Report / Committee on Cattle Diseases.

ECONOMIC ADVISORY COUNCIL

COMMITTEE ON

CATTLE DISEASES

REPORT

Presented to Parliament by Command of His Majesty
May 1934

LONDON
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COMMITTEE ON CATTLE DISEASES

Terms of reference and composition of the committee

On the 2nd November, 1932, the Prime Minister appointed a committee of the Economic Advisory Council with the following terms of reference :—

> To consider what practical measures can be taken to secure a reduction of disease among milch cattle in this country, and to report upon any changes desirable in the existing administrative practice, and, in particular, upon the value and practicability of methods for reducing the incidence of bovine tuberculosis and improving the milk supply.

2. The committee is constituted as follows :—

Sir Frederick Gowland Hopkins, Pres.R.S., *Chairman*.
Sir Merrik R. Burrell, Bt., C.B.E.
Professor E. P. Cathcart, C.B.E., M.D., D.Sc., F.R.S.
Dr. A. Stanley Griffith, M.D., Ph.D., D.P.H.
Sir Charles Harris, G.B.E., K.C.B.
Professor J. H. Jones.
Major-General Sir John Moore, K.C.M.G., C.B., F.R.C.V.S.

Mr. Francis Hemming, C.B.E., Joint Secretary, Economic Advisory Council
Mr. P. K. Debenham, Assistant, Economic Advisory Council
} *Joint secretaries to the committee.*

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I.—INTRODUCTORY.

(a) Procedure adopted by the committee.

On the 15th November, 1932, we held a preliminary meeting for the purpose of laying down the procedure to be followed in our inquiry, and in order to inform ourselves generally of the problems to be studied. We decided in the first instance to obtain written evidence from the government departments principally concerned with the subjects embraced within our terms of reference, namely, the Ministry of Agriculture and Fisheries, the Ministry of Health, the Department of Agriculture for Scotland, the Department of Health for Scotland, the Medical Research Council, and the Agricultural Research Council. We also prepared a preliminary list of institutions and individuals from whom we hoped to obtain information likely to assist us in the prosecution of our inquiry.

2. We were requested by the Minister of Health to report on the question of compulsory pasteurisation of milk in the larger towns. We have taken evidence from representatives of those who would be affected by it, and we make recommendations regarding it in our report.

3. We felt it wise to inquire into the control of animal diseases and the regulation of the distribution of milk in oversea countries. We are much indebted to the Department of Overseas Trade, to His Majesty's Senior Trade Commissioner in the Dominion of Canada, and to His Majesty's Commercial Diplomatic officers stationed in the United States of America, Denmark, Germany, Holland, Norway, Sweden, and Switzerland, for the information that they have collected and sent to us.

(b) Evidence received.

4. We began the hearing of oral evidence on the 14th December, 1932, and in all held 32 meetings for that purpose. We heard evidence from the departments of state concerned both on the limited question of the compulsory pasteurisation of milk, and on the other matters included in our terms of reference; from representatives of institutions devoted to research in the subjects of our inquiry; from professional associations and public companies whose members were likely to be affected by any recommendations which we might make, or whose duties brought them into practical contact with our problems; from associations of local authorities; and, finally, from a number of individuals whose special experience in various fields was likely to be of value to us.

5. In addition to the evidence taken orally, we received a large number of written communications. We received from the government departments to which we have already referred memoranda on a large number of points on which we invited their assistance, and also many communications from institutions and individuals interested in the subject of our inquiry.

6. We desire to place on record our indebtedness to all who have assisted us, whether by giving oral evidence or by furnishing us with written information. In particular, we are under obligations to the Ministry of Agriculture and Fisheries, the Ministry of Health, and to the Departments of Agriculture and Health for Scotland. Particulars regarding the evidence received, whether orally or in writing, are given in appendix 1 to our report.

7. In addition to memoranda specially prepared for us, we received considerable assistance from published information. In particular, we may refer to a memorandum on bovine tuberculosis in man (Ministry of Health: reports on public health and medical subjects, no. 63); a survey of tuberculosis of bovine origin in Great Britain prepared by a committee of the People's League of Health; the report of the Reorganisation Commission for Milk (Ministry of Agriculture, economic series, no. 38); a report on the nutritive properties of milk in relation to pasteurisation, by the late Dr. J. D. Stirling and Dr. J. H. Blackwood; a report on the eradication of bovine tuberculosis by Mr. L. Jordan, being an account of an experiment in eradication undertaken through the Hannah Dairy Research Institute at the instance of the Medical Research Council, and to an article published in the quarterly bulletin of the League of Nations Health Organisation by Professor G. S. Wilson on the system of grading milk in the United States of America.

(c) Arrangement of report.

8. We divide our report into four parts. In the first, we consider the production and distribution of milk and their relation to cattle diseases and public health. In this part we first review the present system of milk production and supply, and then describe the principal cattle diseases and the diseases in man associated with them. In the same section we discuss the importance of milk as an element in human diet, and also the effect of pasteurisation on the constituents of milk. In the third section of this part of our report we describe the existing legislation in regard both to the diseases of animals and to the milk supply, and discuss to what extent it has proved effective in the prevention of disease and the improvement of the milk supply.

9. The second part of our report is devoted to a discussion of possible lines of administrative development. These include the further development of the veterinary inspection of dairy cattle

(section IV), methods of eradicating bovine tuberculosis and other diseases of cattle (section V), and the compulsory pasteurisation of milk (section VI). In part 3 of our report we set out in detail our various recommendations, and these, with our principal conclusions, are summarised in part 4. Attached to our report are a number of appendices bearing on our inquiry, in which we discuss certain statistical points at greater length than would have been convenient in the main body of our report.

(d) Recent government policy and the committee's inquiry.

10. Since our committee was appointed, marketing boards have been set up under the agricultural marketing acts for the dairying industries in England and Wales and in Scotland. Very recently, also, the government has announced its decision to provide £750,000 spread over the next four years to assist in obtaining a purer milk supply. Thus, we have had to report at a time when the industry is undergoing a number of important changes. In preparing our report, however, we have confined ourselves to laying down the principles of a long-term policy; for it must be remembered that the control of disease can only be effected by the consistent application of a scheme designed to cover a long period. We do not feel called upon to offer suggestions for the adaptation of these principles to the immediate situation.

PART 1.

THE PRODUCTION AND DISTRIBUTION OF MILK AND THEIR RELATION TO CATTLE DISEASES AND PUBLIC HEALTH.

I.—THE PRESENT SYSTEM OF MILK PRODUCTION AND SUPPLY.

(a) Milk production.

(i) *The dairying industry.*

11. In Great Britain there are* 2,763,000 cows and heifers in milking herds and, in addition, 481,000 heifers in calf but not in milk. These animals are distributed among over 200,000 herds and produced in 1930–31 1,425,500,000 gallons of milk.† Some of these herds are entirely devoted to the production of milk, whether for sale in liquid or in manufactured form. Others are principally concerned with the raising of cattle for beef production, or for the replacement of breeding stock. There is also a large class of herds which undertake both of these functions. The value, on the farm, of the milk produced in Great Britain is, on the basis of a price of $10\frac{3}{4}d.$‡ a gallon, nearly £64,000,000. The value of milk at the point of consumption is considerably increased, perhaps even doubled. These particulars show that the dairying industry is one of great economic importance, and that the reduction of disease on any considerable scale would be a material economic gain to the nation.

(ii) *The wastage of dairy cattle.*

12. The useful life of a dairy cow, if she escapes the ravages of disease, should extend over at least eight or nine lactations. There are, indeed, instances of cows having very much longer milking lives. But a cow may normally be expected to show signs of deterioration at the age of eleven or twelve years. Of these eight or nine lactations, it is the later which are the more productive, for a cow does not generally attain her maximum yield until her fourth lactation. She should then maintain it for two or three years, and then yield a gradually diminishing quantity. We have reviewed with care the evidence that is available as to the average productive life of dairy cattle under the conditions prevalent to-day.§ We are not able, on this evidence, to attach a precise figure to this average; but we have little doubt that upon extended inquiry it would be found to exceed four and fall short of five years, and it probably

* The figures are those for the 4th June, 1931.

† Exclusive of milk fed to stock.

‡ The price estimated by the Ministry of Agriculture and Fisheries to have been received by farmers in 1930–31.

§ For a fuller discussion of this question, see appendix 2.

lies in the neighbourhood of four and a half years. This average applies to the country as a whole. In those districts where disease is rife, the average life is likely to be less. Thus, the actual milking life of a dairy cow is on the average only half that which might be expected under ideal circumstances.

13. We estimate that this curtailment of productive life is responsible for an annual monetary loss of over £3,000,000, of which £2,500,000 is due to the increased costs of maintaining herds at their full strength; and the remainder to losses of meat condemned on account of disease.* In making this estimate we have not taken into account any increase in the annual productivity of the cow during life, which might follow from the elimination of disease. This loss cannot be estimated, but must be large. We do not suggest that, as a result of the complete disappearance of disease from among dairy cattle any particular class of the community, for example farmers, would benefit to the extent of £3,000,000 annually. The benefit would presumably be diffused throughout the community as a whole.

14. A number of investigations have been made into the causes which are responsible for these heavy losses among dairy cattle. The method of these investigations has been to obtain from farmers† notice of each cow drafted out of his herd and the cause of disposal. Unfortunately the cause which is present in the mind of the farmer is not that which is of interest for our purpose. Broadly speaking, a farmer parts with a cow either because she fails to produce milk economically, or because she is surplus to his requirements. Cows parted with on the first ground may be further sub-divided, from the farmer's point of view, into cows which die, cows which are barren, cows which are unthrifty, and cows which have a low milk yield either naturally or as a result of disease. A further cause of disposal of importance among the producers of tubercle-free milk, is reaction to the tuberculin test. The classification of the causes of disposal of a large number of dairy cows which is given in the table in the following paragraph is evidently influenced by considerations such as these. In fact, however, this classification throws little or no light on the extent to which infection with any one of the main diseases of cattle is a cause of wastage. For each of the symptoms which leads the farmer to dispose of a cow is compatible with several diseases.

15. The most extensive of the investigations to which we have referred were undertaken by the Hannah Dairy Research Institute, by the National Institute for Research in Dairying at Reading, and

* The grounds upon which this estimate is based are considered in appendix 3.

† These farmers belong to milk recording societies, and may therefore not be representative of farmers as a whole.

by the School of Agriculture at Cambridge, with the co-operation of the milk recording societies in the counties covered by the inquiries. The total number of disposals recorded in these investigations exceeded 17,000. The results are summarised in the following table (table 1) :—

TABLE 1.

Causes of the disposal of dairy cows.

Investigation.	Hannah Institute.	National Institute, Reading.		School of Agriculture, Cambridge.			Summary of all investigations.
	1930.	1929–30.	1930–31.	1928–29.	1929–30.	1930–31.	
Number of herds	466	322	470	547	537	488	2,830
Number of cows in herds	19,263	9,478	12,348	13,465	12,984	11,367	78,905
Number of disposals recorded	3,620	2,136	3,013	2,461	3,059	2,958	17,247
Percentage of these disposals recorded as being on account of—							
1. Diseases of the reproductive organs—							
(*a*) Sterility ...	17·2	26·2	25·6	23·7	26·7	26·2	23·8
(*b*) Abortion ...	2·1	3·1	2·8	3·6	3·8	2·7	3·0
Total reproductive disease	*19·3*	*29·3*	*28·4*	*27·3*	*30·5*	*28·9*	*26·8*
2. Udder disease ...	15·0	6·4	6·6	7·1	4·8	4·2	7·7
3. Tuberculosis, Johne's disease and wasting	5·4	12·3	12·3	10·4	9·6	10·0	9·7
4. Death and miscellaneous diseases ...	15·1	8·8	9·8	9·3	7·9	9·6	10·4
5. Tuberculin test ...	2·8	5·5	5·5	2·4	1·8	4·1	3·6
Total from disease ...	*57·6*	*62·3*	*62·6*	*66·5*	*54·6*	*56·8*	*58·2*
6. Old age	4·9	4·4	3·4	5·3	4·0	3·8	4·3
7. Accident	1·5	1·9	1·7	1·2	1·4	1·0	1·5
8. Low yield	16·6	19·4	16·0	19·6	19·1	16·5	17·7
9. Trade	19·4	12·0	16·3	17·4	20·9	21·9	18·3
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

16. The striking feature of this table is the importance of sterility as a cause of disposal. This condition is due to a number of causes, of which infection with contagious abortion is one of the most frequent. Second in importance as a cause of disposal from individual herds is sale to the trade. This is not a source of numerical loss to the herds of the country as a whole, and need not detain us. A large percentage of cows are disposed of on account of their low milk yield, which is the third cause of disposal in order of importance. In part these disposals reflect the effort of the farmer

to maintain an average economic yield in his milking herd. In part, however, they are indirect losses attributable to disease. An interesting example of the importance of the latter was given to us by one experienced witness, who had made an analysis of the milk yields of the cows in a large herd, dividing them up into groups according as they were or were not infected with mastitis or contagious abortion (not in an active form). The average yields in the different groups (corrected to allow for the various extraneous factors which normally affect productivity*) were as follows :—

TABLE 2.

Average milk yield in healthy and infected cows.

——	Disease condition.	No. of cows.	Corrected yield of milk in pounds per annum.
Group (1) ...	Mastitis free, abortus free ...	39	9,718 ± 243
Group (2) ...	Mastitis infected, abortus free ...	56	8,116 ± 274
Group (3) ...	Mastitis free, abortus infected...	12	7,702 ± 630
Group (4) ...	Mastitis infected, abortus infected	19	7,416 ± 350

It may therefore be safely inferred that many of the animals sold out of herds nominally on account of their low milk yield, are in fact the victims of disease.

17. The next group in table 1 refers explicitly to disease; to tuberculosis, Johne's disease, udder disease (principally mastitis), and to miscellaneous diseases. Almost last in the list comes old age. The small number of disposals recorded under this head is not due to a commendable preference on the part of farmers making returns to giving a definite rather than an indefinite reason for each disposal; but simply to the fact that very few cows survive so long that their death can be attributed to old age. Such evidence as we have suggests that the rate at which cattle are disposed of is practically constant at all ages up to perhaps eleven or twelve years, and is so high that only few cows reach these latter. Disposals on account of reaction to the tuberculin test are practically confined to tested herds. Though an unimportant cause in the aggregate, it is in these herds a serious drain, being responsible for as much as one sixth of the total losses. Animals sold on account of reaction to the tuberculin test are frequently again bought into dairy herds. Though the statistical inquiries which we have been discussing in the preceding paragraphs do not enable us to assess the absolute importance of each disease, they show how serious a part disease

* The most important of these factors are age and date of last calving.

plays in the economic management of the country's herds in bringing about the disposal of cattle. Of all disposals, 58 per cent. are directly attributable to disease; of the remainder, some are indirectly attributable to disease and many are only transferred to other herds, and, though not lost to the dairy industry, do nothing to raise the general standard.

18. If the statistical proof is deficient there is unanimity among experienced veterinarians that four diseases are pre-eminently responsible for the farmers' losses, namely, contagious abortion, bovine tuberculosis, mastitis, and Johne's disease. Of these four diseases it is agreed that on the whole contagious abortion is the most, and Johne's disease the least, serious. Our report is mainly concerned with the steps which can be taken to lessen the incidence of these four diseases.

(iii) *Influences affecting the spread of disease.*

19. The influences affecting the spread of disease among dairy cattle may be divided into those which predispose the cow to fall a victim to, or resist, an infection if encountered, and those which increase or diminish the chances of encountering infection. If we make small reference to consideration of the first class it is not because they are unimportant. A cow, producing perhaps a thousand gallons of milk in the course of a year, in addition to supporting a growing fœtus, is making unnaturally severe demands upon her powers of assimilation. In such circumstances quite minor deficiencies in her diet may have serious results. Several witnesses have argued that correct feeding and environment are necessary to the prevention of disease. Government action in this field is necessarily confined to the encouragement of research and to the dissemination of the results of research among farmers. It should be fully realised that owing to the heavy strain to which they are subject, dairy cows are liable to fall easy victims to disease, and that the high incidence of disease among them is closely related to this fact. Moreover, the modern tendency to require a constant increase in yield is likely to increase the incidence of disease. We are further impressed with the importance of the proper feeding of calves and young heifers in order that their constitutions may not be impaired and their vitality lowered.

20. The chances of a cow encountering infection depend, in the first place, on housing conditions. Milking herds spend prolonged periods congregated in buildings. If these are of such construction as to harbour infection, they may be a powerful factor in the perpetuation of disease. The absence of proper premises for isolation of diseased animals or for calving, overcrowding, unsatisfactory ventilation and a water supply which is liable to become contaminated are all dangerous. Buildings to be hygienic require impervious

floors and proper ventilation, and should be kept scrupulously clean. These requirements need not involve any considerable outlay.

21. Secondly, the spread of infection may be influenced by methods of management. The account given in a later section of the four principal diseases of cattle shows what an important and largely preventible part infected material plays in the spread of infection. For example, if hay is allowed to come into contact with dung before being fed to cattle, or if, should a cow slip her calf in a pasture, access to the spot by the rest of the herd is not prevented, there will be serious danger of infection. Unless precautions are taken, mastitis is spread by the hand of the milker. Unless calving boxes are properly disinfected after use they may spread contagious abortion. The list might be extended indefinitely. The farmer with a knowledge of hygienic principles may, by attention to such details as these, greatly reduce the incidence of disease in his herd.

22. Thirdly, disease is largely spread by contact with cattle from other herds. If a herd is self-contained, being replenished exclusively by home-breeding, the danger of infection from outside is very slight. But when cattle are bought in, there is a great risk of infection, even if the bought cattle can be transferred to their new home without contact with animals from a third herd. The risk is obviously increased when animals pass through an open market.

23. The effect of outside purchases in spreading diseases in herds is illustrated to some extent by a table taken from the report on the Cambridge investigation referred to in paragraph 15 above, which we reprint in appendix 4. This table shows that herds which buy in a relatively small part of their total replacements suffer less from disease than other herds. But it does not show separately herds which are entirely supported by home breeding, which should be much less subject to disease than herds in which buying in takes place even upon a small scale.

24. It thus appears that by far the most important part in preventing infection must be taken by the farmer himself. Government, however, may help by providing information and advice, by the encouragement of research, and in other ways indicated further on in our report.

(iv) *The movements of cattle in Great Britain.*

25. In view of their importance in spreading disease, we must call attention to the extensive movements of cattle which take place in Great Britain. Not only are cattle moved between neighbouring farms, one specialising in the production of milk, and another in the rearing of young stock; but analogous movements also take place between districts. Variations in the quality of land, in climate, in proximity to a market and in farming practice combine to make

this specialisation inevitable. Consequently the herds of milking cows established round the larger centres of population, or in districts organised to supply these with liquid milk, are largely, often entirely, dependent on heifers from Ireland, Cumberland and the more out of the way parts of the country for the replacement of wastage. In addition to these movements of milking cattle, movements of cattle for beef production take place on a much larger scale. The eastern and midland counties of England and Scotland draw large numbers of store cattle from the west and from Ireland.

(b) Methods of milk distribution.

26. Milk reaches the consumer through a variety of channels. The size of individual retail businesses varies from that of large combines, such as United Dairies, to that of the small business with a daily turnover of a few gallons. Milk may be sold loose or in bottles; it may or may not undergo a number of processes, such as filtering, cooling and heat treatment; it may be transported great distances before sale, or it may be consumed at the point of production. Without discussing this complex trade in detail, there are certain broad distinctions to be noted.

27. At one end of the scale of distribution there is the large concern, confined to large towns, for which milk has in any case to be brought from considerable distances. The trade has consequently developed economical methods of transporting milk, and, by means of various forms of treatment, of improving its keeping qualities. These have reduced the advantage which the milk-producing areas near large towns formerly possessed over more distant areas, and milk is now being brought into London, for example, from districts where it can be cheaply produced. Previously, this milk was used for the manufacture of milk products and the rearing of stock. The modern methods are to establish local collecting stations in which milk is cooled, cleaned and bulked, to transport bulked milk either by rail or road in glass-lined tanks, each holding 3,000 gallons, to the consuming centre, and to subject the milk at these centres to heat treatment. The milk so treated is either bottled and sold directly at retail, or resold in bulk at wholesale.

28. At the other end of the scale is found the producer-retailer, selling his milk directly to consumers in villages and in all but the largest towns and on the circumference of the latter. Though he sometimes produces on a substantial scale, he is none the less a comparatively small retailer. He often sells his milk unbottled in the immediate neighbourhood of his farm without submitting it to any process, except in some cases cooling. A feature of the trade of some of these distributors is that they establish a special reputation for their own milk, which they would lose if their milk was bulked. Between these two extremes there lie any number of inter-

mediate types of dairymen. Each is likely to predominate where circumstances render it economical, and each has its particular problems from the point of view of public health. The producer-retailer and the large distributor are in competition on the circumference of the largest towns and throughout towns of large but not the largest size. According to figures published by the Milk Marketing Board in England and Wales, the number of producer-retailers is approximately 50,000,* and that of producers selling by wholesale contract, approximately 78,000.

II.—CATTLE DISEASES AND THE DISEASES IN MAN ASSOCIATED WITH THEM.

(a) Cattle diseases.

(1) *Bovine tuberculosis.*

29. The incidence of bovine tuberculosis among cattle is probably as high in Great Britain as anywhere else in the world. A number of witnesses before us have expressed the view that 40 per cent. of the cattle in this country are infected with it in such degree that they will react to the tuberculin test. This estimate is based first upon the percentage infection found in herds tested with tuberculin for the first time, and, secondly, upon the results of the inspection of carcases of cows slaughtered. For example, the results of tests in 144 herds which had not previously been tested for tuberculosis were quoted in various memoranda submitted to us, and showed that of 5,199 cows, 2,233, or 43 per cent., gave a "positive" reaction. It was also recorded in a report drawn up by the People's League of Health that 39·5 per cent. of 55,318 cows slaughtered at various centres were found on post-mortem to be infected. In considering this latter percentage it must be remembered that many cows which are infected with tuberculosis do not reach the slaughterhouse, as they die upon the farm, or are sent to kennels or knackers. It may therefore be unduly low. In the light of such figures as these the generally accepted conclusion that at least 40 per cent. of cows in dairy herds are infected with tuberculosis does not appear exaggerated. This percentage of infection may be compared with a percentage of something over four in the United States, and of approximately twelve in Canada, before steps were taken against the disease. We have no evidence to show whether the disease is increasing or diminishing in Great Britain, but the widespread neglect of adequate precautions against its increase makes the latter improbable.

* Of these, a large number are situated near the towns with a population of over 100,000, in regard to which we make recommendations later in our report. Though no direct information as to their numbers is available, we give certain statistics on this point in appendix 5.

30. In some infected animals the progress of the disease is arrested before it assumes a generalised form. We have received evidence that of animals slaughtered at Edinburgh and found to be tuberculous, about 10 per cent. have to be condemned entirely, about 20 per cent. have to be condemned in part, and the remainder or 70 per cent. are so slightly infected that the whole carcase may be sold. This 70 per cent., in fact, consists of two groups. In the first are those in which the disease is of such recent origin that it has not had time to spread. The second is that in which the disease is not generalised, having been brought under control by the animal's natural powers of resistance. These cows are not free from the danger of a breakdown of their resistance against the disease in circumstances of exceptional strain.

31. Cattle, as has already been mentioned, may be shown to be infected with tuberculosis during life by their reaction to the introduction of tuberculin into their system. This test, however, generally fails to reveal infection incurred less than three or four weeks before the time of testing and sometimes infection incurred as much as three months previously. Unfortunately, reaction to the test does not show what is the stage of the infection, or whether the disease is progressive or quiescent.

32. Cattle become infected with tuberculosis either by inhaling or by ingesting infected material. The source of infection is normally another cow, though the disease may be contracted by contact with other infected animals, for example, with pigs. Indeed, to-day the disease may be contracted from a man suffering from bovine tuberculosis.* Unfortunately cattle, even at an early stage of the disease, excrete tubercle bacilli in great numbers. The principal sources of infected material are the lungs. Infected sputum, however, is swallowed, and in this way the fæces become infected. The udder may eventually become infected, and the cow will in that case yield infected milk. But only a small proportion of tuberculous cows give infected milk. Generally speaking, tuberculosis does not appear in the udder until the disease has reached an advanced stage. Thus infection may derive from matter passed through any of the principal channels of the body. The tubercle bacillus may, in favourable circumstances, remain alive for a considerable time after it has been excreted. The danger of infection through the use of premises is therefore very real, and there is also risk from the use of infected pastures. The incidence of tuberculosis is normally low in calves and heifers, but rises rapidly after the second year. Calves born from infected mothers are nearly always free from the disease and are likely to remain free if segregated at once and kept strictly isolated.

33. No cure for tuberculosis is known, and once a herd is heavily infected it is likely to remain in that condition unless special

* Namely, ulcerative, pulmonary, or renal tuberculosis of bovine origin.

efforts are made to eradicate the disease. There are, however, various methods of immunisation now under examination, which may in time provide a safeguard against infection. Of these, immunisation with Bacillus Calmette-Guérin has been the subject of experimentation for some years, and may soon approach the stage at which it will have practical usefulness. Immunisation, however, is not to-day an important outwork in the farmers' defences against tuberculosis. Nor can we hold out hope that it is likely to provide in any reasonable period of time more than a partial solution of the problem.

34. While the percentage of tuberculous animals in the total dairy stock may be put by common consent at about 40, the incidence in different herds, even within small areas, is known to range from complete freedom to 100 per cent. infection, and the variation in the degree of infection in individual herds is considerably greater than would be expected if tuberculous cows were distributed at random among the herds of the country. The eradication of bovine tuberculosis in cattle would lead to the disappearance of the greater part of tuberculosis in swine, and of practically all the tuberculosis of horses, goats and cats. For though infection of cows from these other animals is rare, infection of the latter from cattle is of the first importance.

(ii) *Contagious abortion.*

35. Little information is available regarding the degree to which cattle are infected with contagious abortion. The practice of testing herds for the presence of this disease is not as common as in the case of tuberculosis, nor, so far as we are aware, have any records been kept of the extent to which carcases of cows slaughtered are infected. We have seen, however, the results of two surveys* of the extent to which the disease in an active form has been found in a number of herds. These show that abortions occurred in more than 40 per cent. of the herds surveyed, and that nearly 9 per cent. of the cows in these herds aborted in the course of the year. It must be remembered that not all these abortions are necessarily due to infection with contagious abortion; and that many infected cows, though they are carriers of the disease, do not abort. The general view appears to be that cattle are infected with contagious abortion to about the same extent as with tuberculosis, namely, 40 per cent. This conclusion, however, is not grounded upon adequate statistical investigation.

36. Unlike tuberculosis, contagious abortion does not result in the death of the infected animal, nor does it unfit the carcase for human consumption. It is, however, responsible for very serious

* These were undertaken by the Agricultural Economics Research Institute, Oxford, in 1932, and by the Department of Agricultural Economics of the University of Reading in 1929.

loss to dairy farmers, both directly by causing the loss of calves and the loss of milk, whether due to lessened productivity or to interference with normal lactation periods, and indirectly by causing disease of the reproductive organs and consequent sterility.

37. The disease is contracted mainly by ingestion of infected material, but also by contact with such material, especially at points where the skin is broken. The sources of infection are matter discharged at the time of calving, vaginal discharges for about one month after calving, and milk. The calves of infected animals are infected at birth, and remain infected for some weeks, or, in some cases, months. A blood-agglutination test can show whether living animals are infected. The organism responsible for the disease is the bovine type of *Brucella abortus*.

38. Contagious abortion is a disease from which herds may achieve a comparatively high degree of immunity. There are, in consequence, two policies open to farmers in respect of it. They may in the first place carefully preserve their herds from infection. If they succeed, they avoid abortions in their herds, but they run the risk of a sudden and serious herd infection. Alternatively, farmers whose herds are already infected, and who have therefore incurred serious initial losses, may prefer to encourage the spread of infection in their herds and thus to avoid the risks of sudden and serious outbreaks, though this course insures chronic but lighter losses. In such herds it is preferable to secure such immunity as is possible by vaccination.

39. Vaccination has been practised in the case of this disease for many years. Experience has shown that vaccination with dead cultures is usually ineffective. If non-pregnant animals are vaccinated with a live culture of moderate virulence, the loss of calves is usually very much smaller than that among unvaccinated animals. Inoculation is most effective among animals that are free from infection. Some experimental work has suggested that pregnant animals may be immunised against any but the most severe infection by an attenuated live vaccine, but this method has not yet been shown to be effective under practical conditions, and is ineffective with animals which are not pregnant. The use of vaccination as a measure of defence does not release the herd owner from the necessity of taking reasonable hygienic precautions against infection, for massive infection may overcome the immunity acquired by vaccination.

