INCREASING PROTEIN FOODS THROUGH IMPROVING ANIMAL HEALTH

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The nature and seriousness of the current world food deficit are summarized in a recent document of the Food and Agriculture Organization of the United Nations (FAO).

> "... some 60% of the people in the underdeveloped areas comprising some two-thirds of the world's population suffer from under-nutrition or malnutrition or both. Since there undoubtedly are some people in the developed countries who are ill-fed, it is concluded that up to a half of the peoples of the world are hungry or malnourished."

Undernourishment in general refers to inadequate intake of energy, i.e., calories, while malnutrition may result from many and varied nutritional imbalances or deficiencies. The most important by far, however, is protein malnutrition.

Protein deficiency particularly affects young children and pregnant or lactating mothers. The clinical forms in children are called marasmus and kwashiorkor. Marasmus results from diets deficient in both proteins and calories, while kwashiorkor occurs when the main deficiency is in proteins. Severe clinical disease in young children is characterized by cessation of growth, loss of weight, edema, dermatitis, and depigmentation of hair. Inadequate mental development may accompany altered physical development. Older people suffer ill health, have reduced ability to resist disease, and are seriously impaired in their work capacity. An important consequence of protein malnutrition is the impairment of the health, vigor, and efficiency of future generations. Protein malnutrition probably is the world's foremost public health problem.

The nutritive value of dietary protein depends as much on its quality as the total amount present. The best sources of the best proteins, those having the highest biological values, are foods of animal origin, i.e., meat, milk, and egg products. Animal products also are rich in other essential nutrients. It has been estimated[10] that 70 per cent of the world's supply of human dietary protein comes from vegetable sources and 30 per cent from animal sources, varying from 70 per cent from animal sources in the United States to 12 per cent in India. Quantitatively as well as qualitatively, animal products constitute an important part of the diet of the people of the world.

The FAO[10] short-term target for animal protein in the diet is 15 gm of animal protein per day with a long-term target of 21 gm. Currently, the world animal protein supplies average about 20 gm per person per day.[12] It is only 9 gm per day in the underdeveloped countries containing two thirds of the world's population (Tables 1 and 2). In view of the rapid rate at which the population of the world is increasing and the magnitude of the animal protein deficit in underdeveloped countries, achievement of these goals will require a great deal of effort.

World Livestock Resources.—The livestock population[11] of the world is roughly equivalent to the human population, i.e., 3 billion head, consisting of 1 billion sheep;

TABLE 1

PER CAPUT PROTEIN SUPPLIES IN DEVELOPED AND UNDERDEVELOPED COUNTRIES

	Gm per Caput per Day	
	Total protein	Animal protein
Developed countries Europe, North America, Oceania, River Plate, countries of South America, and USSR	90	44
Underdeveloped countries Latin America (excluding River Plate), Asia, China, Africa	58	9
World	68	20

TABLE 2

PER CAPUT PROTEIN SUPPLIES BY REGION*

	Gm per Caput per Day	
	Total protein	Animal protein
Western Europe	83	39
Eastern Europe and USSR	94	33
North America	93	66
Oceania	94	62
Latin America	67	24
Far East and Mainland China	56	8
Near East	76	14
Africa	61	11

* From ref. 12.

980 million cattle; 553 million swine; 353 million goats; 121 million horses, mules, and asses; 81 million water buffaloes; and 10 million camels. There are approximately 3 billion domesticated fowl. Although less than 40 per cent of the livestock population is located in developed countries, these countries produced nearly 80 per cent of the world's 434.7 million metric tons of meat, milk, and eggs in 1963.[11]

Livestock in developing countries, in general, produce at a fraction of the level attained in developed countries. For example, the average age of slaughter of animals raised for beef in many parts of Africa is nearly 7 years,[14] compared to approximately 2 years in the United States. In some of these countries the milk yield of 20 cows is barely equal to that of one cow in New Zealand. The average annual yield of meat for a U.S. beef cow is 166.7 lb,[4] while in Asia the figure is 26.2.[4] The average annual milk yield of a dairy cow in California[3] was 10,410 lb in 1963, while the production of an African cow is said to be 192 lb.[4]

The low productivity of livestock in developing countries can be attributed to a number of factors, some of which have cultural and religious roots. The main reason for the low productivity, however, is that scientifically based principles of disease control and animal production, which are mainly responsible for the high state of development of the livestock industries in developed countries, are largely unused. When modern principles of veterinary medicine and animal husbandry have been used in local areas in underdeveloped regions, such as in parts of Kenya, they have been highly successful.

