SOCIAL STRUCTURE AND VETERINARY EPIDEMIOLOGY IN LATIN AMERICA

F. J. Rosenberg[1]

SUMMARY

The objective of veterinary epidemiology is established as the definition, analysis and solution of specific animal-health profiles. In turn, those profiles are understood as the synthesis at a given time and place of the production and sanitary problems with the actions organized by society to resolve them. The reference framework is the economic, political and social structure in which the livestock activity is developed.

Determined by the role played by the livestock activity in the development of Latin America from colonial times to the present, the structure of production assumes specific forms of livestock organization. These forms are conceived as the principal epidemiological categories: pre-industrial beef cattle breeding, industrial forms of breeding and of fattening-finishing, industrial forms of milk production, and peasant subfamily simple mercantile and associative forms.

A methodology is proposed for the objective characterization of these production forms, based on indicators of productivity, indirect indicators of the organization of the animal herd, and economic indicators, some of which are readily available from existing census information.

A short epidemiological analysis attempts to outline the formal and ideological content of the various categories of epidemiology. Within an overall view of the concrete reality, these categories are not exclusive if they are taken as instrumental levels of partial knowledge that are mutually complementary and synthesized in the production form as both a determining and determined category of the animal-health profile. The risk factors, interactions and ecosystems are stressed among those categories, integrated by level of complexity into the form of production.

Finally, epidemiological determination relationships are established between the livestock-production structure and the temporal variations: seasonal, cyclical, secular and atypical. It is proposed that this study serve as a referential-diagnostic basis for the analysis of situational or strategic planning in the veterinary sciences field.

1. OBJECTIVE AND REFERENCE FRAMEWORK OF VETERINARY EPIDEMIOLOGY

Animal health is understood not only as the probable presence or absence of a given etiology-specific disease, but rather as the set of conditions that determine the production characteristics of an animal population at a given time and place.

What can be termed a "profile of animal health and production" is indicated, in the final instance, by that population's demographic and production values. The final makeup of that profile includes not only the specific-etiology diseases, but also aspects related to animal nutrition — generally those aspects having greater relative weight in the overall scheme of livestock production in Latin America with regard to food availability and convertibility as well as to animal nutrition interaction with infections and immunity —, management, with respect to the rational physical and technological utilization of animal capital; and genetics with reference to the most suitable genetic potential for production as concerns the availability of food as well as appropriate technology for its management and its exposure to risks of infectious diseases.

These aspects of negative vector for livestock production are counteracted by society through its official or private measures intended to modify them for the social good. Animal health programs, technological development, production of nutritional, pharmaceutical and biological inputs,

[1] Epidemiologist, Pan American FMD Center (PAHO/WHO), Caixa Postal 589, 20001 Rio de Janeiro, RJ, Brasil. Present address: Dimanche S.A., Av. Belgrano 312, Of.26, Buenos Aires 1092, Argentina.

credits, subsidies and other financial privileges provided to improve livestock production are some of the services offered by the community for this purpose. The existence and degree of development of those services, as well as the livestock producer's access to them, also constitute an equally important component of the population's animal health profile.

Thus the main objective of epidemiology as a branch of the veterinary sciences is to define, analize and resolve the animal-health profile as a synthesis of those actions on the livestock population that produce the problems of nutrition, management, genetics and disease and of the counteractions organized by society to deal with them (Fig. 1).

As previously discussed (Astudillo and Rosenberg, 1983), this synthesis, a fundamental component of the levels and characteristics of animal production and productivity, results from the composite of conditions of the agricultural and livestock sector. In turn, those conditions reflect a given moment in the political, economic and social development of a country or region (Fig. 2).

2. THE HISTORICAL DEVELOPMENT OF THE LIVESTOCK INDUSTRY IN LATIN AMERICA

Livestock raising in most of the Latin American countries has developed as a labor instrument or for domestic consumption of meat and milk, secondary to the extractive economic objectives of the colony (Galeano, 1983; Prado Jr., 1986). The mass of cattle, in those countries, is distributed freely in marginal areas not dedicated to the principal economic activity (lumber, sugar cane, cocoa, rubber, minerals, etc.) either because of their long distances from the seaports or of their low potential for agricultural utilization.

In the Rio de la Plata basin where sheep and cattle-raising have since colonial times played an economically dominant role (Giberti, 1980) for their wool, hides and dried or salted meats, breeding cattle have long been dispersed in the marginal lands, while the cattle being fattened and finished out are concentrated in the better pasturelands nearer the ports.

In the first mentioned countries as well as in the others, the industrial revolution and, especially, the development of the meatpacking industry, had a determining impact on the geographic specialization of the livestock industry. On the one hand there was greater development of the dairy industry near the urban centers and, on the other, increased occupation of the better lands for beef cattle fattening and finishing stages. That latter occupation generated the need to increase profitability in livestock production, because of the relatively higher costs of the better lands. In turn, that situation led to the importation of European stock and, with them the introduction of communicable diseases (including foot-and-mouth disease) and of livestock less resistant to the various etiological agents already existing in those areas (Astudillo and Rosenberg, 1983).

That same phenomenon was repeated in recent decades due to the development of industrial or integrated production of pigs, poultry and other smaller species (Fig. 3). It is therefore clear that the livestock industry's inclusion in the national developmental policies and, especially, the historical moment of that development, have determined the geographical distribution of the cattle herds, as well as the appearance, worsening or even possible disappearance of problems not only of infectious nature, but also those related to mineral deficiencies, overpopulation, fertility, natality, etc.

Kautsky (1983) explicitly pointed out those aspects at the turn of the century in his analysis of how animal and plant health in Germany were affected by the transformation from the feudal mode of production into the capitalist mode of production of livestock raising.

As different geographical regions assume different specific roles in the division gradually occurring in livestock production, quite obviously the problems affecting it will be distributed and impact differently on those various regions according to the production characteristics attributed to the livestock in each of those areas.

3. THE FORMS OF LIVESTOCK PRODUCTION IN LATIN AMERICA

The division of productive labor in the Latin American livestock industry begins to occur with

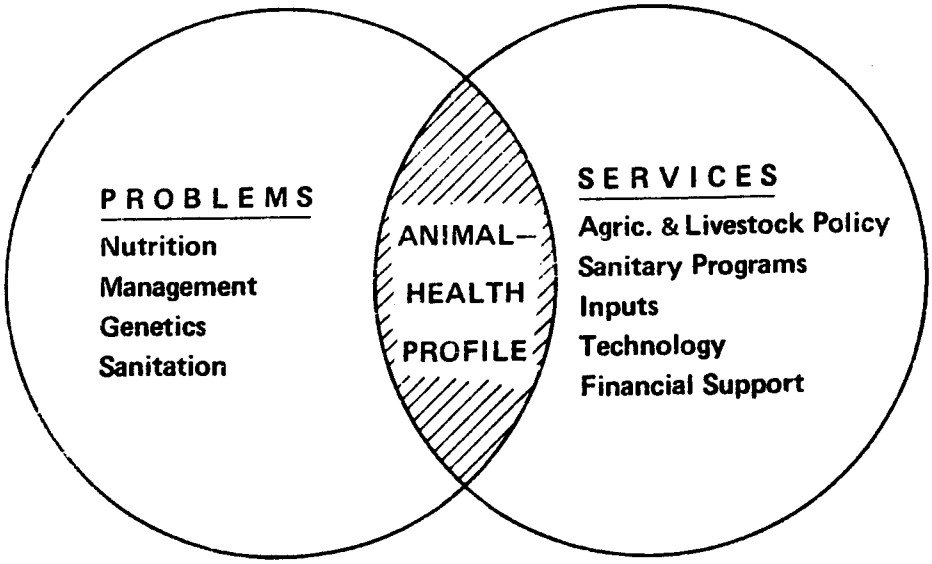

FIGURE 1. *The animal-health profile as synthesis of specific actions and counteractions*