40. Vaccination against abortion has been attacked upon several grounds, and it is perhaps less popular to-day than heretofore. The objections which have been raised on grounds of public health will concern us later, here it is sufficient to notice that vaccinated animals may, as a result, yield infected milk, and that the chances of this are increased if the vaccine used is of a virulent strain. Further, there is some evidence that vaccinated animals may be a source of

infection to unimmunised cattle, but vaccinated animals are far less infective than those that actually abort. On balance, vaccination reduces the chance that infection may be transmitted. Vaccination is useful if a policy of total eradication by segregation is impracticable. It can, moreover, be used in a herd until shortly before eradication is started, as the tendency to react to the blood-agglutination test, which is the means of separating infected from healthy animals, usually disappears in vaccinated cattle within a few months. On no account should animals be vaccinated with a live virus, unless the herd is already heavily infected.

(iii) *Johne's disease.*

41. There is no trustworthy evidence regarding the general incidence of Johne's disease. There is considerable variation in the degree to which different parts of the country suffer from it. In Scotland, for example, it is said to be rare. In some districts, the disease is more widespread than formerly, and is causing considerable anxiety.

42. The disease affects only the intestines and the associated lymphatic glands. It results in emaciation and, finally, in death. But it may be latent in an animal for a considerable time before symptoms appear clinically. Animals may contract the disease at an early age. The organisms responsible for the disease are excreted exclusively with the fæces, and it is assumed that infection takes place exclusively by ingestion. Drinking pools, unless fenced off, are a serious focus of infection, as the result of their pollution by cattle.

43. Diagnosis of the disease before it has reached the stage at which clinical symptoms appear is a matter of difficulty. None of the small laboratory animals are susceptible to Johne's disease; the presence of the responsible organism cannot be reliably distinguished by the complement fixation test; there is as yet no diagnostic agent on the injection of which an infected animal gives a certain and recognisable reaction. Considerable progress has, however, been made towards the production of such an agent, and tests have recently been carried out either with a tuberculin prepared from the avian strain of the tubercle bacillus, or with johnin, a substance prepared in the same manner as tuberculin from the specific organism responsible for the disease. Unfortunately this test has not proved thoroughly reliable in practice. Not only are reactions from time to time obtained from animals which prove on examination to be uninfected (a fault which is not incompatible with the successful use of the test for the elimination of the disease), but also some infected animals, which may or may not have reached the stage at which clinical symptoms are apparent, fail to give positive

reactions. Attempts have been made in the United States to eliminate this disease from a number of herds by means of tests, but the experience so far gained shows the need for further research in the field. No cure for Johne's disease is known.

(iv) *Mastitis.*

44. Unlike those of the diseases which we have hitherto discussed, mastitis is not a condition brought about by infection with a particular organism, but is the infection of a particular organ, namely, the udder, by several kinds of bacteria. Among these is to be found the tubercle bacillus. We do not, however, include tubercular mastitis in the discussion upon which we are at the moment engaged.

45. A large part of the milking herd of this country is probably affected with mastitis in some form or other. Research on mastitis has been carried out in recent years at the Research Institute in Animal Pathology of the Royal Veterinary College, London. Of the 1,613 cows constituting the 30 herds examined in the course of this research, 660 cows (or 40·9 per cent.) gave samples of milk showing definite infection of the udder, usually of a latent character. The majority of the herds were examined because the owner had complained of udder disease. But allowing for this, and taking account of the experience of other countries, it appears likely that 30 per cent. of the milking cattle of this country are infected with mastitis.

46. Apart from tuberculous mastitis, the disease may be caused by *streptococci* (a form which may be either chronic or acute), by *staphylococci*, or by a diphtheroid organism known as *Bact. pyogenes*.

47. The chronic form of streptococcal mastitis accounts for over 90 per cent. of the cases among milking cows. It results in the slow deterioration of the udder of the animal affected, and of the quantity and quality of the milk. The more acute form of streptococcal mastitis is less common, but as it attacks younger cows and results in an immediate reduction of the milk yield, it is the cause of severe loss. Chronic infection is generally held to be spread by means of the hands of milkers, or by the cups of milking machines. The method by which the more acute form is spread is less certain. Infection with *staphylococci* is associated with a gangrenous form of mastitis which usually ends fatally. Infection with *Bact. pyogenes* is responsible for so-called summer mastitis, a severe suppurative form which is prone to attack dry cows and virgin heifers in summer months. Infection is said to be spread by flies.

48. Outbreaks of acute infection are generally dealt with by segregation of the uninfected members of the herd and by the use of vaccines. The latter treatment is of uncertain efficacy. Many cases of mastitis cannot be diagnosed by clinical means, but are

revealed only by laboratory tests of the milk. Such tests are essential in the management of infected herds. For continued infection can only be prevented in such herds by milking the infected cows last. In fact, one infected herd has been cleared and kept clear from this disease by these means. For this purpose an ordinary clinical examination is useless.

(b) Diseases in man associated with cattle diseases.

49. Milk may be dangerous to public health either because it is infected when yielded by the cow, or because it is contaminated during milking or subsequently. The diseases of dairy cattle dangerous to man are tuberculosis, contagious abortion, and certain forms of mastitis, the associated human diseases being respectively tuberculosis (principally non-pulmonary), undulant fever, and occasionally, in the case of mastitis, certain epidemic diseases generally associated with streptococcal infection, such as septic sore throat. Milk originally pure may become infected either with the germs of tuberculosis from dust or dung finding its way into the milk at the time of milking, or with throat, intestinal, or exanthematous diseases derived either from the milker, or from anyone engaged in the subsequent handling of the milk. Finally, milk is often infected in the home itself, the serious milk-borne disease, infantile diarrhœa, being due to infection there; but this lies outside our terms of reference.

(i) *Tuberculosis.*

50. Bovine tuberculosis is responsible for over 2,500 deaths annually among the human population in Great Britain. This estimate is arrived at by the determination of the type of bacillus in a number of cases where infected material is available and applying the percentage of bovine infection indicated thereby for each class of tuberculosis to the total deaths from that class. Such a calculation is made in the following table (table 3):—

TABLE 3.

Deaths from tuberculosis in England and Wales, and estimate of deaths due to infection with the bovine type of tubercle bacillus, 1931.

Variety of tuberculosis.	Deaths at				Percentage bovine in cases examined.				Cases examined.				Estimated deaths from infection with bovine tubercle bacillus.			
	Aged 0–5 years.	Aged 5–15 years.	Aged 15 years & over.	Total.	Aged 0–5 years.	Aged 5–15 years.	Aged 15 years & over.	Total.	0–5 years.	5–15 years.	Aged 15 years & over.	Total.	Aged 0–5 years.	Aged 5–15 years.	Aged 15 years & over.	Total.
Respiratory system—																
North of England* ...	136	281	9,910	10,237	...	...	...	1·55	...	...	...	774	...	...	...	159
Rest of England and Wales	167	299	18,865	19,331	...	...	...	0·6	...	...	...	1,173	...	...	...	114
Central nervous system...	1,286	705	607	2,598	27·4	26·0	20·0	25·7	95	77	30	202	352	183	121	656
Intestines and peritoneum	294	170	630	1,094	...	20·6		82·0	...	136		39	...	119		897
Vertebral column ...	17	47	530	594	44			25·3	34			170	7			126
Other bones and joints ...	20	22	209	251	21·7	14·0		15·5	69	306		375	4	32		36
Skin and subcutaneous tissues	1	1	41	43	37·7	44·7	10·3	44·6	88	114	29	231	...	...	...	5
Lymphatic system (abdominal and bronchial glands excepted) ...	13	9	43	65	85·7	48·2	23·8	46·2	21	56	42	119	11	4	10	25
Genito-urinary system ...	1	13	272	286	...	33·3	15·0	17·4	...	3	20	23	...	4	41	50
Other organs	3	...	28	31	33·3	9·1	nil	8·7	3	11	9	23	1	...	...	1
Disseminated	327	197	774	1,298	...	...	...	...	...	...	...	...	...	...	...	78†
All forms... ...	2,265	1,744	31,809	35,818	...	...	...	...	...	...	...	...	...	...	...	2,147

* The north of England consists of Durham, Northumberland, Cumberland, Westmorland, Yorkshire, Cheshire and Lancashire.
† In the same proportion as the sum of other cases.

51. From the foregoing table it appears that in 1931 in England and Wales 6·0 per cent. of all deaths from tuberculosis arose from infection with the bovine bacillus, the percentage being 0·9 in the case of pulmonary, and 30·0 in the case of other forms of tuberculosis. If the cases notified are divided in the same proportion, nearly 450 cases of pulmonary, and over 4,800 cases of other forms of tuberculosis occurred in 1931 from bovine infection. In Scotland the percentage of bovine infections is higher in all forms of tuberculosis than in England and Wales. Applying these percentages in the same way as for England and Wales, we find that there were 129 deaths and 175 notifications of pulmonary, and 336 deaths and 825 notifications of other forms of bovine tuberculosis in Scotland in 1931. Thus the totals for Great Britain were in 1931, 2,612 deaths and about 6,250 notifications. We do not suggest that such calculations lead to very dependable results. They have obvious statistical imperfections. The number of cases investigated is small; they are probably not a random sample of all cases occurring; they occurred over a number of years, and percentages based upon them are not strictly applicable to the year 1931; there may not be a strict correspondence between the forms of tuberculosis falling under each heading in the deaths taken from the registrar-general's reports and in the published results of experiments. But making all allowance for the error so introduced, it is clear that bovine tuberculosis is responsible in Great Britain for a large number of deaths which is more likely to exceed than to fall short of 2,500 and for a still larger amount of serious illness.

52. Bovine tuberculosis in man is due in practically every case to alimentary infection. Even in the case histories of those suffering from pulmonary tuberculosis (*phthisis pulmonalis*) due to bovine tubercle bacilli there seldom appears to be any evidence of contact with other human cases of the disease which might account for infection, and post-mortem examinations of such cases usually indicate that the channel of infection has been through the digestive system. Recent observations, however, have suggested that persons who come much into contact with tuberculous cattle, such as milkers, cowmen, &c., may contract bovine tuberculosis through inhalation of infective dust from the hides of cattle or in the shippons or byres. Of milk products, cheese is not likely to harbour infection if kept in store for the time usual in commercial cheese manufacturing, as the chemical changes which take place have the effect of destroying the tubercle bacillus; dried milk is rendered safe by the heat used in the process of manufacture; but butter, cream and cream cheese and ice-cream, if made from raw milk, are capable of conveying infection. It is not possible to say to what extent these products are in fact responsible for the infection which takes place. Cases of alimentary tuberculosis due to bovine bacilli and the consumption of milk are at their highest in early childhood, and show a parallel diminution as age advances. Other foods besides milk may

be contaminated with bovine bacilli. We have already referred to the large quantity of meat condemned on that account. It is not to be expected that the precaution of inspection is infallible, and a certain amount of infected meat must reach the consumer. But as meat is generally well cooked, and as the tubercle bacillus is destroyed by exposure to comparatively low temperatures, this is unlikely to be a serious source of infection. It is to infection from milk, the food of childhood, that most of the bovine tuberculosis in human beings is attributable.

53. The extent to which milk as ordinarily sold is infected with tuberculosis is not easily determined. The infected milk of a single cow may be mixed with that from many whose milk is free from infection. The degree to which milk samples prove to contain tubercle bacilli will consequently depend in part on the percentage of cows giving infected milk, and in part on the extent to which milk is mixed before samples are taken. It has sometimes been estimated from the published results of veterinary inspections that between two and three cows in a thousand yield tuberculous milk. This estimate seems to us too low. The evidence that we have received indicates that at least five cows in a thousand yield tuberculous milk. As a result of the mixing of the milk of cows yielding infected milk with that of other cows, a much larger percentage of the samples of milk from individual herds prove to be tuberculous. English local authorities have reported a percentage of infection varying between 5 and 10, and showing an average of under 7. A careful investigation of farm milk coming into the four principal cities of Scotland showed an infection of 10 per cent. The percentage of infection in samples of the bulked milk from a number of farms is naturally very much higher. The extent to which milk, when retailed, is infected with tubercle bacilli depends not only on the original quality of the milk, but also on whether it has been heat treated. In London, for example, the London County Council found that 3·2 per cent. of 282 samples (of which, however, only one-fifth were from milk sold by the large distributors) were infected. In Scotland it has been estimated* that in the four principal cities 5·26 per cent. of the milk sold at retail is infected.

54. It is sometimes suggested that the mixing of tuberculous milk with tubercle-free milk is advantageous for two reasons. In the first place it is argued, the dilution of the tuberculous milk reduces to negligible proportions the risk of anyone contracting serious tuberculosis, and, in the second, the ingestion in childhood of a few bovine bacilli in milk raises resistance to later infections.

55. With regard to the first point, there is no doubt that a small dose of tubercle bacilli swallowed with food is less certain to

* In a report by the Department of Health for Scotland on tuberculous infection in milk published by the Medical Research Council.

infect than a large dose. This fact has been clearly established by experiments on animals. For example, the highly susceptible guinea-pig may escape infection altogether when the bacilli given in food are few in number. This is because the bacilli are not absorbed but pass out of the body with the fæces. But if a non-tuberculous animal or a human being daily consumes slightly infected milk some bacilli will sooner or later invade the tissues. The outcome of this first infection is determined more by the state of bodily resistance at the time than by the numbers of the invading bacilli. Human beings vary widely in their susceptibility to tuberculosis and are in general less resistant in childhood than in adult age, and probably at all times when suffering from another illness, notably measles. In a resistant individual a slight infection with bovine (or with human) tubercle bacilli has not generally any serious consequence; the lesion remains localised and eventually heals completely. The great frequency with which healed tuberculous lesions are found at autopsies on persons who have died from causes other than tuberculosis is evidence that many persons become infected and overcome the infection. On the other hand, in persons whose powers of resistance are naturally low, as generally in infants, or have been lowered by illness a few bacilli entering the tissues multiply and soon spread about the body, causing either acute general tuberculosis or the more chronic forms of the disease, such as bone and joint tuberculosis, kidney and even lung tuberculosis. There is abundant clinical and pathological evidence that much serious disease is caused in young children through the ingestion of small numbers of bovine tubercle bacilli. For example, the majority of cases of bone and joint tuberculosis due to these bacilli must have been caused by quite slight infections since they arose without any clinical evidence of previous tuberculosis of the digestive tract. The bulking of milk therefore, though doubtless making the milk less dangerous to those who are endowed with some degree of resistance, increases—by spreading and keeping up the risk—the probability that tuberculosis will be contracted by those who are naturally, or become temporarily, susceptible to infection with the tubercle bacillus.

56. The second argument that a few tubercle bacilli of bovine type in milk are permissible for their immunising value is based on a misconception that the bovine tubercle bacillus is less virulent for man than the human tubercle bacillus and produces generally a mild non-progressive disease. This belief, originating with Robert Koch, has been definitely disproved by observations in this country. The evidence which has been accumulated goes to show that the bovine bacillus is at least as virulent for man as the human bacillus. Although the bovine bacillus is limited practically to one channel of entry, the alimentary canal, which is a more uncertain route of infection than the respiratory tract, it is able to produce every variety of human tuberculosis and is a frequent cause of death. Numerous instances of phthisis (consumption) due to bovine bacilli in

adolescents and adults with a history of glandular tuberculosis in childhood completely disprove the hypothesis that a slight infection with bovine bacilli in early life preserves one from phthisis later. A person infected in childhood with bovine tubercle bacilli may in adult life develop phthisis due to these same bacilli and may possibly spread bovine tuberculosis to other human beings and to animals through the agency of the sputum. We cannot, in view of these facts, accept the suggestion that a few bovine bacilli may be permitted in milk on account of their immunising value; the evidence that subclinical infections afford permanent protection against tuberculosis is quite inadequate and, as already pointed out, the risk outweighs the hypothetical advantage.

57. There is thus ample evidence that a large number of cases of bovine tuberculosis occur in man, and that the milk supply is seriously infected with bovine tubercle bacilli. The relation between the degree of infection of milk and the incidence of disease in man is complicated and is discussed in a subsequent part of our report (paragraph 133). Here we confine ourselves to the remark that serious cases of disease are few in comparison with the opportunities of infection. We also postpone the discussion of the means by which the degree of infection in milk may be limited.

(ii) *Undulant fever.*

58. Undulant fever is closely allied to Malta fever, an infection derived from the consumption of the milk or the flesh of goats, due to *Brucella melitensis*. It is, however, due not to that organism but to *Brucella abortus* of bovine origin or to *Brucella abortus suis*. It is contracted from the consumption either of cow's milk or of the flesh of swine, or possibly from contact with infected animals. In Great Britain contagious abortion of swine is comparatively rare, and it is believed that milk is the principal source of human infection.

59. The extent to which milk is infected is not definitely known, but it is established that cows infected with contagious abortion pass infected milk in a large proportion of cases, though perhaps intermittently. Such tests of mixed milk as have been taken indicate that herd samples are more frequently infected with *Brucella abortus* than with the bovine tubercle bacillus. In spite of this, undulant fever in man is very rare. The numbers of cases recorded in England and Wales in recent years have been as follows:—

1928	5
1929	17
1930	28
1931	40
1932	57

It is possible that the disease often passes unrecognised, for a considerably heavier incidence is reported in other countries,

Germany for instance. But with an incidence as high as in Germany, the disease would still be unimportant. The real protection of the public is their own immunity. In these circumstances though it is important that farmers should not relax their efforts to reduce the extent to which their herds are infected with abortion, it is doubtful whether any measures that are practicable would appreciably reduce the present incidence of undulant fever in man; and still more, whether, from the point of view of public health, the effort used in such an attempt could not more profitably be expended in other directions.

(iii) *Milk-borne epidemics.*

60. The Ministry of Health has supplied us with a list (given in appendix 6) of the milk-borne epidemics which have been reported in the United Kingdom since the beginning of this century. It cannot be regarded as exhaustive, for many epidemics, though recognised as being due to contaminated milk, are not reported, and many slight outbreaks of common diseases, due to milk, are not recognised as such. It will be observed that there have been approximately 100 outbreaks recorded since 1903, ranging in importance from the outbreak in Hove in 1929, in the course of which 1,000 families were infected and 65 deaths occurred, to inconsiderable outbreaks responsible for as few as three cases. A great variety of diseases is recorded as being conveyed by milk, the most common being scarlet fever, enteric fever, diphtheria, paratyphoid and septic sore throat. In some cases infection has originated from an infected cow; but more frequently infection has been traced to a human source. In the latter case it appears that the milker is responsible for the majority of outbreaks, though there are several instances of infection occurring at a later stage, *e.g.*, when milk is heat-treated. Indeed, the most serious outbreak of milk-borne disease brought to our notice, which resulted in the death of over 500 persons from typhoid in Montreal in 1927, was traced to a typhoid carrier working in a pasteurising plant.

61. The available evidence is not conclusive regarding the importance of milk in the spread of infectious diseases. In spite of occasional serious outbreaks, those reported are neither so numerous nor so severe as to contribute much to the total incidence of the diseases in question. For example, the 28 outbreaks of scarlet fever due to milk in the last twenty years were responsible for between 2,500 and 3,000 cases of infection. But the total number of cases notified has fluctuated between 80,000 and 120,000 annually in England and Wales, and has averaged 17,500 in Scotland. On the other hand, some witnesses expressed the view that unrecorded cases of infection through the milk supply were of considerable importance. It is only where a large number of cases of infection occur that the milk supply is likely to be suspected. Consequently, we cannot rule

out altogether the possibility that infection through milk is more extensive than appears at first sight. In support of this possibility we may quote the results of inquiry undertaken by the United States public health service. It was found that among 1,875 children who were reared exclusively on heat-treated milk (which is unlikely to convey these infections) the following incidence of certain infectious diseases per thousand children was reported: diphtheria 17·1, scarlet fever 23·0, various intestinal disturbances 227·0. The incidence of the same diseases among 1,762 children reared principally on raw milk was, diphtheria 22·7, scarlet fever 41·4, various intestinal disturbances 278·0.

62. One peculiarity of these milk-borne infections is of great importance in large cities. The organisms responsible for them multiply rapidly in milk, and the bulking of milk consequently adds enormously to the chances of infection. Fortunately, however, most of the bulked milk brought into the large cities undergoes heat treatment—a process which, *if properly performed*, destroys the organisms in question.

(c) Milk in human diet.

63. It is generally recognised that milk is the most satisfactory individual food material elaborated by nature, just as it is beyond all question the nutriment *par excellence* for infancy. It is essential in babyhood, but with advancing years and the increasing variety of food materials available, although it always remains a most valuable addition to the diet, it can no longer be considered an essential constituent.

64. Milk holds a unique position amongst the foods of animal origin as it contains the three proximate principles of a diet, protein, fat and carbohydrate, in addition to an adequate supply of inorganic constituents in such proportions as to be peculiarly adapted for the period of active growth. Its value as a foodstuff is of course enhanced by the presence in it of the fat soluble vitamins A and D, and the water soluble vitamins B and C. Of these vitamins, the only one which is, so far as is known, materially influenced by heat treatment is C, or the anti-scorbutic vitamin. The only drawback milk would appear to possess to the claim of being the perfect food for infants, is that it is somewhat deficient in substances necessary for the formation of blood.

65. As regards the individual components which render milk such a unique source of material both for growth and energy it is not necessary here to discuss them in detail. The proteins present, but not in equal proportions, in cow's and human milk are of two kinds. The most characteristic protein of both milks is caseinogen, a so-called conjugated protein of peculiar type, which contains phosphorus in its molecule and, more predominant in human milk,

members of the group of simple proteins, which experiment shows are invaluable for growth. After the clotting of milk—the coagulation of the caseinogen—these valuable simple proteins are found in the whey. Both caseinogen and the lactalbumen and lactglobulin rank high as food proteins of first-class biological value.

66. The fat, which is of importance both as an actual source of energy and of building material, is also the vehicle for vitamins A and D. The fat is present in the form of an extraordinarily fine emulsion, which probably makes it very susceptible to the attack of fat-splitting enzymes. Probably, too, the high content of unsaturated fatty acids makes it of particular value to the organism. As regards the content of vitamins, it has been shown that it is variable, being at its maximum in summer when the cows are at pasture.

67. The carbohydrate exists in the form of lactose, a sugar which is not very susceptible to the attack of yeasts. Possibly one of its main assets is the fact that, unlike dextrose and cane sugar, it is comparatively free from sweetness, so that in this way milk does not become nauseating or even distasteful. Although lactose is not readily fermentable by yeasts, it is very open to attack by certain micro-organisms, such as occur, for example, in the souring of milk.

68. The salt content of human milk is about three times less than that of cows' milk. The content of lime in the ash of milk is about the same in both milks, whereas cows' milk is richer in phosphorus. These various salts of milk yield a basic ash which, on consumption, may play an important rôle in the maintenance of the acid base balance in the tissue fluids.

69. When one speaks of milk as a food in general terms it is commonly assumed that the reference is to cows' milk. It must not, however, be overlooked that, good as a food though cows' milk may be, it is not the ideal nutriment for the human infant. It must be emphasised that the milk secreted by the female of any species is peculiarly fitted for the maintenance, and perhaps even more particularly the rate of growth, of the young of the same species. This special and unique correlation of the quality of the many different milks with the physiological factor of growth is most clearly brought out, emphasising at the same time the really fundamental importance of milk as a food, in the following table :—

TABLE 4.

Composition of milk of various animals.

Animal.	Period in days required to double birth weight.	100 parts of milk contain.			
		Protein.	Salts.	Calcium.	Phosphoric acid.
Human	180	1·6	0·2	0·03	0·05
Horse	60	2·0	0·4	0·12	0·13
Cow	47	3·5	0·7	0·16	0·20
Goat	22	3·7	0·8	0·20	0·28
Sheep	15	4·9	0·8	0·25	0·29
Pig	14	5·2	0·8	0·25	0·31
Cat	9·5	7·0	1·0	...	...
Dog	9	7·4	1·3	0·45	0·51
Rabbit	6	10·4	2·5	0·89	1·00

70. This table renders it very evident that there is a marvellous adaptation of the lacteal secretion to the needs of the developing organism, and, secondly, that the ideal food for the human infant is human milk, and, indeed, probably the milk of its own mother.

71. Although it is clear that the mother's milk is unquestionably the best for the infant, cows' milk in one form or another is the most commonly employed substitute when for any reason the mother's supply is deficient or absent. Provided it is pure, it is or can be rendered a good substitute.

(d) The effect of pasteurisation on the constituents of milk.

72. In what follows, the term pasteurisation applies almost exclusively to treatment by the holding process in which the milk is heated to a temperature of 145°–150° F. for half an hour. In appraising evidence concerning the nutritional value of milk so pasteurised, it is necessary to remember that any faults which may be attributed to it are exaggerated when the processing is carelessly conducted. Observations made without due inquiry as to details in the treatment actually received by the milk employed may therefore tend to obscure the issue.

73. Of the chief organic constituents of milk, the fat and sugar suffer no appreciable change during the treatment, and though the fate of the proteins calls for some discussion, there is adequate evidence to show that their essential physiological value is unaffected. It may be said, indeed, without hesitation that there is no evidence to show that the process has any effect upon the value of milk as a source of energy to the body or as a supply of formative material for the living tissues in general. On the other hand, there is evidence for the occurrence of certain significant changes of

equilibrium among those mineral constituents which are necessary for the normal growth of bone, and it is sure that certain vitamins, present in characteristically small amounts, but serving functions essential to normal nutrition, are destroyed to an extent which varies from case to case and depends to no small degree on the precise conditions of treatment. The practical significance of alterations such as these calls for discussion.

74. A few words, however, may be first devoted to the question of the proteins. Some 5 per cent. of the lactalbumin may be coagulated during the holding process, but this represents a very small proportion of the total protein present, and is in any case not necessarily lost from the milk as consumed. While the essential nutritional value of the proteins, when digested, is unimpaired, the question whether they remain equally digestible after pasteurisation has been much debated and has led to many experimental inquiries. Experiments *in vitro* have suggested that the proteins of raw milk are somewhat more open to the influence of the digestive ferments than they are after pasteurisation, but the results described have varied with the conditions of experiment, and in no case have the conditions been such as occur *in vivo*. Normal digestion of the proteins does not begin while they are in the colloid form displayed in milk. When the fluid, raw or pasteurised, enters the stomach the casein is coagulated and rendered insoluble, and on this solid form the digestive ferments act with special readiness. In the adult, such coagulation is due to the acidity of the gastric juice, in the infant, to the action of the ferment rennin. The case of the infant is the more important, and the effect of pasteurisation on coagulation by rennin has been frequently investigated (Lane-Claypon, 1916). Laboratory experiments have shown that it may be somewhat slowed, but the circumstance is of little significance. The stages of the normal gastric digestion of milk proteins are not easy to reproduce outside the body. For a final decision as to whether pasteurisation has any significant effect on their digestibility, reliance must be placed rather on experiments made with living animals, or, better, with infants. In such experiments the percentage nitrogen loss through the bowel, due to incomplete digestion, is compared when milk, raw or pasteurised respectively, is fed. A survey of the data published during a number of years leaves the complete conviction that any effect of pasteurisation on the digestibility of the milk proteins may be dismissed as wholly unimportant for practical issues.

75. The same cannot be said of the effect on the availability of those important mineral constituents, calcium and phosphorus, on which the growth of the skeleton makes a continuous call. It has long been known that when milk is heated a proportion of the lime and phosphoric acid it contains are precipitated together in an insoluble form. Once again, however, direct experiment must decide whether this change is such as to affect appreciably the nutritional value of the milk, or, incidentally, whether any other

associated happening in the milk diminishes the availability of these elements. Not a few studies directed to this end have been made, alike on animals and on young human subjects. The results of some of these are unconvincing owing to inadequate planning of the experiments or for other reasons, but others deserve attention and indicate that the availability of lime and phosphate is less in pasteurised than in raw milk. Quite the best series of observations bearing on this matter involved a comparison not with raw but with boiled milk (Daniels & Stearns, 1924; and Daniels, Stearns, & Hutton, 1929). It is known, however, and the fact will receive later comment, that when milk is briefly boiled and immediately cooled the changes involved are relatively slight. At any rate in observations of the kind the use of boiled rather than raw milk as a control, if of any significance, must favour the pasteurised milk in the comparison. In the carefully controlled experiments under reference, made by investigators experienced in the technique of infant feeding, comparable groups of young children, placed in precisely similar circumstances, were given equal rations of milk, respectively boiled or pasteurised by the holding process. During the experimental period it was found that the children on boiled milk showed a daily gain of lime to their bodies thrice as great as that shown by those on pasteurised milk, and a notably greater gain of phosphorus. This experiment involved a comparison that was rigorous and, it would seem, conclusive in favour of the boiled milk. It is not without confirmation from other evidence to be found in the literature of the subject (Catel, 1933; Kramer, Latzke, & Shaw, 1928; and Willard & Blunt, 1927).

76. Another circumstance calls, however, for reference here. The retention of calcium and phosphorus in the body, and their proper utilisation in bone formation, are now universally recognised to be controlled by the functioning of vitamin D (*infra*). As part of the above investigation other comparable groups of children were therefore given the same milk ration, boiled or pasteurised, but with the addition of cod-liver oil to increase in each case the supply of the vitamin. These latter groups showed a much greater retention of the elements in question, and only in these, even in the case of the boiled milk, did it reach the amount commonly assumed to be adequate for the proper growth of infants. Before pressing this last point further it will be convenient to make a brief general reference to the function of vitamins and the effect of pasteurisation upon them. (For an account of the literature of vitamins to 1932, see the report included in appendix 7 as "Anonymous, 1932".)