World Animal Diseases.—Man has successfully limited the danger to himself from major epidemic diseases such as smallpox, plague, and yellow fever. A similar level of control, however, has not been achieved over the major epizootic diseases of animals. The distribution of the major epizootic diseases of livestock today does not differ much from the time of Christopher Columbus, except that cattle plague

(rinderpest) has been eliminated from Europe and parts of Asia, and foot-and-mouth disease has spread to South America (Fig. 1). The livestock population of the world, except in developed countries, is subject to much the same depredation from diseases that have plagued it for centuries.

Major Epizootic Diseases.—The most important epizootic diseases of livestock are rinderpest, contagious pleuropneumonia, foot-and-mouth disease, African horse sickness, African swine fever, Newcastle disease, fowl plague, trypanosomiasis, East Coast fever, and piroplasmosis (Table 3). These diseases limit livestock production in susceptible species wherever they occur. It is impossible to develop a fully productive livestock industry in areas where these diseases are not controlled.

These diseases have killed or debilitated hundreds of millions of livestock over the centuries. It is estimated[21] that the rinderpest epizootics which occurred in Europe between 1710 and 1769 killed over 200 million cattle. Tens of millions of livestock and game were killed in the great African rinderpest panzootic which swept through that continent in the latter 1800's, finally burning itself out in South Africa. At least 2 million head of cattle died annually from rinderpest in the Far East[9] until a control program was instituted after World War II. Now the loss is less than 50,000 per year. As late as 1962,[15] rinderpest had more influence on the world's food supply than any other animal disease. Fortunately, a great deal of research has been conducted on this disease in the last two decades and the incidence is being reduced rapidly.

Other epizootic animal diseases also can have devastating effects on livestock populations. Both Newcastle disease and fowl plague are capable of killing 70–100 per cent of the chickens in an area in a few weeks. Although foot-and-mouth disease is not highly fatal, it reduces the total animal production by 25 per cent each year in affected areas.[5] The 1951–1953 outbreak of foot-and-mouth disease in Europe caused an economic loss of $425 million during that critical postwar period even though control measures were reasonably effective.[13] Following its introduction into Spain and Portugal in 1959, African swine fever caused the loss of 136,000 pigs in 1960 alone.[20] In 1959 and 1960, 200,000–300,000 horses and mules died in Asia from another newly introduced disease, African horse sickness.[20]

About one half of the continent of Africa south of the Sahara has been rendered unsuitable for cattle production as a result of nagana, a trypanosomiasis spread by the tsetse fly.[17] This area is reported to be potentially capable of supporting approximately 125 million cattle. This is more than the current U.S. cattle population. Improved breeds of cattle can be raised in large areas of eastern Africa only if they are regularly dipped to control the tick vectors of East Coast fever and other diseases. Tens of thousands of cattle die each year in Africa and Asia from contagious pleuropneumonia.

The major epizootic livestock diseases must be controlled before significant progress in animal production can be expected. Fortunately, enough is known about most of these diseases so that improved control measures can be instituted.

Other Livestock Diseases.—The heaviest losses from livestock diseases, however, result not from the spectacular epizootic diseases, but from the many diseases of parasitic, infectious, nutritional, toxic, metabolic, and organic genesis that continually prey on the livestock population. They cause losses by killing animals or

