in tropical zones for the production of milk at high efficiency levels are well known. In this connection it should be repeated that the improvement in yields that can be achieved in those zones will depend particularly on the measure in which feeding deficiencies and obstacles hindering the adaptation of foreign breeds to the tropical environment can be overcome.

Factors Limiting Livestock Production

The many factors limiting animal production in Latin American countries have been discussed in some detail in various studies. It is therefore only relevant to consider their nature and incidence in a general manner:

a) *Feeding deficiencies:* Seasonal forage crises; predominance of natural pastures with a low nutritional value; shortage of artificial or cultivated pastures; inadequate utilization and management of pastures; insufficient water supplies and mineral elements; and carelessness in the control of toxic plants and weeds.

b) *Diseases and pests:* Infectious and contagious diseases and parasites, which cause numerous losses, slow down growth, and represent an economic drain because of the decrease in meat and milk yields. As it is the basic subject of this conference, special mention should be made of foot-and-mouth disease, which is present to a greater or lesser degree in all of the South American countries, in many of which it constitutes a serious obstacle to the development of animal production and to a greater foreign trade of fresh, packed, and frozen meats and live cattle.

c) *Low level of genetic improvement:* Predominance of native types and low yielding crossbreeds in large tropical areas; a critical shortage of proven breeding males; limited progress in artificial insemination; and frequent confusion regarding selection and crossbreeding practices.

d) *Administrative and managerial deficiencies* in many aspects of animal production.

e) *Economic factors:* Slowness of private and public investment in infrastructure works, improvement of existing exploitations, and expansion of pastures. Livestock producers frequently complain of the low profitability of invested capital.

f) *Institutional factors:* Limitation of credit for livestock production in virtually all of the countries; serious marketing deficiencies; the slow progress of research and technical assistance; shortage of technicians and intermediate-level personnel; some inadequate land tenure structures; and important gaps with respect to integrated livestock development policies in the countries.

Foreign Trade in Beef

Latin American beef and live cattle exports continue to be an important source of foreign exchange; they amounted to a total of 586 million dollars in 1967.* The volume of the Latin American exports is in third place after Western Europe and Oceania. However, the region's participation in world exports decreased from 31 per cent during the 1948-1952 period to 19 per cent in 1965-1967. While Western Europe quintupled its meat exports during this period and Oceania increased them by 72 per cent, Latin America only managed an increase of 47 per cent. Moreover, to maintain a relatively high export level, Argentina and Uruguay, and to a lesser degree other countries, have had to draw to a greater or lesser degree on meat supplies for domestic consumption. Argentina's beef exports represent a little over two-thirds of Latin America's exports. In 1969 shipments from that country reached a peak volume of 561,295 tons (including trimmings and meat extract), for a value of nearly US$367 million. Uruguayan exports, which are second in importance, recovered significantly in 1968 and 1969, showing an in-

* *Examen de las características, tendencias y problemas principales de la economía mundial de la carne.* FAO Document CCP:Mah 69/3, May 1969.

crease of 63 per cent over the low levels of 1965-1967. During this same triennium, Mexican exports of live cattle averaged 557,160 head, followed by Argentine exports—with a yearly average of 141,333 head of cattle—and then Colombian, Honduran, and Brazilian exports in that order. Paraguay continues to be an important exporter of dressed meat. The countries of the Central American Isthmus have incremented their meat and livestock exports substantially in recent years; the first were doubled, increasing from 25,500 tons in 1965 to 49,960 tons in 1967. The United Kingdom and the European Economic Community absorb around 70 per cent of Latin America's meat exports. However, because of various restrictions established by these two important meat importers and the sustained campaign for promoting domestic beef production, Latin American exporters have intensified their efforts to overcome these difficulties, expand their trade with other countries, and find new markets. The importance of the United States as a buyer of dressed and tinned meat continues to increase.

It is worth mentioning that, despite a certain increase observed in recent years, intraregional meat and livestock trade accounts for only a small proportion of Latin American exports; Chile and Peru are the main importers from Argentina and Colombia.

It is an obvious fact that despite marked fluctuations in the volume of world beef trade and a tendency for prices to increase, prospects indicate that demand will increase at a greater rate than production in the importing countries.

Consumption Levels

With the exception of Argentina, Uruguay, and Paraguay, beef consumption is noticeably low in the Latin American countries, particularly in Bolivia, Ecuador, Mexico, Peru, and in the Central American Isthmus, where it barely reaches 8–10 kg per inhabitant/year. Consumption decreases in Argentina and Uruguay during the last few years have been caused by a sustained high export level, and in the case of Chile this is due partially to difficulties in domestic supplies and the substitution of beef consumption. Production in the Central American Isthmus has remained stationary in the last 10 years, and for this reason export increases have been made at the expense of domestic consumption. Excepting the River Plate countries, it may be stated that consumption of meat of different types per inhabitant averages 20 kg a year, which is obviously far below nutritional requirements of animal protein.

The participation of beef in total meat consumption is extraordinarily high in Argentina, Paraguay, and Uruguay. In Brazil, Colombia, Central America, Mexico, and Venezuela, between 75 and 80 per cent of meat consumption corresponds to beef, followed by pork and in a much smaller proportion by sheep and goat's meat. Beef consumption in Bolivia, Ecuador, and Peru barely represents half of the total meat consumption, because of the important contribution of sheep and other animal species.

Regarding the consumption of milk and milk products, important deficiencies occur in all the Latin American countries in relation to the requirements of a normal diet. Average milk consumption per inhabitant in the region is only about 100 liters a year, in terms of whole milk; this is barely one-third of the consumption in the United States, Canada, and New Zealand. Brazil, Colombia, and Venezuela must increase their fresh milk supplies six times to reach the recommended consump-

tion level of 400 grams a day. Chile would have to triple it, and Argentina to double it. The rest of the countries would require an extraordinary effort to remedy their extremely low consumption levels of milk and milk products.

It is a well known fact that protective foods, such as meat and milk, have relatively high prices, as a result of which the purchasing power of low-income consumers for these basic products is very low. However, if we take into account future population and income growth, as the principal factors determining demand, it may be expected that supply problems will be aggravated, unless production or imports grow at a greater rate. Because of the high elasticity of demand for meat and milk in relation to income in most countries with precarious consumption levels, the continued increase of prices will be inevitable unless production for domestic consumption increases at the same rate as the rise in demand and the improvement of available incomes.

To complete this brief analysis of the present situation of meat and milk production and consumption in Latin America, it should be pointed out that while the North American citizen consumes a little over 90 kg of proteins a year, of which 62–65 kg are of animal origin, total protein supplies of most of the Latin American countries barely reach two-thirds of the amounts indicated for the United States of America and Canada; what is more serious, only one-third is animal protein while the remaining two-thirds are proteins from starchy vegetables that are normally consumed. In brief, consumption of animal protein in 90 per cent of the Latin American population has remained at a standstill for many years, at a level equivalent to 20 per cent of protein supplies in developed countries. This situation aggravates social problems of hunger, malnutrition, and diseases caused by protein deficiencies among the poorer sectors. In accordance with its new plans of action, FAO is concentrating its activities on five aspects of primary importance, one of which is the elimination of the protein imbalance; and as a part of this new approach, it is promoting a livestock development strategy in Latin America.

Production and Consumption Prospects

The following section presents a prospective study of the development of beef and milk demand and supply in Latin America during the decade of the 70's. Taking into account also the balance of foreign trade, this analysis shows possible growth of production and consumption. In view of the great variety of factors affecting supply and demand, the projections (for 1975 and 1980) are of a hypothetical nature. Consumption projections have a higher degree of feasibility, as they have been based principally on the well-known trends in the population and to a lesser degree on available income per inhabitant, which is much less dynamic because of its inadequate distribution and the continuing price increases. On the other hand, projections of supply refer only to meat and milk production that it will be necessary to reach by 1975 and 1980 in order to satisfy consumption requirements. The capacity of the countries to meet potential demand depends entirely on the measure in which they are able to promote livestock development.

Hypothesis A (Tables 2 and 3) is a simple extrapolation of trends registered in the past decade and as such it is only presented as a basis for comparison, to indicate the large production and consumption gaps that will occur in Latin America in the next few years if the aforementioned

TABLE 2—Projection of beef production, foreign trade, and apparent consumption, in Latin America, 1975.

(*Thousands of tons of carcass meat*)

	Production	Exports	Imports	Apparent total consumption	Per-capita consumption (kg)
Hypothesis A					
LAFTA countries	6,649	1,226	142	5,565	20.0
Rest of Latin America	477	68	62	471	11.9
Total, Latin America	*7,126*	*1,294*	*204*	*6,036*	*19.0*
Hypothesis B					
LAFTA countries	7,559	1,334	142	6,367	22.9
Rest of Latin America	545	80	62	527	13.3
Total, Latin America	*8,104*	*1,414*	*204*	*6,894*	*21.7*

Source: Joint ECLA/FAO Agricultural Division computation.

stagnation continues. For this reason, the projection of the historic trend cannot be considered as a satisfactory alternative for the growth of meat and milk supplies and demand, because of the adverse effect that would have on agricultural and economic development in general, and because it would lead to an aggravation of the low consumption levels per inhabitant prevailing in large sectors of the population.

Hypothesis B not only considers the effect of population and income on consumption, as far as demand is concerned, but also takes into account the habits and preferences of the consumers, certain policies for self-sufficiency in some countries, programs for the substitution of a part of beef consumption for other meats, plans for substituting imports, and policies for increasing and diversifying exports, even at the expense of domestic consumption—because this complex interaction of factors is what ultimately determines the various levels of consumption. This approach is similar to the one adopted by FAO in the Indicative World Plan for Agricultural Development.

In accordance with this second hypothesis, effective demand for beef would be of 8.1 million tons in 1980, or 2.8 million tons more than in 1966-1968, which is equivalent to a highly feasible increment rate of 3.3 per cent. As it is estimated that the export demand may have doubled by the end of the decade, the combined growth of domestic and foreign demand would have reached a yearly rate of 3.8 per cent. This means that for this demand to be transformed into domestic consumption and real exports, production would have to be incremented at the same rate, as no imports from outside the region are taken into

TABLE 3—Projections of beef production, foreign trade, and apparent consumption, in Latin America, 1980.

(*Thousands of tons of carcass meat*)

	Production	Exports	Imports	Apparent total consumption	Per-capita consumption (kg)
Hypothesis A					
LAFTA countries	7,226	2,005	158	5,419	16.8
Rest of Latin America	512	94	72	490	13.5
Total, Latin America	*7,778*	*2,099*	*230*	*5,909*	*16.0*
Hypothesis B					
LAFTA countries	9,363	2,005	158	7,516	23.4
Rest of Latin America	667	94	72	645	17.8
Total, Latin America	*10,030*	*2,099*	*230*	*8,161*	*22.2*

Source: Joint ECLA/FAO Agricultural Division computation.

account. As approximate supplies required for 1975 and 1980 are 8 and 10 million tons, respectively, these figures should be considered as production targets toward which livestock development must be aimed. It is true that it is not feasible to achieve such a great development in livestock production in a 10-year period, as longer-term plans are required to overcome obstacles of a technical, biological, financial, and institutional nature hindering animal production. However, much can be done in this direction. Consequently, prospects are that growing demand for beef will not be fully met in the present decade, and this will continue to encourage price increases, unless sound regulatory policies are adopted.