77. Germane to the whole question is the circumstance that the vitamin supply, whether provided by breast milk or raw cows' milk, is never in excess of the needs of the infant. In the case of the milk normally provided for the young of any species of animal, it can be understood that the amount of each vitamin is part of a general balance among the constituents of the milk as adjusted to the

specific needs of the suckling (see previous section). If the nutrition of the mother is normal and adequate (though not necessarily otherwise) the vitamins, like other factors, are supplied in proper ratios; each is adequate in amount but not in excess. When milk of another species is consumed in which the whole balance of the constituents is different, as when cows' milk is substituted for human milk, the adequacy of the vitamin supply must be determined by wide experience or by *ad hoc* investigations. The former would seem to have proved that raw cows' milk, when at its best, can cover the essential needs of the human infant.

78. Since it has already received reference, vitamin D may be first discussed. In its absence from the diet, or with a deficiency in its supply sufficiently great, the formation of bone fails to proceed normally, and the infant or young child may display symptoms of rickets. The constitution of this vitamin is approximately known, and it can be produced artificially in a pure form from the substance ergosterol, which in small amounts is somewhat widely distributed in living tissues. Quite inactive itself, this substance is converted into the vitamin when irradiated by ultra-violet light or on exposure to the rays of the sun. This explains the circumstances so abundantly proved that, given an adequate supply of lime and phosphorus in the food, rickets can be prevented or cured either by an adequate supply of vitamin D or, alternatively, by sufficient exposure to sunlight. It has been said that a geographical map showing the distribution of rickets is practically equivalent to a map of regions deficient in sunshine. The efficacy of the rays is due to the circumstance that they produce in the body the active vitamin from its inactive precursor. The climate of this country is such, however, that the aid of the vitamin itself is essential; especially during the winter months when, unfortunately, the supply in cows' milk is at its lowest. It may be said incidentally that it is possible to increase it by irradiating the milk itself, though practical applications of this fact would certainly be difficult.

79. It is important to remember that this vitamin is associated with the fat of the milk. When pure it is resistant to heat treatment, but experiments on animals have suggested that some degree at least of destruction occurs in milk when it is heated. It must not be forgotten, however, that fresh untreated milk is itself liable to be deficient in this vitamin. The highly beneficial influence of cod-liver oil, a rich source of vitamin D, on the assimilation of calcium and phosphorus shown in the experiments on infants previously discussed, suggests that the milk used for those experiments, even when fresh, was unduly deficient in the vitamin. This does not lessen the significance of the results obtained from the direct comparison of the pasteurised with the boiled milk, but it somewhat lessens the practical significance of the experiment as a whole.

80. While, except in a few districts, pronounced rickets has become relatively rare in this country, a minor degree of the

condition, easily detectable by X-rays, is common among milk-fed infants following on the winter lack of sun. While much more common in bottle-fed children it is frequent even in the breast fed. This circumstance makes it more difficult to decide upon the extent to which pasteurisation by itself increases the liability to rickets among infants fed on cows' milk, and no adequate experimental comparison (which would need to be prolonged) with this special end in view has yet been attempted.

81. In central Europe, towards the end of the war and for some time after it, the milk available, because of difficulties in transport, was apt to be subjected to repeated heating, and severe rickets was rife among children. General malnutrition was of course also prevalent and obscured the issue, but observations made in Vienna in 1921 demonstrated conclusively that a supply of vitamin D cured all the symptoms attributable to rickets (Chick and others, 1923). It is fair to say that, while the unfavourable effect of pasteurisation upon the utilisation of the calcium and phosphates must not be ignored, there is to-day no direct evidence to show, if natural deficiencies in the original milk are first excluded, that it is responsible for the incidence of rickets in a form to be recognised clinically.

82. Reliable evidence has made it sure that a deficiency of vitamin D in the diet of children is a factor of importance in the causation of dental defects (Mellanby, 1934), and other evidence has shown that an adequate addition of raw milk to the food may be a successful prophylactic in this connection (Sprawson, 1932). Once again, however, a conclusive proof that pasteurised milk is less efficient in this respect is yet lacking.

83. In the case of vitamin C the essential facts are clear. When it is absent from the food, or when the supply is greatly deficient, scurvy inevitably follows, alike in children and adults. The long and distressing history of that disease in the past provides ample proof of this, and there are districts in Europe to-day in which it is still being demonstrated. It is equally sure that an adequate supply of the vitamin prevents the disease, and when this is established vitamin therapy works a dramatic cure. Vitamin C has now been isolated in a pure state, and its chemical constitution is probably established. It is heat sensitive, and in milk is undoubtedly destroyed to a greater or less degree during the process of pasteurisation. Oxidation plays, however, a notable part in this destruction, which is therefore less when the milk is heated out of contact with air. As bearing with some significance upon what is desirable in the construction of pasteurisation plants, it is easy to show that the oxidation is accelerated by the catalytic action of traces of metals. The following observations were made for the purpose of the present discussion. Samples from a fresh milk supply were heated for half an hour in pyrex glass vessels at 145° F.: (*a*) in open bottles, and (*b*) sealed from contact with the air. In (*a*) the milk without additions lost 33 per cent. of its content of vitamin C;

when an iron salt was present in amount equal to 9 milligrams (one-seventh of a grain) of the metal per gallon, the loss was 39 per cent.; in the presence of copper at an equal concentration the loss was 79 per cent. In (*b*) the milk by itself lost 20 per cent.; with the above concentration of iron, 29 per cent., and with copper, 80 per cent. The copper is much the more active catalyst, and during the times of exposure to heat induces large destruction even when the available oxygen is only that which is dissolved in the milk itself. Aluminium and nickel are apparently without any such action (Schwartze, Murphy, & Cox, 1931).

84. It should not be forgotten that fresh untreated cows' milk in the amounts normally consumed contains a supply of this vitamin no more than barely adequate for the needs of the infant, and from cows not on pasture it may at times be inadequate. The further reduction due to heating, if uncorrected, may therefore be serious. Fortunately a correction for any deficiency is easily made by the administration of the juice of citrus fruits, oranges or lemons, now so easily obtainable throughout the year, or even of the juice expressed from scraped swedes and (less potent) from raw potatoes. In any of these the concentration of the vitamin is out of all proportion greater than in fresh milk. Few will deny to-day that such additions to the food of infants are desirable, whether they are consuming pasteurised or raw milk.

85. The remaining known vitamins require less attention in this discussion. Some have functions remote from those affecting infant nutrition.

86. A supply of vitamin A is necessary for the promotion of growth and the maintenance of health. Cows' milk, however, contains it in relatively large amount, and though it is destroyed when heated in the presence of oxygen, there is no evidence that pasteurisation has anywhere been directly responsible for such nutritional disorders as are known to follow upon lack of this vitamin.

87. Several vitamins with distinct functions are comprised in what has become known as the "B complex." Of these, only two, B_1 and B_2, call for reference here. B_1, which is concerned in maintaining normal conditions in the nervous tissues is present in relatively small amounts in milk, and it is not resistant to heat. Nevertheless, though symptoms attributed to B_1 deficiency in the milk supply have occasionally been observed in infants and proved to be curable by giving yeast preparations as a source of the vitamin, no evidence has come to light showing that pasteurisation has by itself been responsible for such conditions. B_2, of which a deficiency leads to the disease pellagra, is relatively abundant in cows' milk and is resistant to heat at higher temperatures than those involved in pasteurisation. It may be said with some assurance that in connection with nutrition of children, the only vitamins of which a deficiency in milk is serious are those known as C and D.

88. This brief review of available knowledge indicates that the only effects of pasteurisation of milk which call for serious consideration are, diminished availability in its lime and phosphorus, and a lessened anti-scorbutic power. The practical importance of these defects calls for some closer appraisement.

89. It is perhaps only in relation with infant feeding that they can possess significance. Older children seldom depend on milk alone for their supply of the vitamins C and D, and the benefit of a milk ration when added to the average diets consumed say by children in institutions, while unmistakable and even unexpectedly great, would seem to be exerted by pasteurised no less than by raw milk (Mann, 1926). The acid test for any significant nutritional faults in pasteurised milk must be sought in its effects upon infants when it is fed to them without additions.

90. With regard to the effect of the treatment on the minerals of the milk, if it results in nutritional errors, an increase in the liability of infants to rickets would be the most likely indication of these. As already remarked, while minor degrees of rickets are common among infants to-day, cases of the acute or florid disease, leading to chronic conditions and to permanent bone deformities, are in most districts much less common now than they were a generation ago. This is doubtless due to a general improvement in the methods of feeding infants, together with the custom—essentially modern—of taking them freely into the open air, and thus incidentally exposing them more frequently to sunlight. There is no clear evidence that the disease shows less signs of abatement in districts where the greater part of the milk supply is pasteurised than in others where it is not.

91. With regard to scurvy, although there is such abundant evidence to show that the disease inevitably follows when adolescents and adults are deprived of vitamin C for periods sufficiently long, and that cases were frequent among infants in post-war Europe, yet nowhere in this country to-day is overt infantile scurvy other than a rare disease.

92. It was, however, apt till lately to appear in institutions, and probably it is only the typical clinical picture of the established disease that is so rarely seen. It is at any rate noteworthy that well attested observations have shown that minor and less easily recognisable symptoms of scurvy may on occasions arise when pasteurised milk is fed alone. At a large clinic in New York, for instance, infants when fed on it were customarily given a ration of fruit juice and were free from scurvy. When an American investigation committee had reported that the nutritional value of pasteurised milk was apparently equal to that of raw milk, the fruit juice was for a time given up. As a result a large proportion of the children came to display untoward symptoms which, though not those of

typical acute scurvy, were proved to be scorbutic by the fact that they cleared up immediately when the fruit juice ration was restored. It may be claimed, moreover, that what has been called latent scurvy in infants is not very uncommon, and up to a few years ago, before research had focussed attention on the importance of qualitative defects in food, its nature was seldom recognised. It is a condition in which a group of somewhat obscure symptoms disappear at once when an anti-scorbutic is given. Such cases mostly occur in large towns (Hess, 1920). Reference to this clinical experience introduces a consideration which should not be ignored. It is logical to suppose that a food deficiency which, when complete or extreme, results in a recognisable " disease " may, when less complete, be responsible for minor but significant degrees of ill-health. This possibility can only be ruled out when the minimal needs for the variable factors are quantitatively known, and known to be adequately supplied. It is sure that obscure or sub-acute symptoms really due to nutritional errors are still not infrequently attributed to other causes than the right one. Yet such minor degrees of malnutrition maintained throughout infancy may leave a permanent impress upon later development. Such in milk-fed babies may, of course, be due to reasons which have nothing to do with the pasteurisation of the milk supply.

93. If it must be admitted that certain nutritional faults may fairly be ascribed to properly pasteurised milk, it is as unjustifiable to exaggerate their practical importance as it would be erroneous to ignore their existence. Any defects in nutrition which may follow upon its use would, with present knowledge, seem to be minor in degree, limited in kind, and when recognised, very easy to correct. More significant still is the fact that by simple addenda to the dietary they can be prevented.

94. An unprejudiced survey of the evidence available to-day will leave on most minds a conviction that any recognisable changes of quality induced in milk by pasteurisation rightly conducted are as a whole too small to outweigh the great advantage inherent in the protection from infection which the treatment secures and in the public confidence which it inspires. It is sometimes suggested that there may be subtle changes not revealed in the state of present knowledge. Policy cannot justifiably be influenced by vague possibilities which established evidence makes improbable. Nevertheless, that the functions of vitamins C and D are indispensable has been abundantly demonstrated. It is sure that nutrition is no longer normal when the supply of these is below a safe minimum which, for the human infant, is not yet accurately defined. It is highly desirable, therefore, that the bottle-fed child should be protected from possible deficiencies in these health factors, but from what has been said earlier in this discussion it will be admitted that such protection is almost as necessary in the case of raw milk, with its variable vitamin content, as in that of pasteurised.

95. The custom of supplying fruit juice to milk-fed children would seem now to have become common, though not universal (see paragraphs 99 to 101 below). While this practice is desirable, whatever the milk supply, any policy leading to an increase in the pasteurisation of supplies should perhaps call for increased educational efforts on the part of all concerned with the health of infants to make it general. During the winter it is almost equally desirable that cod liver oil should be administered in small amounts to infants reared on cows' milk.

96. A few words will suffice for reference to the effect of other forms of heat treatment. Animal feeding experiments, as well as certain laboratory results, have shown that milk brought quickly to the boiling point in a covered vessel and immediately cooled undergoes but slight changes (Schwartze, Murphy, & Hann, 1929–30; Munsell & Kifer, 1929; and Barnes & Hume, 1919), and this would seem to be confirmed by the results of its use in infant feeding. On the other hand, there is much evidence to show that the temperature used in pasteurisation (145°) if maintained must not be exceeded. Changes become rapid at temperatures only a few degrees higher. Sterilisation, that is to say prolonged treatment by heat above the boiling point or at temperatures near to it for the complete destruction of bacteria, produces, as might be expected, changes similar in kind but more extensive than those due to pasteurisation. No adequate comparison between the relative nutritional value of sterilised and pasteurised milk has been made in actual practice, but the former is now unlikely to be much used in infant feeding.

97. There is evidence to show that milk, when repeatedly subjected to heat treatment of any kind, undergoes progressive deterioration as a food.

98. The bibliographical references to the papers referred to in this sub-section will be found in appendix 7. A full and critical account of the properties of milk in relation to pasteurisation with references to the relevant literature has recently been published by Stirling and Blackwood (1933).

(e) The extent to which a supplementary diet is fed to children whose main diet is milk.

99. It is of importance to the issues raised in this discussion to discover if possible how far the use of anti-scorbutics in infant feeding has become general. The following information is due to the kind offices of Dr. Frank Robinson, medical officer of health for the county of Cambridge, and through him to kindness of the medical officers of three other counties, Gloucestershire (Dr. Middleton Martin), Wiltshire (Dr. C. E. Tangye), and Durham (Dr. C. Franks).

100. In these four representative counties a *questionnaire* was distributed to health visitors and district nurses, asking with regard to the homes visited by them: (*a*) whether the cows' milk fed to

infants is boiled before use, and (*b*) whether orange juice or other anti-scorbutic is administered.

101. For Cambridgeshire answers were supplied with regard to the practices in some seventy rural parishes, being about half those in the county. To the first question, except in four cases, the answers were all in the affirmative; those to the second made it clear that in the parishes concerned fruit juice (and usually orange juice) is almost universally given to the bottle-fed infant. In Gloucestershire answers were supplied from one hundred and five separate districts. In all but four of these the milk is said to be always boiled before use, and in all but two, the addition of orange juice or more rarely tomato or swede juice is practically universal. In Wiltshire replies, twenty-three in all, were obtained from the staff of health visitors and from twelve representative district nurses. They were from several smaller country towns as well as from numerous villages. Again the answers to both questions were almost all in the affirmative. From one district alone came the statement that as the local supply is reliable the milk was not boiled. In all it was stated that the use of orange juice was general. From the county of Durham the information is less detailed. The schedules were not submitted, but the evidence is summarised by the medical officer. It would seem that very few infants are given free milk, the majority of those artificially fed received dried milk, another and next largest number, condensed milk; when, however, liquid milk is given it is invariably heated. With regard to an anti-scorbutic addendum, it would appear that while a fair proportion of infants do receive a daily ration of fruit juice, its administration is less common than in the other counties investigated.

III.—ADMINISTRATIVE MEASURES IN FORCE.

102. The methods used to eradicate sporadic outbreaks of rapidly developing diseases among cattle include immediate notification, the temporary isolation of the infected district, the prohibition of the movement of animals within it, and the slaughter of animals infected or known to have been in contact with the disease. These methods are not applicable to the diseases with which we are concerned, which are endemic, have long periods of incubation, and are difficult to diagnose.

103. More effective measures against such widespread latent infections are possible in the case of those diseases the presence of which may be established by a simple and reliable test, such as the tuberculin test for bovine tuberculosis, the blood-agglutination test for contagious abortion, and the recently developed method of testing the milk of cows suffering from mastitis. It is possible, by segregating those animals which react to the test and by gradually recruiting the uninfected section with uninfected young stock (for the young stock are generally comparatively free from diseases of

this class), to build up herds which are entirely free from disease. Such a policy, though it may be followed by an individual farmer, generally requires some form of official supervision.

104. Finally, the state may improve the general standard of hygienic care among farmers. There are, however, limitations to such a policy, for the state must, in the main, rely upon advice and persuasion. Considerable advances have already been secured by such means.

105. Various measures may be adopted to provide the consumer with a safer milk supply. Where the danger to public health arises from a disease of the cow the public may be protected by three means of varying efficiency. First, disease may be eliminated from the cows. This is only possible if the presence of disease can be determined at an early stage by a test. Fortunately the presence of bovine tuberculosis, which is the disease most dangerous to public health, may be so determined. Secondly, the milk supply may be protected to some extent by the removal from milking herds of cows found to be giving infected milk. These may be discovered by bacteriological or microscopical examination of the milk, and by the examination of the cow itself for clinical symptoms, associated with the giving of infected milk. These are well known to experienced veterinary surgeons. Thirdly, it is possible to render infected milk safe for human consumption by certain forms of heat treatment which destroy the organisms responsible for causing disease in man. These forms of treatment affect the constitution of milk in varying degrees. A satisfactory form must not only be an effective safeguard against infection, but also must not affect adversely the nutritive properties of milk, nor must it, if possible, affect the commercial properties which influence the sale of milk, such as taste, colour and the power of forming a "cream line." It is contended that the process of pasteurisation, as at present defined by the Ministry of Health, fulfils these requirements.

106. Protection against diseases which may be introduced into the milk from human sources is afforded by scrupulous cleanliness in the handling of milk, and by the prohibition of persons suffering from diseases communicable by milk, or who are carriers of such diseases, from being concerned in the handling of milk at any stage. It is, however, impossible to insist on precautions which will eliminate all danger from this direction. Additional protection may be obtained by a satisfactory form of heat treatment. The later the stage at which this is applied, the greater is the protection to the consumer.

(a) Existing legislation in regard to diseases of animals.

107. Under the diseases of animals act, 1894, the Ministry of Agriculture and Fisheries has not only special powers of control of the rapidly developing diseases referred to in paragraph 102 above,

but also general powers to issue orders to control other diseases. There has been some exercise of these powers in the case of bovine tuberculosis and contagious abortion, but not in that of mastitis or Johne's disease.

(i) *The tuberculosis order of* 1925.

108. The tuberculosis order of 1925, which extends to the whole of Great Britain, refers to any animal to which one of the following descriptions applies :—

(i) any cow which is, or appears to be, suffering from tuberculosis of the udder or other chronic disease of the udder; or
(ii) any bovine animal which is, or appears to be, suffering from tuberculous emaciation; or
(iii) any bovine animal which is suffering from a chronic cough, and showing definite clinical signs of tuberculosis.

109. The owner of any such animal must notify the local authority, isolate the animal upon his own premises, and boil its milk. Any veterinary surgeon in private practice discovering such an animal must also notify the local authority.

110. Any local authority which receives such a notification, or which has reason to suspect that such an animal or an animal giving tuberculous milk is kept upon any premises belonging to any person licensed to sell milk, must direct a veterinary inspector to examine the suspected animal, and any suspicious animal belonging to the same herd. If his report confirms the notification or suspicion, the animal must be slaughtered. It then becomes the property of the authority, which must pay compensation to the owner. Compensation is calculated with reference to the animal's market value (as defined in the order, an extract from which is given below*). It exceeds this value by one pound if post-mortem examination shows the animal is free from the disease. If the animal proves tuberculous, the compensation is either a minimum sum of thirty shillings or three-quarters of the value of the animal if the disease is not advanced and half its value if the disease is advanced, less in each case half the costs of valuation. The Ministry of Agriculture repays local authorities three-quarters of the compensation.

* Under the tuberculosis order, 1925, the market value of an animal is defined as "the price which might reasonably have been obtained from a purchaser in the open market who had no knowledge of the existence or suspected existence in the animal of the symptoms of disease disclosed by the report of the inspector . . . . except such knowledge thereof as might reasonably have been obtained by inspection of the animal."

111. The numbers of cattle slaughtered under this order, and the compensation paid under it, are given in the following table (table 5):—

TABLE 5.

Animals slaughtered in Great Britain under the tuberculosis order of 1925 *during the years* 1926 *to* 1932, *and the compensation paid therefor.*

Year.	Number of animals slaughtered by local authorities.	Total compensation.	Average compensation per animal.
		£	£ s. d.
1926 ...	17,348	63,264	3 12 11
1927 ...	17,381	58,872	3 7 9
1928 ...	16,759	58,752	3 10 1
1929 ...	15,532	59,165	3 16 2
1930 ...	15,263	61,353	4 0 5
1931 ...	18,603	76,483	4 2 3
1932 ...	19,027	68,815	3 12 4

112. The reduction in the average compensation paid in 1932 is principally due to the reduction of the minimum compensation from 45 shillings to 30 shillings. The evidence that we have received all points to the fact that the tuberculosis order of 1925 has done nothing to reduce the incidence of disease. Nor has it done much to protect the public from infected milk, as the majority of the cows are not reported until towards the end of their lactation, or when in an advanced state of the disease.

113. The local authorities for the purposes of this order and for the purposes of the diseases of animals acts generally are county borough councils, the councils of boroughs which at the census of 1881 had a population of more than 10,000, and, for other districts, county councils. A provision is included in the act whereby local authorities may transfer their powers under the act to contiguous authorities. Use has been made of this provision in some instances, but not to the extent that is desirable.

(ii) *The epizootic abortion order of* 1922 *and previous orders.*

114. Under the epizootic abortion order of 1922, which applies to the whole of Great Britain, the owner of any cow which has calved prematurely within the last two months, must take certain specified precautions against bringing her into contact with cattle belonging to other owners. Prosecutions occasionally take place under this order, but it is not easy to enforce, and most witnesses considered it ineffective.

115. An order confined to Devonshire was issued in 1912, and remained in force, with modifications, till 1920, when it was revoked

on account of administrative difficulties. Under it, cows which aborted were notified, and if they proved infected were isolated and disinfected.

(b) Existing legislation relating to the milk supply.

(i) *The general effect of existing legislation.*

116. Of the acts of Parliament regulating the milk supply, three are of special importance, namely, the milk and dairies (Scotland) act of 1914, the milk and dairies (consolidation) act of 1915, which does not extend to Scotland, and the milk and dairies (amendment) act of 1922, which extends to the whole of Great Britain. Other provisions relating to milk are included in the public health acts. The milk provisions in the food and drugs (adulteration) act relate entirely to adulteration and do not concern us. In addition to these acts important orders have been issued under them; the milk and dairies (Scotland) order of 1925 under the act of 1914; the milk and dairies order of 1926 under the act of 1915; the milk (special designations) order, 1923; and the milk (special designations) order (Scotland), 1930, both under the act of 1922.

117. These acts and orders provide a comprehensive code for safeguarding the milk supply throughout Great Britain, administered for the most part by local authorities. In Scotland the responsible authority is in all cases the county council or the council of a large burgh. The principal provisions of the code, and the local authority administering them in England and Wales follow:—

(A) Provisions administered by sanitary authorities, namely, borough or district councils:

(i) cow keepers and dairymen must register themselves and their premises;
(ii) cowsheds, milk stores and shops must fulfil minimum requirements with regard to lighting, ventilation, water supply, drainage and structural conditions;
(iii) milking must be cleanly carried out and all utensils scalded or sterilised;
(iv) in England and Wales milk, with certain exceptions, must be cooled;
(v) milk from cows recognisably diseased must not be sold; infectious persons must not be employed to milk cows or handle milk;
(vi) milk must be properly protected in transit.

(B) Provisions administered by county councils and county borough councils:

(vii) local authorities may appoint veterinary inspectors for the purposes of the acts; they are required to have herds examined by these inspectors in the circumstances discussed later (paragraph 118); they may arrange for inspection over and above that required by the order.

(C) Provisions administered by various authorities:

(viii) all local authorities may take samples of milk;

(ix) designations of milk are defined, and selling of milk under the designation is forbidden except under licence granted—

(*a*) to the producers of milk from tuberculin tested herds, by the Ministry of Health;

(*b*) to producers of other graded milk, by county or county borough councils, or if they are unwilling to act, by district councils;

(*c*) to sellers of all graded milks who are not producers, by sanitary authorities.

118. The provisions with regard to veterinary inspection are carried out with varying degrees of effectiveness. In Scotland all dairy herds must undergo a clinical examination at least once in every year. Experience has shown that this minimum frequency is not enough, and the Department of Health for Scotland has succeeded in persuading the councils of sixteen counties containing about 36 per cent. of the dairy cow population to provide three or more inspections a year. In England and Wales the position is less satisfactory. The requirements of the law are set out in the following extract from circular no. 757, addressed on the 20th January, 1927, by the Ministry of Health to the local authorities concerned. It may be explained that section 4 of the act of 1915 requires that any medical officer of health who has reason to suppose, *e.g.*, as the result of the testing of a milk sample, that milk from a particular source is infected with tuberculosis, shall notify this fact to the medical officer of health of the county or county borough in which the farm supplying the milk is situated. The latter is then under an obligation to arrange for the cattle upon the farm in question to be examined, and for other necessary steps to be taken with a view to discovering the source of infection. Article 8 of the order of 1926 requires county and county borough councils to make such inspections as are necessary for the purposes of the act of 1915 and the order of 1926. The passage in question runs:—

"18. The Minister's view is that the minimum which could be regarded as satisfying the requirements of article 8 of the

order, would be such inspections as are necessary for the purpose of sections 3 and 4 of the act, and for investigating cases where some definite cause of suspicion exists, such as the discovery of tubercle bacilli in a sample of milk.

"19. It is for each county council to decide, according to the experience available in their area, what amount of further inspection is desirable. It was not considered practicable, in view of the varying circumstances of different counties, to require in the order that county councils should undertake the regular periodical inspection of all dairy cattle. Inspection conducted on purely routine lines may not, in all cases, be the best means of attaining the objects of the act. The Minister is, however, aware that some local authorities have, in the past, carried out periodical inspections, and have been satisfied that the results were beneficial. Where these conditions exist it is suggested that the county council should consider the advisability of continuing the established practice."

119. Experience has shown that in England and Wales the execution of the minimum requirements of the order does not reduce the degree to which milk is infected with tuberculosis. In some counties* routine inspection is carried out along the lines required in Scotland. Nine counties with a cow population of 523,000 carry out routine inspection by whole-time veterinary inspectors, and eight counties, with a cow population of 199,000 by part-time veterinary inspectors, *i.e.*, veterinary surgeons who also engage in private practice. In addition, a certain number of urban district councils undertake the periodical veterinary inspection of cattle, generally by part-time veterinary inspectors. In a few cases the sanitary inspectors themselves inspect cattle in the course of their normal inspection of cow-houses.†

(ii) *The grading of milk.*

120. Grades of milk are laid down separately for England and Wales and for Scotland. The only substantial difference is that in Scotland all designated milk, except pasteurised, must contain 3·5 per cent. of butter fat, whereas, in England and Wales, no special minimum is laid down, the required butter fat content being determined as for ungraded milk. There are four designations of milk: certified milk, grade A (tuberculin tested) milk, grade A milk,

* See appendix 8.

† We are indebted to the urban district councils' association for information on this point. Answers to a *questionnaire* sent out by that association showed that 22 councils out of 431 replying to the *questionnaire* employed part-time veterinary officers for the examination of about 9,000 cattle. In addition, seven councils (excluding a few giving ambiguous answers) required their sanitary inspectors to examine cattle as well as cow-houses.

and pasteurised milk. Grade A milk may also be pasteurised. The special requirements for each grade are shortly as follows:—

Certified milk is raw milk from cows which have passed a half-yearly veterinary examination and tuberculin test; it must be bottled on the farm, and not contain more than 30,000 bacteria per c.c. or any coliform bacillus in 1/10th c.c.

Grade A (tuberculin tested) milk is raw milk from cows which have passed a half-yearly veterinary examination and tuberculin test; it may be bottled either on the farm or elsewhere. It must not contain more than 200,000 bacteria per c.c. or any coliform bacillus in 1/100th c.c.

Grade A milk is milk from cows which have passed a quarterly veterinary examination, and may be bottled either on the farm or elsewhere. It may be raw or pasteurised; if raw, it must not contain more than 200,000 bacteria per c.c. or any coliform bacillus in 1/100th c.c.; if pasteurised, it is described as *grade A milk pasteurised*, and must not contain more than 30,000 bacteria per c.c. or any coliform bacillus in 1/10th c.c.

Pasteurised milk is milk which has been retained at a temperature of 145° to 150° F. for at least thirty minutes, and does not contain more than 100,000 bacteria per c.c.