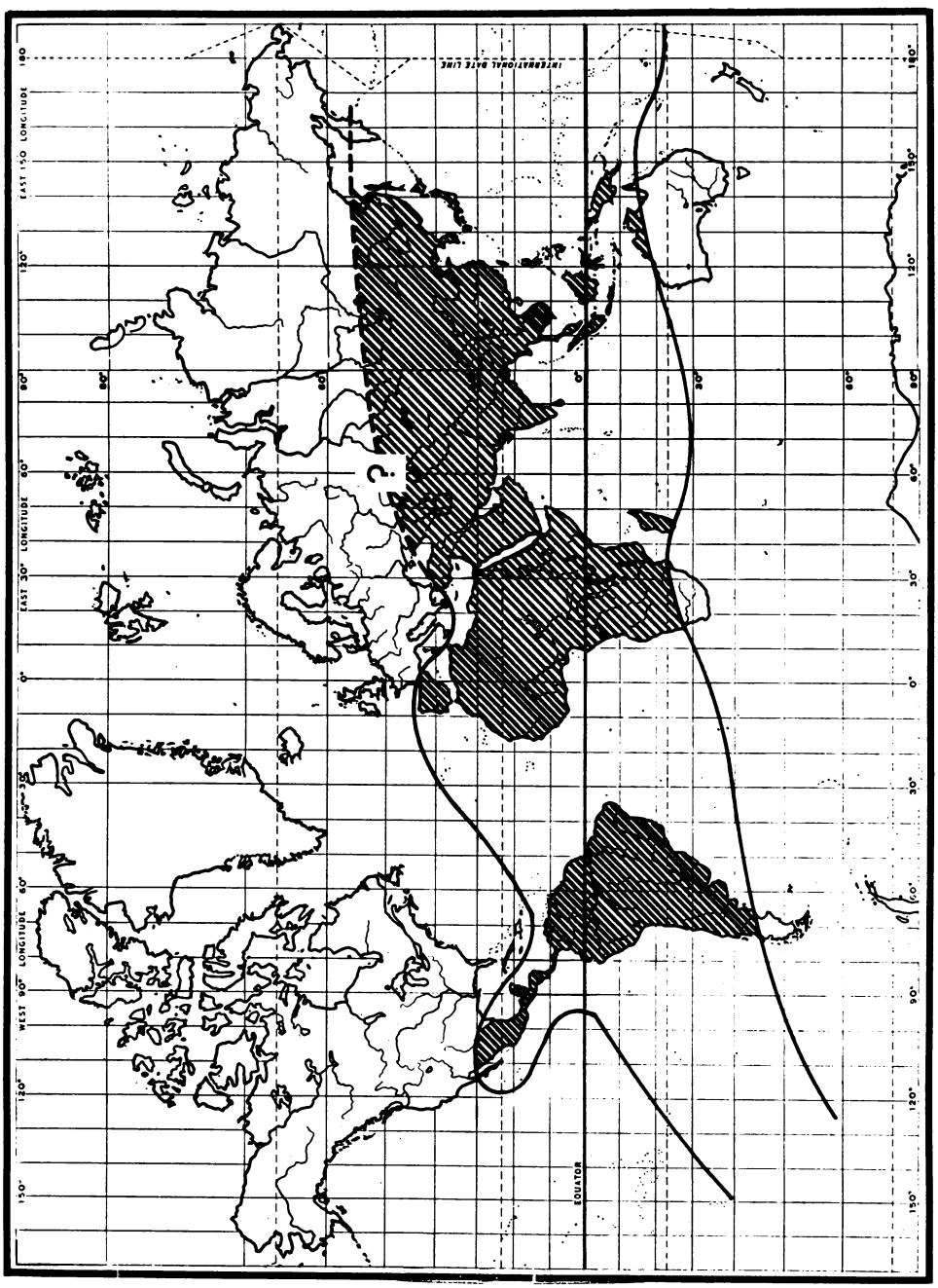

FIG. 1.—Distribution of world's major epizootic livestock diseases (areas in which foot-and-mouth disease is being effectively controlled are not included).

TABLE 3

WORLD'S MAJOR EPIZOOTIC DISEASES

Disease	Cause	Control
Rinderpest	Virus	Effective vaccine
Foot-and-mouth	"	" "
African swine fever	"	Slaughter only
African horse sickness	"	Effective vaccine
Newcastle disease	"	" "
Fowl plague	"	" "
Nagana	Protozoa	Tsetse eradication
East Coast fever	"	Tick control
Piroplasmosis	"	" "
Contagious pleuropneumonia	Mycoplasma	Partially effective vaccine

reducing their productivity. They include diseases commonly known in the United States, such as brucellosis, tuberculosis, anaplasmosis, mastitis, vibriosis, and parasite infections as well as exotic diseases with romantic-sounding names such as Ondiri disease, Nairobi sheep disease, and Rift Valley fever.