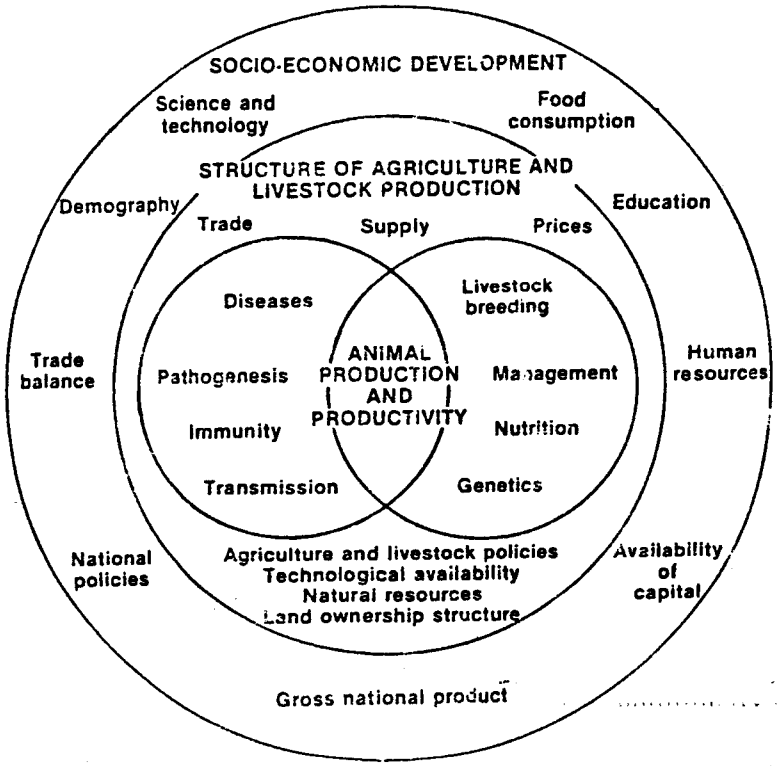

FIGURE 2. *Development of the livestock industry and its relationship to economic and social development*

Source: Astudillo and Rosenberg (1983).

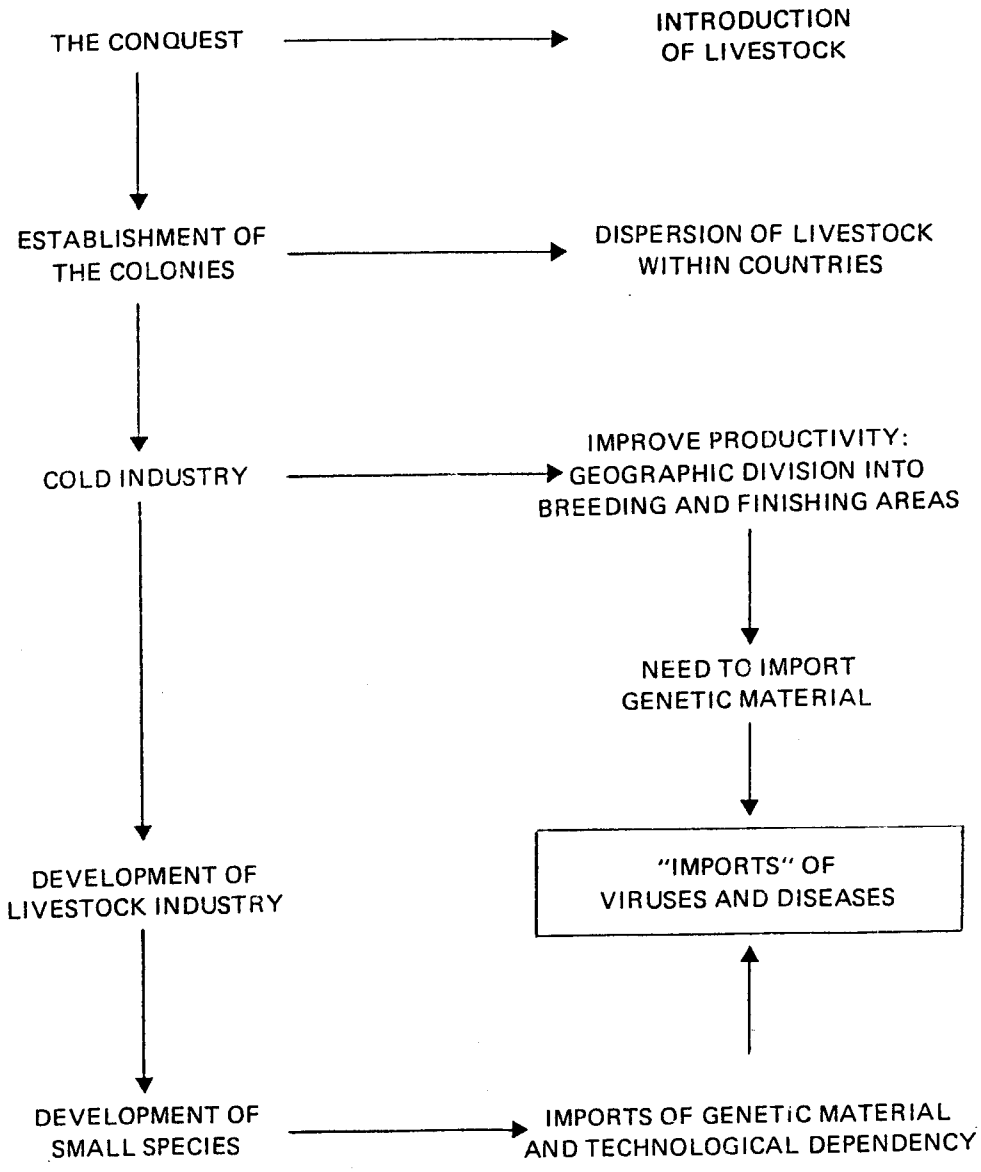

FIGURE 3. *Historical evolution of livestock raising with respect to animal viral diseases in Latin America*

Source: Astudillo and Rosenberg (1983).

the industrial revolution's impact on the organization of urban salaried labor, as well as on domestic (Rutsch, 1984) or international (Slustky, 1978; Giberti, 1980; Prado Jr., 1986) trade in animals and products of animal origin.

This division, which has continued up to recent times in some countries, results from conflicts – of varying intensity and more or less channelled through specific governmental policies – between pre-existent landlord sectors and peasants, or between fractions of the landowner groups having contrary hegemonic interests (Barsky, 1981; Bengoa, 1978; Guerrero, 1983; Martínez, 1984; Rutsch, 1984).

Figure 4 attempts to synthesize the forms adopted by the socio-economic organization of the livestock industry in the majority of the Latin American countries identified as being in a phase of peripheral or dependent industrial development.

This organization of the livestock production reflects the inclusion of the classes or fractions of classes engaged in the rural activity within the social structure. Therefore, livestock-production characteristics depend on the relationships between those classes or class fractions as reflected in the income from the land, the necessities of subsistence, the production of surpluses, the ties with the market, and the dependence-domination relationships with regard to access to the means and instruments of production (land, labor, capital), as well as the eventual destination of the product obtained (market, commercialization).

Thus in the regions previously occupied by the original landlords are organized livestock production nuclei that to a lesser or greater degree fit the characteristics of industrial production. Taking the cattle industry as an example, two main characteristics – the degree of concentration of the means of production (land and capital) and the labor relations, on the one hand, and the product's greater or lesser market dependence, on the other – determine different production forms that may be classed into four groups according to their level of industrial development:

a) **The extensive-extractive pre-industrial form** bases its production profitability on certain social groups' easy access to the means of production (land and breeding stock), the slight use of wage-earning labor, and the low level of investment in technology. This form of production's profitability resides precisely in the extent of the means of production (high concentration) with low investment. At the same time, its dependence on the demand of the market that transforms the calves into product (fattened steers) is maximum, because the vast areas of low-productive lands and the very numerous breeding cattle (animal as capital) on them, can hardly have any alternative

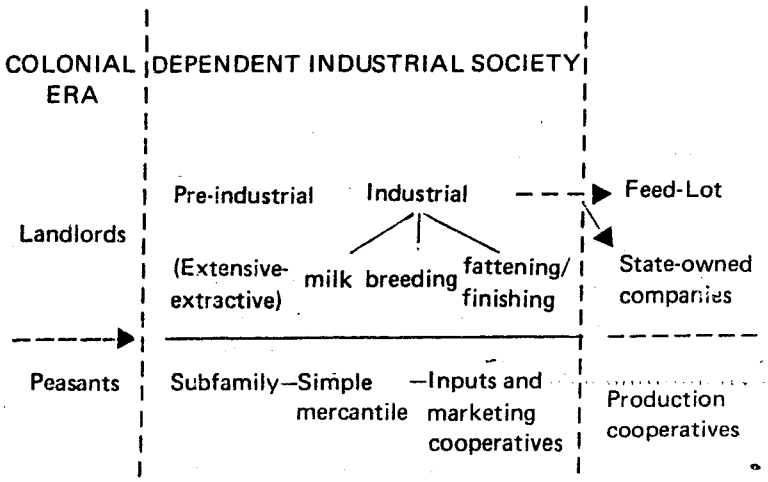

FIGURE 4. *Categories of cattle-production forms in Latin America*

use without structural reforms that alter the grazing capacity of those lands. This form corresponds broadly to the traditional classification of the 'hacienda' (Bengoa, 1978).