Considering that the international market for beef is extremely favorable, because of great foreign demand and high prices on the world market, it is to be expected that traditional Latin American meat exporting countries and others that are developing their exports will continue to increment their sales abroad, even at the expense of domestic consumption, as has happened in the past. This trend has certainly been taken into account when formulating these projections.

As regards beef consumption per inhabitant, prospects are not at all encouraging because of the reasons stated above. In fact, if supplies continue to increase at the slow rate observed in the last 10 or 15 years (hypothesis A), availabilities per person, which in 1958–1960 and 1966–1968 were only 23 and 21 kg, respectively, will continue to deteriorate, decreasing to 19 kg in 1975 and 16 kg in 1980. Under hypothesis B, in which an accelerated production growth is assumed together with a continued expansion of exports, an increase of barely 1 kg would be obtained after 10 years. The need therefore arises to make up for foreseeable consumption gaps of this type of meat with pork and poultry, for which there is also great demand in countries where there is a deficit of meat production. Production of these two meat items can be incremented quickly and easily within short and intermediate terms, as is being done in several countries of the region.

Regarding milk, total consumption, in approximate figures, increased from 19 million tons in the 1958–1960 triennium to a little over 22 million tons in 1965–1967, representing an increment of 18 per cent in seven years, at a cumulative annual rate of only 2.4 per cent, which is lower than the demographic growth rate. For this reason, despite increasing imports of milk products, total milk consumption per inhabitant decreased from 94 to 92 kg during that period. If this slow expansion of real demand for milk should continue during the next 10 years, per-capita consumption would continue to be practically stagnated, unless imports are greatly increased, which is unlikely because of self-sufficiency and foreign exchange savings policies. Recent consumption trends should not be prolonged, of course, if the greater economic development which is to be expected and new strategies for social improvement which are beginning to arise are accepted as a fact. It is for this reason that under hypothesis B it has been assumed that there will be an additional demand of approximately 10 million tons in 1975 and of approximately 16 million in 1980, in relation to total consumption estimated for 1965–1967. This would mean that the yearly growth rate of demand would be of approximately 4 per cent and, if it should become effective, it would increase per-capita consumption to 100 kg (in terms of fluid milk) in 1975 and to 105 kg in 1980. A higher relative increment of demand has been assumed than in the case of meat be-

cause of the effect of imports and because milk production is considered to be more elastic in Latin America. Undoubtedly, large surpluses of exportable milk products from developed countries will continue to relax international prices, a circumstance which under assumed conditions of orderly marketing and distribution (without damaging national production) may represent a relatively important growth of imports (Table 4).

In conclusion, there is a great potential demand for beef and milk which will continue expanding uninterruptedly. As was noted above, it has been estimated that demand for beef—including foreign demand—will grow at a cumulative yearly rate of 3.8 per cent and demand for milk and milk products will grow at approximately 4 per cent; in other words, combined demand for these food products might grow at an annual rate of 3.9 per cent.

Prospects regarding supplies, which in the case of meat are equal to production, are uncertain because future supplies depend largely on livestock development and marketing policies, on one hand, and on the other, on the resources, means, and incentives available to producers. It is very difficult to evaluate the future situation and the changes that might take place with respect to these factors. What may be stated with full certainty is that the prolongation of historic production trends, which show a visible stagnation, would aggravate the imbalance existing in most of the countries between meat supplies and demand; at such a slow rate, production would reach 7.8 million tons in 1980, which in comparison with estimates on total demand shows a deficit of 2.4 million tons. Under these clearly undesirable conditions, supplies would be 22 per cent lower than domestic and foreign demand by 1980.

Milk production in previous years increased a little more than beef production, at a compound yearly rate of 2.4 per cent. If it should continue to increase at the same rate, it would rise from a yearly average of 21.2 million tons estimated in 1965–1967 to 26.3 million in 1975 and 29.4 million in 1980. When compared with demand projections under hypothesis B, these figures show a production deficit of 9 million tons in 1980, with very limited possibilities for covering it entirely with imports. In order to meet future demand in that year and at the same time achieve a complete substitution of imports, production would have to be increased to 39 million tons, representing an increment of 83 per cent, equivalent to a yearly rate of 4.4 per cent. For various reasons, such an

TABLE 4—Projections of milk production and demand in Latin America, 1975 and 1980.
(*Thousands of tons*)

	1975			1980		
	Total production	Total consumption	Per-capita consumption (kg)	Total production	Total consumption	Per-capita consumption (kg)
Hypothesis A						
LAFTA countries	24,059	26,899	97	26,970	31,178	97
Rest of Latin America	2,208	2,730	69	2,476	3,165	68
Total, Latin America	*26,267*	*29,629*	*96*	*29,446*	*34,343*	*95*
Hypothesis B						
LAFTA countries	28,937	28,937	104	35,253	35,253	109
Rest of Latin America	2,945	2,945	74	3,577	3,577	77
Total, Latin America	*31,882* [a]	*31,882*	*100*	*38,830* [a]	*38,830*	*105*

[a] Required production, not projected.
Source: Joint ECLA/FAO Agricultural Division computation.

accelerated increment of production would only be feasible over a very long term. Consequently, it must be kept in mind that in the case of meat as well as milk, projections are only intended to draw attention to the magnitude of the imbalance between supply and demand that may occur in the future and to the need for introducing programs and changes required to modify trends and decrease the differences.

Considering Latin America's vast resources for livestock exploitation and the great increase in demand that is envisaged, the region is facing the urgent need to concentrate efforts on the development of meat and milk production, in order to improve the low nutritional levels affecting more than 80 per cent of the population and to continue maintaining its importance as an exporting region. Without intending to make a quantitative assessment of the possibilities and limitations for incrementing beef and milk production during the Second Development Decade sponsored by the United Nations, it should be mentioned that there are no insurmountable obstacles of a technical type to achieving an accelerated development of cattle production. The following facts confirm this.

Cattle herds in the region have been increasing in number at a rate slightly below population increases. Nevertheless, the livestock history of several Latin American countries shows much greater increments, as was the case recently in Argentina, Mexico, and Paraguay, and during different periods in Brazil, Colombia, and some Central American countries. Economic incentives have encouraged the application of improved reproduction techniques and greater care of breeding herds, as a result of which cattle numbers have been increased. If it is true, on the one hand, that the proportion of breeding cows and their calving rates show a rather low average for the region, it is also true that there is an ample margin for improving reproductive efficiency of herds through measures leading to greater care of breeding cows, an adequate supply of bulls, expansion of artificial insemination services, control of diseases affecting calving rates, and improvement of cattle feeding. In this connection is it worth mentioning that at the experimental and commercial production levels in all the countries, there are many—although still not sufficient—examples of the significant manner in which livestock numbers can be increased.

The death rate, which has an important effect on livestock inventories, is particularly high in the case of young calves because of the insidious attack of colibacillosis, salmonellosis, or paratyphoid, pneumonia, pyobacillosis, and a great many other diseases caused by parasites. In such cases the death rate may be as high as 30 to 40 per cent in herds under careless management. It has also been sufficiently demonstrated that by intensifying health control measures the death rate can be considerably reduced. If it is accepted that mortality in the bovine species is of the order of 7 per cent at present, it is no technical feat to reduce it to 6 per cent in the course of 10 years. Such a decrease would have a great multiplier effect on the size of herds.

Regarding yields and productivity, scope for improvement is equally broad, but it must not be forgotten that comprehensive long-term livestock development plans are required to achieve such an improvement. In any event, it is highly feasible to increase the slaughtering rate of cattle progressively by shortening the fattening period and increasing the proportion of young animals available for slaughter, at an age from 2 to 2½ years, instead of 4 to 5 years as is the case in many meat-producing areas. In fact, many producers are

managing to do this. On the other hand, independently of age, the meat yields per slaughtered animal and per pasture area unit can be increased through better feeding practices. Neither is it technically impossible to increase the slaughtering rate from the present average of 14 per cent, to 16 per cent within 10 years. In the case of dairy production, which it is easier to intensify in temperate climates, yields per cow and per cow in production could be greatly augmented. They could be more than doubled in the Argentine Pampa. Milk production in Uruguay increased at a yearly rate of 6 per cent between 1949 and 1960, thanks to an increase in the productivity of pastures and milk herds. Technical progress in central Brazil, certain areas of the Colombian and Ecuadorian highlands, and dairy zones in Chile, Central America, Cuba, and Venezuela is very encouraging. Milk production in the latter country increased by 73 per cent between 1950 and 1958, that is, at a yearly rate of 7 per cent.

Finally, it should be remembered that much can be achieved in reducing the incidence and morbidity of diseases affecting meat and milk production and yields by intensifying campaigns for both preventing and curing diseases. There is no doubt that beef and milk production could be increased considerably through large-scale control of foot-and-mouth disease, brucellosis, mastitis, and diseases caused by hematozoons and external parasites.

HEALTH PROBLEMS INVOLVED IN THE IMPORT AND EXPORT OF FOODSTUFFS OF ANIMAL ORIGIN

DR. FERNANDO QUEVEDO *

International trade in foodstuffs, particularly animal protein foods, has increased considerably during recent years, and because of the growing worldwide demand for proteins it is certain that the volume of such trade will increase still further.

As this trade increases, there must also be an intensification of current health measures to prevent an increase in the dissemination of pathogenic organisms transmitted in foods of animal origin.

These organisms can be grouped in two categories: (a) those associated with endogenous animal infections transmissible to man (zoonoses), including bacterial, fungal, virus, helminth, and protozoan species and (b) exogenous contaminants of food, which may cause infections or poisoning in man.

The measures necessary to prevent health problems associated with organisms of the first category correspond specifically to the services of veterinary medicine. The Pan American Zoonoses Center is dedicated to the investigation and solution of problems of this category.

This paper will refer in more detail to the public health problems caused by the exogenous contaminants of the second group.

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Salmonellosis

Of the pathogenic organisms for which food of animal origin serves as a vehicle transmitting infection to man, the most important group is undoubtedly the Salmonella, which belong to both of the two categories mentioned above.

The International Committee on Microbiological Specifications for Food (ICMSF) of the International Association of Microbiological Societies (IAMS), in its most recent publication (*36*), defines human salmonellosis as a gastrointestinal infection usually of greatest severity in the very young or very old, though severe illness, with some mortality, may occur in any age group. The disease is characterized by an elevated temperature, diarrhea (sometimes sufficient to lead to severe dehydration), intestinal pain, and perhaps vomiting. Consumption of contaminated food is the most common cause. An incubation period of about six to 18 hours is usual. The duration of the disease may vary from a few days to a few weeks, depending in part on the efficacy of the therapy applied. A subsequent carrier state may persist in an asymptomatic patient for a few weeks to several months, and *Salmonella typhi* may be excreted intermittently throughout the carrier's lifetime.