The incidence of disease and the morbidity and mortality in livestock are very high in developing countries. W. Ross Cockrill[4] of the FAO describes half of the world's livestock as "diseased, hungry, unproductive and a burden upon the... human population." Andrews[1] has said "it is an understatement to say that parasites and infectious diseases are the chief limiting factor in efficient livestock production throughout much of the world." Brucellosis is said to affect 20 per cent, tuberculosis 10 per cent, mastitis 20 per cent, leptospirosis 10 per cent of the cattle of the world.[22] In one area,[18] 45 per cent of the cows' milk examined contained the tubercle bacillus. Deaths from hemorrhagic septicemia[9] in the Far East some years amounts to 1 million cattle and buffaloes, mostly draft animals. The mortality may exceed 50 per cent among affected animals. It is difficult to conceive of efficient livestock production under these circumstances.

Wastage of Animal Protein.—Animal diseases cause significant wastage of foods of animal origin. Wastage results from death of animals, destruction of animal products such as meat, milk, or eggs, and from reduced production. These losses are calculable on the basis of meat or milk destroyed, or the net loss of production resulting directly from disease, provided reliable morbidity and mortality data are available.

A preliminary world-wide estimate of the losses caused by animal diseases was made by the FAO in 1962.[8] They concluded that losses from animal diseases in countries in which veterinary activities had been in progress for many years ranged between 15 and 20 per cent of total annual production. In countries in which veterinary activities are less intensive and more recently established, losses ranging between 30 and 40 per cent were commonly encountered. They did not estimate the loss in countries without animal health programs, but assumed that they must be of a very much higher order of magnitude. These loss calculations make it possible to estimate animal disease losses in tons of animal products or supplies of animal protein in grams per person per day.

Fully realizing the limitations of the data, I have calculated the loss of animal products on the basis of an average loss of 17.5 per cent in Europe, Oceania, and North America (EONA) and an average of 35 per cent in the rest of the world. I am fully convinced, on the basis of first-hand knowledge of animal diseases in Latin America, Africa, and Asia, that the latter figure is far too low—perhaps only

one half as high as it should be. Nevertheless, annual losses at these rates amount to 4.06 million metric tons of animal protein for EONA and 6.71 for the rest of the world.

Salvage of estimated loss would provide approximately 6 gm more animal protein per day for every person in the world. The saving in Africa, Asia, and Latin America would amount to an increase of 4.4 gm per person per day in the supply of vitally needed animal protein.

Complete elimination of wastage from animal diseases is not a realistic objective. The benefit that might be derived from animal disease control measures, however, can be evaluated on the basis that for every reduction of 10 per cent in the wastage from animal diseases, an average per caput increase of at least 0.6 gm of animal protein per day is generated for every person in the world. A 50 per cent reduction in losses from animal diseases in Africa, Asia, and Latin America, which would increase the supplies of animal protein in those areas by 25 per cent, is a realistic objective.

Some Indirect Losses.—Development of a livestock industry ordinarily does not occur if the capital investment in animals is constantly exposed to the risk of being liquidated by disease. Agriculturists will invest in safer ventures even though the return might be greater in livestock. An animal industry rendered unproductive by disease does not provide incentives necessary for the development of necessary marketing, processing, and service industries. Control of the main epizootic diseases and parasites of an area is a necessary prerequisite to development of an efficient livestock industry. The inhibition of the development of a viable scientifically based animal industry in underdeveloped countries is the most important loss produced by animal diseases in the world today. The net effect of a 50 per cent reduction in animal disease losses might well be a doubling of animal production in underdeveloped areas over 10–15 years—if control of animal diseases has its expected effect of stimulating significant livestock development.