121. The effect of the system of licences and grades is to provide milk of a quality maintained by a system of public inspection for those consumers who are prepared to pay for it. The cost of inspection is met, at least in part, by payments made for licences by producers and distributors and there have been complaints in some places of the heaviness of these fees, which vary widely. There are at present some 400 producers of certified and grade A (T.T.) milk in England and Wales who own between 14,000 and 15,000 cows. In addition, many herds are free of tuberculosis, but are not officially registered for the production of designated milk. In Scotland there are approximately 180 producers of these grades owning 7,500 cows. Thus, under one per cent. of dairy cows are in herds officially recognised as being free from tuberculosis. The sales of designated milk as such are far below the supply, and show no sign of expansion. More detailed information on the production of graded milks is given in appendix 9.

(c) The effectiveness of current legislation in the prevention of disease and the improvement of the milk supply.

122. The measures discussed have not appreciably reduced the incidence of tuberculosis among dairy cattle. In practice, cows are only removable under the order at a late stage, after infection has had ample chance of spreading, though in some counties the order has been interpreted to allow earlier removal. But if this interpretation was made universal, the cost to the public would be enormous and there might be a rapid contraction of the milk supply.

123. If there could be found enough buyers of certified and grade A (T.T.) milk at prices high enough to show adequate profit over their cost of production, the grading of milk would provide an inducement to maintain disease-free herds, and so would lead directly to a reduction of disease. But, as we have explained, there is very little demand for these milks. This demand might be improved by a better understanding, on the part of the public, of the meaning of the official designations. In particular, it is unfortunate that the designation of the lowest grade should be grade A. In paragraph 207 we make proposals on this point.

124. It cannot be claimed that, except in certain districts where clinical inspection of dairy cattle is being energetically carried out, there has been as yet any reduction in the extent to which milk at the farm is infected with bovine tuberculosis. But there is general agreement that milk has been produced with greater cleanliness since the milk and dairies order came into force. One reason for this is the increasing interest in the quality of milk consumed displayed by the medical profession and the public at large, and the more stringent requirements to which this has given rise on the part of the large milk distributing concerns. But important contributing factors have certainly been the inspection by sanitary authorities, and the educative activities of the ministries of agriculture and health in England and Wales, and of the corresponding departments in Scotland. It cannot, however, be said that the standard required by the milk and dairies orders is as yet generally attained. Sanitary authorities in rural areas have had recently to contend with a large increase in the number of cowsheds, and this alone has made heavy demands upon the attention of their inspectors. In addition, many rural authorities assert that financial considerations prevent them from employing enough sanitary inspectors adequately to carry out the duties laid upon them.

(d) Milk legislation in countries overseas.

125. Legislation relating to milk and the diseases of cattle in certain countries overseas is reviewed, in so far as it affects our inquiry, in appendix 10. From this appendix it will be seen that a number of interesting schemes have been put into force abroad from which useful experience has been gained. We mention, in particular, the milk grading schemes in force in the United States of America, the eradication schemes which have met with considerable success in Canada and the United States, and the measures taken against bovine tuberculosis, often without any government assistance, in Denmark.

PART 2.

POSSIBLE LINES OF ADMINISTRATIVE DEVELOPMENT.

126. Three major proposals have been made for improving the existing law, and have each found many advocates (and, in one case at least, opponents) among our witnesses. The first is that the higher standard of veterinary inspection of dairy cattle now attained in certain counties should be made universal. The second is that there should be an active policy for the eradication of disease, particularly of tuberculosis, by means of isolation or the elimination of reacting cows, or both. The third is to give certain urban authorities the right to require the pasteurisation (as defined in paragraph 120) of all milk sold within their boundaries which is not either certified or grade A (T.T.). The last of these measures is advocated exclusively on grounds of public health, the other two, both on grounds of public health and of agricultural efficiency. As a first step we proceed to review the merits of each proposal singly. Later we consider their interactions.

IV.—THE FURTHER DEVELOPMENT OF THE VETERINARY INSPECTION OF DAIRY CATTLE.

127. The object of routine veterinary inspection is to remove animals liable to be condemned under the tuberculosis order sooner than farmers have shown themselves likely to report them. It is hoped by such removal to reduce the infection of milk with tuberculosis and, to a lesser extent, the spread of infection among cattle.

128. That thorough clinical inspection does reduce the amount of tuberculous milk passing into consumption is certain; but it can never render the milk supply safe. For, in the first place, some cows showing no clinical symptoms yield tuberculous milk. In the second place, they reach the stage of giving tuberculous milk between the visits of the inspector. Further, there must often be cases where milk is contaminated with tubercle bacilli present in infected dung or dust; for a large proportion of reacting cows without clinical symptoms excrete matter liable to cause infection in this way.

129. It is important to form a quantitative estimate of the extent to which routine veterinary inspection reduces the degree of infection of the milk supply. The data, however, on which we are forced to rely in making such an estimate, are to some extent contradictory, and in many respects deficient. It is certain, for

example, that many cows yielding tuberculous milk are not discoverable by clinical examination. The results of the two investigations bearing upon this point known to us are not easily reconciled. But the proportion of such cows is not likely to be less than one in four. Again, it is highly improbable that having regard to the intervals between inspections, veterinary inspection of the frequency we contemplate would eliminate much more than three-quarters of those cows which yield tuberculous milk and show recognisable clinical symptoms of tuberculosis.

130. That routine inspection has been to some extent effective in reducing the infection of milk, is supported by the following table (table 6), which gives the results of tests for the presence of tubercle bacilli in samples of mixed milk from individual herds in the West Riding, by the county borough councils of the principal towns* drawing milk from that area :—

TABLE 6.

The number of samples containing tubercle bacilli obtained from the mixed milk of individual herds situated in the West Riding of Yorkshire sold in certain county boroughs in Yorkshire and Lancashire.

Year.	Total number of samples taken.	Number of samples found to contain tubercle bacilli.	Percentage of samples containing tubercle bacilli.
1923	174	13	7·5
1924	439	21	4·8
1925	426	33	7·8
1926	586	52	8·9
1927	573	33	5·8
1928	729	45	6·2
1929	670	38	5·7
1930	697	31	4·4
1931	955	48	5·0
1932	855	44	5·1
1933	847	44	5·2

A chief veterinary officer was first appointed in the West Riding in the year 1927 and routine clinical inspection had been extended throughout that area by the year 1929. In interpreting this table it must be borne in mind that the percentage of infection shown depends upon the technique employed in the test and on the size of herds, that these vary from year to year and from town to town, and that

* Barnsley, Bradford, Dewsbury, Doncaster, Huddersfield, Leeds, Rotherham, Sheffield, Wakefield and York in Yorkshire, and Manchester Oldham and Salford in Lancashire.

the proportion in which each town contributes to the result fluctuates considerably.* The figures for individual towns are given in appendix 11.

131. The efficacy of routine clinical inspection would be materially increased if adequate use were made of the microscopic and the biological testing of herd milk samples. This is of particular importance where cows with clinical symptoms have been removed from a herd. For this affords some ground for expecting that other animals in the herd may have reached the stage at which their milk is infected, though they do not yet show any recognisable clinical symptoms. The full biological test, which alone can be relied on to show that milk is *not* infected, takes six weeks to complete. But an earlier positive result may be obtained, at any rate in a majority of cases, either by the use of a microscopic test, which can be applied to bulked samples of milk or by killing the first guinea-pig used in a biological test within six weeks if it shows glandular enlargement.

132. It thus appears from both practical and theoretical considerations that routine veterinary inspection of dairy herds is capable of reducing appreciably the extent to which milk is infected with tuberculosis, but cannot be relied on to reduce infection to really small proportions, though it has not yet been sufficiently developed to show how effective it might be in this direction.

133. A reduction in the infection of milk with bovine tuberculosis is not accompanied by a proportional reduction in the infection in man. Those who are highly susceptible to the disease run almost the same risk of contracting it, whether the percentage of infected samples is seven or five or two. Among those, on the other hand, who are highly resistant to it, and who only succumb to the small minority of very highly infected samples, there is likely to be a reduction in disease almost proportional to the reduction in the infection of milk. We are not in a position to predict whether the reduction which would be achieved by means of veterinary

* The percentages of infected samples disclosed in this table are higher than those recently found in samples sold in the administrative county of the West Riding, which were as follows:—

	Milk supplied to schools.		Other milk.	
	Grade A.	Ungraded.	Grade A.	Ungraded.
1931 Samples	25	126	100	401
Positive samples ...	1	6	4	14
Percentage positive ...	4·0	4·7	4·0	3·5
1932 Samples	6	294	140	637
Positive samples ...	Nil	8	3	23
Percentage positive ...	Nil	2·7	2·1	3·6

inspection in the proportion of tuberculous milk is likely to be associated with a noticeable diminution in the extent to which human infection occurs from that source. But it is possible that the results of such a policy would prove disappointing. We have evidence which suggests that the rural parts of the West Riding, where routine veterinary inspection is energetically carried out, are no more free from bovine tuberculosis than the rural parts of Kent, where there is no routine inspection.

134. An advantage of veterinary inspection over some methods of improving the milk supply is that it benefits the health of the country as well as that of the town population. We look forward to the day when eradication of tuberculosis will provide a complete safeguard to the milk supply in rural areas. With a vigorous campaign the interval need not be too long. But until that time, clinical inspection, especially in herds from which milk is sold directly by the producer, should reduce the extent of infection of milk consumed by the public.

135. The second advantage sometimes claimed for more frequent veterinary inspection, is that it reduces the incidence of disease by removing infectious cows from herds where they may do considerable damage. But cows in the early stages of tuberculosis, before clinical symptoms appear, may spread infection as readily as those removable under the tuberculosis order, and as they are much more numerous, the strict administration of the order, though it might have some, would be unlikely to have an important, effect in this respect. Witnesses before us have generally confirmed this conclusion.

136. The prompt elimination of diseased cows is not the only advantage of routine veterinary inspection. We have already indicated the part which day-to-day management and hygienic precaution play in the prevention of disease. A veterinary officer making periodical examinations of dairy herds would be well placed both for observing the effects of different plans of management upon the health of cattle, and for giving advice directed towards their improvement. Farmers are often unaware of the presence of disease in their herds. It is an essential preliminary to the reduction of disease that their attention should be directed towards its existence. Routine veterinary inspection, carried out with a sympathetic understanding of the farmers' point of view, would not only do this, but would also play a most important part in creating among farmers an atmosphere favourable to eradication schemes such as we discuss further on.

V.—METHODS OF ERADICATION.

(a) Bovine tuberculosis.

137. The total eradication of bovine tuberculosis from all herds is generally agreed to be the only complete solution of the problem of tuberculous milk. It should also, to some extent, reduce the

farmer's costs in producing milk, so offsetting some of the costs incurred in eradication, especially if this is economically carried out. But any such scheme must take account of conditions peculiar to Great Britain. In the first place, the incidence of tuberculosis among our cattle is so high that the wholesale slaughter of infected animals (as in the United States and Canada) is out of the question. Not only would its immediate cost be prohibitive, but it would also seriously contract the supply of milk. Further, the continual movement of dairy cattle, not only between farms, but also between districts, adds very materially to the difficulties of freeing herds from tuberculosis and of keeping them free afterwards.

138. It is not enough to secure that all infected animals have once been removed from a herd; steps must also be taken to ensure that no infected animals are subsequently introduced into the herd. Nor is it enough to secure that all animals introduced themselves come from disease-free herds and do not, at the time, react positively to the tuberculin test. For there is always the risk that they may have incurred infection in transit. As the presence of infection in its early stages is not disclosed by the tuberculin test, the fact that they pass this test is no guarantee that they will not subsequently develop disease. This risk of reinfection has an important bearing on the question of eradication of tuberculosis in this country. It is sometimes held that it would be sufficient to take the important step towards eradication of encouraging individual farmers to free their own herds from tuberculosis. In this way it is hoped that a gradually increasing number of disease-free herds would be created. But the difficulties that exist, and would continue to exist, in preventing the reintroduction of disease in herds which depend even in part on recruitment from outside for the maintenance of their numbers, seriously limit the usefulness of such a policy.

139. Self-supporting herds, indeed, may be cleared of tuberculosis by the method first proposed by Professor Bang in Denmark, or by some modification of it. According to this, calves are reared in isolation on pasteurised milk. At maturity they pass into a separate herd, which ultimately entirely replaces the old infected herd. The period of building a free herd may be shortened by dividing the original herd into two sections, reactor and non-reactors to the tuberculin test.

140. But most herds are not self-supporting, and some special provision must be adopted to deal with them. The first of the possible ways of doing so would be to eliminate flying herds (*i.e.*, those entirely or mainly maintained by buying-in cows to replace those dropping out) by obliging all farmers to rear enough calves of their own to maintain the strength of their herds. In existing circumstances we unfortunately cannot advocate such a policy, as it would run counter to the present organisation of the industry. Though there are large numbers of herds, already self-supporting

in part, which might well be made entirely so, the fact that herds, and to some extent districts, are specialised for breeding and dairying respectively is economically so advantageous and so firmly established that the flying herd must be accepted as part of our system.

141. A second method that has been advocated is the progressive formation of disease-free *areas*, as has been done in both the United States of America and Canada. Eradication would be undertaken in contiguous farms, under compulsion where necessary, to form solid blocks of clean territory. Any movement of dairy cattle into such an area, unless under very stringent conditions, would be prohibited. It would be natural first to establish such areas in the cattle exporting districts, and to extend them gradually over the cattle importing districts.

142. The appeal to compulsion involved would give rise to acute difficulties. It would certainly create a demand for compensation on the part of farmers who were unwilling to free their herds on their own account. But it would be inequitable that those farmers who showed the least initiative in the matter of eradication should receive the most favourable treatment. Such a policy would also retard the progress of eradication. But, if compensation were granted to all farmers who undertook eradication the cost would be unduly high. Secondly, the setting up of special areas would necessarily be accompanied by regulation of the import of cattle into them. Even if the areas were selected with the greatest care, these regulations would entail a great deal of interference with the free flow of cattle, to the importance of which we have already drawn attention. Though for these reasons, we do not advocate the setting up of special areas to-day, the question will require to be considered further when most of the herds of the country have been freed from tuberculosis.

143. The third and last alternative involves neither compulsion nor undue restriction in the movement of cattle. Its aim is to prevent the infection of cattle from disease-free herds in transit by their strict segregation from all cattle other than from disease-free herds, by measures such as special markets (or sections of markets) and special precautions during transport. Similar precautions would be necessary to protect animals from infection when being exhibited at agricultural shows. The adoption of such measures would considerably increase the number of herds in which eradication would be feasible. The practical difficulties involved may be considerable; but they are not insuperable.

144. There are three ways in which the farmer may to-day reduce the incidence of tuberculosis among his cattle. First, he may slaughter tuberculous animals. Secondly, he may segregate them for the remainder of their lives. Thirdly, he may sell them to other herds. Slaughter is the most effective means of safeguarding the milk supply, but it is obviously not economical to sacrifice the milk

of all cows that react to the test so long as good care is taken to prevent the sale of tuberculous milk. In view of the high rate of infection in this country the method of isolation, as well as that of slaughter, must be permitted under any scheme of eradication. The propriety of permitting the sale of reacting cattle in the open market has been called in question; but such sales do not increase the total amount of tuberculous milk sold at present, and they serve to reduce the number of tuberculous cows in the future. For though the sale of a reacting cow by A to B, and the sale of a clean cow to replace it by C to A leaves unaltered the total numbers of diseased and clean cows respectively, they advance eradication if carried through as a means of preserving the rest of A's herd from infection, so long as B's herd is already so heavily infected that it becomes no worse for the change. In fact, the sale of reacting cattle in the open market is probably a more effective method of progressive eradication than their isolation upon farms. It is also in many cases likely to be less expensive, for it does not involve the construction of temporary premises for their isolation. We are therefore strongly of the opinion that any official scheme of eradication should permit the sale of reacting animals.

145. To insist that known reactors should be declared as such on sale would obviously make eradication more expensive and might prejudice the success of any scheme. The objection to such sales has less weight if markets are set up devoted to the sale of tuberculosis-free cattle. Whoever then buys in the ordinary market does so with the knowledge that cattle bought there may be tuberculous. It would be unjust that one class of sellers in that market alone, namely, those who are taking part in an eradication scheme, should be forced to make a declaration which is likely to depress the value of the animals they are selling.

146. It is sometimes objected to schemes for eradication, that the advance of knowledge may soon make possible the immunisation of cattle against tuberculosis, and that if this were to occur a cheaper and more effective means of ridding this country of it would be available. In such circumstances, it is argued, it is improvident to encourage the expenditure of considerable sums of money on eradication. We do not share this view. We are aware that a high degree of resistance, amounting in some instances to complete immunity, to an experimental tuberculous infection can be conferred on the bovine animal by vaccination with the attenuated strain of bovine bacillus known as B.C.G. (Bacille Calmette-Guérin). This method of obtaining tubercle-free herds has, however, not yet been put to scientific proof under farm conditions in this country, and because it is essential that this should first be done, a long time must elapse before a decision can be reached on its efficacy and practicability in the field. On the practical side there are points in immunisation which have not perhaps been generally appreciated by the farming community. Immunity to tuberculosis produced by

vaccines takes time to develop, necessitating immediate removal of calves from their dams and strict isolation before vaccination and for a period subsequently. Also the immunity only lasts for from six to twelve months and must be renewed periodically by revaccination. While, therefore, vaccination may afford a means of raising healthy stock from heavily infected herds, the attention, skill and expense needful for its success cannot be less than in the scheme of eradication based on the tuberculin test. Furthermore, it must be remembered that animals which have been vaccinated with tubercle bacilli, either living or dead, react to the test for a variable, sometimes long, period subsequently. Such animals would, therefore, have to be excluded from a scheme of eradication based on the test, and could not be permitted to enter tuberculosis-free herds, as it would be impossible to decide whether a reaction was due to the vaccine or to a natural infection following on the decline of immunity.

(b) Other diseases of cattle.

147. Other diseases besides tuberculosis may be attacked by the methods which we have just described, provided that there is a test that can reveal them in their early stages. This condition is fulfilled, in the case of contagious abortion, which is disclosed by a blood agglutination test, and of chronic streptococcal mastitis which can be discovered by a bacteriological examination of milk samples. Johne's disease cannot yet be identified with any certainty before clinical symptoms appear, and concerted steps to eradicate it must await further research.

148. In many respects contagious abortion and chronic streptococcal mastitis lend themselves more readily to eradication than does tuberculosis. The loss occasioned to farmers is even more severe; at the same time the precautions which the farmer himself may take against the spread of infection in his herd are possibly simpler and more effective. Every attempt, therefore, on the part of individual farmers to eliminate these diseases from their herds is to be encouraged. But a concerted scheme should not apply to more than one disease at a time. For otherwise either the government scheme must apply to animals free from all the diseases, which would seriously reduce the number of herds which could be looked to for supplies of disease-free cattle, or separate schemes must be operated concurrently for each disease. This course would lead to great administrative complications. If two diseases were dealt with there would be four classes of animals; those with both diseases, those with neither, those with the first disease but not the second, and those with the second disease but not the first. A government scheme would have to arrange that no animal should come into contact with any animal belonging to a different class. This, however, we believe to be impracticable. We hold, therefore, that the various diseases must be dealt with by the state successively and not concurrently, whatever course the

individual farmer may adopt. The first disease to be dealt with officially must be tuberculosis because of its great danger to public health.

VI.—THE PASTEURISATION OF MILK.

149. The proposal to make the pasteurisation of milk compulsory raises two distinct questions. Much of the milk consumed in large towns is already heat-treated to prevent it souring before it reaches the consumer. To substitute in the interest of public health a special form of heat-treatment for those at present in use, though as shown in paragraph 163 this would raise a number of important technical problems, would not greatly interfere with the interests of individuals. But these interests would be seriously affected if pasteurisation were made compulsory in and around large towns and throughout towns of smaller size, where raw milk is to-day sold in competition with heat-treated milk. Here the raw milk is produced on land with labour the price of which is enhanced by proximity to a town. But it is not burdened with heavy transport charges; it is distributed directly by the owner fresh from the cow;* and it avoids the cost of heat-treatment. It is therefore able to compete with milk produced more cheaply but further from the town. The compulsory pasteurisation of milk produced and sold under these conditions is a quite different question from a change in the method of heat-treatment.

(a) Compulsory pasteurisation in areas now largely consuming raw milk.

150. Compulsory pasteurisation of milk throughout Great Britain would involve in many areas the widespread replacement of raw milk by treated milk. But raw milk has its determined advocates who base their case partly on its alleged nutritional superiority and partly on the discouraging effect that compulsory pasteurisation would have upon efforts to produce clean and disease-free milk.

151. The ambiguous results of large-scale feeding experiments, and the uncertainty of deductions from more theoretical considerations lead us to the conclusion that there is not sufficient evidence to support the presumption that pasteurisation is harmful from the point of view of human nutrition. In view of the fact that innumerable healthy children are to-day reared on a diet containing no unpasteurised milk, we do not feel that the suggestion that pasteurisation may at some future time be shown to have bad results should be given much weight in deciding on the general merits of pasteurisation as a safeguard to public health.

152. It has been argued that if farmers knew that their milk was to be pasteurised, they would relax their efforts to produce a safe and clean milk. In considering this argument it is essential

* There is a demand for such milk from a section of the public.

to distinguish between the clean milk, namely, milk free from the bacteria responsible for souring, and safe milk, namely, milk free from those dangerous to public health. Considerable efforts have been made in recent years by farmers to improve the cleanliness of their milk. For the slackening of these efforts pasteurisation would afford no ground. The bacteria responsible for the deterioration of milk may be divided into two classes, those which are destroyed by pasteurisation (*i.e.*, by being exposed to a temperature of 145°–150° F.) and those which survive it and subsequently multiply. The latter are encouraged by slovenly methods of production. Dirty milk cannot be made clean by pasteurisation. We believe, therefore, that once this is firmly grasped by farmers, they would not be discouraged from producing clean milk by the knowledge that it was subsequently to be pasteurised. We are confirmed in this view by the importance attached by the large milk distributing companies to the cleanliness with which the milk which they buy is produced.

153. The production of safe milk raises different questions, for most farmers are not making determined efforts to free their herds from tuberculosis. It has been represented by several witnesses that pasteurisation would deter farmers from undertaking eradication, and there is no doubt that many farmers at present regard pasteurisation and eradication as alternatives. But whether this feeling would ultimately influence their actions would depend on the way in which both pasteurisation and eradication were introduced. (See paragraph 169 below.)

154. There are three further objections to the compulsory pasteurisation of milk which carry little weight. In the first place, it is sometimes said that pasteurisation is contrary to the spirit of other legislation respecting dangerous foods, which has always followed the principle that such food should be destroyed and not reconstituted. This objection might have force if applied against pasteurisation in any form, but it is not valid against the extension of a process which is already permitted. Secondly, it is objected that compulsion in respect of this process is improper, as whoever wishes to buy pasteurised milk may do so to-day. It is held, therefore, that there is no ground for compelling those who do not wish to do so to take this additional precaution for the benefit of their own health or that of their children. We do not accept this view. Finally, it has been suggested to us that a requirement that all milk not from tuberculosis-free herds should be pasteurised, would have the result of establishing small local monopolies in the distribution of milk. It is argued that pasteurisation is a process that is most cheaply carried out on a large scale; that this will result in the formation of larger distributing organisations, and that these in turn will be in a position to obtain unduly favourable terms both from the producers and from the consumers of milk. We are not ourselves apprehensive that this will occur. For the existence of a class of producer-retailer with tuberculosis-free herds would afford a guarantee against the extension of monopolistic practices.

155. For these reasons we do not accept the view that the substitution of pasteurised for raw milk is an evil in itself. Such objections as there are on this plane are easily outweighed by the saving in human life and suffering which would result. But a substantial objection of a different character remains. We have seen that there is at present a balance in the supply of heat-treated milk, generally brought from a distance into large towns, and raw milk, generally produced in the country immediately surrounding them, determined by the relative costs of production and distribution of milk of each class. Compulsory pasteurisation would disturb this balance adversely to the neighbouring producers. These would suffer because they would have to bear either the high cost of pasteurisation in small plants or the increased costs of distribution, which combination to operate larger plants would involve. Moreover, the latter course is impossible for many of them, as it is important to their business to preserve the identity of their herds' milk.

156. We must anticipate, therefore, that in the event of pasteurisation being made compulsory in large towns, and in the absence of any provision designed to mitigate the economic consequences of such a change, a large number of farmers who produce milk and sell it on the circumference of such towns would be deprived of their present means of livelihood, and would be forced to find other employment for their capital and their industry. It is hardly to be expected that they would succeed in this without a break-up of their homes and a general deterioration in their economic position, which might in some instances amount to actual distress.

157. The existence of an interest, however deserving of consideration, which would be harmed by a proposed change in the law is not in itself a sufficient reason for refusing to entertain any desirable reform. Factory legislation affords a precedent. The constantly increasing regulation of industry under successive factory acts through the nineteenth century imposed, no doubt, considerable burdens upon employers, especially on small employers. But the health of those employed in factories was held to be of greater importance than the immediate material interests of the owners of factories. And it was never suggested that those who were unable to afford the minimum standards of safety and comfort laid down in the acts had any claim to compensation. But the fact that provisions which are necessary from one point of view are likely to have unfavourable repercussions in another direction is a sufficient reason for proceeding with great circumspection and moderation. In the present instance it would be improper to recommend a policy of compulsory pasteurisation even for large towns if there were a reasonable expectation that the objects of this reform could be achieved by other means, which, even if they were more expensive, would not be disadvantageous to the livelihood of producer-retailers. Any change should be so introduced as to allow producer-retailers gradually to adapt their businesses to the altered conditions.

158. We have discussed the two methods whereby it has been suggested that the interests of producer-retailers might be reconciled with those of public health. We have shown that the first, namely, the removal of cows yielding tuberculous milk by periodic clinical examinations, can only effect a moderate reduction of the infection of milk with tuberculosis; and that it is unlikely that this reduction would be associated with a comparable decrease in the infection of man by the consumption of milk. The possibilities of the bacteriological examination of samples of bulked milk, though a valuable additional safeguard, do not affect this conclusion. For these reasons we are satisfied that clinical inspection alone is not a satisfactory alternative to pasteurisation in those areas where the latter is practicable.

159. Secondly, milk sold by producer-retailers could be made safe by the eradication of tuberculosis from their herds. If this could be effected economically it would be a satisfactory solution of the problem. Indeed, most witnesses who recommended compulsory pasteurisation recognised that milk from tuberculosis-free herds should be excepted from the general rule, though others, impressed by the danger of other milk-borne diseases, objected even to this exception. But difficulty arises from the fact that until a sufficient supply of tuberculosis-free animals has been secured by eradication in breeding herds, eradication among producer-retailers whose herds are generally recruited by purchases from outside sources is not practicable. Eradication might, in such circumstances, prove at least as onerous to these herd owners as pasteurisation. If, however, eradication in breeding herds is vigorously pursued, this will in time be a satisfactory alternative.

160. To sum up, there is, in our view, no policy which at the outset satisfies the interests of public health, and safeguards the position of producer-retailers in large towns. Taking a longer view, however, we consider that a policy giving producer-retailers the alternative of pasteurising their milk or of freeing their herds from tuberculosis, would be compatible with both these interests as soon as a sufficient supply of tuberculosis-free dairy cattle was available from which they could recruit their herds. We explain later (part 3) the legislative and administrative measures necessary to give effect to such a policy.

(b) Compulsory pasteurisation in areas where milk already undergoes some form of heat-treatment.

161. The objections to pasteurisation which we have just considered are relevant only to the question of making obligatory the pasteurisation of milk now sold raw. But most of the milk at present sold in towns large enough to render the adoption of compulsory pasteurisation practical, is to-day either pasteurised or

undergoes one of the forms of heat treatment which though often incorrectly spoken of as pasteurisation do not comply with the terms of the milk (special designations) order. We may summarise the evidence which we have received on this point as follows :—

(i) Most of the milk which undergoes heat treatment is treated in unlicensed plants, and is consequently free from any inspection other than that required by the milk and dairies orders for premises where milk is stored. This cannot secure that the milk treated (*a*) is not damaged from the nutritional point of view by the process it undergoes, and (*b*) is in any way improved hygienically.

(ii) Milk so treated, as well as milk treated in licensed plants, is often sold as "milk" or even "raw milk" without any indication to the purchaser that the milk has undergone heat treatment in any form.

(iii) The inspection of licensed plants is unsatisfactory. It is not uniform between districts. It does not prevent occasional gross errors in the construction of plants. It does not secure the proper operation of plants.

(iv) Milk sold from licensed pasteurising plants, and, still more, milk sold from plants where other forms of heat-treatment are carried out, is not infrequently found to be infected with tubercle bacilli.

162. We consider this is a sufficiently disturbing situation. No milk should be permitted to undergo any form of heat treatment which is not approved by the Ministry of Health or the Department of Health for Scotland, for the purposes of the milk (special designations) orders,* with the exception of sterilised milk, which should be sold as such. All milk, except sterilised milk, which has undergone heat treatment should be sold as pasteurised. All plants for the heat treatment of milk should be regularly inspected and the standard of inspection should be raised and made uniform throughout the country.