Among all diseases transmitted by food,

the salmonelloses are also the ones more frequently reported. The number of persons affected per annum by this disease is extremely high. In the United States of America today it constitutes one of the most important problems among communicable diseases, amounting to 2 million human cases yearly. In the United Kingdom morbidity figures are similar. In other countries, notwithstanding deficiences in surveillance as well as in reporting of cases, it is certain that the salmonelloses have the same graveness.

As a logical consequence of the magnitude of the problem, there are very significant economic losses. Considering only the expenses of medical treatment and associated losses, such as absence from work by the affected individuals, the impact on the American economy is of the order of US$200 million annually (*25*). To these figures must be added the costs of preventive measures and the losses deriving from the destruction or reprocessing of contaminated products. For example, the cost due to rejection of a preparation of powdered milk found contaminated with Salmonella has been estimated at approximately US$5 million. Expenses incurred for professional and auxiliary personnel by various government agencies concerned with the problem have been equally high. The large sums allocated to investigation of the disease must also be added to the total.

Livestock owners and food processors also suffer large losses because of salmonellosis. In this regard the U.S. Department of Agriculture, in a report presented in 1969 before a specialized committee of the National Research Council (*25*), points out that the economic influence of Salmonella infection for livestock and avian industrialists can be summarized in the following points:

- Losses due to mortality and morbidity of the infected animals.
- Costs of drugs and veterinary services.
- Decrease in dairy cattle production.
- Decrease in the average weight increment of cattle, swine, sheep, chickens, and turkeys.
- Decrease in egg production.
- Loss of consumer confidence in dairy and poultry products, especially in eggs and their derivatives, which is reflected in the lower prices paid to the producer.
- Production losses due to rejection, reprocessing, and/or destruction of livestock, meat and derivatives, dairy and poultry products which are found contaminated with Salmonella after the processing and/or distribution.

Besides the expenses listed above, industrialists invest large amounts of money in their own programs of research and in bettering equipment and facilities with the object of reducing contamination and recontamination of their products to the minimum.

A discussion of all of the epidemiological aspects of salmonellosis is outside the scope of the present report. However, we will point out that animals are important reservoirs of Salmonella, obtained through their feed, particularly animals which are used as a source of food by man. This is reflected in the fact that food of animal origin, such as red meat, poultry, eggs, and their derivatives, are the principal sources and disseminators of salmonellosis, whether it be by direct consumption or by cross-contamination in factories, restaurants, and family kitchens. Some animal-origin drugs and pharmaceuticals have also been designed as sources of Salmonella outbreaks (*29*).

Human carriers play an important role in the dissemination of Salmonella. Although it has been pointed out that their

proportion does not exceed 0.3 per cent in the developed regions, in other areas that percentage notably increases (*14*). Workers at food industries can become carriers of Salmonella. It has been suggested, therefore, that for this group of workers salmonellosis be considered as an occupational disease (*12*).

Poor sanitary practices, rodents, domestic carnivores, birds, and insects, especially flies (*28*), are important factors in the propagation of salmonellosis.

Finally, we can say that although more than 1,000 different serotypes are known, only 100 of them are frequently isolated. It has been observed that only 10 serotypes are the ones that occupy the first places in the isolation from human and non-human sources.

Information on the most common serotypes is of great importance for public health specialists. Epidemiological surveillance of salmonellosis, which should be implemented worldwide, would help to control this disease. The U.S. Center for Disease Control in Atlanta, Georgia, the Public Health Laboratory Services in England, and, since 1966, the European Regional Office of the World Health Organization have established epidemiological surveillance in their respective geographic areas.

In some regions, particularly in Latin America, we can point out the presence of the Arizona group of bacteria, which may cause problems similar to salmonellosis.

Health Problems Caused by Preformed Bacterial Toxins in Foods

In this group we find only staphylococcal intoxication and botulism. There is no clear information on the nature of the disease produced by *Clostridium perfringens*.

Staphylococcal Food Poisoning

This disease is characterized by nausea, vomiting, diarrhea, general malaise, and weakness. In severe cases there may be collapse and other signs of shock. The symptoms start 30 minutes to three hours after consumption of food. Total recovery may take three days to one week (*3*). Mortality is low except in the case of children and the very old, who often die of dehydration.

The symptoms are caused by specific polypeptides, which act as emetic toxins. Four classes of these enterotoxins have been characterized: A, B, C, and D. They are relatively thermostable, especially when found in foods (*3*).

The responsible microorganism is the enterotoxic *Staphylococcus aureus*.

For the enterotoxin to be produced, the staphylococcus that contaminates the food has to proliferate abundantly, requiring nutrients, adequate temperature, and time. Food such as meat, dairy and egg products, and seafoods may stimulate the enterotoxin production.

The contamination of food is effected in various ways. Mastitis-affected cows are an important source of contamination, but the most common way is through food handlers. A person with infected wounds or respiratory infections, by handling food products, coughing, sneezing, or expectorating, disseminates appreciable quantities of staphylococci on them. Simple refrigeration is not always sufficient to impede the production of toxin; and once the toxin is produced, the heating of food is not enough to eliminate it. All food containing enterotoxins must be destroyed.

To give an idea of the importance of this poisoning, we can mention that in the United States of America in 1967 it was responsible for 25 per cent of the outbreaks of foodborne diseases; in 1968 and during the first six months of 1969, it was the most

frequent cause of those diseases, accounting for 25 per cent of all reported cases and 25 per cent of all outbreaks (*7, 8, 10*).

Botulism

This disease is not frequently present, but it is nevertheless very important owing to its high mortality (50 per cent). Food of animal origin, like meat and fish derivatives, have been incriminated in serious botulism outbreaks.

The responsible agent, *Clostridium botulinum,* an anaerobic spore-forming organism, produces a thermolabile toxin which is the most powerful known. One ten thousandth of a microgram is enough to kill a mouse (*3*). The toxins capable of affecting man are the types A, B, E, and F.

The incubation period is rarely shorter than six hours. It is generally between 12 and 26 hours, but it can sometimes be longer.

The principal symptoms are related to the central nervous system, while digestive disturbances and vomiting may or may not be present. The characteristic symptoms are muscular weakness, double vision, speech and swallowing difficulties, and respiratory and cardiac paralysis. In severe cases, particularly with type E cases, for which seafood serves as the vehicle, death may occur 20–24 hours after ingestion, but it generally occurs after three to six days.

The thermoresistant spores of *Cl. botulinum* are widely but irregularly distributed in nature. Effective sanitary measures and adequate technical processes minimize the risk of botulism.

Clostridium perfringens—Bacillus cereus

The exact nature of this disease has not been well defined, and it is not known if it is an actual infection or an intoxication. However, ingestion of food contaminated with a large number of *Clostridium perfringens* causes, after 8–18 hours, severe abdominal pain and diarrhea. This foodborne disease has not been given the importance it deserves except in the United Kingdom. However, in the United States in 1968 *Cl. perfringens* was the cause of the largest number of cases of diseases of food origin, and during the first semester of 1969 it accounted for 40 per cent of all cases, against 25 per cent noted for staphylococci intoxications. Meats and their derivatives are the most frequent vehicle of this illness (*17*) but milk, cheese, and shellfish have also been incriminated in some outbreaks.

The anaerobic spore-forming organism, *Cl. perfringens,* is found in soil, water, milk, dust, drains, and the intestinal tract of man and animals. If the animals do not receive the necessary care immediately before being slaughtered (for example, 24-hour rest after transport, and feed and water administered before slaughter), they may suffer an internal contamination by systemic means though they may be clinically healthy (*40*). Adequate sanitary measures and a correct application of refrigeration, especially after cooking, prevent the massive multiplication of the organism.

A disease with similar symptoms and epidemiological characteristics is caused by *Bacillus cereus,* a spore-forming aerobic organism which can be found in large numbers in sausage, powdered milk and eggs, and also in food of vegetable origin.

Many other microorganisms are capable of producing food-poisoning symptoms, even if they are not strictly considered as pathogens. However, it is necessary to point out that these organisms must be present in highly concentrated form in order for symptoms to break out.

Indicator Organisms

These are microorganisms whose presence in food is undesirable, not necessarily because they are considered pathogenic, but because they may indicate contamination with dangerous organisms or precarious hygienic conditions during production, storage, and/or transportation of the food product. For reasons of safety and esthetics, their investigation is an almost general rule, especially with food involved in international commerce.

Among these indicator organisms we find *Escherichia coli,* coliforms, enterobacteria in general (total count), enterococci, staphylococci, *Streptococcus salivarius, Clostridium* sulfite reductors, and of course, in a quantitative estimate aerobic mesophilic bacteria, psychrophilic and thermophilic microorganisms, and anaerobics.

Although the subject is outside the scope of this report, which centers on public health problems, it should be mentioned that many microbial species are capable of altering the commercial quality of food, infringing heavy losses on producers who are forced to destroy stocks because of major changes that occur in the organoleptic characteristics of the food (*6, 11*).

International Trade in Animal-Origin Food

Because of their growing importance in international trade and their significance to public health, special attention should be given to problems arising from the following foods: meat and derived products, dairy products, fish and fish products, dehydrated protein concentrates, egg products, and seafood. These also constitute important sources of foreign currency for many Latin American countries.

Meat and Meat Products

These are the products most frequently involved in foodborne diseases.

With reference to salmonellosis, meats serve as the most frequent vehicle for this infection.

Veterinary inspection before slaughter helps to discover and separate clinically sick animals. Unfortunately, the same does not hold true for animal carriers or those that develop a subclinical disease; these are slaughtered and later processes such as bleeding, skinning, splitting, and especially boning—which notably increase exposed surfaces and handling—result in contamination of the environment, the food handlers, and the utensils used. If adequate sanitary measures are not applied, especially good disinfection practices, and if the room temperature during the process is not sufficiently low (10° C or less), Salmonella will finally be found in high proportions in the finished product samples. Furthermore, misapplication or interruption in the cold chain during storage or transportation will favor multiplication of dangerous microorganisms.

Aware of the serious risks involved, large meat-importing countries routinely search these products for Salmonella, and very significant results are obtained.

For example, England during 1961, 1962, and 1963 found between 5 and 90 per cent samples of imported beef and mutton contaminated. During the same period, 50 to 60 per cent of horse meat samples were found contaminated; products from some establishments showed 100 per cent contamination (*16*). Unfortunately, most contaminated meat samples were from South America.

These findings, together with the disclosure of Salmonella outbreaks in which the responsible serotypes corresponded to

the ones isolated in the meat, induced English authorities to adopt a series of restrictive measures. They decided to import meat coming only from establishments approved by their technical representatives, on the basis of stipulated sanitary conditions.

The United States, Canada, and some European countries intensified their controls and requirements after their investigators obtained findings similar to those of the British. The United States and Canada base their import programs on the requirement that meat and derived products be handled and processed under the same standard inspection procedures as those observed by their own systems (*32*) (*38*). To ensure that the requirement is met, the United States and other countries send technical missions to the exporting countries to select the most appropriate establishments.

This new requirement has led many industrialists to approach the problem with firmness, investing large amounts of money in order to comply with the sanitary and technical specifications laid out by the importing countries.