Animals are the principal source of power for agricultural enterprises in developing countries. The death or debilitation from disease of draft animals may result in reduced food production because farmers are unable to cultivate crops. Not only starvation, but also loss of foreign exchange may result. A good example is the destruction of a valuable 3-million-ton rice surplus for export, which accompanied a rinderpest epizootic in Burma just after World War II.[9] In other parts of the world, horses, mules, asses, camels, buffaloes, and even elephants serve as important sources of agricultural power. Diseases of these animals have an important adverse effect on food production.

Of the more than 300 diseases transmissible among animals, more than 100 also are communicable to man. The incidence of zoonotic diseases is very high in underdeveloped countries.[22] Farmers and handlers of animals and their products run the greatest risk from the zoonoses because of their close contact with infected livestock. Debilitation of the human populations of underdeveloped countries is an important indirect loss from animal disease.

What Are the Prospects for the Future?—It is realistic to expect that the world supply of animal protein could be strikingly increased in the very areas where they are most needed if losses from livestock diseases were reduced to a minimum. Norris E. Dodd, a former director-general of FAO, has gone so far as to say,

". . . if the blood-sucking intestinal parasites of domestic animals could be removed, the resulting increase in food would more than satisfy the needs of all the deficient areas of the world." [13] It will require considerable time and effort to bring the world's animal diseases under practical control. However, there is no doubt that it can be done. The history of the medical sciences has shown that most problems of disease can be solved through research,[2] and many qualified experts believe that nearly all infectious diseases will prove to be preventable.

It is my belief that the development of a viable and reasonably productive livestock industry in developing countries is one of the best presently available solutions to the world protein deficit. The key to the success of livestock development is control over the major diseases of livestock. A fully productive livestock industry has never been developed in areas where epizootic disease constitutes a threat. Control of disease must receive the highest priority in countries with animal protein deficits and the potential for livestock production.

Cost of Disease Control.—I know of no way to predict what the cost might be to bring the world's major animal diseases under control. For diseases such as rinderpest, for which effective tools for eradication are at hand, the cost can be accurately estimated, which of course is not the case with nagana because cheap and effective ways to control it or its tsetse fly vector have not yet been devised.

Some cost figures for eradication of certain diseases might be helpful in arriving at an understanding of the relationship of the cost of eradication and the losses caused by a disease. Nine diseases have been eradicated from the United States at a total cost for eradication procedures alone of less than $180 million (Table 4). Foot-and-mouth disease was eradicated from Norway at a cost of $2 million,[9] which was equal to the annual loss. The 40-year cost of the bovine tuberculosis control program in the United States has been $326 million[20] as compared with an estimate of savings of $150 million per year, i.e., $6 billion, as a result of the program.

The measures required to bring the world's animal diseases under control undoubtedly will be costly. These costs, however, in the long run will constitute only a fraction of the losses that will be imposed on the people of the world if these diseases are not controlled.

TABLE 4

COST OF ERADICATING CERTAIN DISEASES FROM THE U.S.A.*

Disease	Date	Cost
Contagious pleuropneumonia	1892	$1,502,100
Fowl plague	1925 and 1929	101,495
Dourine	1934	314,926
Glanders	1942	35,078
Piroplasmosis	1943	11,999,511
Foot-and-mouth	1870, 1880, 1884, 1902, 1908, 1914–16, 1924–25, and 1929	9,170,411 (total for all outbreaks)
Foot-and-mouth in Mexico (joint Mexican-U.S. program)	1954	134,571,653
Vesicular exanthema	1959	11,158,737
Screwworms (southeast U.S.)	1959	10,000,000
	Total	$178,853,911

* Source: U.S. Department of Agriculture.

Development of a Livestock Industry.—During the period when major epizootic diseases of an area are being brought under control, steps can be taken to develop the scientific base for a productive livestock industry.[1, 6, 14, 16, 19] Effective veterinary services calculated to reduce enzootic animal disease losses through disease prevention programs must be established. Research on breeding, environmental physiology, nutrition, range management, and marketing must be instituted. These programs should be closely coordinated with other phases of agricultural research. It is fully recognized that the problems in livestock production in underdeveloped countries are complex and often are compounded by religious and cultural ramifications that may be more difficult to overcome than are the technical ones. However, these problems are not insurmountable.