b) **The industrial form of breeding** of beef cattle is developed on smaller properties having better quality lands than (a) above. Depending on the relatioship of availability among land, capital and labor, this form of production — in accordance with the market situation — can increase its output of calves, dedicate part of the investiment to prefattening the calves produced or, moreover, engage in the complete breeding, fattening and finishing cycle. But due to the high level of investment required, rarely does it have enough appropriate land for a suitably profitable finishing or agricultural activity.

c) **The industrial production of milk** does not require extensive land areas, but rather high investments in specialized cattle as well as in technological implements, inputs and labor. Despite the high investment in capital animals, there are alternatives for partial diversification in this form of production, such as dedicating part of the land (generally of very good quality) to agricultural activities (mainly truck farming) or retaining the male calves for meat production. But the form's high dependence on the milk market renders it extremely vulnerable in view of the perishable nature of its product.

d) The greatest control over the livestock production structure is exerted by the **industrial steer fattening and finishing form**. The requirements of having the better quality soils needed to sustain the required pastures necessarily causes the land engaged in this production form to be the relatively most expensive. Hence the cattlemen generally regard the cost of these lands as capital investment (Bengoa, 1978) and assign to them a speculative value not considered for the lands utilized in other forms of livestock production. The areas in South America where this activity exists are relatively few, being usually geographically limited (part of Argentine Humid Pampa, small areas of Brazil's south and central west, sectors of the middle Magdalena Atlantic coast and Piedemonte in Colombia) where they generally compete with agricultural export crops. The high proportion of operating capital in relation to the fixed capital enables this form of production to decide about the most suitable production option. It therefore plays an important role in the impact that meat prices exert on the meat cycle (CEPAL, 1983, Pereira, 1986) or on structural transformations in the agricultural and livestock space (CEPA, 1984). These are the reasons why this form of cattle production ranks as the most readily included in the industrial organization category. Its maximum domination over the rest of the production structure likewise renders it the most dependent from the sanitary viewpoint. The substitution of the pasturelands by enclosed (artificial) feeding of the cattle is infrequently observed in Latin America.

On the other hand, the original peasant forms adopted two predominant tendencies beginning with the industrial development of the societies. The tendency to proletarization and the consequential migration to the cities (Kautsky, 1983; Martínez, 1984; Guerrero, 1983) is reflected in a marginal livestock-production activity insufficient for the subsistence of the peasant family (subfamily form). Actually, this situation becomes one of an immense number of "landholders" who constitute a reserve pool of rural or urban labor. This category includes about 50% of the rural producers counted in the Brazilian census (Silva, 1983).

The other rural sector composed of settlers (colonos) or indigenous communities (Archetti and Stölen, 1975; Bartra, 1980; Guerrero, 1983; Sorj, 1980) is able to reproduce the rural farm family structure through own consumption and the sale of excess agricultural and livestock production (simple mercantilism). Usually subsidized by the surplus labor force supplied by the family members, in or out of the agricultural and livestock activity, this production form is unable to expand livestock activity although in certain circumstances the excess production enables the family to actively participate in the consumer market.

Without wishing to engage in discussion with authors who regard the family businesses (Sorj, 1980) or the "colonos" (farmers) (Archetti and Stölen, 1975) as intermediary forms approaching capitalism (mainly because of their use of wage-earning labor), we consider that at least in the

livestock-raising activity the family-level production form is unable to expand the production capital. Hence its transformation into an industrial form with accumulative logic would occur only in exceptional or individual cases, always accompanied by a favorable market situation.

In the cattle industry, the mercantile and/or simple reproductive form is characterized by the production of milk and male calves. The associative forms, mainly the input and marketing cooperatives, and the so-called "integrations", customarily attain a high level of land use although with average-to-low productivity levels, and a great dependency on the industrial forms with respect to the profitability of their production.

4. INDICATORS FOR THE CHARACTERIZATION OF THE CATTLE-PRODUCTION FORMS

4.1 Productivity

Whereas the four proposed forms of production constitute several levels of organization in the livestock sector, a differential analysis of the productivity of labor, land and capital (Kageyama and Da Silva, 1983) will provide a quantitative assessment of the degree to which each form participates in the capitalistic mode of production.

Table 1 shows the hypothetical relationships between the forms of livestock production and the productivity of the factors.

Because of their pre-industrial nature, the extensive-extractive forms exhibit low land productivity, the use of little labor that may or may not be engaged through wage-earning relationships, and reduced fixed investment. The family forms, otherwise, obtain their marketable surplus through the productivity of the land – available in small proportions – and through the subsidy of the family labor force. The means of production are normally scarce and barely productive because of the limited size of the farm unit. The cases of community use of the technological inputs are excluded.

Finally, of the industrial forms, the one specialized in cattle fattening and finishing extracts relatively maximum productivity from the land, whose differential price requires high investments (animals as product, pastures, veterinary inputs, etc.) and a small need of highly productive labor. The industrial milk production form extracts maximum productivity from the land in that it requires the smallest land surface. Its productivity on capital (animals, inputs and technology) and on labor is less because it requires greater investment and labor in order to obtain a like value of production.

TABLE 1. *Relationships among the forms of livestock production and the productivity of the factors*

Form of production	Productivity		
	Land	Capital	Labor
Extensive-extractive	+	++++	++++
Industrial breeding	++	+++	+++
Industrial milk	++++	++	++
Industrial fatten./finish.	++++	++++	++++
Simple mercantile	++	++	+
Subfamily	±	±	±

Of the three forms analyzed, the industrial breeding of cattle yields the lowest productivity; its profitability is assured by the lower price of the lands utilized.

4.2 Indirect indicators

Within an overall view of the forms of production, and given the difficult availability of their direct determinant indicators (value of the production, investments, labor, inputs), production variables are utilized that, when analyzed as a whole, are the consequence of a given economic and social organization of production. The following indicators are interpreted solely at the regional level, not at the individual herd level.

a) *Composition by age*

Analysis of the age makeup of the regional cattle herd enables not only the main purpose of that species' production to be established, but also serves to indicate the reproductive efficiency. The following are some simple examples of this indicator:

– The calf/cow ratio approaches the possible weaning rate (except in cases of milk production,

where it is preferable to multiply the female calves by two instead of using the total of calves), being generally higher in areas where industrial breeding forms predominate.

– The male calf/female calf ratio certainly indicates the specialization of dairy cattle; the lower the ratio, the higher the degree of industrial development of the milk production form.

– The male calf progression to 1-2 year-old steers, to 2-3 year-old steers, and to steers over 3 years old, indicates the point where the meat animal is extracted, and suggests: (i) predominance of breeding with early extraction; (ii) predominance of breeding with late extraction (breeding/prefattening); (iii) predominance of prefattening; (iv) predominance of fattening or finishing, and (v) tendency toward the complete cycle.

– The heifer/cow ratio indicates the proportion of cullings of cows annually. However, this indicator usually reflects more contextual aspects with respect to the meat cycle than to the production structure itself.

– The steer/cow ratio is the most frequently utilized because it represents an approximate synthesis of the age structure as a whole.

This indicator is frequently utilized to identify the type of specialization of the cattle-raising activity. From the structural viewpoint, it represents the ratio between product animal and capital animal. Depending on the existence or absence of other investments, the predominance of capital animals (animals as capital) does not in itself define the level of industrial development of the production. On the other hand, the predominance of the product animal (animal as product) necessarily indicates financial availability for the purchase and transformation of a calf or "prefattened steer" into a consumer product. It therefore follows that values which imply a surplus of steers exceeding those that the cows could produce, almost always indicates the predominance of industrial forms. Marginal "lasso" fattening activities in certain predominantly Indian areas are excluded.

Grouped into four categories, the values of this indicator are presented as follows:

\+ = Extraction of the calf before or immediately after weaning $<$ .40 with great variation depending on the productivity of the zone or country. This value is compatible with industrial or pre-industrial breeding in marginal areas where the calf can not be retained for prefattening, or with the industrial production of milk.

++ = Extraction of either the young or the finished steer, depending on the age of extraction and the levels of productivity. This category generally varies between .40 to .60 and characteristically represents pre-industrial forms of extensive breeding with prefattening of the males, family forms and industrial forms of breeding, breeding and prefattening, or complete cycle (breeding, prefattening and fattening).

+++ = Complete cycle with surplus pastures for finishing. Values over .60 but less than 1.00 imply the existence of a significant cow population, the finishing of the males produced by those cows, and the additional entry of males for prefattening or finishing. It is typical of some simple mercantile forms with family finishing of males produced in neighboring zones also by family forms or, more characteristically, of industrial forms of breeding with surplus pastures.