Results are beginning to be favorable. Let us take, as an example, the frozen, packed, boneless, raw horse meat analyzed in English laboratories (*18*). Argentina in 1964 had 39.4 per cent of positive samples; in 1967 this was reduced to 13.6 per cent. Paraguay in 1964 had 31.6 per cent positive samples, and only 14.0 per cent in 1967. Brazil in 1965 had 19.7 per cent, and in 1967 had 16.3 per cent. For Uruguay, figures are available only for 1966 and 1967, and these do not show significant differences.

Important measures to cope with these problems have been taken by the Latin American Governments. The official Argentine action is reflected in the programming of intensive courses for veterinary inspectors, the improvement of official control laboratories, and other similar activities. Especially important was the publishing and wide distribution in 1969 of the Animal Health Regulations: Inspection of Animal-Origin Products and Derivatives (Decree 4.238/38) (*2*), a very useful tool of great value in the solution of these problems.

Authorities in Uruguay, with great urgency, have dictated new regulations to provide veterinary personnel and auxiliaries with full-time positions offering more adequate remuneration; and they are organizing intensive training seminars for newly appointed veterinary personnel to give them up-to-date information on the subject. Also, they are proposing official action to be developed with reference to bacteriological control, designed to ensure the hygienic quality of meats.

At the international level, the countries of the southern cone, through COTERSA (Regional Technical Committee on Animal Health), are devoting close attention to the sanitary aspects of exportable meats and derived products.

Importing countries should appraise these efforts in their true perspective. For example, to request frozen meat totally free of Salmonella is *irrational*, given the particular characteristics of the problem. The action taken against imported meat is made more difficult to understand by the fact that meat products in the importing countries themselves are also frequently contaminated. In Great Britain 15 per cent of calves were found to be excreting Salmonella when entering slaughterhouses. The carrier rate for Salmonella in calves varied from year to year, but on one occasion was as high as 35 per cent. The situation in the United States appears to be similar to that in Europe. A survey showed that 50 per

cent of finished animal by-products examined in U.S. establishments contained Salmonella (*35*).

Australian horse meat (frozen, boned, and packed), was found contaminated in British laboratories: in 1965, 17.3 per cent; in 1966, 25.9 per cent; and in 1967, 40 per cent (*18*).

All these developments indicate the necessity of intensifying control and sanitary measures related to the meat industry, and also of improving the technical processes even further.

Precooked frozen packed meat, for example, after removal of recontamination risks, will have an ever-growing demand on the international market.

We do not wish to dwell further on the risks offered by other meat products such as sausages and canned meat. Let us, however, remember the sad episode of typhoid fever in Aberdeen caused by corned beef, contamination of which was finally attributed to the cans which were cooled in contaminated water, after autoclaving.

Milk and Dairy Products

A very good review of diseases transmitted by milk and milk products has been made by Kaplan *et al.* (*22*).

With reference to dairy products involved in the international trade, powdered milk has been responsible for salmonellosis and staphylococcal enterotoxic outbreaks. Also, certain varieties of cheese have been found to be implicated.

It should be emphasized, however, that the technological progress made in the dairy industry and the systematic practice of pasteurization and other controls have extraordinarily reduced the involvement of dairy products in foodborne diseases.

Poultry

Modern poultry breeding is done in large establishments; mixed dehydrated feeds are used, and these are frequently contaminated with Salmonella.

Slaughter and subsequent processing—bleeding, feathering, evisceration, washing, chilling, and freezing—contribute to the dissemination of Salmonella, with the result that poultry meat serves as a very important vehicle of salmonellosis.

Elliot, at the Meat Industry Research Conference in 1969, indicated that verified analysis of 597 chicken carcasses (whole, i.e., 1,200 g for each sample) showed a 28.5 per cent rate of contamination with Salmonella. More complete information on this investigation was published later (*34*).

The use of water with a high concentration of chlorine has given impressive results in some countries, leading to an appreciable reduction in contaminated carcasses (*40*).

Chicken, duck, and turkey meats, besides being contaminated with Salmonella, may serve as vehicles for enterotoxic staphylococci and *Clostridium perfringens*.

Fish and Fish Products

Fish and fish products have been incriminated frequently (*31*) in staphylococcal food poisoning, salmonellosis, and botulism, particularly in countries where fish is an important part of the diet. We shall not refer to the disease caused by *Vibrio parahaemolyticus*, since we do not have information on its effect on the international food trade.

With reference to salmonellosis, this problem usually arises when the fish are caught in contaminated waters, or during processing. Fish taken in the open sea will have their intestinal tracts clear of enterobacteria (*5*).

The principal problem caused by this type of food is related to type E botulism. This risk apparently has been increased by consumption of vacuum-packed smoked fish. More research on this particular subject is required. Detailed information on type E botulism outbreaks caused by fish products from 1932 to 1957 has been published by Shewan (*31*). Cases occurring in the United States and Canada from 1899 to 1964 are shown in publications by Meyer and Eddie (*23*). Interesting data on this subject may be found in "Botulism 1966," by Ingram and Roberts (*19*).

Dehydrated Protein Concentrates

The practice of feeding cattle and poultry with dehydrated protein concentrates has greatly increased, as has the volume of international trade in these items.

Unfortunately, these feeds constitute one of the principal sources of Salmonella carriers among animals. In fact, they represent the first link in the chain "feed-cattle-meat-man," having been incriminated as original sources of contamination in salmonellosis outbreaks due to ingestion of meat and by-products (*20*).

The presence of Salmonella in these products is explained by recontamination suffered after their processing, through birds (*21*), insects (*28*), and rodents, and by man himself. This is applicable to meals processed from meat, blood, fish, and feathers as well as to those of vegetable origin.

Well-controlled processing and the use of adequate sanitary measures to avoid recontamination offer very good results. This has been demonstrated (*27*) in fish reduction plants in Peru, the major producer of fish meal, where serious problems were encountered when products were found contaminated with Salmonella. Manufacturers in that country, through their industrial associations and with the help of specialists from the universities, were able to notably improve the hygienic quality of their products. Mass transport of protein concentrates in large containers brings with it new problems that increase the recontamination risk.

Egg Products

Frozen and powdered eggs have caused numerous salmonellosis outbreaks. These products, which are used in the production of ice cream, puddings, and pastry and which generally are submitted to heat processes after their reconstitution, offer great danger. Let us recall that total counts or coliform tests practiced on these products in most control laboratories are not always related to the presence or absence of Salmonella (*35*) and may give a false indication of safety.

Pasteurization processes and adequate hygienic measures are diminishing the risks connected with egg products.

Shellfish

Export and import of frozen or precooked shellfish acquires more importance each day. These products have been associated with staphylococcal food poisoning, salmonellosis, and epidemic hepatitis. The practice of fishing in contaminated areas, and improper hygienic-sanitary conditions during processing and packaging are the major factors favoring contamination.

The health problems related to all of the foods mentioned above are many and complex, and the intensification of measures directed toward their solution is an urgent necessity.

Official Control

Authorities in each country will have to improve and increase their control over

foodstuffs, especially those entering international trade. In regard to controls on manufacturers in their own countries, it is important to remember that the modern concept of control relies on food surveillance, in contrast to the classical concept of inspection.

Inspection methods are retrospective, regressive, punitive, and uneconomical if they are applied without surveillance. On the contrary, surveillance methods are prospective and preventive and are carried out by studying the processing chain to determine at which point the contaminating agent enters this chain.

Certainly, surveillance should not replace conventional methods such as inspection, but it will indicate the direction and extent of the food protection measures necessary (*39*).

Surveillance should be conducted at the primary source of production, during processing, storage, and distribution, and even at places of consumption.

Help to Industries

Government authorities should help industrialists continuously, offering technical advice, encouraging personnel training, and showing interest in their problems. To point out their deficiencies in production is not sufficient; rather, ways to eliminate them have to be shown. Controls should serve to encourage industry, not to destroy it. After all, industry is fundamental for the countries' development.

For no reason, though, should this policy be synonymous with complacency in the face of bad-quality export products. For example, the granting of official approval or good-quality certificates without the performance of strict controls is bad practice and discredits the industrialist as well as the official agency that grants them.

Furthermore, even when such official certificates are easily obtained, they do not help in evading the controls imposed by the importers. Many cases confirm this observation. One of them, published by a journal of international circulation (*30*) relates that during the second half of 1960 the Liverpool (England) laboratory rejected 10,000 cans of Yugoslav canned ham (10 pounds each) because they were found contaminated with a great variety of microorganisms, among them *Clostridium perfringens*, although the official certificate of origin guaranteed its quality and safety (*30*).

Cases such as these have even given rise to doubts concerning the advantage of official certificates in international food trade.

Reprocessing

Other more radical measures implemented by large importing countries have resulted in indiscriminate reprocessing of all food of animal origin coming from areas where general sanitary conditions leave something to be desired. For example, total lots of meat would be irradiated at the unloading port, all fish meal consignments would be repasteurized, etc.

It is evident that such a procedure would be totally undesirable for different reasons.

1) It would not stimulate exporters to improve the hygienic quality of their products.

2) The development of food technology and training of competent technicians would not be encouraged.

3) A continuous contamination of loading and unloading ports and of transport media would be favored.

4) It would be necessary to establish long quarantine periods for the products, always unpleasant and uneconomical.

5) Decrease in the organoleptic and commercial value of the products would be encouraged, whether by the action of the microorganisms, which under certain conditions could continue to develop (for instance, psycrophilic microorganisms in meat or fish), or by the nature of the reprocessing. It is important to point out the latter because of the decrease in the nutritive value of some food by repeated treatments.

6) Finally, the food prices would notably increase, causing economic loss to producers and to consuming public.

Destruction of Contaminated Food

The reprocessing described above could be feasible when food is found highly contaminated with Salmonella. On the other hand, systematic destruction would be much more difficult, not only for economic reasons but also because such practice would represent a large reduction in the world supply of protein. In some countries there is a tendency to avoid Salmonella investigation in food, so that supplies will not have to be destroyed if found contaminated (*40*). Also, the lack of official control of imported food results in a situation in which substandard products, which do not meet the requirements implemented in regions or countries that have adequate industrial and official controls, are marketed without difficulty in areas where controls are not effective (*35*).

Good Manufacturing Practices

Throughout this report we have insisted on the importance of hygienic and sanitary measures for obtaining noncontaminated food. For these principles of hygiene to be easily understood by industrialists and by personnel responsible for production, they have to be explained in a clear and comprehensive manner.

A compilation of these principles and recommendations should be prepared in the form of codes or regulations of good manufacturing practices for each type of industry. Government technicians, industry representatives, and specialists from universities and research centers should collaborate in their preparation.

There are various codes of this type already published which have shown magnificent results. Application has been voluntary in some cases and compulsory in others. Those prepared by Hobbs (*15*), the South African Bureau of Standards (*33*), AFDOUS (U.S. Association of Food and Drug Officials) (*1*), U.S. Food and Drug Administration and Department of Agriculture (*37*), and the Committee of Food Hygiene of the *Codex Alimentarius* Commission of FAO/WHO are good examples.