Special Attributes of Ruminants.—Like man, monogastric animals such as swine and poultry must be fed diets containing all of their essential amino acids, and must receive their carbohydrates in the form of simple sugars or starches. Consequently, in food-deficient areas, except to the extent that they use by-products or wastes unsuitable for human use or sources of protein that are esthetically unacceptable to people, these animals compete directly with man for dietary energy and proteins. Hence, their value in a food-deficient area depends simply upon the seriousness of the animal protein deficit when compared to total supplies of protein and energy.

The polygastric ruminant, on the other hand, possesses in the form of a rumen a fermentation factory which renders the animal capable of utilizing complex polysaccharides such as cellulose for energy and synthesis of proteins from other proteins and nonprotein nitrogen. The ruminant does not require a dietary source of essential amino acids.

Ruminants are admirably suited to convert forage crops that are unsuited for human consumption into highly nutritious meat and milk, containing the life-giving amino acids as well as other essential nutrients. With over 25 per cent of the world's surface suitable only for grazing[7] and the tremendous potential for utilization of by-products of human food crops as feed for ruminants, every effort should be made to capitalize on the unique ability of the ruminant to convert substances that are unsuitable for human food into animal protein, man's most needed dietary factor.

Conversion of Proteins from Unconventional Sources to Highly Acceptable Animal Protein.—Swine and chickens are particularly efficient converters of feed into meat. For example, it is possible to produce a 3-lb chicken from well-bred stock kept free of diseases with approximately 6 lbs of a properly balanced ration. Meat from pigs and chickens are highly acceptable components of human diets throughout the world except where there are religious restrictions to their consumption. These animals, therefore, might serve as effective and efficient converters of proteins produced from unconventional sources, such as algae fed on sewage effluents or yeast grown on paraffinic hydrocarbons obtained from refining petroleum, into highly acceptable food for people. One of the major limitations to the use of unconventional foods has been the difficulty of getting people to eat them. This objection can be overcome by using these products as animal feeds because animal products are almost universally accepted as desirable foods.

Tropical Animal Disease Research Needed.—Veterinary medical science has been

largely preoccupied during the past 50 years with the solution of animal disease problems of developed countries, all of which are located in temperate climatic zones. In general, it has been highly successful in providing means to control the major livestock diseases in these areas. With the exception of a few high-quality tropical veterinary medical research programs carried out by European countries in their former Asian and African colonies, very little research in tropical veterinary medicine has been conducted. Unfortunately, many of these programs are not being continued by newly independent nations. The FAO has done a great deal to fill this gap, but it has not been able to meet the needs completely. Consequently, there is much to be learned about tropical animal diseases before underdeveloped tropical areas can be fully exploited for animal production.

There is need for the establishment at a very early date of a major research center located in the tropics devoted to tropical diseases of animals. Its mission would be to provide the world with the knowledge about tropical animal diseases necessary to bring these diseases under control and open up the tropical areas of the world to profitable livestock production.

Summary and Conclusions.—Over half of the people of the world are hungry, or suffer from malnutrition, the vast proportion of which is protein malnutrition even though the world has vast livestock resources. The animals in underdeveloped countries are highly unproductive. Disease plays an important role as a causative factor of low production. Diseases of livestock also cause a direct loss equivalent to 6 gm of animal protein per day for every person in the world. One of the best solutions to the world shortage in quality proteins is the development of productive livestock industries in underdeveloped countries.

The epizootic diseases, such as rinderpest, foot-and-mouth, contagious pleuropneumonia, and nagana, must be controlled before the livestock industries of developing countries can initiate serious livestock development programs. Livestock disease control programs, although costly to conduct, in a very short time will save many times as much as they cost. There is no doubt that properly mounted control programs can be successful.

There is an urgent need for the development in the tropics of an animal disease research laboratory which will provide the world with solutions for important tropical animal disease problems.

The author wishes to thank Drs. M. Merala, N. M. Konnerup, and F. D. Maurer for assisting him with the collection of the data used in this discussion.

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