++++ = The net predominance of males to cows ($>$ 1.00) represents the entry of steers for finishing as the main economic activity. It is characteristic of the more developed industrial forms, the extensive or semi-intensive finishing forms, and the infrequent extensive forms of industrial fattening and finishing.

The standard demographic table (Table 2) shows the basis for grouping the four categories discussed above.

b) *Cattle density*

The cattle density value represents the cattle-raising activity's share of the regional economic activity, the grazing capacity and the level of technological development of the livestock sector. The use of three different denominators enables one to assess the relative weight of each of those three structural determinants: (i) cattle density/total Ha.; (ii) cattle density/agric. & livestock Ha.; (iii) cattle density/livestock Ha.

(i) includes the surface dedicated to non-productive lands, forests and mineral extraction, in addition to the agricultural and livestock activity.

(ii) includes the permanent or temporary agriculture, in addition to the cattle-raising activity.

(iii) reflects only the grazing capacity as determined by the natural quality of the soils or by technological investment. In either of the cases a high (iii) value implies a highly developed industrial development of the livestock activity. A high value of the three density indicators is found in industrial forms of predominant cattle-raising activity, generally associated with industrial finishing and less frequently with industrial complete-cycle production. In this last form, however, it is common to find an important income from agricultural activities, which can mean a high value in (iii) but lower in (ii).

The simple mercantile forms are likewise characterized by high (iii) values. However, in these production forms the economic activity is customarily diversified when the regional level is analyzed. Hence the existence of breeding activities of other species, as well as truck farming, usually cause the value of (ii) to be significatly lower than the value of (iii). This is likewise observed in the zones where the industrial production of milk is the predominant activity. Table 3 provides examples of the relationships between the comparative densities with the three indicated denominators and the predominant form of livestock production.

c) *Land and herd ownership*

Although this indicator is usually the one most frequently utilized to differentiate family forms from industrial or landlord forms, its isolated use has led to deep distortions in the analysis of the structure of agrarian production (Silva, 1983).

A classic way of analyzing this indicator compares the relative values of the number of properties and/or herds in each size range with the proportion of surface or of animals that each range has in relation to the regional total. This analysis reflects the degree of concentration or dispersion of the means of livestock production and, as such, is closely related to the regional predominance of the forms of production.

TABLE 2. *Standard cattle demographic table*

Total cattle	R S/C	Male/female cattle	Steers		Heifers	Cows	Other
		< 1 year	1-2 yrs	>2 yrs			
100	.58	21	9	13	13	38	6

TABLE 3. *Relationships among production forms and cattle densities*

Cattle/Livestock Ha.	Cattle/Agr. & Livestock Ha.	Cattle/Total Ha.	Form of production
Very high	Very high	Very high	Industrial cattle only
Very high	High	High	Industrial cattle and agriculture
Very high	High	Low	Extract. activity other than agric. & livestock raising
High	Average	Average	Simple mercantilism
Average	Average	Average	Extractive cattleraising
Low	Low	Low	Marginal peasant

In general terms, the highest values of concentration are found in the pre-industrial extensive breeding areas, while the widest dispersion is found in the areas of simple mercantile predominance, especially under the colonial-cooperative organization.

In the industrial forms, especially the fattening and finishing form, the middle ranges customarily predominate; occasionally the cattle herds are large (but mid-size establishments) and there is an absence of livestock activities in lower ranges. In some countries it is common to find regions with a high dispersion among mid and small ranges, which reflects the coexistence of industrial milk-production and simple mercantile forms.

A simplified way to analyze the distribution of the tenure of the means of production results from using only two indicators, one for the larger ranges and one for the lower ranges (50 head of cattle is usually taken as the differentiating value, although this will depend greatly on the country to be evaluated).

c.1) *Average size of larger herds (50 head or more).* The degree of concentration and the profitability of the productive activity influence the average size of the cattle herds (excluding the little herds). The higher averages are found in regions of extensive-extractive breeding and diminish gradually in the industrial forms of fattening and finishing, the industrial breeding form and milk-production form. The averages are difficult to interpret where the family forms predominate.

c.2) *Proportional ratio of cattleraising on small properties (less than 50 head).* This is an approximate indicator of the regional economic importance of the family forms of livestock production. It is obtained by dividing the proportion of cattle on the small properties among the total cattle population, by the proportion of small properties among the total number of properties, or:

$$\frac{\dfrac{\text{Number of cattle on small properties}}{\text{Total number of cattle}}}{\dfrac{\text{Number of small properties}}{\text{Total number of properties}}}$$

The higher the ratio, the greater are the degree of organization and the economic relevance of family production in the region. For example, in Ecuador's Central Sierra region, this value customarily exceeds one, whereas in the cattle zones of the Rio de la Plata basin it is rarely over .2 even in areas where the family-level livestock activity is important.

d) *Complementary indicators: cattle flows*

When the geographic division of the socio-economic organization of the livestock activity is clearly defined, that is, where a striking predominance of a specific form of production is readily profiled, the aforementioned indicators are usually sufficient (age composition of the herd, specific density, and distribution of ownership of the means of production). Likewise, specific surveys are unnecessary because most, if not all, of the information needed for these indicators is easily available in the national livestock censuses.

However, the differences between the forms of production may not always be striking, particularly in the areas of transition from one form to another, or in regions undergoing transformation from livestock to agriculture, or vice versa. In these cases, two or more forms of production usually coexist within the same geographic unit. On the other hand, cattle flows may be observed, notably of animals bound to slaughter or to industrial "enclaves" (animal shows and auctions) or to industrializing enclaves (slaughterhouses, packing plants) in zones where the predominant livestock production form has no direct economic relationship with that flow (for example, industrial forms of milk production). From the viewpoint of epidemiological risk, the characteristic of the flow of animals usually show a dominant value with respect to the definition of the area. Information about cattle flows is normally available in the South American countries where the foot-and-mouth disease prevention, control or eradication programs maintain information systems. The following indicators may be utilized:

d.1) *Percentage of exiting animals, according to purpose.* The percentage is found by dividing the number of cattle exiting for prefattening, finishing and slaughter, by the total existing

population, and relating it to the estimated extraction rates for each region or country. If the estimated regional extraction rate is shown as ++, and + and +++ indicate values significantly lower or higher than that rate, the alternatives shown in Table 4 are respectively generated.

d.2) *Entering-exiting balance.* The entering-exiting balance indicates in absolute numbers the receptive predominance of cattle in a region. Positive balances are always associated with slaughter or with possible clandestine transit of cattle in border areas. Negative balances indicate the degree of "extractivity" in a region and, therefore, its economic dependence on other regions for the placement of its product. Finally, near zero balances may indicate the area's potential self-sufficiency in terms of its livestock production. The latter is an objective pursued by livestock-development plans as well as animal-health control plans.

d.3) *Entering-exiting ratio.* As a complement to the preceding indicator, this ratio provides information on the degree of receptive-extractive specialization, more than on the net volume of the inbound/outbound movement. With the exiting number as the denominator in this ratio, the higher the slaughter activity in the region, the higher the value of the indicator. This is different from the intermediary inclusion areas in the productive cycle (prefattening or finishing) where, regardless of the entering-exiting balance, this indicator tends to show a low value.

4.3 Economic indicators

The characterization of the agricultural and livestock structure should be based on an analysis of the family income generated by the productive activity (Bartra, 1980). However, the difficulty of taking that analysis to a concrete empirical methodology has limited this proposal solely to theoretical application.

Some of the proposed indicators in the livestock activity are easily obtainable, particularly those referring to investment, but not those related to the value of the product.

Perhaps the most valuable of those indicators is the average price of the land. As a reflection of capitalized income (Kautsky, 1983), it provides a fundamental approach with respect to the access to that means of production by different social classes, as well as the potential profitability of those lands.

This indicator can be correlated with the proportion of land used for diverse productive purpose, and with the relative value of the regional product obtained by ranges (Silva, 1983). Other direct indicators of the economic structure are listed as follows:

a) *Ratio of number of animals/wage-earning labor*

This ratio is determined by dividing the total number of animals (by species or homogeneous animal units) in the herd, by the number of permanent and temporary workers engaged in livestock activities during a calendar year.