The *Sanitation Handbook* (*37*), for example, prepared by the U.S. Department of Agriculture, is of great value for meat-processing establishments. The Spanish version of this useful manual has been incorporated in the series of Technical Notes of the Pan American Zoonoses Center and is being widely distributed (*26*).

Microbiology Control Laboratories

Insofar as official control is concerned, the participation of microbiology laboratories in the international food trade is most important. Their intervention protects public health by avoiding the import or export of contaminated products.

With reference to industry, private laboratories assist in the proper selection of raw material and in the approval or rejection of the finished product before it is launched on the market (*36*). A good ex-

ample is the favorable experience obtained with microbiology laboratories in the dairy industry, which were largely responsible for the notable decrease in health problems caused by milk and milk products.

Every industrial establishment should install its own control laboratory or make use of the services of commercial laboratories. The industrialist should not wait for the official laboratory to inform him of his product's quality.

It is necessary that analytical methods and techniques be standardized at the international level. Certain attempts are already giving good results (*24, 36*), but in this respect many problems are encountered; the complete analysis of these is outside the scope of this report. However, with coordinated efforts and official support, the required results can be obtained.

Microbiological Criteria

Microbiological criteria (standards, specifications, limits) are useful instruments in the international food trade. By familiarizing themselves with them, industrialists will know the standards that should be met.

Such criteria must be established methodically and on the basis of appropriate experimental studies. Figures cannot be invented nor "pulled out from the air" (*13*). They have to be rational and feasible to attain. Too rigid criteria discourage industrialists or cause dishonest producers to employ fraudulent methods which are dangerous to health and which cannot always be detected.

Training

The scarcity of specialists in food hygiene and microbiology and of professionals well trained in the modern aspects of food technology is a factor that may prove an obstacle to the effectiveness of measures taken to reduce the risks in the international food trade.

It is necessary to stimulate and help universities and research centers to organize proper training in food microbiology through intensive courses for postgraduates.

Research

Research in food microbiology, hygiene, and technology, as well as in other scientific disciplines, is essential. Proof of this is the great volume of research done in this field by the more industrialized countries, and the prodigious sums of money invested by Governments and industries in those programs.

However, in this field it is necessary that the results of tests and research done in other regions be adapted to our own area, taking into account, among other factors, the climatic or ecological differences, different methods of breeding and feeding animals, particular characteristics of our seas and fishing industry, variations in microbial flora, practices of food workers and handlers, and differences in general health conditions.

Because of the complexity of the problems to be dealt with—embracing such disciplines as microbiology, toxicology, technology, and public health—comprehensive research will only be possible if there are sufficient numbers of trained personnel, an adequate number of laboratories, well-equipped pilot plants, and continuing cooperation and support on the part of the competent authorities.

Recommendations

In view of the magnitude of the problems involved and the fact that Latin American

countries will have to increase the production and exportation of food while at the same time meeting the higher quality requirements of importers, a number of measures, coordinated at the continental level, should be taken without delay.

First, the education and training of professional personnel specialized in the food sciences should be promoted, and universities and scientific centers should be provided with the material assistance they need in order to properly discharge that function.

Codes of hygienic manufacturing practices for each type of industry should be drawn up or adopted as soon as possible. They should be widely circulated to put them into the hands of persons engaged in the processing, storage, transport, and sale of foodstuffs.

Expert representatives of our countries should be encouraged to take a more active part in the various committees of the *Codex Alimentarius* (FAO/WHO).

Appropriate steps should be taken to standardize methods of food control, especially of foods involved in international trade.

To coordinate the above-mentioned activities, regional centers should be established under the auspices and with the technical assistance of the United Nations specialized agencies, and should undertake research and training activities and provide the countries with technical assistance in microbiology and food hygiene.

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DISEASE PROBLEMS ASSOCIATED WITH THE IMPORT AND EXPORT OF ANIMAL PRODUCTS INTENDED FOR CONSUMPTION

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International movements of livestock are usually carried out in order to achieve one of the following objectives:

1. To promote the development or improvement of livestock, through the use of male and/or female breeding animals from another country whose livestock numbers are usually substantial because it possesses the necessary natural resources and technological facilities.

2. To replace over-mature animals by others produced at lower cost in the exporting country. The reduced cost may be due to the fact that the exporting country possesses resources not available to the importing country, as in the case of natural pastures. This type of movement is usually limited to dairy cattle, either unregistered or a pure breed developed by crossbreeding. Nevertheless, it may involve transport of many thousands of head per year.

3. To transfer young steers from one country to another for fattening and consumption. This type of movement is frequent among bordering countries, particularly when one of them has good facilities for breeding while the other has a good consumer market, attractive prices, and facilities for fattening the animals. Many different types of arrangements made are for these movements, depending on prevailing conditions in international trade areas and livestock production practices.

4. To import young steers for slaughter shortly after arrival at their destination in the importing country, in order to compensate for local meat production shortages.

Livestock other than cattle are also traded, particularly sheep, for which there is a good market in some countries. The movement of live animals has been and continues to be one of the ways in which contagious diseases and animal parasites are most easily spread from country to country and from continent to continent. Foot-and-mouth disease is one of the most widespread diseases in the entire world and the movement of livestock has contributed significantly to its dissemination.

To achieve the goals for which livestock imports and exports are intended, it is essential to use the methods which research and technology have made available to animal health specialists for the purpose of reducing animal diseases. Otherwise, the results may be negative, producing losses of unpredictable dimensions.

The movement of livestock always involves certain risks, some of which are listed below:

1. The possibility of introducing more serious exotic diseases—for example, the danger of introducing a devastating animal disease from one country to another or even from one continent to another. These diseases include contagious pleuropneumonia in cattle, bovine plague, and African swine fever, which fortunately has not spread to the Americas.

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2. The possibility that major livestock diseases which exist in both exporting and importing countries may develop to epizootic proportions through imports of diseased and/or carrier animals. This has been the source of some epizootic waves of foot-and-mouth disease which have occurred in several South American countries. Such waves sometimes become explosive in the exporting country itself because of the concentration of animals from various areas.

3. The possibility that diseases which are usually undetected on the originating farms may occur in explosive outbreaks at the time of concentration of animals of diverse origin in the exporting country, within transit holding facilities, or in the reception or quarantine centers of the importing country. Such diseases include infectious bovine rhinotracheitis, viral diarrhea, and parainfluenza 3, which, when combined with the stresses caused by confinement and transportation, produce clinical symptoms and losses which oftentimes are severe and are practically indistinguishable from those of "shipping fever" or hemorrhagic septicemia. The infectious bovine rhinotracheitis and diarrhea viruses have caused problems in movements of livestock from North to South America.

4. The possibility that diseases which have a low prevalence in the exporting country may become very highly prevalent when introduced into herds of the importing country because of different ecological and management conditions that are more favorable for the organisms. Bovine tuberculosis may be cited as an example. It usually reaches a high level of prevalence after its introduction through diseased animals into herds that are managed through a close-confinement system, such as holding and breeding operations carried out in corrals, in which the animals are never sent to pasture.

5. The possibility that internal and external parasites, as well as blood parasites, which affect animals moved from one country to another, may propagate and establish themselves in the livestock native to the country of importation. In such cases it may be found that the cattle are infested with ticks (Boophilus) that transmit bovine piroplasmosis and anaplasmosis. These blood diseases cause considerable losses when they attack animals from areas formerly free of them.

Many measures may be adopted in order to prevent all these dangers. Although transfers of live cattle generally entail greater risks than the movement of fresh meat and animal products, it is possible to avoid—at least in some cases—the transportation of stock from countries or areas of countries in which such movements would be dangerous. Prevention can be accomplished by means of improved knowledge of the epizootiology of diseases, their distribution, control methods employed in various countries, and periodic reports on the changes that occur in health conditions in exporting and importing countries. Such information is provided through international agencies such as WHO and PAHO, the Pan American Foot-and-Mouth Disease and Zoonoses Centers, the International Office of Epizootics (OIE), and FAO. Such knowledge is also very useful in establishing technical standards that the animal health authorities of the exporting country, the country or countries of transit, and the importing country may agree to implement.

International transport of breeding animals does not always entail the same health risks as the transport of livestock for purposes of consumption. In breeding animals, tuberculosis and bovine brucellosis constitute a serious threat to native animals which are in proximity with the

imported livestock, as well as to their progeny.

The movement of livestock to consumer markets usually involves large numbers of animals. Although they are slaughtered shortly after reaching their destination, during round-up operations in the exporting country and during transit to the slaughterhouse in the importing country they may cause serious epizootics if they are affected by a highly communicable disease, and especially a disease that can be contracted by indirect as well as direct contact.

External parasites, such as certain Diptera (flies), which may accompany the animals while they are in transit, may complete the cycle and establish themselves in the importing country if the environment at the point of destination is conducive to reproduction and the population of male and female parasites is adequate. The possibility of such a development is greater in the case of large-scale movements of animals destined for slaughter because they are usually subject to less stringent health requirements than those pertaining to livestock imported for breeding purposes.

Transport of fresh meat and other animal products is not exempt from risks. In the liver and kidneys of swine affected by foot-and-mouth disease which are preserved by means of refrigeration, the virus may remain viable for long periods and cause epizootics in the importing country if brought into contact with susceptible animals. In this case, the native swine may be susceptible if they feed on refuse that has not been boiled or sterilized in some other way. Bone meal obtained by means of a process that does not ensure sterilization may transmit *Bacillus anthracis* and produce anthrax in animals which receive such meal in their feed as a mineral supplement. However, in the case of imports of fresh meats from countries which have an efficient animal health organization and maintain strict sanitary controls for slaughterhouses and for the export of slaughterhouse by-products, the risk is very small when compared with that involved in the movements of live animals.

Thus, from the standpoint of animal health, when it is necessary to import products to compensate for shortages in national production of meats or other animal products, fresh meats should be preferred.

For various reasons, at present there is considerable international trade in live animals destined for slaughterhouses. One of the reasons is that in order to carry on international trade in fresh meats, and to pack, distribute, and sell them to the consumer, a special infrastructure is required, including refrigerated transportation and storage facilities, and also such export products are subject to more stringent controls than those applied to animals that are slaughtered locally.

Furthermore, purchasers usually prefer the meat of freshly slaughtered animals; they object to frozen meats because they are unaccustomed to preparing and consuming them. And finally, in certain cases imports of live animals permit the operation of slaughterhouses with greater capacities than in circumstances where supplies are obtained from national sources only. In many instances, of course, the reasons listed may not apply, and trade in live animals may be replaced by trade in fresh meats.

Thus, in the interest of the importing country, priority may be assigned to the establishment of an infrastructure designed to permit the aforementioned substitution. Furthermore, in the case of a country whose livestock capital is increasing and will eventually cover the needs of its internal

market, the same structure could be used in national production.

Perhaps the most difficult task will be that of changing consumer preferences. This can be achieved, at least in some cases, if the processing techniques employed permit the presentation of a product that is indistinguishable from those obtained from animals slaughtered locally, and also result in the improved appearance of certain products. Likewise, information regarding the correct preservation and use of refrigerated meats would tend to achieve the same purpose.