163. We have seen that pasteurisation is designed to raise the milk to a temperature high enough, and to hold it there long enough, to destroy the tubercle bacillus and other micro-organisms, without appreciably detracting from the nutritional value of the milk. The margin of safety is narrow. Every particle of the milk must be held for at least thirty minutes at a temperature neither below 145° F. nor above 150° F. lest bacilli should survive in some little pocket. In this matter no minority of failures can be accepted as negligible. Witnesses before us have expressed this by saying that in the day-to-day working of commercial plants a full laboratory standard of exactitude must be maintained. This gives rise to mechanical problems of some difficulty. In some of the earlier plants these

* At present the only method approved by these departments is the holder method, to which paragraph 163 relates.

problems were not adequately solved; but there are now plants on the market capable of giving the desired results, if scrupulously used. We have not, however, considered it part of our task to examine their technical merits.

VII.—THE INTER-RELATION OF THE VARIOUS POLICIES ADVOCATED.

164. The considerations which we have hitherto advanced lead us to make a number of recommendations for the better control of cattle diseases and for the improvement of the milk supply. These we may express as follows:—

(i) The veterinary service should be expanded and charged with the duties of carrying out periodical clinical examinations of dairy herds, and of putting into effect measures for the better control of all, and the elimination of some, of the diseases among dairy cattle.

(ii) The eradication of bovine tuberculosis should be promoted by securing to owners of tuberculosis-free herds a higher price for their milk than that obtained by other owners; by setting up a register of herds free from tuberculosis, by setting up markets (or parts of markets) confined to the sale of tuberculosis-free animals from such herds, by providing free technical advice to farmers making genuine attempts to free their herds from tuberculosis and by refunding to such farmers, provided they continue to carry out this advice conscientiously, the costs of tests with tuberculin necessary for the purpose of eradication.

(iii) The heat-treatment of milk, except pasteurisation or sterilisation, in licensed plants should be prohibited forthwith. Milk bulked in any considerable quantity should be required to be pasteurised or sterilised after bulking.

(iv) Large municipalities should be given the right to require that after two years' notice all milk (except sterilised milk) sold within their boundaries which is not derived from herds free from tuberculosis shall be pasteurised, but the power to exercise this right should be deferred for three years in order that the measures recommended for the eradication of tuberculosis may have had sufficient effect in breeding areas to provide a supply of tuberculosis-free cattle, and thus to make the policy of eradication possible to producer-retailers near such towns.

165. We must emphasise the interdependence of these proposals. The expansion of the veterinary service with the duties which we have assigned to it will involve considerable fresh expenditure. But we believe that this expenditure is fully justified in view of the objects which it will serve. We have recommended an expansion of the veterinary service not so much for its immediate benefit to public

health but as a part of a wider programme aiming at the complete eradication of bovine tuberculosis and the reduction of other diseases. We consider that without such an expansion a programme of eradication must fail, but that with its support and as a result of the educative influence which it would exert, it would effect its object.

166. We have not hitherto entered into the question of the inducements to be offered to farmers to eradicate tuberculosis and the financial assistance to be afforded to them in the process. There has been great divergence in the policies adopted by other countries in this respect. In the United States and in Canada compensation has been paid on a high scale for tuberculous cattle slaughtered; in other countries, notably in Denmark, important results have been achieved without any serious expenditure of public funds. In Great Britain the heavy incidence of the disease and the importance of economy in public expenditure rule out the possibility of high compensation for cattle slaughtered in the course of eradication. It is therefore all the more important that substantial inducements should be offered to farmers to incur the costs of eradication, which at the outset may be heavy. The simplest and most effective inducement is to secure for the owner of a tuberculosis-free herd a higher net return for the milk which he sells than is obtained by the owners of other herds. In part we believe that this may be done by altering the rules governing the grading and pasteurisation of milk so as to give a greater advantage to the herd which is free from tuberculosis, and these alterations are discussed in paragraphs 168 and 169. But these alterations would only influence particular groups of farmers and would not by themselves cause farmers to volunteer to undertake eradication in such numbers as to produce a material reduction of disease within a reasonable period.

167. We have therefore considered whether an inducement of a more general character could be offered and what form it should take. A higher return might be secured to the producer of tuberculosis-free milk by the payment of a bonus either directly from the Exchequer or from a levy on the milk industry as a whole. But the former of these alternatives is open to insuperable objection, for apart from the equity of calling upon the general taxpayer to subsidise the industry for such a purpose, a direct grant from public funds, though the total would be small at the outset, would, if it achieved its purpose of inducing farmers generally to eradicate, reach a sum which it would be quite impossible to expect the Exchequer to find. We are, therefore, left with the other alternative, under which a bonus would be provided for milk from non-tuberculous herds, irrespective of the use to which it is put, from the proceeds of a levy on all milk. The Milk Marketing Boards could supply the machinery through which this levy could be raised, whether it was imposed in the first instance on producers or distributors or in part upon both, though their existing powers would require to be modified in order to bring graded milks within their purview. This levy would be borne

the more easily because, as a result of the various measures which we have proposed for securing a safer milk supply, the consumption of milk in liquid form should show considerable expansion, to the benefit of all sections of the industry. It should not rest with the marketing boards themselves to determine whether or not this levy should be raised, or at what rate the bonus should be paid. As the strength of the inducement which this bonus would afford to owners who have not yet cleaned up their herds depends on an assurance that it will be continued long enough after they have eradicated tuberculosis for them to recoup the cost of doing so, it is essential that there should be no ground for fearing that the policy might be reversed. We therefore consider that the collection of this levy should be made a statutory obligation of the present Milk Marketing Boards or of any organisation which may replace them, and that the rate of the bonus to be paid should be fixed by the government.

168. The present system of grading milk is based upon two factors, first, safety, and secondly, cleanliness or freedom from organisms likely to cause souring. A higher standard of cleanliness is required for safe raw milk than for ungraded milk. But cleanliness is within the reach of every farmer, and should be insisted on universally. We consequently recommend (paragraph 206 below) that all milk sold for liquid consumption, whether it is subsequently to be pasteurised or not, should reach a certain standard of cleanliness on the farm. If this is secured, grading can be confined to milk which is safe, either because it has been produced in tuberculosis-free herds or because it has been pasteurised. In this way the inducement to produce tuberculosis-free milk would be increased. For the difference of price in favour of safer milk would remain, though the extra trouble of producing a milk of greater cleanliness would be common to all producers.

169. The way in which compulsory pasteurisation is introduced may profoundly influence the prospects of eradicating tuberculosis from dairy herds. If milk from tuberculosis-free herds need not be pasteurised, though milk from other herds, when sold in certain areas, must be pasteurised, the owner of a tuberculosis-free herd, if a producer-retailer near such areas, enjoys a permanent economic advantage. But if at the time when this change is introduced the costs of eradication are unduly high, as they would be to-day owing to the shortage of tuberculosis-free cattle, the organisation of milk production may be adjusted to the alternative of pasteurisation instead of to the alternative of eradication. It is for this reason that the measures which we have recommended, for the setting up of a register of tuberculosis-free herds, should be put into operation before producer-retailers are offered the choice between pasteurisation and the eradication of tuberculosis. At the same time, if the measures for promoting eradication are to be successful, it is necessary that it should be generally realised that the sale of unpasteurised milk from herds which are not free from tuberculosis

will be prohibited at any rate in some districts at a not too distant date.

170. In coming to the conclusion that a reasonable period should be allowed to elapse before pasteurisation was anywhere made compulsory we have indeed been influenced by a desire to prevent an injury to an important section of the farming community. But considerations of public health alone would have led us to the same conclusion. For many reasons it is impossible to pasteurise milk except in large urban areas. In country districts and in the smaller towns, failing a milk supply which is healthy at the source, the consumer can safeguard himself only by boiling all milk—for infected milk may be made safe for human consumption by heating it in a double saucepan until the water in the outer pan comes to the boiling point.* Though we strongly urge the adoption of this practice, we cannot hope that medical education would bear such fruit in the districts we are considering that in every household all milk from tuberculous herds would be carefully treated in the manner prescribed above. Thus, only the eradication of the disease among cows themselves will secure the rural population against the dangers of infection with bovine tuberculosis. A policy of pasteurisation which was so carried into execution that it promoted the eradication of tuberculosis from cattle in districts surrounding large urban areas would inevitably have the effect of creating a demand for cattle from tuberculosis-free herds for replacement purposes in these districts. The expectation of this demand would promote the eradication of tuberculosis in the rural areas from which supplies of cattle for replacement purposes were drawn, and the human population of these areas would benefit immediately. Moreover, the immediate advantage to public health of introducing compulsory pasteurisation, without regard to its repercussions on the prospects of eradication, must not be exaggerated. It must be remembered that, under our scheme, all

* Two experiments with tuberculous milk are quoted to show the efficaciousness of this simple method of heat-treatment of milk in the home:—

Experiment 1.—Some heavily-infected milk was brought to the boiling-point of water in a double saucepan; the gas was then turned out and the milk was left for 15 minutes, after which it was rapidly cooled. A dose of 0·5 c.c. of the unboiled milk caused general tuberculosis in 2 guinea-pigs; the heat-treated milk was inoculated into 2 guinea-pigs, each receiving 5·0 c.c., that is 10 times the amount used for the controls. They remained free from tuberculosis.

Experiment 2.—A sample of milk heavily infected with tubercle bacilli was again used. In this experiment the test was more severe, as the treatment was purposely less thorough. The inner pan did not touch the water in the outer pan and, as soon as steam began to issue, the inner pan, containing the milk, was removed and immersed in cold water. The maximum temperature reached by the milk was 85·0 C. (185·0° F.). The unheated milk, in a dose of 0·01 c.c., produced general tuberculosis in 2 guinea-pigs. The heated milk, dose 5·0 c.c., that is 500 times as much as was used for the controls, did not produce tuberculosis in 2 guinea-pigs.

milk which for commercial reasons must be heat-treated to prevent souring will in future require to be either pasteurised or sterilised. The class of consumers who would be protected if compulsory pasteurisation were permitted in large towns would consequently be small, being confined to those who in such towns buy raw milk which would at present be ungraded. But if the granting to local authorities of powers to require pasteurisation immediately seriously delayed the progress of eradication this protection would be secured at the expense of consumers in rural areas. We believe that on balance more lives would be saved if a reasonable delay were insisted upon than if the immediate introduction of compulsory pasteurisation were permitted to local authorities.

171. It is clear from the argument of the preceding paragraphs that the majority of our other recommendations are made on the hypothesis that a policy of eradicating tuberculosis from the dairy herds of this country is pursued vigorously.

PART 3.

RECOMMENDATIONS.

VIII.—ADMINISTRATIVE CHANGES RECOMMENDED.

(a) Veterinary inspection.

172. Routine veterinary inspection of dairy cattle should be made obligatory for all local authorities. If the veterinary service is to be developed a number of questions arise for decision. In the first place is the service to be carried out by the state or by local authorities? At present veterinary surgeons are extensively employed both by local authorities and by the Ministry of Agriculture. It is natural to suggest that the time when a considerable extension is being made in this service is propitious for a re-examination of the division of functions between central and local authorities.

173. The need for a high standard of administration and of uniformity of administration is universally admitted. It is argued, on the one side, that this standard may best be achieved and maintained by the establishment of a national veterinary service. Under such a national scheme the veterinary officers now employed by local authorities would be transferred to the Ministry of Agriculture, which would be solely responsible for veterinary inspection. It is claimed that, in this way, national uniformity of administrative practice would be secured, that the activities of existing administrative authorities could be effectively co-ordinated, and that administrative regions or districts could be constituted to meet the special needs of veterinary control. On the other side it is argued that the best method of procedure is to strengthen control by local authorities.

174. Those who favour an expansion of the existing local service also emphasise the importance of maintaining a high minimum standard of administrative practice throughout the country. They support their view by arguments that are partly general and partly specific. They point out that while the absence of any form of state co-operation or control may, and usually does, result in a multiplicity of standards of service it is precisely this type of administration that has revealed possibilities of advance and thereby gradually influenced public opinion and raised the general minimum standard for the country as a whole. Local administration enlarges the scope for initiative and experiment; it enlists active voluntary co-operation and provides greater opportunity for leadership on the part of the more progressive local authorities. Many of the existing public services have reached their present level of efficiency through such initiative and leadership. Central administration, on the other hand, is apt to be more impersonal in the case of services in which the personal element is valuable. In the modern state it is one of

the recognised functions of the central government to enforce uniform minimum standards of administration upon diverse local authorities, and this can be done without curtailing opportunities for local experiment and leadership. More specifically it is held that, as local authorities will continue to be responsible for the administration of existing acts relating to cattle, meat and milk, it would be a retrograde step to deprive them of responsibility for the inspection of herds and the administration of measures designed to eradicate disease.

175. Most of us agree* that the veterinary staffs of the local authorities should be expanded and that the local veterinary services should be placed upon the same footing as the public medical services. Chief veterinary officers should only be appointed or dismissed by local authorities with the approval of the Ministry of Agriculture in England and Wales. In Scotland their dismissal already is, and should remain, subject to the consent of the Department of Health. This suggested method is identical with the method already employed in the appointment of principal medical officers of health of local authorities. The Ministry of Agriculture should have the same powers and duties in relation to the veterinary services of local authorities as the Ministry of Health has in relation to the public health services of local authorities.

176. In the second place, we suggest that no veterinary officer should be eligible for appointment as a member of the local veterinary staff unless he possessed the qualification represented by the diploma of veterinary state medicine. There will in any case be a need for increased numbers of veterinary surgeons specially trained in research and preventive medicine, and it should therefore be arranged that the veterinary colleges should give greater facilities for those wishing to take this diploma. In this way it should be possible to provide a supply of veterinary officers of the requisite standard of attainment. Veterinary officers employed by the local authority for the purpose of this service should be eligible for benefit under the superannuation scheme for local government officers.

177. In the third place, the Ministry of Agriculture should contribute towards the maintenance of the veterinary service established by local authorities, the basis of contribution being the cow population within the controlled area (see paragraph 226). By virtue of this contribution the Ministry would be able to enforce the desired standard of local service in the manner indicated in our first suggestion.

178. Finally, we suggest that for the purpose of central co-ordination the country should continue to be divided into regions or administrative areas and that within each of these the Ministry of Agriculture should establish an administrative centre under the

* For a reservation by Sir Merrik Burrell, see page 99.

control of its own officer. The regional officer of the Ministry of Agriculture would act as liaison between the local authorities and the central department of the Ministry; he would be responsible to the Ministry for securing uniformity of administration within his own region; he would be the officer of the Ministry to whom application would first be made upon the outbreak of an epidemic in any part within that area. He would act in an advisory capacity in relation to local veterinary services and chief veterinary officers, in an administrative capacity as representing the Ministry of Agriculture and in an executive capacity upon the outbreak of an epidemic. If the general preference for local government, which is now observable in British administrative practice, were shown in the case of veterinary inspection, we believe that the scheme that we have outlined would secure better results than those likely to be achieved by any other scheme based upon a similar preference. But whatever form of organisation is adopted we are all of us of the opinion that the same veterinary officers should be responsible for the routine clinical inspection of dairy cattle and for the duties in connection with eradication discussed in paragraphs 186–205 below.

179. It has been suggested to us that the functions of sanitary authorities relating to the inspection of dairy premises under the milk and dairies orders might with advantage be transferred to county councils and executed through their veterinary officers concurrently with the routine clinical examination of cattle which we have recommended. It has been urged in favour of this proposal that the addition of these duties would place little, if any, extra burden upon veterinary officers, who would in any event be upon the spot, and might result in the saving of the time of the sanitary inspectors of sanitary authorities. An examination of this proposal has convinced us that the saving of the time of sanitary inspectors is likely to be unimportant, and that in any event sanitary inspectors must remain responsible for the structural condition of buildings, including the drainage and water supply. We have also found that in many urban districts the examination of dairy premises by sanitary inspectors is carried out much more frequently than would be the clinical inspection of cattle by veterinary inspectors. In some rural districts, financial considerations have prevented the appointment of sufficient sanitary inspectors to carry out adequately the duties lying upon them. But the provision of the present order, which allows these duties to be transferred by sanitary authorities to the county council, seems to provide a satisfactory remedy for this state of affairs. We recommend that the sanitary authorities themselves should consider taking advantage of this provision as soon as the veterinary service has been expanded. In any case, close co-operation should be established between the sanitary authorities and the veterinary service, especially in regard to the design of cow-houses and their modification when eradication is in progress. But we are of the opinion that the functions of sanitary authorities under the

milk and dairies orders should not be diminished. It may be observed that this question only arises in England and Wales. In Scotland the same authority is responsible both for the veterinary inspection of cows and for the inspection of dairy premises.

180. We have seen that the local authority for the purposes of the diseases of animals act in England and Wales is not always the local authority for the purposes of routine veterinary inspection. For certain boroughs other than county boroughs are constituted local authorities under that act. The total number of local authorities under the act is 309.* This is too great a dispersal of authority for the efficient and economical control of disease. We therefore recommend that the opportunity offered by the expansion of the veterinary service should be taken to transfer these powers under the acts, other than those relating to cattle market inspection, to the appropriate county councils.

181. We also recommend that in England and Wales the duty of testing herds with tuberculin for the purpose of the milk special designations order, which is now undertaken by the Ministry of Health, should be transferred to the expanded veterinary service. If this service is to be controlled by local authorities, though the actual standard would require to be laid down by the appropriate government departments in consultation, the granting of licences for the production of designated milk would also be made a function of county councils.

182. The functions of the veterinary service would, as a result of these recommendations, be as follows:—

(i) the present duties of veterinary inspectors of local authorities under the diseases of animals acts and orders issued under those acts;

(ii) The veterinary duties falling to be performed under the milk and dairies acts and orders, including the extension of the routine clinical examination of dairy cattle which would result from the amendment of the present orders so as to require that such examination should be made throughout Great Britain;

(iii) the testing of cattle with tuberculin for the purposes of the milk special designations orders;

* These are made up as follows:—

——	Administrative counties.	County boroughs and large burghs.	Other boroughs.	Total.
England	49	80	108	237
Wales	13	3	5	21
Scotland	30	21	...	51
Total ...	92	104	113	309

(iv) the duties placed upon veterinary officers under the scheme for the eradication of bovine tuberculosis which we describe hereafter;

(v) any functions that may be imposed upon them in connection with other diseases of livestock and poultry.

183. An important issue which remains to be decided concerns the employment of veterinary surgeons engaged in private practice as part-time veterinary officers of local authorities. At present the majority of county councils employ such part-time officers, even in some cases for the purpose of the routine clinical examination of dairy cattle. The experience of such counties, when compared with that of counties employing full-time officers, leaves no room for doubt that the employment of part-time officers is generally unsatisfactory. It is obvious that such part-time employment must not infrequently involve the officer in some conflict of loyalties, and whether from this or from other causes the experience of counties employing whole-time officers strongly confirms the view that the employment of such officers is more satisfactory. In view of the evidence on this point we are strongly of the opinion that whole-time officers should be employed wherever it is practicable. We do not, however, assert that the employment of whole-time men is practicable in every instance. In certain sparsely populated districts where there is not sufficient private practice to support a properly qualified veterinary surgeon, the withdrawal of the steady source of income which employment as the part-time veterinary inspector of a local authority represents to the local practitioner, would probably have the result of forcing him to seek employment elsewhere. The ordinary veterinary facilities would consequently be lost to the district, with unfortunate results to the local agricultural population. In order to guard against this contingency, we recommend that the veterinary inspectors appointed by local authorities for the purposes set out in paragraph 182 should be whole-time officers, and should not be engaged in private practice except in those districts in which the Minister of Agriculture, if the district in question is in England and Wales, or the Department of Agriculture for Scotland, if it is in Scotland, has certified that by reason of the difficulty of securing adequate veterinary facilities, the agricultural interests of the district would be likely to suffer if a whole-time officer were appointed. The employment of part-time veterinary officers should also be permitted as a temporary measure during the period of reorganisation. Some witnesses have urged that the appointment of a whole-time staff of veterinary surgeons would be detrimental to the interests of veterinary practitioners generally. We do not accept this view, as the advice given by veterinary surgeons in the public service, by directing the attention of the farmer to the incidence of disease in his animals, tends to make him call in his own veterinary surgeon more freely for the purpose of treatment. Moreover, until the public veterinary service is fully established, many of the duties of local authorities,

such as cattle market inspection, should continue to be discharged by private practitioners.

184. A veterinary service with the duties which we have outlined above cannot be established immediately. We assume that one veterinary officer would be required for 10,000 dairy cattle. The number of inspections that would be possible annually on such a basis would vary in different parts of Great Britain. In Scotland, where cattle are kept indoors for a longer part of the year and can therefore be more readily inspected, a minimum of three inspections should be possible. In England and Wales it might not be possible to inspect so frequently, though a minimum of two inspections annually should be maintained. On the above basis a total force of some 300 veterinary inspectors would be required. Veterinary inspectors would also be required for the work to be undertaken in connection with the eradication of tuberculosis, to which we subsequently refer. At present we understand that the number of veterinary surgeons who enter the profession every year is only enough to fill the places of those who retire. The gradual replacement of part-time veterinary officers by whole-time officers will release a number of qualified veterinary officers for public service. For at present many veterinary surgeons with an extensive private practice are obliged to employ assistants as a result of the calls which their public duties make upon their time. But it is not likely that so many veterinary surgeons could be withdrawn from the ranks of those engaged in private practice without causing a serious shortage and without the offer of a salary well above the level at present in force. We do not doubt that students of a good type will offer themselves in adequate numbers for veterinary training once it is fully realised that, on the expansion of the veterinary service, an attractive career will be open to those joining the service. But it will be impossible to attain immediately to the general standard which is ultimately to be hoped for. The shortage of veterinary surgeons may be relieved, at any rate to some extent, by the employment under their supervision of trained, but unqualified, laboratory assistants for some of the laborious routine duties which at present engage so much of the attention of veterinary officers.

185. The expansion of the veterinary service would have the advantage that the local authorities would be able to co-ordinate its activities with their own agricultural services. In particular, their agricultural educational staffs would be able to carry out an intensive instructional campaign among farmers in regard to the importance of the segregation and correct feeding of calves and young heifers and, generally, of caring for them under hygienic conditions. Co-operation on these lines between the veterinary and agricultural staffs would be of great value and would play an important part in the prevention of the occurrence of disease.

(b) A scheme for the eradication of bovine tuberculosis.

186. We have seen that the only remedy, even tolerably complete, for the condition into which our dairy industry has been allowed to fall, is the complete eradication of bovine tuberculosis from the herds, and that there is need for immediate action. The limiting conditions of such action at the outset are the lack of trained veterinary staff and the shortage of healthy cows available to replace those infected. The uncoordinated initiative of individual farmers under the stimulus of higher prices for pure milk at a rather distant future will not of itself create the necessary conditions for any general advance. It is therefore essential in our view that the Ministry of Agriculture, as the central authority in England and Wales, should take an active hand in planning and subsequently in directing the campaign for eradication, especially in its early stages. Apart from more veterinary officers, the primary necessity is to stimulate the breeding of clean young stock in suitable districts for sale to farmers whose herds, in the national interest, ought to be cleaned up first. These are first the breeding herds most suitably situated for eradication and, next, the producer-retailer herds nearest the great cities in which the call for pasteurisation is most urgent. It is necessary that the right farmers (and perhaps to some extent their landlords) should enter zealously into these operations. This cannot be accomplished by compulsion. Relatively large sums will be required in many cases for the purchase of clean stock and for the provision or adaptation of buildings, &c., for segregation of infected cows temporarily retained, and for new comers bought in, for even if purchased from tuberculosis-free herds they will require at least two months' quarantine before re-testing for final acceptance. Though the necessary capital will prove to be within the power of many to provide, the state should be prepared to give temporary financial help, on easy terms, in cases of proved necessity. At the same time, any farmer who is prepared to find the capital for himself should be encouraged to eradicate without state financial assistance, finding his reward by realising earlier a higher price for his milk or, in the case of breeding herds, the good prices at which, under the stimulated demand, he will sell his young stock. But in the interests of the progress of the scheme as a whole, it will be necessary at the beginning to give to the herds specially selected for assistance, a prior claim to the services of the limited veterinary staff available. Our terms of reference do not admit of our dealing with the problem of tuberculosis in beef cattle. Owing to the way in which such cattle are reared, the incidence of the disease among them is probably lower than among dairy cattle, though where climatic conditions compel the housing of the cattle in winter it is by no means negligible. Where calves are reared on unpasteurised skimmed milk from creameries, tuberculosis among them is common. When most of the dairy herds have been freed of tuberculosis and the problem is to clear up the remainder, the question of beef herds will also have

to be faced. For otherwise there would be no end to the trouble and expense of double boundary fences, and to the risks of infection at shows, sales, markets, and in transit. The owners of dairy herds would thus never reap the full reward that they would have earned, and would always have the fear of the re-infection of their herds hanging over them.

187. The scheme which we have outlined in previous paragraphs of this report for the eradication of bovine tuberculosis consists of six parts :—

(i) the institution of a list of tuberculosis-free herds (accepted herds) tested with tuberculin from time to time under official supervision, and declared to be free from bovine tuberculosis;

(ii) the provision of free advice and free tuberculin testing for approved owners of herds who agree to make *bona fide* efforts to free their herds from tuberculosis or who have established free herds;

(iii) financial help where necessary by way of loans or the guarantees of loans to approved owners for the purpose of undertaking expenditure required by the veterinary inspector as necessary to eradication;

(iv) the securing to owners of disease-free herds of a higher price for their milk than that obtained by other owners;

(v) the taking of administrative measures designed to secure that tuberculosis-free cattle from accepted herds should be moved about the country and exposed for sale without running the risk of being brought in contact with other cattle;

(vi) the adjustment of regulations governing the production of graded milks and the grades of milk officially approved, and the making of regulations relative to the compulsory pasteurisation of milk with a view to increasing the incentive to farmers to eradicate tuberculosis from their herds.

188. The principal proposal advocated before us as part of an eradication scheme which we have not adopted is, the constitution of tuberculosis-free areas. We have rejected this for reasons fully set out in paragraphs 141 and 142.

189. We recognise that the progress of eradication is likely to be checked in the areas where it is most needed unless special assistance is given to farmers to enable them to defray the initial expenditure required. This may take the form of expenditure on the adaptation of buildings (in which case the landlord may also be concerned) or on the replacement of infected by clean animals. The latter consideration is particularly important in the case of producer-retailers who under our scheme will need to complete the process of eradication within a period of five years.

190. We discuss later the provisions relating to the compulsory pasteurisation and grading of milk. The others might be carried into effect by the following measures. In the first place the Milk Marketing Boards should be required by statute to pay to the owners of accepted herds a bonus at a rate per gallon to be determined from time to time by order of the Minister of Agriculture. The funds from which this bonus would be paid should be secured by a levy on all milk sold whether through the boards or by producer-retailers.

191. We contemplate that the government would announce the general principles on which they proposed to base their policy of eradication and would indicate the conditions on which they would be prepared to offer special assistance. Those farmers who volunteered to undertake eradication and whose situation was such that the conditions laid down by the government scheme were complied with in their case would be entitled to ask the local authority to enter into an agreement on the following lines. The farmer on his side would undertake—

(*a*) to pay for the testing of his herd by the local authority at six-monthly intervals with approved tuberculin at a standard charge to be laid down by the Ministry of Agriculture;

(*b*) to take all reasonable steps to carry out the directions of the veterinary inspector of the local authority relating to the freeing of his herd from tuberculosis;

(*c*) to obey the regulations issued by the Ministry of Agriculture and Fisheries relating to supervised herds.*

192. The local authority would undertake—

(i) to test the farmer's herd with approved tuberculin at six-monthly intervals;

(ii) in the event of his having fulfilled the conditions of the contract to the satisfaction of the local authority, to refund the sum received in payment for the testing of the herd with tuberculin at the time of the next test.

(*Note.*—In the event of a local authority withholding the payment, the farmer should be given the right to appeal to the Minister of Agriculture for a declaration that he had carried out his contract.)

193. The local authority would be free to refuse to enter, or to defer entering, into an agreement on the above lines on the grounds that the herd or its situation did not comply with the general principles of the government scheme (including the limitations of finance) or was so situated or so managed that there was no early prospect of eradicating tuberculosis from it at a reasonable cost.

194. We have suggested that the payment for tuberculin testing should be made subject to the farmer taking reasonable steps to

* For the definition of "supervised herds," see paragraph 196.

carry out the advice of the veterinary inspector for six months in order that payment should not be made for the testing of a herd the owner of which is not prepared for any reason to proceed with eradication. If for any reason a local authority should decide to discontinue its assistance to an owner with whom it had entered into an agreement, it should be obliged to repay immediately the charge for the testing of the herd which would otherwise be repayable at the close of six months from the time of testing.

195. Any farmer would of course be free to undertake eradication at his own expense and without the advice of the veterinary inspector. He should be entitled to require the local authority to test his herd, if he could produce *prima facie* evidence of freedom from tuberculosis, though he should be liable for the cost of such testing at the standard rate of charge. On passing two successive tests at an interval of six months, his herd should become an accepted herd (see paragraph 197 below) and he would be entitled to all the privileges of other owners of accepted herds.