TABLE 4. *Relationships between production forms and rates of existing cattle*

Existing animal rates			
Prefattening	Fattening/finishing	Slaughter	Predominant production forms
+	+	+++	Industrial fattening and finishing
++	+	+	Industrial milk or extensive-extractive
+	++	+/++	Industrial breeding or extensive-extractive
+	+	+	Simple mercantile
+	+	–	Subfamily

It is important to include in the denominator the total of workers/year involved in temporary tasks (vaccinations, branding, roundup, fence repair, etc.) as per the following example:

Permanent workers (wage-earners):	2.00
Temporary workers:	
fences (2 workers x 45 days)	0.25
herding (5 workers x 7 days)	0.10
Total workers/year	2.35

b) *Ratio of family labor/wage-earning labor*

Using the same criterion as in (a) above, the ratio is obtained by dividing the number of family workers/year by the number of wage-earning workers/year, for the region under study.

c) *Technological investiment*

This indicator applies a system of points to quantify the degree of use of certain technologies commonly utilized in the livestock industry. The Following scores are given as an example:

Breeding:	Free mating	0
	Seasonal mating	1
	Artificial insemination	2
	Embryo transfer	3
Nutrition:	Open pasture	0
	Field rotation	1
	Artificial pasture	2
	Rations	3
Health care:	Mandatory vaccinations	1
	Antiparasite treatments and/or other vaccinations	2
Assistance:	Occasional veterinary	1
	Permanent vet. or agronomic	2
	Permanent vet. and agronomic	3
Milking:	Manual	0
	Automatic	1
	Automatic and cooling	2
Management:	Daily record keeping	1
	Systematic individual log	2
	Microcomputer	3

The regional value of technological investment will be the average points of all surveyed herds in a given area.

Table 5 shows some of the above indicators obtained in adjoining counties ('partidos') in the province of Buenos Aires, Argentina, from a sampling survey conducted as a practical excercise of a regional course sponsored by SENASA/ PAHO/IDB, 1984.

This type of analysis opens a broad spectrum of social and economic investigation about livestock production, about its implications on the health-disease process in the cattle population and, what is considered of utmost importance, on the planning of sanitary and livestock-development programs.

TABLE 5. *Structural characteristics of the cattle production in 4 'partidos' of the province of Buenos Aires, Argentina, 1984*

Indicators	Partidos			
	Pila	Rauch	Balcarce	G.Alvarado
Average price Ha. (US$)	414	610	1080	1966
% livestock Ha.	97.5	90.1	75.7	60.5
% livestock Ha. w/artificial pasture	13.3	17.6	36.5	76.9
Cattle density/livestock Ha.	0.68	1.05	1.35	1.42
Cattle/worker	637	390	378	375
Family worker/paid worker	.02	.61	.13	.02
Technological level (points)	3.4	3.7	5.7	5.8
Steer/cow ratio	.13	.09	.41	1.12
Predominant form of production	Extensive/ extractive	Family/ industrial breeding	Industrial breeding	Industrial prefattening & finishing

Source: PROASA Course. Tandil, prov. Buenos Aires, Argentina. SENASA/PAHO/IDB.

5. EPIDEMIOLOGICAL CATEGORIES

Man's changing conception of the sciences responds to the philosophical and ideological currents prevailing in each historical period, consistent with the necessities of reproduction and development of the hegemonic mode of production (Portelli, 1973).

Technological advances are generated and utilized, most of the time, for the purpose of consolidating those conceptions.

With respect to the health-disease process, the theoretical concept evolved in line with the prevailing philosophical theories (Garcia, 1983), parallel with the changing economic and social needs. Hence, the early XIX Century's view of the exogenous origin of diseases, necessary for the development of the "sanitary police" which on the one hand justified the deplorable urban health conditions while also controlling the postfeudal migrations, is consolidated by the discoveries of the disease-"causing" etiological agents that initiate the "bacterian era" and that contradict the hypothesis of the "environmental determinants" evoked by the production relationships with which Virchow and Farr, among others, sought to explain the health conditions in England and Germany at midcentury.

The bacterian theory rests on and strengthens the positivist doctrines that accept the visible and quantifiable elements of nature as the only reality. The causal theories up to the mid-1900's are more or less complex variants of the same reference framework: multicausality and McMahon's causal networks seek to provide a response to the empirical results that demonstrate that the mere presence of the microbian agents is not sufficient to produce disease. But in the final instance, the incorporated "causal factors" fulfill the role of "other agents" whose causal simultaneity in time would determine the effect observed. This effect – "the disease" – is conceived and detected as an "abnormality", i.e., as a variable quantifiable "phenomenon" that departs from the normal values corresponding to the state of "health". The union of this bacterian Manichaean view of disease with the development of the industrial mode of production, however, fomented the fantastic progress achieved by humanity in biological control, through the development of antibiotics and immunogenic agents, among other therapeutic or preventive products.

The certainty that the control of the biological "causer" would not, by itself, resolve the problems of disease (Dubos, 1971; Pessoa, 1978), the discovery of ecological nidi of certain transmissible diseases (Pavlovsky, 1966), and the development of the structural-functional approach as a current of modern western thought, replaced the concept of "health as normality" and the positivist reference framework by the concept of health as equilibrium and by the ecological structuralism on which Armijo and Leavell and Clark, among others, based themselves.

At a descriptive level, significant progress was achieved in acquiring knowledge of the natural phenomena; equal importance as conditions determining the ecological "imbalances" was given to the characteristics of the microbian agents, the susceptible host, and environmental elements. "Socioeconomic factors" are included among the latter. The incorporation of the systems theory into epidemiological analysis led to an important development in the description of ecosystems as a reflection of a systemic conception of the social structure.

From the standpoint of the applicability of epidemiological knowledge, this approach led to a broadening of the narrow framework of biological causality by including climatic, populational, economic and cultural processes as systemic components of the social and ecological balance. Although the definitions of health maintain the concept of equilibrium as a phenomenon-related question, there is no doubt that this approach opened the door to a more dynamic view of the question when this same equilibrium is understood as an interactive process.

This ideological and methodological approach, however, is unable to explain the inner mechanisms by which the historical development of the societies determines the prevalence of certain health problems in specific periods and places, and the very generation of the so-called ecosystems. In synthesis, systems are ahistorical and horizontal in the conception of their analytical categories, and

limited in their reference framework insofar as they are divorced from the social context in which they are immersed (Testa, 1985). Thus the observations by Pessoa and Dubos, among others, regarding the appearance, disappearance and change of numerous "plagues" that have affected humanity in definite historical periods, are outside the methodology of the proposed epidemiological analysis. The concept of equilibrium, in the final instance, does not explain society's "progress" and the advance of the sciences as synthesis of the history of humanity.

The pursuit of a determinant essence of observed phenomena, to replace the view of phenomena as a reality in themselves (Kosic, 1983) and, specifically, the interpretation of the health-disease process as a particular expression of the social process (Testa, 1985), has fostered the development of the schools of social medicine during the last twenty years. This has been especially intense in Latin America. Basically, the intention is to explain the health-disease process as the synthesis (result) in the human organism of the hegemonic mode of production and its specific production forms in the countries analyzed. In general, however, it has not been possible to develop a methodology, and much less the means necessary to put this theoretical conception into epidemiological practice. Nevertheless, certain recent attempts at systematization that have taken as their immediate category the urban distribution of the social classes (Breihl and Granda, 1983) or the process of labor (Laurell and Marquez, 1983) must be emphasized.

In the field of animal health, the concepts of health and disease and the epidemiological method utilized for their study developed concurrently with the described view of human health. But two circumstances favored the possibility of a more concrete analysis: on the one hand, the health of animals is associated in a more immediate fashion with production and productivity, the objective of economic development. Therefore the importance of including the livestock producer in the mode of production is more clearly identified. On the other hand, the foot-and-mouth disease-control programs in South America, in effect for more that 20 years under the coordination of the Pan American Foot-and-Mouth Disease Center (PAFMDC/PAHO), have generated a great volume of homogeneous and reliable information at the macro- and micro-geographic levels. This information is hardly available for other specific diseases.

Based on that information, Rosenberg and Goić (1973) first questioned the exclusively biological approach to the problem of foot-and-mouth disease when they pointed out the disease's different behavior in different geographical areas of South America.

A detailed attempt to systematize the possible associations between pairs of variables, in order to establish conceptual models of the disease based on causal networks, has not passed the exclusively descriptive level. This is because of the infinity of associations, some proven, some suspected, that are difficult to integrate into an overall analytical process (Rosenberg, 1975).

A less detailed but more representative view of the geographic context is established with the proposal of the foot-and-mouth disease ecosystems (Rosenberg, 1977). This approach permits proposing specific regional strategies for counteracting the disease according to each of the ecosystems described (Rosenberg *et al.*, 1980).

Nevertheless, this approach is limited to a largerly biological determination, in that it considers the processes of pathogeny, immunity and transmission as the major factors in the ecological characterization of the disease.