If complete substitution is achieved and the requirement for cooking or heat sterilization of all refuse fed to animals in the importing country is established, particularly in the case of swine, the danger of introducing and disseminating diseases would be reduced considerably.

As long as there is international trade in live animals for slaughter, health standards should be adopted and applied in the exporting country and in the country or countries of transit, as well as the importing country.

Such standards should establish the general requirement that the animals should originate from areas where there have been no problems with communicable diseases, and that the farms or ranches of origin should participate in the disease-prevention programs applied in the exporting country. Furthermore, it is highly desirable that, prior to transit, the animals be vaccinated against those preventable diseases to which they may be exposed until their arrival and slaughter in the importing country. It should also be established that transport facilities, as well as resting places of cattle, should be controlled by the official animal health authorities. Such authorities should also supervise cleaning and disinfection operations after their use by each herd of animals.

In addition, the feed received by the animals while in transit should originate in places that are free of outbreaks of contagious animal diseases and of infestation by parasites. During transit from their point of origin to their final destination, the livestock should not have contact with animals which have been subject to less rigid sanitary and health control. Preferably, each shipment should comprise animals from a single area that has uniform animal health conditions.

Importing countries must report findings of any test that is of significance from the standpoint of animal health in international trade.

One of the most effective measures for alleviating the problems caused by international movements of livestock for purposes of consumption will be the adoption of multinational programs for control of communicable diseases and parasites which affect the animals that are of greatest importance for the respective national economies.

NEED FOR UNIFORM ANIMAL HEALTH GUIDELINES AND REGULATIONS GOVERNING THE IMPORT AND EXPORT OF ANIMALS INTENDED FOR CONSUMPTION AND BREEDING

DR. H. O. KÖNIGSHÖFER *

Present International Activities

The need has long been recognized for uniform animal health guidelines and regulations governing the import and export of animals intended for consumption and breeding, and work for this purpose is under way in many parts of the world. The following are only a few examples.

In Europe, the six countries of the European Economic Community have been negotiating for more than 10 years in this field, and several Community directives have resulted from that work. Other directives, mainly those concerning imports from outside the Community, are still under discussion. In the Council of Europe, an agreement has been reached concerning the transportation of live animals. The United Nations Economic Commission for Europe has held meetings of experts to discuss facilitation of inspection procedures in international inland traffic in Europe.

In the Organization for Economic Cooperation and Development (OECD), a governmental organization of 22 countries, most of them situated in Western Europe and North America, sanitary regulations for international trade in slaughter stock and meat have been discussed for more than 10 years and considerable progress has been made in the technical field, although a final agreement has not yet been reached. OECD has also endeavored to prepare an agreement for the description of the quality-determining properties of carcasses, with the purpose of coordinating the various meat-grading systems applied at present on the national level.

In the Near East, the work of unification and standardization was initiated by the League of Arab States, and a meeting was held in Khartoum (Sudan) in 1957, which reached a near concurrence of opinion on certificates to be used in the region. In 1966 a Symposium on International Traffic in Animals in the Near East Region was held in Beirut (Lebanon), under the auspices of FAO, which agreed on some basic principles. Later, an Animal Production and Health Commission for the Near East Region was formed, which held its first meeting in Beirut in May 1969. As an outcome of one of the recommendations of that meeting, negotiations are now under way for a regional agreement on certificates for slaughter animals.

In Central America, the work of the International Regional Organization for Health in Agriculture and Livestock (OIRSA) is well known to the participants of this meeting.

The International Air Transport Association (IATA), a nongovernmental international aviation organization, has drawn up guidelines for air transport of live animals, on the basis of the recommendations of a study group established for that pur-

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pose. The facilitation division of the governmental International Civil Aviation Organization (ICAO) is at present studying the possibilities of harmonizing the requirements concerning veterinary disinfection and disinsectization of planes on international flights, and of drafting guidelines for the use of containers for animals and animal products.

A committee for meat and meat products is working within the framework of the joint FAO/WHO *Codex Alimentarius* Commission. This committee seeks to formulate international agreements on certain standards and, if possible, also an international code of practices for slaughterhouses. It is working on a worldwide level, in close cooperation with the aforementioned OECD groups.

The International Office of Epizootics (OIE) has made remarkable contributions to the international work on veterinary regulations, since its establishment in 1924. FAO, through interagency agreements, is maintaining close cooperation with OIE and with WHO/PAHO in this field. In 1964 a joint FAO/OIE/WHO meeting was held in Bern (Switzerland) on basic principles for the control of international traffic of animals and animal products. The conclusions and recommendations of that meeting, which continue to be valid, are presented in Appendix 1 to this paper.

The governing body of FAO has repeatedly stressed the need for further study of the international aspects of veterinary regulations. Paragraph 258 and extracts from paragraphs 291 and 318 of the report of the Fifteenth Session of the FAO Conference held in Rome, 8–27 November 1969, are shown in Appendix 2.

In the framework of these activities, a general review of laws and regulations governing import and export of livestock and associated products in Latin America was prepared by the FAO Legislation Branch, in cooperation with the Animal Health Branch, and was published in 1968 as a FAO working document (*Animal Health Monograph No. 9*). This document was distributed to the directors of veterinary services of all countries of the Americas, and it is hoped that it will prove useful in future work.

Purposes and Objectives

It is obvious that such extensive activities have not been developed without reason, and in fact there are many purposes and objectives envisaged, among which the following general considerations can be distinguished:

a) Multilateral agreements aimed at the liberalization of trade are obviously bound to remain of rather limited value, as long as flexible sanitary and health requirements can at any time be misused as a pretext for nonimplementation. Agreements on veterinary health requirements are therefore an indispensable precondition for the satisfactory working of international or regional commercial agreements on trade in animals and animal products.

b) Diverging and sometimes contradictory requirements in the various importing countries are embarassing for exporting countries. It is felt that many of these difficulties could be eliminated through international standardization, or at least harmonization.

c) Transporters have to comply with a variety of formalities, different at each frontier and in each exporting, importing, or transit country. They feel that these requirements could be harmonized, and largely simplified, without detriment to the final sanitary and health objectives envisaged by these requirements.

d) Nearly all Governments are inter-

ested in information on foreign veterinary legislation, for various purposes: to obtain guidance in their import decisions, to conform with the requirements of potential importers, or to prepare reference material for their own legislative bodies. No international organization is at present in a position to provide adequate information on this subject, and consequently there is an enormous duplication of effort in the various national Governments, causing a general feeling that the present chaotic situation must be amended in some way.

Latin America has special reasons to be interested in this work. There is an enormous potential for livestock production in the region, which is still largely unutilized, although a nutritional demand for more animal protein undoubtedly exists in the world. It has been stated with good reason that the protein gap is not so much a problem of production, as one of distribution. With increased prosperity, the nutritional demand will progressively develop into a true commercial demand. The most important single factor limiting the access of South American meat to world markets is the presence of foot-and-mouth disease. Great efforts are being made to eradicate this disease from the Hemisphere and to control or eradicate the various zoonoses which constitute a hazard to public health. It is important that these efforts not be frustrated and that the results once obtained be reliably maintained. The most effective way to achieve this end will be to protect the Americas as a whole. For that purpose, animal health regulations based on uniform guidelines must be enacted and equally enforced by all the countries.

Prospects and Problems

The prospects of achieving agreements on uniform animal health guidelines are promising in Latin America. The preconditions are in fact more favorable than in many other parts of the world. There is, first of all, a recognized common interest. The earning of foreign exchange through meat exportation is necessary for the technical development of the Region; all Latin American nations will profit, economically and socially, from that common development.

Further, the expansion of trade within the Region is in the economic interest of all the countries. The veterinary supervision of animal trade within Latin America, especially trade in slaughter stock, may be developed into a powerful instrument of common animal disease intelligence, which is needed for joint veterinary action. It is also in the common interest that these technical objectives be achieved through proper coordination and harmonization, without unnecessary obstacles to intraregional trade.

Importation of breeding animals from other continents may be desirable in the framework of organized and well-planned livestock improvement programs. Here again, it is a matter of common interest to ensure, through uniform guidelines and regulations enforced by all countries concerned, that such imports are effected without hazards to the animal health situation in the Hemisphere.

The regulatory and technical preconditions are also favorable for an agreement on uniform guidelines. The aforementioned summary prepared by the FAO Legislation Branch shows that veterinary legislation in the various Latin American countries is based largely on identical technical principles and very similar legal approaches. To mention only one important example, the compulsory veterinary control of exports appears to be a common feature of nearly all the legislations. Other common principles include a certain pref-

erence for the vertical approach to animal disease control, through organized campaigns; and, for the time being mainly in the field of veterinary food inspection, the basic idea of a graduation of obligations and privileges according to the type of inspection received. These principles of time phasing and systematically graduated enforcement may become important elements in the future uniform animal health guidelines of an area that is so rapidly developing and is characterized by such a wide range of differences in basic conditions.

In spite of a justified optimism, however, the problems and difficulties should not be underestimated. One of the first questions to be resolved is that of the working procedure. It is quite obvious that without direct contact on the technical level, agreement can never be reached. On the other hand, Governments may insist that any statement which may commit the country must be channelled through the ministry of foreign affairs; this is, of course, a lengthy procedure and hardly suitable for the purpose. The solution of the dilemma found in other regions and groups of countries may perhaps serve as a model for Latin America; it consists in forming groups of experts, where the veterinary services of all participating countries are represented and authorized to discuss and exchange correspondence on the technical level, in their capacity as technical experts only and with the understanding that no statement made by them, in speech or writing, shall commit the Government concerned. Experience has shown that in this way it is possible to arrive at draft agreements, on the technical level, which are likely to be acceptable to the Governments of participating countries. The Governments, of course, remain always free to accept or to reject the agreements proposed by their groups of technical experts.

The method of procedure is not the only problem. In spite of the far-reaching concurrence of opinion on matters of principle and on scientific approaches, there are still technical and administrative implications at the executive level which must be thoroughly discussed before an agreement on uniform guidelines and coordinated implementation of veterinary regulations can be reached. The first step must be to initiate such discussions. No time should be lost, since the favorable prospects existing at present are not likely to last forever.