196. Herds the owners of which entered into such agreements with local authorities would be known as supervised herds. The Ministry of Agriculture and Fisheries would issue rules governing the introduction of animals into such herds. The veterinary inspector of the local authority would give directions on such subjects as the isolation of reacting animals, the disinfection of buildings, the management of the herd with the object of preventing the spread of infection, and the segregation or sale of reacting cattle.* The sanitary regulations for temporary buildings for the milking of cattle in a supervised herd should be somewhat less rigorous than those required of more permanent buildings, as it is important that they should be constructed as cheaply and lightly as is compatible with public health. These regulations should be determined by the departments of health and agriculture acting in consultation.

197. Any supervised herd which passed two consecutive tests would become an accepted herd and would remain an accepted herd until a tuberculous animal was revealed, either at one of the periodic tests referred to later, or otherwise. The Ministry of Agriculture and Fisheries would maintain lists of accepted herds and would arrange for them to be published on a county basis from time to time. The owner of an accepted herd would receive from the local authority a certificate of freedom from disease which he would be able to show to prospective buyers. The Ministry would also issue regulations governing the management of accepted herds, especially with regard to the introduction of animals into, and the periodic re-tests of, such herds. The regulations regarding the frequency of re-tests would

* For an example of rules which have been drawn up for the management of a herd in which an attempt is being made to eradicate bovine tuberculosis, see appendix 12.

vary from district to district in accordance with the disease situation in each, but at the outset such tests should be made once every six months.

198. The principle underlying the regulations governing the introduction of animals into both supervised and accepted herds would be to prohibit the introduction of all animals except healthy animals from accepted herds. Until, however, a considerable number of accepted herds existed, this would be equivalent in many cases to the complete prohibition of the introduction of animals from the outside into a supervised herd. There is, indeed, much to be said for such a prohibition; but it would be necessary to relax this rule during the early stages of the eradication scheme and to admit cattle to the farm that pass the test, on the understanding they would not be admitted to the clean herd till they passed a second test at an interval of at least two months.

199. In addition to specifying the sources from which animals introduced into accepted and supervised herds should be drawn, the regulations would also govern the movement of such animals. They would prescribe that these animals should only be moved directly from one accepted herd to another, or from an accepted herd to an accepted market, or from an accepted market to an accepted herd, and that they should only be moved in vehicles either devoted exclusively to the carriage of similar animals or specially disinfected. Experience would doubtless suggest directions in which such regulations needed elaboration and extension. But we believe that it will prove possible to secure such cattle from the risks of infection while being moved, without subjecting the trade to a mass of impossible regulations. As the scheme of eradication develops it will become necessary to make stringent regulations governing the importation of breeding cattle from overseas.

200. An accepted market would be a market or part of a market confined to the sale of healthy cattle from accepted herds brought there in accordance with the regulations of the Ministry of Agriculture. The Ministry would also issue regulations for the conduct of accepted markets.

201. In the event of reacting cattle being discovered in an accepted herd in the course of a periodic re-test, the herd would immediately relapse to the position of a supervised herd. It might, however, be provided that if the reactors numbered less than, say, ten per cent. of the herd, if they were immediately removed from the herd and disposed of, and if, at a re-test, completed ninety* days after the reactors had been removed, no further reactors were found, the herd might regain the position of an accepted herd.

* As the technique of testing improves, it may be possible to shorten this period.

202. It is essential that the personnel of a farm where eradication is in progress should be perfectly healthy. A number of cases of tuberculosis of the lungs caused by bovine tubercle bacilli have recently been discovered among persons in attendance on cattle. Reinfection of an accepted herd might readily be brought about through the agency of the sputum of a man so affected.

203. We also recommend that where the owner of an accepted, or supervised, herd is forced to erect an extra fence against the cattle of his neighbour (that neighbour not owning a supervised or accepted herd but being the owner of the boundary fence) he shall be entitled to claim the reasonable cost of such fencing from his neighbour who has failed to fence against his own cattle. This does not refer to any fence that he may erect to prevent contact through, or over, a boundary fence if in a proper state of repair.

204. We also recommend that a clause should be inserted in all contracts for the sale of milk indemnifying the seller if, by reason of his having disposed of diseased cattle on the direction of the veterinary inspector, the quantity of milk delivered falls below the prescribed minimum by an amount not exceeding that yielded by the cows at the time of such disposal.

205. The functions to be performed in England and Wales in regard to eradication by the Ministry of Agriculture should, in Scotland, be performed by the Department of Agriculture for Scotland.

(c) Regulations governing the grading of milk and pasteurisation.

206. Milk grading may be either permissive or compulsory. In Great Britain it is at present permissive. The federal milk ordinance in the United States provides an example of compulsory grading. If the object of grading is to establish a market for special qualities of milk at higher prices than those at which the great bulk of the milk is sold, then permissive grades are likely to be at least as effective as compulsory grades. But if the object of grading is to improve the standard of milk consumed, then this object is likely to be more quickly achieved by the adoption of a system of compulsory grading. For in this way the comparative advantages of the different grades of milk are brought more directly to the attention of the public. We therefore recommend that all milk sold for consumption in liquid form should be required to be sold under an official designation. The grade of the milk should be clearly marked on the bottle or other vessel in which it is sold to the public, a distinctive colour being prescribed for marking each designated milk. It should be a condition of the sale of any liquid milk that a fixed standard of cleanliness, or pre-pasteurisation standard, should be attained at the farm. This standard should approximate to that at present required for grade A milk. To this recommendation we attach great importance. For we do not believe that the general

cleanliness of milk would be improved by the proposal contained in a recent scheme to offer a bonus to selected producers, to be known as accredited producers, who attain a standard of cleanliness which is within the reach of, and should be made compulsory on, all producers. In addition to attaining this standard of cleanliness on the farm, all milk sold for liquid consumption should conform to one or other of the designations which we recommend.

207. The four following designations alone should be recognised in place of those already existing:—

(i) **Certified milk,** namely milk which has not undergone any process of heat treatment and is derived from tuberculosis-free herds. These are either herds accepted under the eradication scheme described in the preceding sub-section, or herds which have been accepted up to the time of the preceding test provided in the latter case that (*a*) all reacting cattle had been removed from the herd immediately after the test, and (*b*) the immediately preceding test had been completed not more than ninety days before the date of production of the milk sold as certified. This milk should not be required to be bottled on the farm.

(ii) **Pasteurised milk,** namely milk which has undergone once only a process of heat-treatment approved for this purpose by the Ministry of Health and in Scotland by the Department of Health for Scotland, and has undergone no other process of heat-treatment. Pasteurisation should be permitted only in a plant licensed for the purpose.

(iii) **Sterilised milk,** namely milk which has been raised to the boiling point or higher* in a plant licensed for the purpose and which has undergone no other process of heat-treatment.

(iv) **Milk (uncertified),** namely milk which has undergone no form of heat-treatment, and is not derived from tuberculosis-free herds, but which attains a certain hygienic standard.

We exclude from our definition of certified milk any requirement that it should be bottled on the farm, on the ground that this is a provision of only secondary importance to public health, but one which adds materially to the costs of production. Our major concern is to provide a grade of raw milk which is reasonably safe and at the same time not beyond the means of the consuming public.

208. We further recommend that no milk which has been held in any vessel containing more than 100 gallons of milk unless derived from a single herd should be sold for consumption in liquid form unless it has subsequently been pasteurised.†

* In some modern plants, the temperature is raised to 224° F.

† The bulking of milk in smaller quantities may, indeed, be dangerous, especially if the vessel used is not sterilised before further milk is added to it each time milk is removed from it. In addition, any bulking which has the effect of confusing the milk from one farm with that of another makes the identification of the source of disease more difficult.

209. Finally, we recommend that the council of any county borough or municipal borough, large burgh, or urban district, the population of which exceeds 100,000, and the London County Council shall have the right to prohibit the sale of milk (uncertified) as defined in paragraph 207 (iv) above after a date which shall be not earlier than five years after the initiation of the scheme of eradication described in the preceding sub-section, provided that it has given not less than two years' notice of its intention to do so. We have suggested that this right should be confined to the larger local authorities in the first instance, on the ground that the policy we recommend is necessarily experimental, and if applied haphazard by the smaller local authorities, might cause considerable hardship to particular groups of farmers. If, however, experience should show that this policy is successful in promoting indirectly the eradication of bovine tuberculosis, we believe that the minimum size of town required of local authorities before the right to prohibit the sale of uncertified milk is allowed might gradually be reduced.

210. If pasteurisation is to be officially encouraged, as it would be under the regulations which we have recommended, it is essential that every precaution should be taken to ensure that the process is carried out in a way which makes it the greatest possible safeguard to human health. At present sanitary authorities are charged with the duty of inspecting pasteurising plants. We have evidence to the effect that this duty is not in all cases effectively carried out. For example, we have been told in evidence of a licensed plant in which *inter alia* milk which had not been pasteurised was leaking into milk which had been pasteurised. This indicates perhaps as fundamental an error in the construction of the plant as it is possible to conceive. Inspection which overlooks such errors is clearly inadequate. The duties of sanitary inspectors should be made more precise.

211. The pasteurisation of milk to be sold under the order should only be permitted in plants, the design of which has been officially approved, which have themselves been tested on erection to ensure that they conform to the approved design, and which are frequently inspected during working by an officer of the sanitary authority, who should apply prescribed tests and record the results at each visit. The authority responsible for approving the design of plants should act only after consulting the National Physical Laboratory. It might also be desirable to require certain qualifications of the person operating the plants.

212. An essential feature of such a plant is a mechanism producing automatically whenever the plant is worked a time and temperature chart, secured from all interference and accessible only to the inspector. It is needless to dilate upon the temptations which must arise when some accidental delay makes it important to the owner of the plant to reduce the time at which milk will be ready for delivery, or in other ways to tamper with this silent witness.

(d) Recommendations in regard to diseases of cattle other than tuberculosis.

213. We have, for reasons given in paragraph 148, confined our principal recommendations to measures directed against bovine tuberculosis. Although for the reasons there explained, we are of the opinion that the time is not ripe for the launching of a comprehensive attack upon the other diseases of cattle, there are certain points in connection with them upon which we desire to submit recommendations.

214. The chronic streptococcal form of mastitis can be controlled in herds where it is prevalent only if laboratory tests are made of the milk of each of the cows so as to reveal those cases which, though capable of spreading infection, have not developed clinical symptoms. It is, therefore, essential that adequate facilities should be provided for farmers whose herds are suffering from this complaint to have such tests carried out. We recommend that the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland should examine the existing laboratory equipment and scientific personnel devoted to veterinary preventive medicine in England and Wales, and Scotland respectively, and to take such steps as are necessary to secure that this service is available to farmers through their veterinary advisers in return for the payment of a fee to cover the cost.

215. The most pressing need in the control of Johne's disease is the perfection of the technique of diagnosis. Important progress has been made in this direction in recent years, and we recommend that the Agricultural Research Council should press on as rapidly as possible with their programme of research into this disease. The recent indications that this disease is on the increase gives an added urgency to this recommendation. Once the infected animals can be detected in the early stages by a reliable diagnostic, it will be possible by at once weeding out the advanced cases and by segregating and fatting those not yet showing clinical signs to clean the herd up without much expense to the farmer.

216. The various problems connected with contagious abortion are at present under examination by a committee on *Brucella abortus* infection in animals and man appointed in May 1932 by the Agricultural Research Council in consultation with the Medical Research Council. We understand that important progress has been made by this committee in carrying out a thorough investigation into the various problems that this disease presents; and in particular that they are concentrating their attention on devising a method for its eradication. We consider that this is a question of great economic importance to the farmer and we recommend that this committee should be given through the Agricultural Research Council every possible facility for the completion of its programme.

217. We consider that these three diseases fall into a different category from tuberculosis, inasmuch as they cause severe direct pecuniary loss to the farmer and are of less importance to the consuming public. The farmer does not feel the wastage in his herds from tuberculosis so acutely, though the disease is of great importance to public health. The technical assistance referred to already, together with the advice and guidance of the veterinary officers during their routine examinations of the herds should be sufficient to enable the farmer to eradicate these diseases. In the case of tuberculosis, however, he can never, in our opinion, successfully undertake eradication without assistance from the state.

(e) Miscellaneous recommendations.

(i) The relation of the research conducted by the Milk Marketing Boards to that conducted by government.

218. The establishment of the Milk Marketing Boards, with powers to expend money upon research into questions affecting the production of milk, raises an important question regarding the organisation of agricultural research in Great Britain, and as diseases of animals are among the most important subjects of investigation, we feel that this is a matter that may properly be raised in our report. We hold that it is of the first importance that the co-ordination of Government-assisted research on this subject, which is effected by the Agricultural Research Council, should in no way be weakened. We therefore recommend that the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland should invite the attention of the Milk Marketing Boards to the fact that it is the policy of the Government that research should only be undertaken after consultation with, and with the concurrence of whichever is the appropriate council of the three research councils (the Advisory Council for Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council) now established under the Lord President of the Council; and should invite the Boards to adopt the principle that their funds should be expended on research in regard to dairying and animal diseases, only after consultation with the Agricultural Research Council and in a manner that will not conflict with the schemes of research already in progress.

(ii) The standardisation of tuberculin.

219. Tuberculin for the testing of cattle is at present prepared by a number of different private firms. Many of these products are of a good quality; but in the absence of a standard of prescribed potency and purity it is only natural that some less satisfactory products are on the market, with the result that the efficacy of the tuberculin test is called in question. There is, however, the further important

argument in favour of standardisation that the interpretation of the test would be more accurate and the results obtained more readily comparable if all tuberculin were of standard strength and quality. We find ourselves in full agreement with this point of view, and we consequently recommend that the Ministry of Agriculture and Fisheries should approve a standard for tuberculin and should provide that it should be sold only to qualified veterinary surgeons. We understand that the Joint Tuberculosis Committee of the Medical Research Council and Agricultural Research Council has recommended to the Ministry of Health the use of a new synthetic tuberculin. If this new product is officially recognised as an improvement, it should be accepted as providing the required standard.

(iii) Proposed extension of powers of local authorities.

220. We have received a considerable amount of evidence that it is not uncommon for cattle which should have been reported under the tuberculosis order to be sold to dealers and knackers. It is suggested, and indeed a number of instances have been submitted to us in support of this suggestion, that dealers and knackers sometimes dispose of cattle or meat, which should properly be condemned, through irregular channels for human consumption. We are not in a position to say how widespread this practice is, but we are satisfied that it is sufficiently prevalent to call for an amendment of the law. We recommend that the police, and sanitary officers of local authorities and all veterinary officers in public employment should be given the right of access to dealers' and knackers' premises, and the right to require information upon the source from which cattle are received and the destination to which cattle and carcases are despatched. The adoption of this recommendation would we believe provide an important safeguard against this practice and would block an improper channel for the disposal of such cattle and meat.

IX.—THE FINANCIAL EFFECT OF THE MEASURES RECOMMENDED.

221. The measures which we have recommended involve expenditure under the following headings :—

(i) expansion of the veterinary service and its necessary laboratory equipment to undertake the routine clinical examination of dairy herds, and the work in connection with the eradication of tuberculosis which we have recommended;

(ii) the testing of supervised and accepted herds with tuberculin;
(iii) the provision of a bonus upon the milk produced in accepted herds;
(iv) the actual costs of eradication, *e.g.*, the cost of the replacement of reacting cattle with clean cattle.

In addition, as the law now stands, there would, as a result of more frequent veterinary inspection, be larger claims for compensation under the tuberculosis order.

222. An estimate can be made of the increase in expenditure which would arise from the extension of the existing veterinary service for the purposes of routine inspection. The routine inspection of reasonable frequency would cost for the whole of Great Britain between £250,000 and £300,000 per annum and the net cost of compensation under the tuberculosis order would probably rise to between £80,000 and £90,000 per annum. To-day local authorities are probably spending over £100,000 per annum on administering the milk and dairies orders and the tuberculosis order, and the Ministry of Agriculture has to find between £50,000 and £60,000 per annum for compensation under the tuberculosis order. There would thus be an increased cost under these two headings of about £200,000 per annum. If, in accordance with our later suggestion, compensation is no longer paid for cattle slaughtered under the tuberculosis order, this sum would be reduced by between £80,000 and £90,000.

223. Most of the new expenditure, however, would be determined by the degree of support given by farmers to an eradication scheme, which it is impossible to estimate in advance.

224. The burden of this expenditure must be divided between the farming community, the milk industry as a whole, and those who contribute either as taxpayers or ratepayers to national and local funds. The recommendations which we have already made have the following effects:—

(*a*) the farming community would be responsible for the costs incurred in eradication with the exception of the costs of tuberculin testing and general veterinary advice. The state or the local authority, however, would in cases of necessity make advances to meet this expenditure, repayable over a reasonable period;
(*b*) the milk industry as a whole would be responsible for finding the sum required to pay the bonus on milk produced in accepted herds;
(*c*) the costs of the increased veterinary services and laboratory work and of free tuberculin testing, would be met from national or local funds. Loans to farmers for the purpose of eradication would either be made from the same source, or under the guarantee of the state or local authority.

225. We do not, however, consider that the state should continue to bear the cost of compensating the owners of tuberculous animals slaughtered under the tuberculosis order. The evidence before us suggests that the payment of this compensation has had little effect in inducing farmers to report cows for slaughter, and that it would have been of little advantage had they done so. It is also anomalous that compensation should be paid for the slaughter of an animal which is debarred by law from being put to profitable use, on the grounds that its product is dangerous to public health. The extension of routine veterinary inspection would remove the only ground on which this payment can be defended, namely, that it is an inducement to comply with a law which could not otherwise be enforced. We are, therefore, of the opinion that the payment of this compensation should cease, except in those cases where the animal proves on post mortem not to be infected with tuberculosis. It is clearly desirable that the end of compensation should coincide with the grant by the government of substantial help in the eradication of tuberculosis. We realise, however, that in view of the present crisis in the dairying industry it may not be practicable to take this step immediately. Even if the local authority ceases to pay compensation for cattle slaughtered under the order, it may be desirable that the ownership of cattle condemned should continue to be vested in it. In that event, the salvage money received for the carcase would be payable to the farmer.

226. The extension of the veterinary inspection of dairy cattle, if carried out by local authorities, would impose a very serious burden upon certain authorities. For a large part of the dairy herds of this country happen to be situated in the areas administered by comparatively poor county councils. The rateable value per cow in each county is a measure of the financial resources which are available to meet the cost of veterinary inspection. We give particulars on this point for each administrative county in Great Britain in appendix 13. The rateable value per cow varies from £6 in the case of Cardigan to £413 in the case of Surrey and £2,200 in the case of Middlesex. An expenditure of two or three shillings a cow which in the latter cases represents a quite negligible addition to the rates, in the former would be severely felt. It is therefore essential if this service is to be carried out adequately by all authorities that the Exchequer should make a contribution to local authorities and that this contribution should be apportioned among the various counties in such a way that those on which the burden would be most severe would benefit the most.

227. We have recommended that the cost of tuberculin testing should in the first instance be met by farmers who would pay a standard charge determined by the Ministry of Agriculture. This charge would be calculated to cover the average cost of veterinary attendance during testing as well as the cost of tuberculin used. It is

to be repaid to farmers by local authorities at the close of six months. Considerations similar to those set out in the preceding paragraphs have led us to recommend that local authorities themselves should be entitled to recover these repayments or at least a substantial part of them from the Ministry of Agriculture.

228. The loans to farmers for the purposes of eradication should be made on such terms that after making adequate allowance for possible bad debts, there should be no loss to the authority making or guaranteeing the loan. But if such a loss should occur, it should be appropriately divided between the local authority and the Exchequer.

PART 4.

SUMMARY OF PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS.

(a) Principal conclusions.

229. We summarise our principal conclusions as follows :—

The present system of milk production and supply.

(1) The dairying industry is of great economic importance, and the reduction of disease on a considerable scale would be a material gain for the nation (paragraph 11).

(2) The milking life of a dairy cow is only half that which might be expected under ideal conditions, with the result that there is an annual loss to the nation of over three million pounds. Fifty-eight per cent. of the cows passing out of herds are disposed of on account of disease, and the loss of many of the remainder is indirectly attributable to disease. The four principal diseases are bovine tuberculosis, contagious abortion, mastitis and Johne's disease (paragraphs 12–18).

(3) The proper feeding and care of dairy cattle are of the greatest importance, and Government should bring education to bear in this field. The chance that a cow will encounter infection depends on housing conditions, methods of management, and the extent to which cattle come into contact with animals from other herds. When cattle are bought into the herd, there is great risk of infection, especially when they pass through an open market. Herds and districts are specialised, to a greater or less extent, some in the production of milk and others in the rearing of young stock. This specialisation makes considerable movements of cattle inevitable (paragraphs 19–25).

(4) Milk reaches the consumer through a variety of channels. At one end of the scale there is the large concern in large towns that buys in bulk, and at the other the producer-retailer, selling direct to the consumer the milk that his own herd produces. Between these extremes there lie a number of intermediate types. The producer-retailer and the large distributor are in competition on the circumferences of the largest towns and throughout towns of large, but not the largest, size (paragraphs 26–28).

Cattle diseases.

(5) The incidence of bovine tuberculosis among cows is probably as high in Great Britain as anywhere else in the world. Cattle may be shown to be infected with it by their reactions to tests with tuberculin. At least 40 per cent. of cows are infected with it in such degree that they will react to the tuberculin test. Infected cattle, even at an early stage of disease, excrete tubercle bacilli in great numbers. Calves born from infected mothers are nearly always free from the

disease. Immunisation is not to-day of any importance in the control of tuberculosis (paragraphs 29–34).

(6) Cattle are probably infected with contagious abortion in as great numbers as with tuberculosis. The disease does not cause death, but is responsible for very serious loss to farmers by causing the loss of calves and of milk and by rendering animals sterile. Living animals may be shown by a blood agglutination test to be infected. Herds may achieve a comparatively high degree of immunity from this disease, either naturally or as a result of vaccination. Vaccination can usefully be adopted if the total eradication of disease by segregation is impracticable; but, if a living virus is used, vaccination should only be adopted in dealing with heavily infected herds (paragraphs 35–40).

(7) The incidence of Johne's disease varies greatly throughout the country. In some districts it is increasing and is causing considerable anxiety. It results in emaciation and, finally, in death. There is not yet a reliable agent for the diagnosis of the disease before clinical symptoms appear. There is no known cure (paragraphs 41–43).

(8) Thirty per cent. of the milking cattle in this country are probably infected with mastitis other than tubercular mastitis. Chronic streptococcal mastitis is responsible for 90 per cent. of the cases. It gradually reduces the milk-producing powers of the infected animal (paragraphs 44–48).

Diseases in man associated with cattle diseases.

(9) The diseases of dairy cattle which are dangerous to man are bovine tuberculosis, contagious abortion, which is responsible for undulant fever, and those forms of mastitis which may cause the epidemic diseases that are associated with streptococcal infection. Milk originally pure may convey disease as a result of subsequent infection (paragraph 49).

(10) Bovine tuberculosis is responsible for over 2,500 deaths annually among the human population in Great Britain, and for a still greater amount of serious illness. Most bovine tuberculosis in human beings is attributable to milk. At least 5 cows in every 1,000 yield milk infected with tuberculosis. As the result of the mixing of such milk with pure milk, over 5 per cent. of samples from individual herds are infected. A very much larger percentage of the milk conveyed in large containers is infected. The degree of infection of milk when retailed is affected by the extent to which it has been treated. In London, an investigation by the London County Council showed that 3·2 per cent. of samples of milk retailed are infected. In the four large cities of Scotland the corresponding percentage has been estimated at 5·26. The bulking of milk is more likely to increase than to decrease the risk of infection to man (paragraphs 50–57).

(11) Undulant fever, the disease associated with contagious abortion in cattle, is very rarely reported in Great Britain, though possibly the disease often passes unrecognised. Though it is

important that farmers should not relax their efforts to reduce the extent to which their herds are infected with abortion, it is doubtful whether any measures that are practicable can be taken to reduce the incidence of undulant fever in man (paragraphs 58, 59).

(12) Approximately 100 outbreaks of epidemic disease, attributable either to mastitis among cattle or to subsequent infection of milk by those handling it, have been recorded in this country since 1903. The most important outbreak occurred at Hove in 1929, when 1,000 families were affected and 65 deaths occurred. The most common epidemic diseases carried by milk are scarlet fever, enteric fever, diphtheria, paratyphoid and septic sore throat. The reported outbreaks have not contributed much to the total incidence of the diseases in question, but the possibility that infection through milk is more extensive than appears from the outbreaks reported cannot be ruled out. The organisms responsible for these infections multiply rapidly in milk, and the bulking of milk contributes enormously to the chances of infection (paragraphs 60–62).

Milk in human diet and the effects of pasteurisation on it.

(13) Milk holds a unique position amongst the foods of animal origin, as it contains the three proximate principles of a diet, protein, fat, and carbohydrate, in addition to an adequate supply of inorganic constituents in such proportions as to be peculiarly adapted for the period of active growth. Cow's milk is not the ideal nutriment for the human infant, as milk secreted by the female of any species is peculiarly fitted for the rate of growth of the young of that species. Although mother's milk is unquestionably the best for the infant, cow's milk can be counted as a good substitute, provided that it is pure (paragraphs 63–71).

(14) The evidence available to-day leaves the conviction that any recognisable changes of quality induced in milk by pasteurisation rightly conducted are too small to outweigh the great advantage inherent in the protection from infection which the treatment secures and in the public confidence it inspires. It is sometimes suggested that there may be subtle changes not revealed in the state of present knowledge, but policy should not be influenced by vague possibilities which established evidence makes improbable (paragraphs 72–98).

(15) Children reared on milk should be supplied with fruit juice, whether the milk is raw or pasteurised. The custom seems now to have become common, though not universal. Through the winter, it is also highly desirable that cod liver oil should be administered in small doses to children under twelve months reared on cow's milk (paragraphs 99–101).

Administrative measures in force in regard to cattle diseases and the milk supply.

(16) The tuberculosis order of 1925 requires that animals yielding tuberculous milk or showing clinical signs of tuberculosis should be

notified to the local authorities, and by them slaughtered, subject to the payment of compensation. In recent years, the number of animals slaughtered under this order are between 15,000 and 19,000, and the compensation paid has amounted to between £60,000 and £70,000 a year, exclusive of the cost of administration (paragraphs 102–113).

(17) Under the epizootic abortion order of 1922, certain specified precautions must be taken against bringing cows which have aborted into contact with other cattle. This order is generally considered ineffective (paragraphs 114, 115).

(18) The principal effect of the acts and orders affecting the production and sale of milk is to require that the milk of a cow recognised to be diseased should not be sold, to give power to local authorities to appoint veterinary inspectors, who must examine herds in certain circumstances, and to define special grades under which milk may be sold (paragraphs 116, 117).

(19) In Scotland, all dairy herds must undergo a clinical examination at least once every year, and in many parts herds are inspected three or even four times a year. In England and Wales the position is less satisfactory. Though in some counties routine clinical inspection is undertaken, this is not compulsory, and experience shows that the execution of the minimum requirements of the order does not reduce the degree to which milk is infected with tuberculosis (paragraphs 118, 119).

(20) There are four kinds of milk officially recognised under the milk (special designations) orders, namely:—

(a) certified milk, or milk from herds free from tuberculosis, which is bottled on the farm;
(b) grade A tuberculin-tested milk;
(c) grade A milk;
(d) pasteurised milk (paragraph 120).

(21) Less than 1 per cent. of dairy cows are in herds officially recognised as being free from tuberculosis. The sale of designated milk as such is far below the supply and shows no sign of expansion (paragraph 121).

(22) The measures discussed have not appreciably reduced the incidence of tuberculosis among dairy cattle. Infected cows are removed too late to prevent the infection of other cattle or appreciably to improve the purity of the milk supply. At the price at which it is placed on sale, there has been little demand for graded milk from tuberculin-tested herds (paragraphs 122–124).

Possible lines of administrative development.

(23) The three principal proposals promising an improvement of the milk supply are:—

(i) an extension of routine veterinary inspection;
(ii) an active policy for the eradication of bovine tuberculosis;

(iii) the grant to large urban authorities of the right to require pasteurisation of milk other than that produced from herds free from tuberculosis (paragraph 126).

The further development of the veterinary inspection of dairy cattle.

(24) Though clinical inspection reduces the amount of tuberculous milk passing into consumption, it can never render the milk supply safe as—

(i) some cows showing no clinical symptoms yield tuberculous milk;
(ii) cows reach the stage of giving tuberculous milk between the visits of the inspector;
(iii) milk is often contaminated with tubercle bacilli present in infected dung or dust.

Experience shows that clinical inspection cannot be relied on to reduce infection to really small proportions, though it has not yet been sufficiently developed to show how effective it might be in this direction (paragraphs 127–132).

(25) A reduction in the infection of milk with bovine tuberculosis is not accompanied by a proportionate reduction in the infection in man, and the results of clinical inspection may prove disappointing from this point of view. Routine clinical inspection will not greatly reduce the incidence of bovine tuberculosis by removing infected cows from herds, but it will improve the day-to-day management of herds, awaken farmers to the necessity of eradication and benefit country as well as town populations (paragraphs 133–136).