The first attempt to systematize the possible determining influence of the livestock-production structure on the ecosystems was conducted by Obiaga *et al.* (1979). That proposal established four typical forms of socioeconomic organization of livestock production in South America, as well as the corresponding foot-and-mouth disease ecosystems determined by them and by the relationships of economic dependence existing among them.

Tamayo (1981) later attempted to establish a methodology for analysis of the distribution and conduct of some animal diseases based on the livestock-production structure in Ecuador. Using the characterization of the livestock-production forms in Rio Grande do Sul, Brazil, Astudillo (1984) systematized and associated production

indicators with indicators of foot-and-mouth disease endemism, and Martins (1984) conducted a detailed analysis of the distribution of the livestock-production forms and foot-and-mouth disease in Santa Catarina, Brazil. Likewise, the Animal Health Service of Argentina conducted a diagnosis and projection of the distribution of foot-and-mouth disease and other diseases based on the geographic distribution of the livestock-production forms predominant in that country (SENASA, 1985).

In 1984 Machado studied the forms of goat production in Minas Gerais, Brazil, as determinants of the presence of antibodies against Toxoplasmosis. The following year Tinoco associated goat pathology in Bahia, Brazil, with the socioeconomic organization of the "campesinos". Finally in 1986, Pereira analyzed the structure of industrial production of cattle in an area of Minas Gerais, Brazil, and its relationship with the foot-and-mouth disease cycles in the area.

6. LEVELS OF INTEGRATION OF THE CATEGORIES IN VETERINARY EPIDEMIOLOGY

Figure 5 shows, by levels of complexity, the integration of the epidemiological categories analized in the preceding chapter.

There is no doubt that, depending on the specific object of analysis, the instruments developed from neopositivism have been and continue being extremely useful. The recent lines of biotechnological research (recombinants, genetic engineering, polypeptide synthesis, embryo transfers, etc.) constitute a clear example of the validity of that theoretical framework. However, the distance between the "scientific" development of those instruments and their democratic appropriation, that is, access thereto for purposes of social development of nations (and not only as a direct commercial benefit for the patent holders or the product manufacturers) is something that is obviously not resolved by the instrument developed.

In the final instance, the variables able to be analized (the list is practically unlimited and depends on the level of specialization imposed by the advance of scientific knowledge) are expressed according to their interactions in certain basic processes: pathogeny, immunity and transmission (only in the communicable diseases) and the results of the interaction between host species and society: density, management, flows and trade. The form of association among these seven basic processes can be synthesized into "ecosystems" which would be nothing more than the "typical" synthesis of the interactions among the variables, abstractly classified under agent, host or environment.

Through the use of the instruments of traditional epidemiology, applied to the empirical study of health problems, it is clearly demonstrated that processes such as population density, the movements of cattle and their handling, are critical for the transmission, for the concrete results of the pathogenic process, and for the immune state (acquired by natural or artificial exposure to the specific immunizing agent) of the population.

If it is admitted that the object of the livestock-raising activity is mainly, if not solely, economic, then one will readily understand that the social organization of livestock production in both its productive and commercial aspects will, in the final instance, determine the result of the interactions among the variables and, therefore, of the ecosystems of the specific-etiology diseases. For the same reason, those aspects also play a determining role in the remaining sanitary and production problems. Hence it is postulated that if the category of analysis focuses on the form of production, dialectically integrated into a specific geographic space, a particular animal-health profile corresponding to each of the production forms can be discerned.

7. TEMPORAL ASPECTS

So far we have summarized the relationships of dependency between the geographic structure of the behavior of the diseases (categorized as ecosystems) and the dominant livestock-production structure.

However, that dependency does not explain the reasons for the temporal variations within each ecosystem. In terms of their recurrence

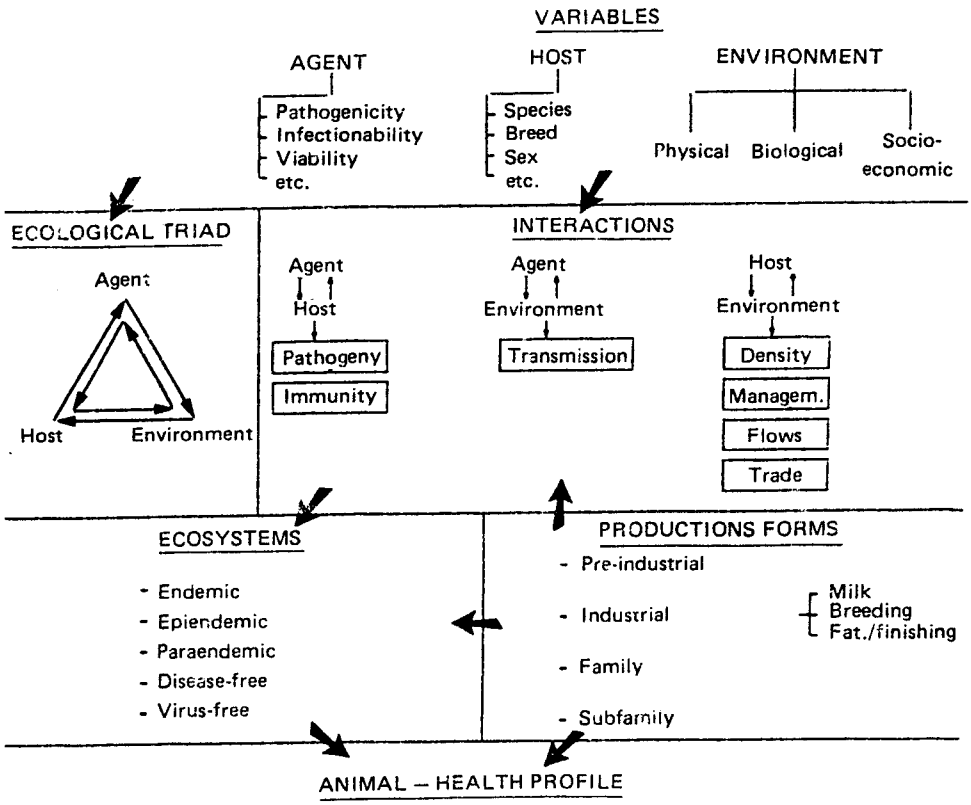

FIGURE 5. *Levels of integration of the epidemiological categories*

these variations can be classed into four groups: intra-annual variations (seasonal), inter-annual variations (cyclical), atypical variations (not periodical), and secular trend.

a) *Intra-annual variations (seasonal)*

Although determined by natural and climatic characteristics, their concrete expression will differ according to the specific production-sanitary problem, and depending on the dominant form of production.

The cattle movements deriving from the breeding-fattening cycle in a first instance and, subsequently, finishing-slaughter cycle (Astudillo, 1984) will determine the seasonal variations observed in the majority of the acute communicable diseases, whether due to the increased density of young populations or to the introduction of sources of infection. Hence, for example, the areas of industrial finishing are annually subject to a relative increase in disease incidence, although its origin may be located in family, industrial or pre-industrial breeding areas. Thus the seasonal epidemic phenomenon will in reality reflect an endemic ecosystem determined by a production form other than that in which the phenomenon appears.

Other animal-health problems of manifest seasonal variation (arthropod-borne diseases, mineral deficiencies, intoxications) will be all the more striking wherever the social control of the natural phenomena is lesser. So, in general, they will be

less apparent in the industrial forms (particularly finishing and milk) and more significant in the pre-industrial forms of extensive-extractive breeding, as well as in the subfamily production areas.

b) *Inter-annual variations (cyclical)*

The lack of long historical series of records of communicable diseases in Latin America impedes an exact knowledge of the existence of inter-annual cycles. The exception is foot-and-mouth disease, for which the cyclical conduct has been shown (Rosenberg, 1975). It is presumed that the cyclical behavior is characteristic of the majority of the acute communicable diseases.

Two processes are believed determinants in this type of variation. In the first, the average lifespan of the animal population will be the basis for the extinction of the populational immune level reached immediately after the widespread epidemic. In this case the areas with greater coverage and systematicity in the application of vaccination programs, generally involving the industrial production forms, would normally feel less impact produced by the renewal of the animal population massively exposed to the agent in a natural way. The second process, whose impact is more generalized, refers to the meat cycles, whose existence is typical of the market economies and mainly of those economies closely related to the international market (CEPAL, 1983). Whereas the meat cycles determine variations of up to 20% in the existence of cattle, and hence in the populational density, they change the volumes of commercialization (that is, of animal movements) and therefore alter not only the age structure of the cattle population but, consequently, the relationships between the adult and young populations.