Appendix 1

RECOMMENDATIONS OF THE FAO/OIE/WHO MEETING ON BASIC PRINCIPLES FOR THE CONTROL OF INTERNATIONAL TRAFFIC OF ANIMALS AND ANIMAL PRODUCTS

Bern, Switzerland, 12–17 October 1964

The meeting prepared, discussed and approved the following recommendations:

Animals and Animal Products

The meeting recommended:

that governments organize in their countries a veterinary service adequately provided with qualified staff and means to ensure an efficient control of animal diseases as well as inspection of meat and products of animal origin;

that the veterinary service be in a position to confirm as soon as possible outbreaks of contagious animal diseases in their country and to transmit this information to the competent international organization;

that veterinary sanitary regulations established regarding importations and exportations of animals and animal products concern only sanitary matters with the exclusion of all economic considerations;

that each country adopt lists of animal diseases of significance for importations and exportations, taking into account the risk of their spread and the means of control available, on the basis of the lists already established by OIE;

that account be taken of work already carried out by various international organizations on:

(a) the definition of conditions under which animals can be declared free of the above-mentioned diseases, taking into account the most recent diagnostic methods. These methods should be standardized;

(b) the definition of conditions under which a country may be declared free from the above-mentioned diseases;

(c) the modalities under which quarantine should be organized.

that under the aegis of the different international organizations studies be undertaken concerning the consequences of vaccination in international traffic of animals, meat and products of animal origin;

that taking into consideration the new storage techniques, the report of the FAO/OIE Meeting on International Regulations for the Import and Export of Cattle Semen, held in Cambridge in 1955, be brought up to date;

that studies be undertaken to establish the methods of treatment (for example heat, irradiation, etc.) which will assure the destruction of virus in meat, meat products and all products of animal origin;

that the inspection of meat and products of animal origin be carried out by a sufficient number of specialized veterinarians who may be assisted by qualified lay inspectors under their supervision, applying inspection methods and practices harmonized on an international basis;

that detailed international standards concerning conditions with respect to construction, management, hygiene and especially potable water supplies, to be fulfilled by slaughterhouses, and establishments handling meat and other products of animal origin for export purposes be promulgated;

that the work on the *Codex Alimentarius* be taken into consideration and encouraged;

that sanitary requirements prescribed by an importing country with respect to its imports be comparable to those of all countries in which the health status of livestock, the technical equipment and the efficiency of the veterinary services are similar;

that adequate advance notification of conditions governing the importation of animals, meats and products of animal origin be given by importing countries;

that taking into account points already agreed, the drafting of model certificates and identification systems suitable for use in international traffic of animals and all products of animal origin should continue.

Fish and Fish Products

Recognizing the necessity for the sanitary control of international traffic in fish and fish products the meeting recommended:

that this task be entrusted to appropriate government services since these products may be the cause of the transmission of infectious and parasitic diseases of man and animals, including fish, and

that OIE and FAO continue their work on this subject and that other international organizations working in this field be invited to collaborate.

Associated Items

Recognizing the risk of animal and human disease transmission inherent in garbage and other refuse from ships, planes, trains or road transport engaged in international commerce, the meeting recommended:

that governments introduce regulations requiring that when such garbage or refuse is removed from carriers, it be immediately incinerated or, if this is not feasible, it be buried or sterilized with strict sanitary precautions;

Recognizing the potential danger of disease transmission through the use of hay, straw and other plant materials for the packing of manufactured products in international commerce and considering the general availability of other acceptable materials, not associated with animal production, the meeting recommended:

that all countries encourage commercial shippers to use other generally available materials such as man-made materials;

Recognizing the need for the control of international movements of biological products for the prevention or treatment of disease, and of living pathogens and of vectors of disease, the meeting recommended;

that committees of existing organizations further study these matters and recommend measures that should be adopted by governments.

International Transport

The meeting recommended:

that the transport of animals, meat and products of animal origin should be carried out in such a way as to avoid any risks of propagating disease for transit countries as well as the country of destination and that to this effect, adequate disinfection and

disinsectization of means of transport particularly by aircraft, be carried out in accordance with norms to be agreed upon. In this connection, points of entry, in particular airports, should be equipped with adequate animal health installations;

that transport of animals should take place in suitable vehicles under veterinary control and in such conditions as will avoid unnecessary distress;

that studies be continued to determine the best conditions for the transport of animals, meat and products of animal origin;

that close cooperation be established with organizations concerned with transportation at the national and international levels.

The Future Role of International Organizations and Any New Bodies Whose Establishment May Be Proposed

The meeting recognizing the value of the work done by the various organizations and appreciating the results already obtained in the control of international traffic in animals and animal products, realizing the need for promoting international trade, while maintaining adequate safeguards against the introduction of animal diseases, considering further that the time has come when there would be advantage in a degree of standardization of the practices, recommended that:

(a) collaboration in this field be continued under the existing agreements between OIE, FAO and WHO and with other interested organizations;
(b) FAO and OIE cooperate in the production of a comprehensive dossier of regulations governing animal import and export, their products and associated items; this should be in such a form as to permit constant revision for the information of authorities;
(c) present available information and supplementary information obtained from governments should be collated and systems of harmonization devised;
(d) the basic principles as elaborated in the report should be followed as far as possible by governments;
(e) in view of the importance to the economies of the developing countries of the export of animals and animal products, special consideration should be given to the problems involved by international organizations;
(f) in view of the limitations placed upon the traffic of animals and their products from developing countries due to the presence of diseases, FAO should give sympathetic consideration to requests for help in this connection from such countries;
(g) since it is realized that harmonization on a global basis is impossible at present, existing regional committees of FAO and OIE, in cooperation with other organizations, should be requested to foster regional harmonization, particularly between countries in which the animal health situation is comparable.

The meeting having discussed the veterinary aspects of the international traffic in animals and animal products,

recognizing the need of a more efficient use of information available in the various bureaus, central and regional, of international organizations,

recommended that FAO, OIE and WHO investigate the possibility of establishing a joint international center for veterinary documentation and information in Paris.

Appendix 2

EXTRACTS FROM THE REPORT OF THE FIFTEENTH SESSION OF THE CONFERENCE OF THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, Italy, 8–27 November 1969

Paragraph 358, page 69

Particular attention was directed to the potential of livestock production as a source of foreign exchange, especially beef production in developing countries. The greatest single impediment to the export of livestock products lay in the incidence of diseases, although advances were being made in their control, particularly in Latin America and Africa. The Conference *requested* FAO to intensify its efforts in this field and to assist member countries in the establishment of quarantine measures. The Organization should study the health regulations which appear to be impeding meat imports and keep potential exporters informed as to these. The creation and recognition of disease-free zones was proposed, and it was noted that this would be closely examined by FAO, in cooperation with other interested bodies, during the coming biennium. In addition to its actions in respect of disease control and the elimination of trade barriers against meat, FAO should strengthen its work on improving local breeds and should continue its appraisal of the world's grassland resources.

Extract from paragraph 291, page 57

. . . The great potential which existed for beef and milk production, particularly in Africa and Latin America, was frequently stressed; and the Conference *considered* that this should be developed through programs of disease control of cattle, the establishment of an international code for the control of animal diseases, and of health regulations for processing . . .

Extract from paragraph 318, page 62

The need for implementation of quarantine and other measures in the control of animal diseases, including foot-and-mouth, rinderpest, contagious bovine pleuropneumonia, tickborne diseases, and trypanosomiasis was strongly *emphasized* by the Conference although it was recognized that the degree of importance of each would vary between individual countries. . . .

PRESENT AND FUTURE PROBLEMS ASSOCIATED WITH THE IMPORT AND EXPORT OF ANIMALS AND ANIMAL PRODUCTS, AND THEIR EFFECT ON THE ECONOMIC DEVELOPMENT OF COUNTRIES

DR. ERNEST E. SAULMON *

It is with distinct pleasure that I appear here today to discuss with you a matter for which I have real concern—the introduction and spread of devastating livestock diseases as a result of the international shipments of animals or animal products. My concern is not borne of unreasoning fear or undue apprehension, but rather of the full realization that the matter to which I now address myself becomes more of a challenge every day. Each new trade route opened, every development in transportation technology, the continued expansion of commerce, and expanded travel by the world's population are all mixed blessings. Although they promote better living conditions and contribute to a more affluent society, they also create problems with respect to possible livestock disease spread. To those of us who bear the responsibility for protecting our nation's livestock and poultry from possible devastation from alien diseases, these rapid movements of animals, people, and products pose serious problems.

What once was a leisurely trip of several weeks or even months by sailing vessel can now be accomplished in a few hours by plane. The built-in quarantine period that existed en route for animals transported by ocean vessel no longer exists. Similarly, there is danger from exposure of susceptible native animals to imported animals that might be silent carriers of diseases which, though perhaps not considered of great economic consequence in the country of origin, could be devastating in the country of destination. This situation can be likened to that in which Europeans, in their explorations of the New World, wrought havoc with native populations of the area by introducing such diseases as measles—but perhaps there was some measure of retribution then, for the same venturesome voyagers returned home from this Hemisphere with well-established cases of a new disease called syphilis.

Fortunately today technology has helped the sentinel forces to combat animal disease by developing certain safeguards. These include standards for specific kinds of quarantines, better pesticides for precautionary treatments, a wider choice of effective disinfecting compounds, and greater selectivity for certain health conditions through the formulation of new and more meaningful diagnostic procedures. These are all available as components of a protective regimen which each country may establish when dealing in the international movement of animals and animal products.

In the United States of America, several acts of Congress authorize the Secretary of Agriculture to provide protection to the nation against the introduction of animal diseases, but it is interesting to note that the same legislation also makes provision

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for the expansion of export trade in livestock and animal products by prescribing requirements for animals intended for shipment to foreign countries and for their humane handling in transport. In addition, there are procedures for the inspection and certification of export animal products to comply with the import requirements of the receiving country.

In a discussion of this entire field, it is easy to oversimplify such an intricate and complex system, which is required to serve as a barrier against animal diseases of foreign origin and thus protect a nation's economy; however, suffice it to say that such a system must be constantly reviewed to be sure that it keeps pace with the times.

Any nation's demand for imports of animals or animal products is usually based upon the economic needs of its citizens. The need for new breeds, new bloodlines, or new germ plasm, or the importation of animal products in the development of new industries, must be weighed against the risks of disease introduction. Every importing country must therefore accept the fact that the international movement of animals, animal products, and related materials always creates some degree of risk. However, we believe that applying the knowledge drawn from many sources and acquired over the years in combating animal diseases will give us a substantial amount of assurance that most importations may be completed without undue risk to our native animal population.

Every country is, or should be, proud of the animals and agricultural commodities it exports to foreign countries. Since international commerce is most beneficial to the exporting country when it is repetitive, acceptability in the country of destination is most important. Trade in animals, animal products, and related materials tends to draw countries together. Under such circumstances, the need for veterinary authorities and other officials of the countries in question to develop and maintain close contact in connection with problems relating to international trade may become one of the more important bonds forged between those countries. To that end, and to help its economy, an exporting country should be expected to take all reasonable precautions so that only sound and healthy animals, as well as disease-free and uncontaminated animal products, are exported to foreign countries. No country, however, can offer a complete guarantee that such shipments will never be the means of disease introduction or spread.

It may be surprising to many of you to learn that the United States is primarily an importing country insofar as livestock is concerned. It imports from 750,000 to 1.3 million cattle annually, while exporting approximately 100,000. For livestock exports, we are often asked to certify that the animals in the shipment or the herd of origin or the area of origin are entirely free of a certain named disease. This is possible when such certification refers to such diseases as foot-and-mouth disease, rinderpest, vesicular exanthema, bovine contagious pleuropneumonia, and other diseases that do not exist in the United States. It may be possible also with respect to brucellosis, tuberculosis, scabies, and hog cholera, diseases for which we have official control or eradication programs. For certain other diseases that may not be included in our control and eradication programs, certification becomes a more difficult matter.