Methods of eradication.

(26) The total eradication of bovine tuberculosis from all herds is the only complete solution of the problem of tuberculous milk. Self-supporting herds may be cleared by the isolation or elimination of infected cattle; but most herds are not self-supporting, and some special provision must be adopted for them. The specialisation of herds for breeding and milk production respectively is economically advantageous and firmly established and cannot be reduced. A campaign based from the beginning on progressive formation of clean areas would require compulsion at the outset and would greatly interfere with the free flow of cattle on which our whole cattle industry is based, and cannot now be undertaken (paragraphs 137–142).

(27) It is therefore essential to prevent the infection in transit of tuberculosis-free cattle. The practical difficulties involved will be considerable, but not insuperable (paragraph 143).

(28) Farmers may reduce tuberculosis in their herds by the slaughter, the segregation, or the sale of reacting animals. Any

organised scheme must permit the sale of reacting animals without declaration that they have reacted (paragraphs 144, 145).

(29) The general immunisation of cattle against tuberculosis is unlikely to be a satisfactory alternative to eradication and is incompatible with it (paragraph 146).

(30) Every attempt on the part of individual farmers to eliminate disease from their herds should be encouraged and, where possible, helped; but a concerted scheme based on official regulations should not apply to more than one disease at a time. The first disease to be dealt with officially must be tuberculosis, because of its great danger to public health (paragraphs 147, 148).

The pasteurisation of milk.

(31) Much milk consumed in large towns is already heat-treated to prevent souring. The pasteurisation of such milk could be required without great interference with the interests of individuals. But the interests of the individual would be seriously affected by the compulsory pasteurisation of all milk at present sold in a raw state (paragraph 149).

(32) There is not sufficient evidence to support the presumption that pasteurisation is harmful from the point of view of human nutrition. It cannot make dirty milk clean and, therefore, would not discourage farmers from producing clean milk. If correctly introduced, it would encourage them to undertake eradication. On the other hand, the compulsory pasteurisation of milk would disturb the balance at present existing in large towns between the producers of milk in comparatively distant areas for sale after heat-treatment, and the producers of milk in the immediate neighbourhood of large towns for sale in a raw state (paragraphs 150–155).

(33) Pasteurisation is incompatible with the business methods of producer-retailers and, if made compulsory at once, a large number of them would be deprived of their present means of livelihood (paragraps 156, 157).

(34) No policy at the outset satisfies both the interests of public health and those of producer-retailers near large towns. Clinical inspection is not a satisfactory alternative to pasteurisation in those areas where the latter is practicable, nor could producer-retailers make their milk safe by the eradication of tuberculosis until this has made considerable progress in the breeding areas. But, as soon as a sufficient supply of clean cows can be created to enable producer-retailers to free their herds from tuberculosis, it will be fair to make them choose between doing so and submitting to pasteurisation (paragraphs 158–160).

(35) Though most milk sold in large towns undergoes some form of heat-treatment, the bulk of it is at present treated in unlicensed plants. Milk thus treated, and pasteurised milk, are often sold without any indication that they have been treated. Inspection of licensed

plants is at present unsatisfactory, and milk sold both from licensed plants (pasteurised milk), and still more that from other plants, is often tuberculous. No milk should be permitted to undergo any form of heat-treatment which is not approved by the Ministry of Health or the Department of Health for Scotland. All pasteurised and sterilised milk should be sold as such, and the plants in which it is pasteurised or sterilised should be of approved design and regularly and efficiently inspected. In the day-to-day working of commercial plants a full laboratory standard of exactitude must be maintained (paragraphs 161–163).

The inter-relation of the various policies advocated.

(36) The veterinary service should be expanded as the first part of a programme for the eradication of bovine tuberculosis and the control of other diseases (paragraph 164).

(37) Substantial inducements should be offered to farmers in the form of a higher price for the milk they sell, to incur the costs of eradication, which at the outset may be heavy. A levy should be made on the milk industry to provide a bonus for milk sold from non-tuberculous herds, through the machinery of the Milk Marketing Boards. The collection of this levy should be made a statutory obligation of the present Milk Marketing Boards or of any organisation which may replace them (paragraphs 166, 167).

(38) A satisfactory standard of cleanliness should be insisted on universally, so that the advantages of price owing to grading would be confined to milk which is safe (as distinguished from clean). In this way the inducement to produce tuberculosis-free milk would be increased (paragraph 168).

(39) The measures which we recommend for the registration of tuberculosis-free herds should be put into operation before the choice between the alternatives of pasteurisation or the eradication of tuberculosis is placed before producer-retailers. In order to enable a reservoir of tuberculosis-free cattle to be built up, a reasonable period should be allowed to elapse before pasteurisation is anywhere made compulsory (paragraphs 169, 170).

(40) Our recommendations are made on the hypothesis that a policy of eradicating tuberculosis from the dairy herds of this country is pursued vigorously (paragraph 171).

(b) Recommendations.

230. We summarise our recommendations as follows:—

Veterinary inspection.

(1) Routine veterinary inspection should be made obligatory for all local authorities. The veterinary service should be expanded under the immediate control of local authorities, but with precautions

designed to secure to the departments of agriculture the power to co-ordinate the activities of local authorities (paragraphs 172–174).

(2) The chief veterinary officer should only be appointed or dismissed by the local authority with the approval of the departments of agriculture. Eventually, all veterinary officers in public employment should be required to have taken a diploma in veterinary state medicine (paragraphs 175–177).

(3) The veterinary officers of local authorities who are responsible for veterinary inspection should also be responsible for duties in connection with eradication (paragraph 178).

(4) Close co-operation should be established between the veterinary service and the sanitary authorities. But the functions of sanitary authorities under the milk and dairies orders should not be diminished (paragraph 179).

(5) Certain boroughs, other than county boroughs, are constituted local authorities under the diseases of animals acts. Their duties in this connection should be transferred to the appropriate county councils (paragraph 180).

(6) The testing of herds with tuberculin for the purposes of the milk designations order should be transferred to the expanded veterinary service. The granting of licences for the production of designated milk should also be made a function of county councils (paragraphs 181, 182).

(7) Only whole-time officers should be employed in the veterinary service, except where, by reason of the difficulty of securing adequate veterinary facilities, the agricultural interests of the district would be likely to suffer if a whole-time officer were appointed. The employment of part-time veterinary officers should also be permitted as a temporary measure during the period of expansion (paragraph 183).

(8) A full veterinary service with the above duties cannot be established immediately, as it would require about 300 veterinary surgeons. Steps should be taken to provide these (paragraphs 184, 185).

A scheme for the eradication of bovine tuberculosis.

(9) The scheme for the eradication of bovine tuberculosis will require the active supervision of the Ministry of Agriculture, and should provide for:—

(i) the institution of a list of tuberculosis-free herds (accepted herds), tested with tuberculin from time to time under official supervision, and declared to be free from bovine tuberculosis;

(ii) the provision of free advice and free tuberculin-testing for owners of herds who agree to make bona fide efforts to free their herds from tuberculosis, or who have established free herds;

(iii) financial help, where necessary, by way of loans or the guarantee of loans, to approved owners for the purpose of undertaking expenditure required by the veterinary inspector as necessary to eradication;

(iv) the securing to owners of disease-free herds of a higher price for their milk than that obtained by other owners;

(v) the taking of administrative measures designed to secure that tuberculosis-free cattle from accepted herds should be moved about the country and exposed for sale without running the risk of being brought in contact with other cattle;

(vi) the adjustment of regulations governing the production of graded milks and the grades of milk officially approved, and the making of regulations relative to the compulsory pasteurisation of milk with a view to increasing the incentive to farmers to eradicate tuberculosis from their herds (paragraphs 186–204).

(10) The functions to be performed in England and Wales in regard to eradication by the Ministry of Agriculture should in Scotland be performed by the Department of Agriculture for Scotland (paragraph 205).

Regulations governing the grading of milk and pasteurisation.

(11) All milk sold for consumption in liquid form should be required to be sold under an official designation. The designation of the milk should be clearly marked on the vessel in which it is sold to the public, a distinctive colour being prescribed for marking each designated milk. No liquid milk should be sold that does not attain a fixed standard of cleanliness, or pre-pasteurisation standard, at the farm. This standard should approximate to that at present required for grade A milk. In addition, all milk should conform to the definitions of one of the following designations:—

(i) *Certified milk,* namely, milk which has not undergone any process of heat-treatment and is derived from tubercle-free herds. (This milk should not be required to be bottled on the farm.)

(ii) *Pasteurised milk,* namely, milk which has undergone, once only, a process of heat-treatment approved for this purpose by the Ministry of Health or the Department of Health for Scotland, and has undergone no other process of heat-treatment. Pasteurisation should be permitted only in a plant licensed for the purpose.

(iii) *Sterilised milk,* namely, milk which has been raised to the boiling-point or higher in a plant licensed for the purpose, and which has undergone no other process of heat-treatment.

(iv) *Milk (uncertified)*, namely, milk which has undergone no form of heat-treatment and is not derived from tuberculosis-free herds, but which attains a certain hygienic standard (paragraphs 206, 207).

(12) No milk which has been held in any vessel containing more than 100 gallons of milk, unless derived from a single herd, should be sold for consumption in liquid form unless it has subsequently been pasteurised (paragraph 208).

(13) The council of any county borough, municipal borough, large burgh, or urban district in an area, the population of which exceeds 100,000, and the London County Council should have the right to prohibit the sale of milk (uncertified) as defined above after a date which shall not be earlier than five years after the initiation of the scheme of eradication, provided that it has given not less than two years' notice of its intention to do so (paragraph 209).

(14) The pasteurisation of milk to be sold under the order should only be permitted in plants the design of which has been officially approved, which have themselves been tested on erection to ensure that they conform to the approved design, and which are frequently inspected during working by an officer of the sanitary authority, who should apply prescribed tests and record the results at each visit. The authority responsible for approving the design of plants should act only after consulting the National Physical Laboratory (paragraphs 210–212).

Recommendations in regard to diseases of cattle other than tuberculosis.

(15) The departments of agriculture should arrange that facilities for testing milk samples for the chronic streptococcal form of mastitis should be available for farmers through their own veterinary surgeons in return for the payment of a fee to cover the cost (paragraphs 213, 214).

(16) The programme of research into Johne's disease of the Agricultural Research Council should be vigorously pursued (paragraph 215).

(17) The committee of the Agricultural Research Council on *Brucella abortus* infection should be given every possible facility, through the Agricultural Research Council, for the early completion of their programme (paragraphs 216, 217).

Miscellaneous recommendations.

(18) The departments of agriculture should invite the Milk Marketing Boards to adopt the principle that their funds should be expended on research in regard to dairying and animal diseases, only

after consultation with, and with the concurrence of, whichever is the appropriate council of the three research councils (paragraph 218).

(19) The Ministry of Agriculture should approve a standard for tuberculin of prescribed potency and purity, and should provide that it should be sold only to qualified veterinary surgeons (paragraph 219).

(20) The police, and the sanitary officers of local authorities and all veterinary officers in public employment should be given the right of access to dealers' and knackers' premises, and the right to require information upon the source from which cattle are received and the destination to which cattle and carcases are despatched (paragraph 220).

The financial effect of the measures recommended.

(21) The burden of the new expenditure recommended should be divided between the farming community, the milk industry as a whole, and those who contribute, either as taxpayers or ratepayers, to national and local funds, on the following basis:—

(a) The farming community would be responsible for the costs incurred in eradication, with the exception of the costs of tuberculin testing and general veterinary advice. The state or the local authority, however, would, in cases of necessity, make advances to meet this expenditure, repayable over a reasonable period.

(b) The milk industry as a whole would be responsible for finding the sum required to pay the bonus on milk produced in accepted herds.

(c) The costs of the increased veterinary services and laboratory work and of free tuberculin testing would be met from national or local funds. Loans to farmers for the purpose of eradication would either be made from the same source, or under the guarantee of the state or local authority (paragraphs 221–224).

(22) The state should not continue to bear the cost of compensating the owners of tuberculous animals slaughtered under the tuberculosis order. The end of compensation should coincide with the grant by the government of substantial help in the eradication of tuberculosis. In view, however, of the present crisis in the dairying industry, it may not be practicable to take this step immediately (paragraph 225).

(23) To assist the expansion of the veterinary service, the Exchequer should make a contribution to local authorities apportioned among the various counties in such a way that those on which the burden would be most severe would benefit the most (paragraph 226).

(24) Local authorities should be entitled to recover either the

whole, or at least a substantial part, of the cost of providing free tuberculin testing from the Exchequer (paragraph 227).

(25) There should be no loss to the authority making or guaranteeing loans to farmers for eradication. But, if such a loss should occur, it should be appropriately divided between the local authority and the Exchequer (paragraph 228).

(Signed) F. GOWLAND HOPKINS, *Chairman.*
MERRIK R. BURRELL.*
E. P. CATHCART.
A. STANLEY GRIFFITH.
C. HARRIS.†
J. HARRY JONES.
JOHN MOORE.‡

(Signed) FRANCIS HEMMING, P. K. DEBENHAM } *Joint secretaries to the committee.*

2, *Whitehall Gardens, S.W.* 1,
April 16, 1934.

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* For reservation by Sir Merrik Burrell, see page 99.
† For addendum and reservation by Sir Charles Harris, see page 102.
‡ For addendum by Major-General Sir John Moore, see page 108.

Reservation by Sir Merrik Burrell.

Owing to the fact that the report has gone a considerable way to rectifying the defects of an organisation to control animal diseases based solely on the haphazard actions of over 300 local authorities, as exists at present in the United Kingdom, I have signed it, but subject to the following reservations :—

2. The nation not as a whole, including even the agricultural section of it, has never appreciated fully the very large economic value of the herds and flocks in the United Kingdom, nor the large annual production of fresh wealth derived from them. Still less has the diminution of that wealth through wastage from disease been realised. I had hoped that the production of this report would bring with it the realisation of the necessity of an attack on animal diseases on a national scale, conducted by a nationally organised staff, which I am convinced would be the most efficient and economical method.

3. The following memorandum, which has been submitted to the committee, sets out the reasons for my opinion.

4. I wish to refer to the levy on all milk suggested in paragraphs 167, 190, 224, and to make quite clear the fact that the producers of milk will not be able to shoulder any portion of such levy unless the price they receive for their milk is sufficient to enable them to do so. This refers with especial force to the owners of supervised herds. They will be incurring already extra cost in their attempt to clear their herds of the disease. Any voluntary scheme of eradication of tuberculosis will be doomed to failure before it starts if it threatens the owners of the herds with initial costs greater than they can bear, or have any hope of recouping.

5. I entertain also considerable doubts as to whether the delay of five years after the initiation of the scheme before the producer-retailers will be faced with the necessity of submitting to compulsory pasteurisation, if they have not cleared their herds of tuberculosis, will prove sufficiently long for the building up of a reservoir of clean cattle of such a size that they can obtain the cattle they require at a reasonable price, if at all.

(Signed) MERRIK R. BURRELL.

Memorandum attached to reservation by Sir Merrik Burrell.

Those who, with me, advocate a state organised service argue that disease knows no geographical boundaries, and to be controlled, let alone eradicated, must be attacked on a national scale in a consistent and co-ordinated manner. That if not, the good work of one local authority may be nullified, wholly or partly, by the inefficiency, lack of organisation, or intervention of some local interest of a neighbour. That the present duties of the state

veterinary officers are so restricted that their lives must lack the interest necessary to attract the best men, and the incentive to them to keep up to date in all necessary branches of their profession.

That if a state service was formed to do the whole of the work at present divided, the opposite result would be obtained.

In time it should be made obligatory for a man to hold the diploma in veterinary state medicine before he could join the state service. The best men would be required and attracted for they would have a definite, responsible, and assured future, and pension. This in its turn would attract a higher standard of recruits to the veterinary profession.

It is argued also that the efficient and economical control of diseases of all domestic animals and fowls must be looked upon as one problem of vast importance to the nation, that it cannot be split up into compartments and men trained and allocated especially to one compartment without human and financial waste. And great emphasis is laid on the necessity, if any real measure of success and an adequate return for the money spent is to be obtained, for the right men to be attracted to the veterinary profession and every opportunity afforded them to become proficient. Examples have been given us, such as the persistence of sheep scab in this country, to shew that diseases are not efficiently controlled when left to local authorities, and the high incidence of bovine tuberculosis cannot be denied.

The formation of a state service would have the advantage that in the event of a sudden flare up of some serious disease, a large number of specially trained men could be concentrated on it with a minimum of delay.

The men could be allocated to the districts where they were most wanted, instead of the numbers appointed in any county being determined by the whim or the wealth of that particular county.

Appendix 13 shows the anomalies which exist between counties with a large animal population, and therefore needing large expenditure on veterinary officers, but having a low rateable value, and rich counties with few animals.

To balance these financial differences fairly would be very difficult, especially as regards money spent on the control of bovine tuberculosis. The milk produced in the more rural and more sparsely populated areas is consumed chiefly in the denser populated areas, and it is already a grievance in the former that they should have to pay in working the various milk orders for the benefit of the latter. If all work amongst the dairy herds was a state function all these difficulties would disappear.

It is not suggested by those advocating a state service that local authorities should lose all influence. Conditions vary so much up and down Great Britain that it would be necessary for any national scheme to be sufficiently elastic as to take advantage of the local knowledge and advice of the county council animal diseases committees. Through these the chief veterinary officer in each area

would seek the assistance and co-operation of the police and agricultural organisers. If financial arrangements could be made to give the chief veterinary officers and their staffs office and laboratory accommodation in the county buildings it would have the great advantage of keeping them in close touch with the chief constables, medical officers, and agricultural organisers.

It is recognised that local authorities may object to relinquishing so much control over animal diseases, but it is held that they could not be in opposition once they understood that to be so was being an obstacle to a new, determined, and co-ordinated national attack on all kinds of diseases of farm animals and fowls.

It is impossible to arrive at exact figures, but it is held that a state service would for various reasons actually cost less than a local authority service, overlooked by state veterinary officers for the sake of co-ordination, plus the present 100 veterinary officers already employed by the Ministry of Agriculture. And it is argued that through smoother running and greater efficiency the lower cost would achieve the greater success.

Addendum and reservation by Sir Charles Harris.

The question what steps are practicable is so closely linked with finance that I hope it may be not altogether unprofitable if I attempt —not as a dissent from section IX but as an addendum to it—to carry a stage further some of the inevitable financial questions arising out of our recommendations. We put forward an active campaign to eradicate tuberculosis from milch cattle, not only as the necessary long-range cure for unsafe milk, but also as best reconciling the urgent claims of public health with due consideration for many thousands of farming families. In this second sphere, in particular, the time-factor is in conflict with the limitations of trained staff and money; and it will be useful at the outset to have some yard-stick as a rough measure of the order of magnitudes involved. The figures throughout are illustrative rather than accurate.

(i) *The time-table.*

As the best measure to hand I take the experience of the veterinary officer who supervised the recent Hannah eradication experiment in Ayrshire. He found that one whole-time man could comfortably supervise at least 100 herds of 50 cattle each in process of eradication by the methods we recommend, making a very generous allowance for time taken in visiting and advising herd-owners and other incidental work; and on this basis he puts the cost of staff, travelling and tuberculin, &c., at £1,000 a year for 5,000 cattle, with an average clean-up period of four years. At this rate, to clean up 3½ million cattle (allowing a little for growth of numbers) at the rate of half a million in each four-year period, would occupy 100 veterinary officers for twenty-eight years or, counting on accelerated progress towards the end, say twenty-five years, at a cost, for staff and incidentals, of £100,000 a year.

A rough departmental calculation shows that a producer-retailer population of milking cattle (all in flying herds) would require, to keep it supplied with heifers, free from tuberculosis and consequently living (say) six years in the herd, clean breeding cattle in the proportion of about 85 per cent. of its strength. The first half-million cattle cleaned up would therefore give milking herds of 270,000 cattle with 230,000 breeders in support—sufficient (if the milkers were all sold to producer-retailers) to meet the requirements of all the principal towns of Great Britain without recourse to compulsory pasteurisation and, even if considerable numbers went to producer-wholesaler herds, to show that the problem was well on the way to solution. The first questions (assuming the approximate correctness of these figures to have been established) are therefore (1) whether progress at a rate conditioned by 100 officers doing "campaign" duty would be accepted as satisfactory, and (2) how soon that strength could be realised and the necessary funds found. Nothing has come before us to suggest that this rate of progress could be exceeded at the beginning of the campaign. These campaign

officers are additional to the 300 clinical inspectors of paragraph 184, costing from £250,000 to £300,000 (paragraph 222); but desirable as it is to introduce routine inspection in every county of England and Wales at the earliest practicable date, its small results in the direction of eradication suggest that priority might be given to the campaign, in allocating the time of the combined staff. For accepted herds, periodically tuberculin-tested, routine clinical examination for tuberculosis will be superfluous.

The present expenditure on compensation under the tuberculosis order should be stopped (as proposed in paragraph 225) at the earliest possible moment, and the relief to the Exchequer thus secured should be taken into consideration in settling the amount of the new Exchequer contribution proposed in paragraph 177.

(2) *Farm costs of eradication.*

The Agricultural Economics Research Institute of Oxford, in 1926, from costings on some twenty farms (spread over a wide area), which, starting from the then prevailing standard of "milk," had raised themselves to the standard of grade A (T.T), found an extra cost for the latter of 2·88*d.* per gallon, leaving a small increase of profit out of an extra price of 3d. That standard does not aim at eradication, but requires the periodical removal of all reactors; and no further special measures seem to have been taken. Eradication, on a scale involving not immediate sale of reactors, but their complete isolation while retained, would in some cases involve fresh expenditure on buildings; and we have recommended loans to meet such expenditure where necessary. With this exception the continuing costs of eradication, equally with those of grade A (T.T.), come under the Institute's conclusion that "there is only a minor difference in actual cost between grade A and grade A (T.T.) milk . . . . the difference for the two grades amounts merely to about 14*s.* per cow for actual testing, and an average of about 10*s.* per cow per year for elimination of reactors . . . . there is little more than ½*d.* a gallon difference." In other words, the extra cost in eradication consists only of those items for which our scheme makes special provision, and any other extra expenditure necessary pertains not to safety but to cleanliness. In this latter respect there has been great progress since 1926, and we now propose the enforcement of an adequate standard on all producers alike, as a condition of remaining in the business.

The above figures take no account of the future gain by the elimination of the losses (paragraph 13) of £2,500,000 by curtailment of productive life and over £500,000 by condemnation of meat, through disease; but nearly the whole of the latter arises from tubercle, and this loss together with the loss of meat from cows which because of tubercle do not reach the slaughterhouse at all must reach a much higher figure, placed in a departmental estimate by the Ministry of Agriculture at between £1,000,000 and £1,500,000. We are unable to separate the contributions of different

diseases to the total of £2,500,000; but it would seem to me reasonable to put the losses to be saved, directly and indirectly by the complete eradication of tubercle, at £2,000,000 out of a total of £3,500,000 a year. As regards the diffusion of this benefit through the community as a whole (paragraph 13), it is true that under competitive conditions the primary and final incidence of such items between producer, distributor, and consumer will differ widely; but unless the results achieved by the Milk Marketing Boards altogether disappoint the hopes which led to their foundation, the diffusion of the two millions accruing primarily to the farmer will at least be very much slower than it would have been without the Boards.

(3) *Loans.*

These are not to be regarded as inducements to join the voluntary eradication scheme, but as necessary to remove otherwise fatal hindrances, viz.: (1) the difficulty of finding the very large numbers of breeding herds required at the outset, (*a*) of the right breeds for the producer-retailer herds, (*b*) in the right places, and (*c*) in the right hands, if the choice is further restricted to farmers with the necessary free capital; and (2) the very short time allowed before the producer-retailer must either clean up his herd or drop out, giving in fact no choice unless those in need are allowed access to capital. But loans should be restricted to those for whom they are unavoidable, and, as herds in the ordinary course of life will frequently change hands, it is desirable that those granted for the replacement of reactors should be paid off in the shortest possible time.

Putting the loss on each reactor replaced at £10 (probably a low figure at first, while clean cattle are scarce and demand urgent) the average sum required (not all in the first year) would be £4 per head of the herd, with 40 per cent. infection. But for the essentially "flying" herds of producer-retailers infection will average much higher: 80 per cent. will be frequent in many districts and some herds are said to reach 100 per cent. Taking 70 for producer-retailers, the sum for a 50-cow herd would be £350. If, of the 50 cows, 10 were dry, or heifers not yet calved, bonus at 1*d.* a gallon on the milk of 40 cows at 600 gallons each would produce £100 a year and roughly this should pay off loan and interest in four years. Further, if loans averaging £7 per cow were required for half the first 500,000 cleaned up, the total borrowed for reactors would be £1,750,000 in the first four years; and, the advances being spread fairly evenly over that period and the repayments beginning at once in the next four years, a point would soon be reached at which the loans and repayments would approximate to a revolving fund, and the total outstanding at any time might not exceed £2 millions.

As regards loans for building purposes and the like, the circumstances of different farms differ so widely that it is not possible to give even illustrative figures here. It may be hoped that the cases in which any large amount is required will be few; but, as

the Hannah experiment showed, one such case in which neither the farmer nor his landlord can provide the necessary funds might endanger success over a whole neighbourhood. There are technical questions of some difficulty in connection with such matters as security, tenure, and the position of the landlord in the matter, into which it has been impossible for us to enter, but it is not to be supposed that such difficulties are insuperable; and the recent lowering of interest rates for agricultural credits, and the powers of the Milk Marketing Board mentioned below should help towards solutions.

Under paragraph 66 of the milk marketing scheme it is provided that the Board may lend to any registered producer up to a limit of two-thirds the total value of his milk and may guarantee payment of any sums secured by an agricultural charge under the agricultural credits act of 1928. Free use of these powers would admirably facilitate the arrangement and recovery of eradication loans for both purposes.

(4) *Inducements to join the scheme.*

Free advice and testing (except in cases where the farmer draws back from the scheme), with some eventual share of the £2 millions of paragraph 18, do not promise an early and direct increase of income; for that attraction the scheme relies on a bonus on all "certified" milk (in its new signification) provided by a levy on all milk produced. In originating this proposal, the Grigg Commission provided that half the levy should be recovered from the producer and half from the distributor. Where the shares of these parties in the total divisible product are annually resettled, the primary incidence of such a levy is likely soon to cease to be the ultimate incidence, and I here assume that the levy, whatever its amount, would be recovered primarily from the producer, as provided in the milk marketing scheme. The working of the levy-bonus plan would not be free from difficulty. Breeding herds would only come into it to a minor extent; their main reward would come from an active sellers' market for clean cattle. For milking herds, assume a bonus of 1*d*. per gallon, *i.e.*, £2 10*s*. 0*d*. a year for a 600-gallon cow. At first the only cows earning bonus would be those (say 20,000) already registered in tubercle-free herds, with perhaps an equal number now in herds clean in fact, but not registered as such, which might secure an "accepted" certificate in the first year. The total bonus on these lines would be £100,000, and the levy a small fraction of a penny per gallon. Each year, as eradication progressed, the rate of levy would have to be raised until at last the total of levy and bonus alike had reached £6 millions, and, each farmer receiving exactly what he paid out, the plan would have come to an end. What any producer received under such a plan would depend on the date of his "accepted" certificate; and the owners of the last 500,000 cattle cleaned up would receive nothing, though they would have paid levy all along. (Facts would not, of course,

be as simple as this diagrammatic arithmetic, but the principle holds.) Some selection for priority is unavoidable; but such levy and bonus arrangements as these would throw a great strain on the scheme, especially where a producer had been enabled to take a high priority by the grant of an official loan. Further, if the Government, to give the scheme a good send-off, should undertake to pay the bonus for the first few years, most of the public money so spent would fall as a reward to owners who, in earlier years, had for their own reasons cleaned up their herds, and would give little or no return in the shape of bringing new men into the scheme. In these circumstances it may be well to consider the alternative of paying the bonus only from (say) a year after the opening of the list of supervised herds, and continuing it for a fixed number of years from the date of the "accepted" certificate of each herd. Putting the number at ten years, the result would be that the total of levy or bonus would never rise much above £3,000,000, and for ten years after eradication was complete a diminishing number of farmers would continue to draw bonus, the levy decreasing as gradually as it grew at first.

On the figures above assumed for "reactor" loans, those who borrowed the full amount per cow would assign the first four years of bonus to the extinction of the loans and enjoy the £2 10*s*. 0*d*. per cow for six years—£15 in all. Those who used their own capital instead of borrowing, would replace it and also receive £15 per cow.

From the evidence given before us, I have gathered that one of the chief reasons that in the farmer's mind weigh against undertaking eradication is the risk that, owing to some casual re-infection, four years of effort may leave him in a position to begin all over again; and, with no time limit in the levy and bonus scheme, he would not only have the continued expense of replacing reactors to meet, but also see his years of recoupment vanishing. To remove the re-infection risk a scheme had been suggested to us, before the advent of the Milk Marketing Board made a levy possible, under which the farmer in return for a fixed number of annual payments into a mutual insurance fund, would be guaranteed assistance out of the fund for replacing reactors as long as might be unavoidably necessary, the scheme when eradication was practically complete being transformed into a scheme of insurance against the re-infection risk, at a small continuing premium. The desirability of a permanent scheme of this latter kind should still be borne in mind.