The alterations produced by the meat cycles will be reflected in the diverse forms of productions at different times, according to the relative dependency that each of them has on the market. Thus the industrial finishing forms will be the first to manifest the increased risk produced by the price variations triggers of the meat cycle, mainly through the incorporation of new pasture areas toward the end of expansion phase of the cycle (hold up).

It is of interest to stress that the analysis of country's or region's economic macropolicy will enable the analyst to predict the intensity and duration of the populational variations produced by the meat cycles and, consequently, the epidemic risks. Figure 6 represents the cattle industry cycles in Argentina from 1935 to 1985. Four different phases are clearly observed in that timespan, coinciding with four strikingly different periods in the country's economic policy. In the first period, which lasted to the end of the 1940's a cycle of depressed but stable livestock existence coincided with the international meat market whose particular form was determined by the second world war (CEPAL, 1983). The second cycle – to 1955 – reflected a long period of expansion accompanied by the increased volume of slaughter of males. That period coincided with implementation of production policy of central planning (first and second 5-year plans) and with a rising international demand for meat. Then there began a phase when the national policy became actively involved in the market economy, as reflected in the sequence of three meat cycles of similar intensity and duration certainly limited by the turnover of the cattle population (CEPAL, 1983). Lastly, the prolonged phase of decline (selling off) from 1978 on coincided with the implementation of a monetarist economic policy that brought about a deep recession in all the productive sectors, including the cattle industry. This latter phase coincides with a quick drop in foot-and-mouth disease records in Argentina. This does not mean necessarily that the observed drop is exclusively due to the depressed livestock activities. However, when the epidemiological behavior of foot-and-mouth disease type O virus is analysed noteworthy coincidences are observed with the meat cycles' evolution as assessed through the average weight of steers at slaughter in Uruguay (Figure 7) or by the overall extraction rate

$$\left(1 - \frac{\text{number of cattle slaughtered}}{\text{total cattle population}}\right)$$

in Argentina (Figure 8). In both cases the peaks of foot-and-mouth disease type O virus records and the peaks of maximum retention (expansion) of

cattle livestock are coincident for the period 1970-1985.

Unfortunately, there are few studies tending to associate the cyclical epidemiological behavior structurally with the meat cycles, and their results are not very conclusive (SENASA, 1985; Pereira, 1986).

c) *Atypical variations*

This section refers to occasional epidemic phenomena without known periodicity. Although these phenomena are attributed to biological "calamities" (introduction of exotic agents, antigenic variations of the agents) or natural "calamities" (floods, long drought periods, storms, etc.), a concrete structural epidemiological approach would enable one to detect the "accumulation of risk" in the geographic areas particularly exposed to those phenomena, and in the areas that surely will reflect the impact of such "calamities". If the "immunity break" produced by antigenic variants is taken as an example, it is undoubtable that the detection of this phenomenon has required a prior "period of accummulation" during which variants with several degrees of separation from the pre-existing strains have been selected until the one with the best conditions to overcome the barrier presented by the host species becomes dominant. Conditions for this type of selection occur optimally in large herds submitted to vaccination programs where coverage is partial and not very intensive, a characteristic of the extensive-extractive production form. In general, these variants are detected only when their degree of accumulation enables them to affect large geographic areas of more intensive production.

Similar reasoning can be applied to the production forms subjected to the greater risk of introduction of exotic agents, to the impact of the displacement of the cattle by climatic catastrophes, etc.

d) *Secular trend*

This last type of variation is clearly determined by structural, not conjunctural reasons. In general there are two structural transformations that can affect the secular trend of the sanitary problems that affect the cattle-raising sector: the transformations of the production structure, or the development or inactivation of sanitary programs. In the first case there may be deep generalized changes resulting from a process of agrarian reform, or rather lesser localized changes resulting from the replacement of certain production activities by others (agriculture replacing cattle finishing, extensive cattle-raising replacing lumbering, etc.).

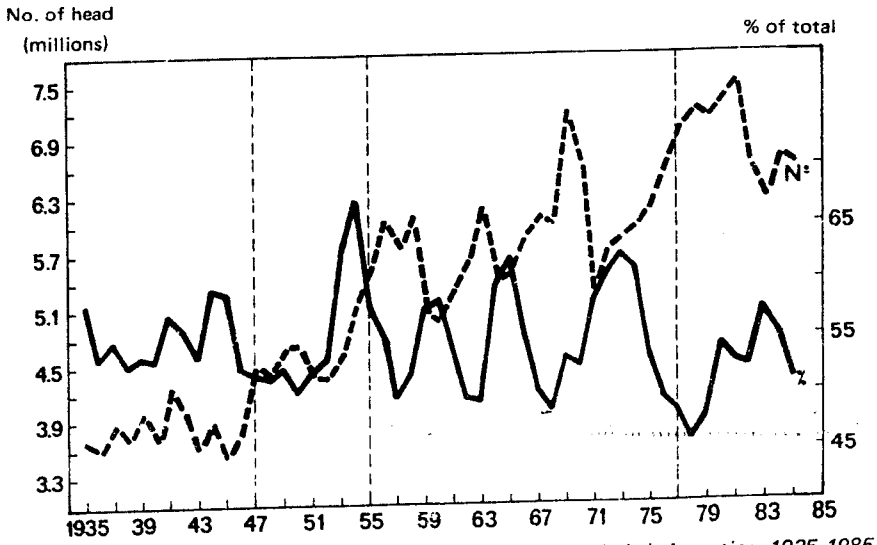

FIGURE 6. *Slaughter of males, calves and unweaned males exciuded. Argentina, 1935-1985*

The impact of such substitutions on the structure and organization of the land use are manifest (CEPA, 1984) and thus the behavior of the health problems will also tend to be deeply modified.

8. CONCLUSIONS

In the first chapter of this paper animal health is defined as the synthesis of vectors harmful to animal production and productivity as determined

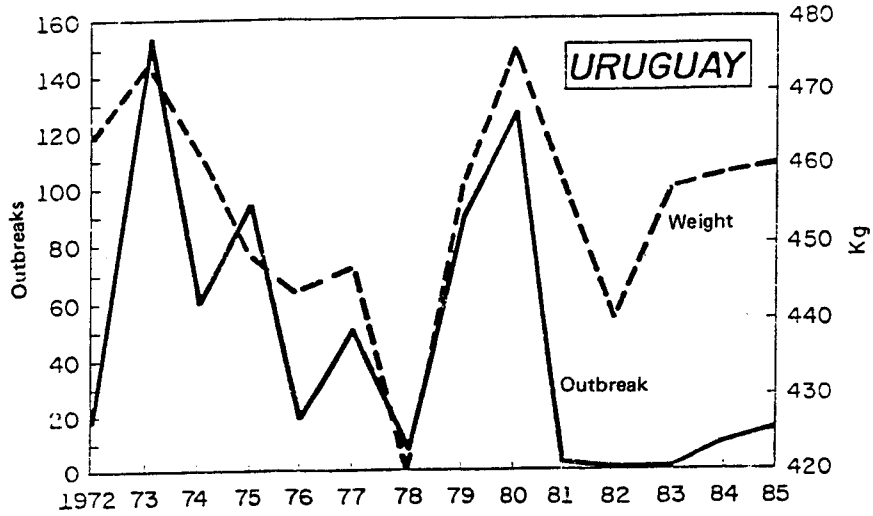

FIGURE 7. *Outbreaks of foot-and-mouth disease type O and weight of steers at slaughter. Uruguay, 1972-1985*

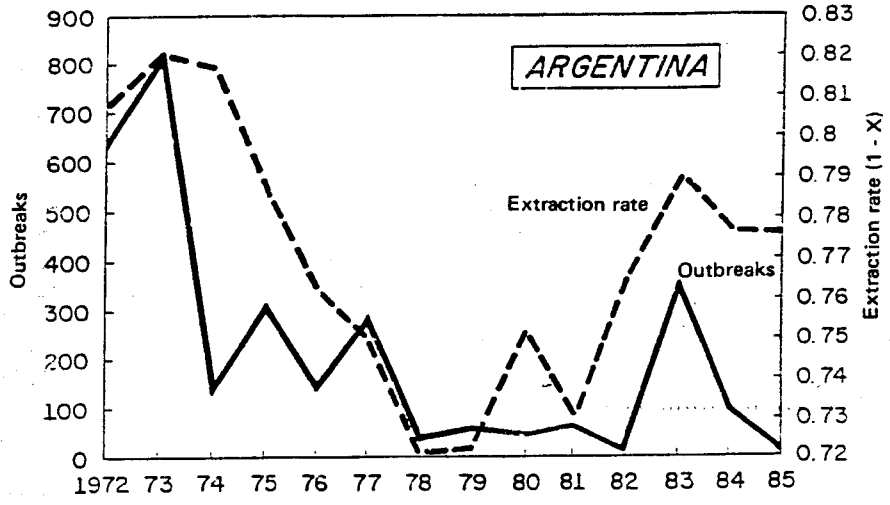

FIGURE 8. *Outbreaks of foot-and-mouth disease type O and extraction rate. Argentina, 1972-1985*

by the forms of livestock organization, counteracted by those same forms' access to the services and technology developed by society to prevent or control them.