We make every effort to use accepted laboratory test procedures as valuable tools to help clarify the status of herds or areas of origin. However, when definitive diagnostic tests have not been established or accepted, the tests themselves sometimes create problems. These facts are well understood by animal health specialists, but to a lesser extent by others connected with

the livestock industry. Thus, problems may arise when veterinary health officials must negotiate on health matters through non-technical offices in diplomatic channels by means of persons not thoroughly knowledgeable in this area. Most assuredly, language barriers and different interpretations or concepts can be most successfully dealt with by direct negotiations between veterinary health officials in the two countries concerned. This has not been possible often enough in the past, but we are hopeful that such direct dialogue may be a more accepted practice in future negotiations.

In our country, imported meat and animal products are divided into two classes: those from countries that are declared infected with foot-and-mouth disease or rinderpest, and those from countries considered free of such devastating diseases. All meat and animal products are subject to port-of-entry inspection, and it is the responsibility of our Animal Health Division to determine eligibility of such products for entry.

Fresh meat and other meat products derived from ruminants or swine originating in countries where foot-and-mouth disease or rinderpest exists could carry the virus, and thus the international movement of such products is an ever-present threat to disease spread. To be safe for importation, such products must first be processed in a manner to destroy the virus, if present, and then they must be handled in such a way as to prevent contamination after processing. A very real problem involved with meat is that although thorough cooking (heating) destroys the virus, no accurate practical test exists to determine the exact temperature to which the product was heated.

Other animal products, such as organs, glands, skins, hides, and bones, are potential sources of various kinds of animal diseases. All such animal products must be inspected, and those that present a high risk must either be refused entry or be permitted restricted entry so as to be transported and processed in a manner that will render them safe. This necessitates the assignment of appropriate supervisory personnel over such transport and processing, as well as the disposal of affluent material from the processing and the cleaning and disinfection, as appropriate.

This leads us to a major part of our subject: What are the effects of import-export problems on the economic development of countries? Livestock health officials in each country must assume the responsibility for preventing the entry and spread of devastating diseases that could adversely affect the livestock production or the economy of their country. Sometimes such officials appear less apprehensive about the introduction of diseases that already exist in their country than about a similar disease that is not known to exist there. This is not necessarily a valid position, because there are other factors which must be considered. The Western Hemisphere, for example, remains in the very fortunate position of being free from many diseases prevalent in other parts of the world. African swine fever, African horsesickness, and rinderpest are but three examples of such diseases. Thus, if for no other reason, the threat of each of these devastating diseases should be cause for all the animal health officials in every country in this Hemisphere to be equally concerned with international shipments that might lead to the introduction and spread of any of them. Further, although some types of foot-and-mouth disease now occur in some areas of the Hemisphere, other types are not present. The introduction of foot-and-mouth disease strains SAT-1, SAT-2, SAT-3, or Asia-1, for example, could certainly create as devastating results in a country already infected with types A, O, and C as would

the introduction of any of the seven types into a country then free of all such types.

Much of the landmass area in the Western Hemisphere is agriculturally oriented, and thus livestock production is an important, if not a major, part of the economy that must be protected. The point we are trying to make is that even though a country in the Hemisphere may be infected with one or more types of foot-and-mouth disease, the officials in that country should be as concerned with precautionary measures to prevent the introduction and spread of additional types as are the officials in a country that is free of all seven types of foot-and-mouth disease. In reality, the necessity for continued international movements of animals and animal products should bring about closer liaison between appropriate health officials in the countries, so that adequate precautionary measures against the introduction and spread of disease can be applied as a combined effort for the uniform protection of all the countries.

One area of growing concern to us, and one that is most difficult to control, is that of increased world travel. A livestock owner may be in contact with animals in one country at a given moment and a few hours later be on a ranch in another country thousands of miles away. Could he be a mechanical carrier of livestock diseases? Unfortunately, yes! Or someone hunting in Africa may take the cape of a wild boar to his country as a trophy. If the wild boar were infected with African swine fever (and many such animals are inapparent carriers), this could be an effective method of disease introduction and dissemination. The fact that dangerous disease organisms are not visible to the naked eye makes it very difficult for the average traveler to understand when he is told that his perfectly harmless-looking animal product may actually be a carrier or transmitter of devastating livestock diseases. It may also be difficult to explain the legal or technical reasons for applying arbitrary restrictions on the importation of any animal or animal product, but those reasons, if based on facts and experience, must be adhered to in order to protect a nation against disease introduction, even at the risk of momentary ruffled feelings of a world traveler.

Export certification of animal products is an important function of the veterinary service of any country. Whereas animals can be inspected, tested, quarantined, and even vaccinated against some diseases, animal products in most cases cannot. Importing countries must depend, in part, upon certifications issued by veterinary officials in the country of origin. Such statements and certificates must be examined to determine that they are reliable, factual, and not misleading; otherwise the integrity of later certification will be questioned.

One other avenue we can follow is to pool our knowledge for disease prevention. The reporting of disease conditions in our countries through the regular channels should definitely be continued. New techniques for disease diagnosis and prevention should be shared by all countries once their validity is recognized. Finally, one of the best approaches is to be sure that we keep all lines of communication with each other open. Regular formal meetings, such as this one and others as necessary, will give us a better understanding of problems as they develop, thus promoting early resolution. In this way, I believe we can minimize or avoid many of the pitfalls connected with our respective import-export programs.

We in the Americas must not only continue to be conscious of the economics of animal agriculture in our respective coun-

tries and take such steps as may be necessary to protect and improve the health status of our animal populations, but we must work together in the exchange of scientific knowledge, technological know-how, and general information to bring about improvements that will be reflected in the economic expansion of the Hemisphere.

ANNEXES

Annex 1

EPIDEMIOLOGICAL SURVEILLANCE OF FOOT-AND-MOUTH DISEASE

DR. ROBERTO GOIC MARTINIC AND DR. VÍCTOR H. MOSCOSO *

The II Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control (Rio de Janeiro, May 1969), in Resolution I, supported the proposal of the Pan American Foot-and-Mouth Disease Center to institute an inter-American epidemiological surveillance program against this disease. It further recommended that the affected countries in the Americas submit to the Center at regular intervals epidemiological reports on outbreaks, identifying the types and subtypes of causative virus, in accordance with the guidelines issued by the Center; that the Center analyze and distribute this information to the animal health services of the countries of the Americas; and that it follow the same procedures for vesicular stomatitis.

A number of measures and activities were undertaken in order to build a system which will lead gradually toward this objective, according to the Center facilities and the various situations and capacities of the national agencies in this field.

The first steps were taken toward organizing and developing the regular information furnished by the countries, as is described in PASB Document RICAZ2/9 (mimeographed), "Data on Foot-and-Mouth Disease in South America." This led to the publication and distribution of the *Epidemiological Report on Foot-and-Mouth Disease and Vesicular Stomatitis*, which in the first issue summarized all the available data on laboratory-confirmed diagnoses of foot-and-mouth disease and vesicular stomatitis in Central America, Panama, and South America during 1968 and the first half of 1969. The following two issues covered similar material for the third and fourth quarters of 1969. Starting in 1970, the publication was issued monthly. Each issue contains epidemiological news and comments, according to the data provided by the countries.

Argentina, Colombia, Paraguay, and Uruguay subdivide their information in fortnightly periods. Chile, Ecuador, and the Brazilian State of Rio Grande do Sul provide monthly information, while Venezuela maintains bimonthly statistics. Unfortunately, delivery of data to the Center continues to be irregular in many cases, but close attention is being given to the matter in order to ensure the regular and timely receipt of all statistics. The information received from the other states of Brazil and from Bolivia and Peru has in general been scarce and sporadic, as is reflected in the Center's publications.

The *Epidemiological Report* is mailed to all Member Countries of the Pan American Health Organization, a total of 105 addresses, including 26 Ministers and Secretaries of Agriculture, 32 directors of livestock and chiefs of animal health, and 14

* Pan American Foot-and-Mouth Disease Center, Rio de Janeiro, Brazil.

official diagnostic laboratories for vesicular diseases. Furthermore, it is mailed to international bodies, such as the Inter-American Development Bank, the International Office of Epizootics, the Food and Agriculture Organization of the United Nations, and to the International Regional Organization for Health in Agriculture and Livestock, which includes Mexico, Central America, and Panama.

Another increasingly important function forming part of the epidemiological surveillance program is the analysis of field samples of foot-and-mouth disease sent by the countries, in order to detect the presence of virus strains which have characteristics different from the usual ones and which may affect significantly the defense-attack relationship of the viruses in the field.

During 1969 and up to March 1970, the Center verified the existence of six virus strains with qualities of new subtypes, found in Argentina, Colombia, Paraguay, Peru, Uruguay, and Venezuela, respectively. The results were made known to the interested parties, and in certain cases immunity studies were completed, for immediate application. Temporary identification was allotted to these viruses, until a final classification is given by the World Reference Laboratory. They were named: A Colombia/69, A Peru/69, A Uruguay/68, A Venezuela/70, C Argentina/69, and C Paraguay/69. The letter signifies the type of virus to which the studied strain belongs, while the number is the year when the sample was obtained. In 1969, 610 vesicular samples from all the Latin countries of South America and from Guyana, as well as 41 samples from Central America and Panama, were tested.

With a view to increasing the effectiveness of these services, especially as regards the availability of specialized personnel, the Center is making the necessary studies to improve the vesicular diseases surveillance system, taking as a basis foot-and-mouth disease, which could even serve as a frame of reference for a system encompassing animal communicable diseases in general.

The immediate purpose of the project is to contribute to the prevention and control of foot-and-mouth disease in the Americas, through the collection, analysis, and dissemination of comparable epidemiological data on animal vesicular diseases. Among its objectives are the assessment of the animal population's characteristics and of the distribution and frequency of vesicular diseases which affect it, as well as the determination of factors related to the transmission and spread of the diseases and their socioeconomic effects.

In order to attain this goal, an attempt will be made to develop a methodology which will include the evaluation of each country's possibilities, definition of the minimum of comparable information required, testing of the reliability of the data sources, and formulation of adequate procedures for the collection, classification, analysis, and distribution of data.

An important aspect of the project is the definition of parameters which will best fulfill the objective of measuring the distribution and frequency of the disease. In general, the animal health services maintain systems which do not offer the necessary information for evaluating the disease. In line with the advances in modern veterinary science, and particularly epidemiology, marked changes must take place in the attitude of professionals and in the activities of the agencies responsible for the collection of epidemiological data. This process of change is usually slow, and to pursue this objective the Center has undertaken certain exploratory activities. These have given good preliminary results in Brazil (State of Rio Grande do Sul), where the

foot-and-mouth disease campaign now publishes a monthly epizootiological bulletin, containing adequate data for assessing the status of the disease.

During 1970 the Center hopes to take the necessary steps for implementing a complete system of epidemiological surveillance of vesicular diseases in the Americas. Meanwhile, it will continue to publish the *Monthly Epidemiological Report,* and endeavor to gradually improve the basic information provided by the countries, utilizing a special printed form recently developed for this purpose.

Annex 2

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