The subsequent chapters attempted to demonstrate how the category "form of livestock production" constitutes the specific populational space in which that synthesis is manifested at a given historic moment.

If it is understood that veterinary planning in its particular aspects (fighting etiology-specific diseases), as well as in the more general aspects (livestock-development plans), seeks to increase animal production and productivity, international trade in animal origin products, or else social development (better nutrition and greater inclusion of the peasant in the productive activity), then one must acknowledge that it has generally failed to achieve such goals in Latin America.

Two theoretical-methodological factors should possibly be assigned the responsibility for that failure. First, the situation diagnosis, based on a reference framework of traditional epidemiology, has not utilized analytical categories that enable it to characterize and interpret the role played by the socio-economic organization of production in the determination of the production problems. Secondly, and as a consequence of that same situation diagnosis, the policies, strategies and homogeneous plans of action have been molded on the intentionally or ingenuously erroneous principle that all the social and economic components involved in livestock production and commercialization share the same common interests.

The characterization of the social and economic form of livestock organization as determinant of its sanitary and production profile will not only enable models to be established for predicting the occurrence and distribution of etiology-specific diseases. Also, and what is more important, it will serve to establish an authentic planning of situations that will in turn foster concrete transformations in the distinct sectors involved in animal production.

The analysis, and consequently the decision about the political and economic scope of strategic livestock-sector planning at the regional, national, provincial, public, private or community level, represent only some of the possibilities unlocked by this reference framework.

The role of the social and economic groups in animal-health planning and livestock development will be discussed in a subsequent study.

REFERENCES

1. ARCHETTI, E.P. & STÖLEN, K.A. Explotación familiar y acumulación de capital en el campo argentino. Ed. Siglo XXI, Bs.As., 1975.
2. ASTUDILLO, V.M. Formas de organização da produção como determinantes de risco da febre aftosa. *A Hora Veterinária*, Rio Grande do Sul, *3* (17): 11-20, 1984.
3. ASTUDILLO, V.M. & ROSENBERG, F.J. Relationships between animal viral diseases and socio-economic development. Rev. Sci. tech. off. Int. Epiz. 2 (4): 1013-1036, 1983.
4. BARTRA, R. Estructura agraria y clases sociales en Méjico. Ed. Era, Méjico, 1980.
5. BENGOA, J. La hacienda latinoamericana, Ed. Ciese, Quito, 1978.
6. BARSKY, O. & COSSE, G. Tecnología y cambio social. Las Haciendas Lecheras del Ecuador. Ed. Flacso, Quito, 1981.
7. BREIHL, J. & GRANDA, E. Clases sociales y determinantes de la mortalidad infantil en el Ecuador. Ed. CEAS, Quito, 1983.
8. CEPA. El sector agropecuario pampeano en la década del 70. Ed. CEPA, 1, Buenos Aires, 1984.
9. CEPAL. El ciclo ganadero y la economía argentina. Cuadernos de la CEPAL, 43, 1983.
10. DUBOS, R. Mirage of health: utopia, progress and biological change. N.York: Harpen and Row, 1971.
11. GALEANO, R. Las venas abiertas de América Latina. Ed. Siglo XXI, Argentina, 1983.
12. GARCIA, J.C. Medicina y sociedad. Las corrientes de pensamiento en el campo de la salud. *Educ. Med. Salud 17* (4): 363-397, 1983.
13. GIBERTI, H.C.E. Historia económica de la ganadería argentina. Ed. Solar, Buenos Aires, 1980.
14. GUERRERO, A. Haciendas, capital y lucha de clases andina. Ed. El Conejo, Quito, 1983.
15. KAGEYAMA, A. & Da SILVA, J.G. Produtividade e emprego na agricultura brasileira. *In* Desenvolvimento Capitalista no Brasil. No. 2, Ed. Brasiliense, S.Paulo, 1983.
16. KAUTSKY, K. La cuestión agraria. Ed. Siglo XXI, Méjico, 1983.
17. KOSIC, K. Dialéctica de lo concreto. Ed. Paz e Terra, S.Paulo, 3a. Ed., 1983.

18. LAURELL, A.C. & MARQUEZ, M. El desgaste obrero en Méjico. Ed. ERA, Méjico, 1983.
19. MACHADO, T.M.M. Freqüência de anticorpos anti-*Toxoplasma gondii* em caprinos criados sob diferentes formas de exploração no Estado de Minas Gerais. Tesis, Esc. Vet., U.F.M.G., 1984.
20. MARTINEZ, L. De campesinos a proletarios. Ed. El Conejo, Quito, 1984.
21. MARTINS, C. Caracterização epidemiológica da febre aftosa no espaço catarinense. Tesis, Esc. Vet., U.F.M.G., 1984.
22. OBIAGA, J.A., ROSENBERG, F.J., ASTUDILLO, V.M., GOIĆ, R. Las características de la producción pecuaria como determinantes de los ecosistemas de fiebre aftosa. (Characteristics of livestock production as determinant of foot-and-mouth disease ecosystems). *Bol. Centr. Panam. Fiebre Aftosa 33-34*: 33-42, 43-52, 1979.
23. PAVLOVSKY, E.N. Natural nidality of transmissible diseases. Ed. Univ. of Illinois Press, 1966.
24. PEREIRA, P.L.L. Estudo do comportamento epidemiológico da febre aftosa no contexto pecuário do Triângulo Mineiro, M.G. Tesis, Esc. Vet., U.F.M.G., 1986.
25. PESSOA, S. Ensaios médico-sociais. Ed. Cebes, Hucitec., S.Paulo, 1978.
26. PORTELLI, H. Gramsci y el bloque histórico. Ed. Siglo XXI, 1a. ed., 1973.
27. PRADO Jr., C. História econômica do Brasil. Ed. Brasiliense, 34a. ed., 1986.
28. ROSENBERG, F.J. El conocimiento de la epidemiología de la fiebre aftosa con particular referencia a Sudamérica. *Ser. Monog. Cient. Técn. 5*, CPFA, 1975.
29. ROSENBERG, F.J. Principios de epidemiología. *Ser. Man. Didáct. 1*, CPFA, 1977.
30. ROSENBERG, F.J., ASTUDILLO, V.M., GOIĆ, R. Regional strategies for the control of foot-and-mouth disease: an ecological outlook. *In* Proc. Sec. Intern. Symp. Vet. Epid. Econ. Aust. Gov. Publ. Serv., Canberra, p.587-596, 1980.
31. ROSENBERG, F.J. & GOIĆ, R. Programas de control y prevención de la fiebre aftosa en las Américas. *Bol. Centr. Panam. Fiebre Aftosa 12*:1-22, 1973. 1973.
32. RUTSCH, M. La ganadería capitalista en México. Ed. Línea, México, 1984.
33. SENASA (Servicio Nacional de Sanidad Animal). Plan Argentino de Salud Animal (PLANARSA). Argentina, octubre, 1985.
34. SENASA/OPS/BID. Programa de Adiestramiento en Salud Animal (PROASA). Informe de Curso. Tandil, Argentina, 1984.
35. SILVA, S.S. Sobre a estructura de produção no campo. *In* Desenvolvimento Capitalista no Brasil. No. 2. Ed. Brasiliense, S.Paulo, 1983.
36. SLUSTKY, D. El caso de la agroindustria de la carne en Honduras. Ed. Ceplaes, Ecuador, 1978.
37. SORJ, B. Estado e classes sociais na agricultura brasileira. Ed. Zahar, Rio de Janeiro, 1980.
38. TAMAYO, H. A estructura de produção como determinante de saúde animal. Uma proposta metodológica. Tesis, Esc. Vet., U.F.M.G., 1981.
39. TESTA, M. Planejamento em saúde. As determinações sociais. *In* As Ciências Sociais em Saúde em América Latina. Ed. OPAS, p.335-367, 1985.
40. TINOCO, A.L.A. Caracterização das formas de produção caprina da micro região 138, Senhor do Bonfim, Bahia. Tesis, Esc. Vet., U.F.M.G., 1985.