In this question of inducements, it is essential to be not only definite but also liberal enough to bring into the voluntary scheme so large a majority of herd owners that compulsion, if and when the question should arise, would apply only to a small minority of recalcitrants. It would be very easy to spend large sums in eradication and yet fail to attain the objective, in consequence of some relatively small but injudicious parsimony. Any idea in the farmer's

mind that, by hanging back, better terms for joining the scheme might be exacted, would have deplorable effects.

(5) *Incidence as between private and public purses.*

The farming industry pays the initial costs of eradication, other than staff and incidentals, restoring the capital sum to the farmer who uses his own resources, or to the source from which he borrows, out of the bonus provided ultimately to all by means of a levy on all. (The inequalities between individuals to which this might give rise are dealt with under (4).) When the levy and bonus have ceased, the farmer is left with the net gain ($\frac{1}{3}d.$ per gallon, or £2,000,000 in all) arising under paragraph 13 of the report, unless the Milk Marketing Boards fail to prevent its diversion to the dairyman (or even the consumer) in the annual settlement of prices.

Except for a small increase of the Ministry of Agriculture staff for the direction of the eradication scheme, and the cost of providing the "revolving fund" of perhaps £2,000,000 (on my rough assumptions) for a period of years, which might fall primarily on the Exchequer, the other costs both of eradication and of the new staff for clinical inspection, and later for other duties connected with diseases, fall primarily on county funds. Tempting as it may be to think that some portion of all this expenditure might properly be made to fall on the private purse of the consumer, it must be remembered that nothing can prevent him from opposing to higher prices his ultimate retort of restricting his purchases, with serious results to the dairy industry as a whole.

Unless it be the general plea of hard times for farming, I see no reason why the farmer should be rewarded by a *permanent* increase of income, large in aggregate amount, as a reward for making his product safe for human consumption, while the ratepayer continued to pay large sums; but the real amount of this increase and the extent to which the farmer should retain it, require to be examined and decided on grounds outside the province of the committee.

(6) *Incidence as between different ratepayers and the taxpayer.*

Whatever may be the fair total to levy on ratepayers as a whole in this connection, it requires special re-allocation between different localities, not only because the dense human populations that create high rateable values do not share ground with the dense cow populations that require veterinary attention, but also because from the point of view of the counties much of the expenditure represents costs of producing milk for vast numbers of absentee consumers whose rateable values bring nothing into the county exchequers concerned. This fresh expenditure was not provided for in the recent general "block" settlement with the counties, and without an equitable re-adjustment such as will secure the zeal of the local authorities, on whom the scheme depends for the executive work of the campaign, its success will be endangered. If such a re-adjustment can

be produced on the lines recommended in paragraph 177, so much the better. But I should hope that a broad settlement could be effected between exchequer and local funds which would obviate the detailed recoveries suggested in paragraph 227; and I see no balance of advantage in bringing county funds into the provision and repayment of loans to farmers as suggested in paragraphs 224 and 228.

Where a local authority elects to make pasteurisation compulsory, frequent and minute inspection will be necessary to guard against the risk, never negligible, that a plant may become a public danger rather than a safeguard. The cost of this will depend on the number and size of the plants and cannot be here estimated; it will, of course, fall entirely on the local authority.

Such examination as we have given to the boiling of milk leaves me strongly impressed with its superiority over pasteurisation, in safety, simplicity, and economy, as a treatment for milk not of assured purity. The comparatively trivial disadvantages of its effects on the cream-line and on the taste of milk are a slender foundation for all the elaboration and expense of maintaining the laboratory standard (paragraph 163) necessary in commercial pasteurisation. Domestic boiling, no doubt, would be too often omitted or overdone; but if there is any convincing reason why, for the milk supply of the generality of the urban population, a wholesale boiling process immediately followed by cooling and bottling cannot be adopted, it has escaped me.

(Signed) C. HARRIS.

Addendum by Major-General Sir John Moore.

Until the veterinary services can be expanded on a well-organised basis as recommended by the committee, I am of the opinion that veterinary surgeons in private practice in rural areas who, in ordinary circumstances, are employed by the farming community, should be made use of for the control of animal diseases. If they are not in possession of the Diploma of Veterinary State Medicine (D.V.S.M.), it might be arranged that they should undergo a "refresher course" at a veterinary college or, alternatively, at the laboratories proposed in the report (see paragraph 214 of report, and recommendation (15) in the summary of recommendations). Furthermore, as a good many existing veterinary practitioners have sons who are taking up a veterinary career, and following in their fathers' footsteps, preference might be extended to these young men on the understanding that they should obtain the D.V.S.M., a dual partnership of state and private practice thereby being established. It has to be remembered that the older practitioners are the more experienced in the control of animal diseases and in the necessary advice to farmers.

(Signed) JOHN MOORE.

APPENDIX 1.

Evidence received.

(a) List of witnesses who gave oral evidence.

Witness.	Description of witness.
Mr. J. N. Beckett	Assistant Secretary, Ministry of Health.
Dr. T. Carnwath, D.S.O., M.B. ...	Senior Medical Officer, Ministry of Health.
Mr. H. E. Dale, C.B.	Principal Assistant Secretary, Education and Research (Agriculture and Horticulture Division), Ministry of Agriculture and Fisheries.
Accompanied by—	
Mr. P. J. L. Kelland, M.R.C.V.S. ...	Chief Veterinary Officer, Ministry of Agriculture and Fisheries.
Mr. D. A. E. Cabot	Deputy Chief Veterinary Officer, Ministry of Agriculture and Fisheries.
Mr. J. F. Blackshaw, O.B.E. ...	Dairying Commissioner, Ministry of Agriculture and Fisheries.
Mr. J. M. Vallance	Assistant Secretary, Department of Health for Scotland.
Dr. G. R. Leighton, O.B.E., M.D., D.Sc.	Medical Officer, Department of Health for Scotland.
Mr. T. Baxter, *Chairman, Milk and Dairy Produce Committee.*	Representatives of the National Farmers' Union.
Major R. H. Dorman-Smith, *Vice-Chairman, Milk and Dairy Produce Committee*	
Mr. F. E. Knight, *Secretary, Milk and Dairy Produce Committee*	
Captain E. T. Morris, *Chairman, Livestock and Wool Committee*	
Dr. R. A. Fisher, D.Sc., F.R.S. ...	Rothamsted Experimental Station.
Dr. S. Bartlett	National Institute for Research in Dairying, University of Reading.
Sir Robert Greig, M.C.	Secretary, Department of Agriculture for Scotland.
Mr. F. W. Medlock	Chief Veterinary Officer, Surrey County Council.
Professor J. C. G. Ledingham, C.M.G., M.B., F.R.S.	Director, the Lister Institute of Preventive Medicine.
Professor W. W. Jameson, M.D., F.R.C.P., D.P.H., *Professor of Public Health*	The London School of Hygiene and Tropical Medicine.
Professor G. S. Wilson, M.D., F.R.C.P., D.P.H., *Professor of Bacteriology as applied to Hygiene*	
Mr. Ben Davies	Joint Managing Director, United Dairies, Limited.

Witness.	Description of witness.
Mr. D. M. Lewis	Chairman of Council, Amalgamated Master Dairymen, Limited.
Mr. Wilfred Buckley, C.B.E. ...	... ...
Dr. W. G. Savage, B.Sc., D.P.H., *Medical Officer of Health, Somerset*	Representatives of the People's League of Health.
Professor J. C. Drummond, D.Sc., F.I.C., *Vice-Dean of the Faculty of Medical Scientists, University College, London*	
Professor Sir Frederick Hobday, C.M.G., F.R.C.V.S., F.R.S.E., *Principal and Dean of the Royal Veterinary College, London*	
Dr. A. T. R. Mattick, B.Sc., Ph.D., *Head of the Bacteriological Department, National Institute for Research in Dairying, Reading*	
Dr. Nathan Raw, C.M.G., B.S., F.R.C.S., M.R.C.P., *Member of the Council of the International Union against Tuberculosis*	
Sir William Wilcox, K.C.I.E., C.B., C.M.G., M.D., *Medical Adviser to the Home Office*	
Miss Olga Nethersole, R.R.C., *Founder and Honorary Organiser of the People's League of Health*	
Dr. R. Veitch Clark, M.B., Ch.B., D.P.H.	Medical Officer of Health, Manchester.
Dr. Norman C. Wright	Director, the Hannah Dairy Research Institute.
Professor S. H. Gaiger, F.R.C.V.S. ...	Department of Animal Pathology, University of Liverpool.
Mr. James Mackintosh, O.B.E. ...	Head of Dairy Husbandry Department, National Institute for Research in Dairying, Reading.
Dr. F. G. Minett, D.Sc., M.R.C.V.S.	Director, Research Institute in Animal Pathology, Royal Veterinary College.
Mr. W. Cassels Jack	Member of Central Executive Committee, National Farmer's Union of Scotland.
Mr. Hugh Begg, F.R.C.V.S. ...	Representatives of the Scottish Society of Veterinary Inspectors.
Mr. A. Douglas, M.R.C.V.S. ...	
Mr. D. G. Barbour, *Secretary* ...	
Mr. D. S. Rabagliati, F.R.C.V.S. ...	Chief Veterinary Officer, West Riding County Council.
Mr. William Lawson	Director of Agriculture, West Sussex County Council.
Mr. T. G. Wilson	Scottish Chamber of Agriculture.
Sir Frederick Hobday, C.M.G., F.R.C.V.S., F.R.S.E.	Principal and Dean, Royal Veterinary College.
Mr. J. Hammond...	Physiologist Animal Nutrition Institute, Cambridge.
Mr. W. S. Mansfield	Director, University Farm, Cambridge.

Witness.	Description of witness.
Mr. R. E. Glover	Institute of Animal Pathology, Cambridge.
Dr. J. B. Orr, F.R.S.	Director, Rowett Research Institute, Aberdeen.
Lieutenant-Colonel J. P. Simpson, D.S.O., F.R.C.V.S., *President* Mr. G. P. Male, M.R.C.V.S., *Chairman of the Veterinary Officers' and Public Health Committee*	Representatives of the National Veterinary Medical Association of Great Britain and Ireland.
Dr. J. J. Buchan, *Medical Officer of Health, Bradford* Dr. Thomas Orr, *Medical Officer of Health, Ealing* Mr. D. S. Rabagliati, F.R.C.V.S., *Chief Veterinary Officer, West Riding County Council* Mr. G. C. L. Elliston, *Executive Secretary*	Representatives of the Society of Medical Officers of Health.
Dr. A. S. M. Macgregor, O.B.E., *Medical Officer of Health, Glasgow, President* Dr. W. G. Clark, *Assistant Medical Officer of Health, Glasgow, Hon. Secretary*	Representatives of the Scottish Branch of the Society of Medical Officers of Health.
Mr. E. P. Everest, M.B.E.	Vice-Chairman, Executive Council, Rural District Councils Association.
Professor Share Jones, F.R.C.V.S. ...	Director of Veterinary Studies, School of Veterinary Science, University of Liverpool.
Mr. R. A. Howson, *Assistant Secretary* Mr. G. Walworth, *Agricultural Adviser of the Co-operative Union*	Representatives of the Parliamentary Committee of the Co-operative Congress.
Mr. Ernest C. King, *Clerk and Solicitor to the Coulsdon and Purley Urban District Council* Accompanied by— Dr. F. R. Edbrooke, *Medical Officer of Health* Mr. H. Buxton, *Sanitary Inspector*...	Urban District Councils Association.
Dr. R. Seligman	The Aluminium Plant and Vessel Company.
Mr. D. Cumming, M.R.C.V.S. ... Mr. W. Nairn, M.R.C.V.S.... ... Major J. G. McGregor, M.R.C.V.S. ...	Representatives of the Scottish Branch of the National Veterinary Medical Association of Great Britain and Ireland.
Mr. F. Dent (*Essex*), *Chairman of the Agricultural Committee of the Association* Mr. J. Donaldson (*Oxfordshire*) ... Mr. J. D. Davidson, *Director of Agriculture, Glamorgan*	Representatives of the County Councils' Association.

Witness.	Description of witness.
Mr. J. E. Shaw, *County Clerk, County of Ayr*	Representatives of the Association of County Councils in Scotland.
Mr. Hugh Begg, F.R.C.V.S., *County Veterinary Inspector, Lanarkshire*	
Mr. H. A. Pritchard, *Town Clerk, Leicester (Chairman of the Law Committee of the Association)*	Representatives of the Association of Municipal Corporations.
Mr. J. K. Allerton, *Town Clerk, Worthing*	
Mr. Brennan de Vine, F.R.C.V.S., *Chief Veterinary Officer, Birmingham*	
Mr. P. W. Margetts, *Secretary of the Law Committee of the Association*	
Dr. W. Allen Daley, *Principal Medical Officer in charge of the General Public Health Division of the Public Health Department*	Representing Sir Frederick Menzies, K.B.E., County Medical Officer of Health, London County Council.
Mr. T. E. Birtwisle, *Chairman* ...	Representatives of the Sanitary Inspectors' Association of England and Wales.
Mr. H. T. Perry, *Senior Vice-Chairman*	
Mr. T. Topping, *Member of the General Council*	
Mr. E. Whone, *Member of the General Council*	
Mr. W. B. Jepson, *Secretary* ...	
Dr. E. G. Annis, *Chairman of the Pure Milk Committee of the Institute, and Medical Officer of Health for Greenwich*	Representatives of the Pure Milk Committee of The Royal Institute of Public Health.
Dr. G. W. N. Joseph, *Medical Officer of Health for Warrington*	
Mr. H. E. Bywater, M.R.C.V.S., *Veterinary Officer for West Ham*	
Professor H. E. Armstrong, D.Sc., F.R.S.	
Sir Daniel Hall, K.C.B., F.R.S. ...	

(b) List of institutions and persons from whom written, but not oral, evidence was received.

Agricultural Economics Research Institute, University of Oxford.
Animal Diseases Research Association, Moredon Institute, Gilmerton, Midlothian.
Viscount Astor.
Professor J. Basil Buxton, F.R.C.V.S., D.V.H., Director, Institute of Animal Pathology, Cambridge.
Dr. E. P. Calder, M.B., Ch.B., D.Ph.
Cumberland Agricultural Committee.
Mr. Arthur Gofton, F.R.C.V.S., Chief Veterinary Inspector, Edinburgh.
Mr. John Golding, D.S.O., F.I.C., National Institute for Research in Dairying, University of Reading.
The Graham-Enock Manufacturing Company, Limited.

Mr. G. H. Johnstone.
Dr. H. D. Kay, Director, National Institute for Research in Dairying, Reading.
Dr. E. C. V. Mattick, M.Sc., Ph.D., National Institute for Research in Dairying, University of Reading.
Royal (Dick) Veterinary College, Edinburgh.
Royal Sanitary Association of Scotland.
Dr. Evelyn Sprawson, M.C., M.R.C.S., L.R.C.P., L.D.S., Director of Dental Studies and Lecturer on Dental Surgery, the London Hospital.
Mr. A. M. Trotter, M.R.C.V.S., Chief Veterinary Inspector, Glasgow.
West of Scotland Agricultural College.

APPENDIX 2.

The average life of dairy cows.

THERE are three sources from which estimates of the average annual wastage of dairy cattle have been made:—

(i) from the investigations carried out by milk recording societies into the number of animals drafted out of recorded herds;
(ii) from the age distribution of a large sample of cows;
(iii) from the annual agricultural census carried out by the Ministry of Agriculture and Fisheries and the Scottish Department of Agriculture.

(i) *The investigations of milk recording societies.*

There have been two large-scale investigations by milk recording societies which bear upon the annual wastage of dairy cattle, undertaken respectively by the School of Agriculture, Cambridge University, and by the National Institute of Research in Dairying at Reading. The results of these two investigations are surprisingly difficult to interpret. It appears that only about 80 per cent. of the actual number of disposals are reported by farmers. This deficiency is said to be largely accounted for by the fact that dry cattle which are awaiting disposal on the 1st October, the date at which the annual register is opened, are not entered in the register and their disposal is not subsequently noticed. In addition, some disposals are overlooked, as a result, *e.g.*, of transfers between herds belonging to the same owner.

In view of the discrepancies resulting from these causes, those responsible for both these investigations have taken the number of new entrants as being the better measure of wastage. In one case (Cambridge), the size of the herd has been based upon the number registered at the beginning of the year (which excludes dry cows being fattened for sale); in the other (Reading), the closing number has been chosen. As the opening number presumably corresponds with the two classes "cows and heifers in milk" and "cows in calf, but not in milk," adopted for the yearly agricultural census, it has been used in the sequel.

The principal source of error in this method of calculation is to be found in increases or decreases in the numbers included in the herds during the period under review. The cow population of England and Wales does not vary greatly; but it is possible for variations to take place in the herds in question which would sensibly affect the results.

The results in question are as follows:—

		Cambridge inquiry.	Reading inquiry.	Combined result.
1928–29.	Number of cattle in herds ...	13,465	...	13,465
	Number of entrants	3,670	...	3,670
	Percentage of entrants ...	27·3	..	27·3
1929–30.	Number of cattle in herds ...	12,984*	9,478	22,462*
	Number of entrants	3,479	2,612	6,091
	Percentage of entrants ...	26·8	27·6	27·1
1930–31.	Number of cattle in herds ...	11,367	12,348	23,715
	Number of entrants	3,482	4,122	7,604
	Percentage of entrants ...	30·6	33·4	32·1
1928–31.	Number of cattle in herds ...	37,816*	21,826	59,642*
	Number of entrants	10,631	6,734	17,365
	Percentage of entrants ...	28·1	30·9	29·1
1929–30	Number of cattle in herds ...	24,351*	21,826	46,177*
and	Number of entrants	6,961	6,734	13,695
1930–31.	Percentage of entrants ...	28·6	30·9	29·7

* partly estimated.

The counties covered are, by the Cambridge inquiry, Bedfordshire, Cambridgeshire, Hertfordshire, Lincolnshire and Norfolk; by the Reading inquiry, Hampshire, Berkshire and Dorsetshire in 1929–30, together with a few herds in Buckinghamshire, Oxfordshire and Northamptonshire in 1930–31.

It appears from these figures that approximately 30 per cent. of an average herd is disposed of every year. But, in order to arrive at the true wastage in dairy herds, it is necessary first to deduct those animals which, though sold from one herd, are bought into another, and are consequently not lost to the dairy industry. In both investigations there is an analysis of the state in which animals sold from each cause are disposed of. It may be assumed that animals, sold in milk or in calf, for the trade or on account of low milk yield or on account of failure to pass the tuberculin test, are bought for dairy herds. Animals parted with from one of these causes, but which were sold when dry but not in calf, or when fattened, or which died or were sent to kennels, and all animals parted with from other causes in whatever condition they were disposed of, may be assumed to have passed finally out of dairy herds.

On these assumptions, 27·6 per cent. of animals disposed of were re-absorbed into dairy herds. If it is further assumed that of those low yielders sold in milk only those sold within two months of calving were retained in dairy herds, this figure is reduced to 25·3.

If this latter figure is taken, and 29·7 per cent. (the average for the two years 1929–30 and 1930–31) is taken for the percentage disposed of, the wastage, properly so called, in dairy herds is approximately 22 per cent., a figure which is consistent with an average milking life of 4½ years.

(ii) *Investigations into the age distribution of large samples of cows.*

An account of an attempt to determine the working life of milk cattle from the age distribution of selected groups has been published by Dr. Norman Wright.* Extracts from his article are attached as annex A.

* 1933, *Scottish Journal of Agriculture*, **16**, no. 1.

Dr. Wright states (*in litt.*) that he has now come to the conclusion that the method adopted in that paper for estimating the average productive life of animals from their average age cannot be upheld. We have therefore constructed an alternative method of estimating, with which Dr. Wright is in agreement. In a table in annex B, the average ages of herds calculated upon various assumptions are given. The losses from the herd are there assumed to be of two kinds: (i) a percentage annual loss to which all cows at whatever age are equally subject, and (ii) a loss by superannuation, all cows being assumed to die as soon as they reach a certain age. The average age given in Dr. Wright's paper is 5·6 years. This is the age *at last calving*. But the average age of a herd at any moment is greater than this, by an amount which, if there are twelve months between calvings, may be estimated at 5½ months. Allowing for this, the average age of the herd is about 6·05 years. From a rough interpolation from the table in annex B it appears that, if cows are superannuated after 9 years of milking life (or at nearly twelve years of age), an average age of 6·05 years is compatible with a total wastage of 23½ per cent. The Cambridge inquiry gives the average life in the herd of homebred cows disposed of on account of old age as seven years.

The Cambridge and the Reading investigations showed that estimates of the average milking life of cows, based upon the direct returns of farmers, were lower than was to be expected from the wastage which more accurate statistics indicated as having taken place. This deficiency is to be accounted for in part by failure to return the ages of the older cows, for which records are less likely to be available; in part, perhaps, by a tendency to understate the ages of cows returned. Both these difficulties are likely to be encountered in an attempt to estimate the average age of a random sample of cows. They would, however, be of less importance in the case of pedigree cows.

In the case of samples which are not random, a further difficulty arises. The cow population of Scotland as a whole is stable. But it does not follow that every section of that population is stable. If in any instance this is not so, the average age of that section (the average life being supposed given) will be affected. Increasing populations or populations from which emigration is taking place are younger, other things being equal, than decreasing populations or populations into which immigration is taking place. Herds of pedigree cattle may be either increasing or subject to emigration. Average ages based upon samples drawn from them may consequently be misleading, if applied to cattle in general.

(iii) *An estimate based upon the annual agricultural census.*

It is possible to base an estimate of the number of heifers drafted into herds annually, upon the number of heifers recorded as being in calf on the 4th June every year. If calving were carried on regularly all through the year, the latter number should be 77 per cent. of the former. In fact, however, there are considerable seasonal variations in the rate of calving. In the year 1930, in addition to the annual census upon the 4th June, a partial census was made in England and Wales upon the 11th January. From this it appears that the ratio of heifers in calf in June to those in calf in January is as seven to eight. Making an allowance for this, it seems that 72 per cent. of the heifers calving between the 4th June one year and the next should be recorded as in calf on the former date. A slight adjustment in the figure for calvings of home-reared heifers has to be made for Irish heifers included in the numbers recorded in the census. From figures published in the 20th number of the Ministry of Agriculture and Fisheries series of economic reports (page 147), it appears that about one-quarter of the cows and heifers imported from Ireland are heifers. If it is assumed that the latter are in Great Britain for six months before calving, one-eighth of the number of cows and heifers imported from Ireland must be deducted from the number of heifers in calf in Great Britain before using the latter

figure for calculating the number of calvings of home-reared heifers. To the number of calvings must be added the importation of cows and heifers from Ireland and elsewhere, the sum representing the total number of cows and heifers drafted into herds in Great Britain for the first time during the year in question. Figures for the imports of cows and heifers are given only for calendar years, and have to be adapted to the year ending on the 4th June. No account can be taken of the external trade in cows and heifers of Northern Ireland.

The wastage of cows and heifers from breeding herds in Great Britain. 1928–29 *to* 1930–31.

Year ending 4th June.	Number of cows and heifers in milk and cows in calf but not in milk at end of year.	Number of heifers in calf at beginning of year.	Estimated number of calvings of home-reared heifers during the year.	Estimated number of cows and heifers imported during the year.	Net increase (+) or decrease (−) in the size of herds during the year.	Wastage of cows and heifers in milk and cows in calf but not in milk during the year. (4) + (5) − (6).	Wastage as per cent. of herd at beginning of year.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1928 ...	2,775,190	...	...	...	...	...	...
1929 ...	2,750,190	407,515	560,500	40,900	− 25,000	626,400	22·6
1930 ...	2,719,825	416,102	572,300	44,600	− 30,400	647,300	23·5
1931 ...	2,762,735	408,171	559,900	46,500	+ 42,900	562,600	20·7

The average wastage for the three years is 612,100, or 22·3 per cent. of the average herd at the beginning of the year.

The principal objection that may be brought against this calculation is that it assumes a greater degree of accuracy in the returns of farmers to the agricultural census than can be reasonably anticipated. The variation shown between different years is itself an indication of this. It is not, however, obvious in which direction, if in either, there is likely to be a permanent bias.

A further objection is that the above figures include beef cattle as well as dairy cattle. Dr. Wright's article gives reason for supposing that cows in beef herds have a rather longer life than those in dairy herds. In view, however, of the fact that the numbers of beef cattle are small in comparison with dairy cattle, this is not a point of major importance.

The three lines of investigation discussed above point with some unanimity to an average annual wastage among dairy cattle in the neighbourhood of 23 per cent. None of them, however, is so free from the possibility of error that implicit reliance can be placed on this result. It may, however, be asserted with some confidence that an annual wastage of less than 20 per cent. or of more than 25 per cent. is very improbable.

Annex A to appendix 2.

*Extracts from an article by Dr. Norman Wright entitled "Wastage in dairy cows."**

A FAIRLY reliable indication of wastage can, however, be obtained from the study of the mortality rates of cattle at different ages, since such figures will provide an accurate estimate of the average age of dairy cows throughout the country and, therefore, of the extent of premature losses

* First read as a paper at the meeting of the British Association for the Advancement of Science at York in 1932, and subsequently published in January 1933 (*Scottish Journal of Agriculture*, **16**, no. 1).

among stock. Actual mortality statistics are, of course, unobtainable, but approximate values can be fairly accurately calculated from a study of the age distribution among large and representative groups of cows. Such calculations have been made by Buchanan Smith for random groups of six breeds of cattle. Buchanan Smith tabulated the ages of the parents of about 2,600 pedigree calves born during a single year, and calculated the average age of the parents. For cows the average age at calving worked out for all breeds at 5¾ years, and for dairy breeds 5½ years. . . . . In such stock it is possible that there will be an abnormally high weeding out of unsatisfactory animals, particularly on account of poor milking capacity. It has already been pointed out that disposals under the latter heading cannot properly be classified as wastage, and Buchanan Smith's average values may therefore be too low. It appeared that a better estimate would be obtained by taking a selected group of cattle in which voluntary disposals would probably be reduced to a minimum. Such a group is available in the class I dairy cows in the annual reports of the Scottish Milk Records Association. The minimum yield which must be attained by an animal in this group corresponds to 800 gallons of milk at 3·5 per cent. butter-fat, and, since such a yield can be classed as highly satisfactory for Ayrshire cows, it is reasonable to assume that a high mortality rate at a premature age would, in such a selected group, hardly be due to voluntary disposal by the owner. Yet, the mortality rate, as judged by age-distributing calculations, is abnormally high during the earlier productive years. For instance, it was found that, in 1931, the average calving age of over 7,000 animals* whose ages were recorded, worked out at 5·6 years, and that only 25 per cent. calved at ages over 6·5 years.

Annex B to appendix 2.

The relation between average herd age and wastage as a percentage of the herd.

On the assumptions that—

(1) the number of cattle entering the herd in the course of a year is unity;
(2) the rate of entrance is uniform;
(3) all cattle (irrespective of age) are exposed to a risk of death such that the ratio of survivors of a group at the end of a year to the members of the group at the beginning of the year is A:1;
(4) all cows die on attaining (n + m) years of age;
(5) the age of all cows on entering the herd is m years;
(6) the numbers in the herd are constant;

then the total number of cows in the herd is—

$$\int_0^n A^x \, dx = H \text{ (say)},$$

where x is the time which an animal has spent in the herd. The rate of wastage is therefore $\frac{100}{H}$ per cent., and the average age of the herd is—

$$m + \left(\int_0^n x A^x \, dx \right) \Big/ \left(\int_0^n A^x \, dx \right) = L \text{ (say)}.$$

$$H = \frac{A^n - 1}{\text{Log}_e A}$$

$$\text{and } L = m + \frac{nA^n - (A^n - 1) / \text{Log}_e A.}{A^n - 1.}$$

* As the percentage of heifers whose ages were recorded very considerably exceeded the percentage of cows, an appropriate adjustment was made in the figures used as a basis for these calculations.

Giving "m" the value of 2·8 years, as in Dr. Wright's paper, the following table may be constructed:—

Average herd age, and rate of wastage.

Maximum life in herd (*n*).	7 years.		8 years.		9 years.	
Chance of survival at end of a year. (A.)	Per cent. wastage annually.	Average herd age in years.	Per cent. wastage annually.	Average herd age in years.	Per cent. wastage annually.	Average herd age in years.
·65	45·3	4·77	44·5	4·86	44·0	4·93
·70	38·9	4·98	37·8	5·11	37·2	5·22
·75	33·2	5·20	32·0	5·39	31·1	5·54
·80	28·2	5·42	26·8	5·67	25·8	5·89
·85	23·9	5·65	22·3	5·96	21·1	6·25

APPENDIX 3.

The estimated loss to the farming industry from cattle diseases.

Monetary loss attributable to disease among cattle occurs under three headings:—

(*a*) the increased cost of maintaining milking herds at their full strength consequent upon the higher death rate due to disease;
(*b*) the loss of meat due to condemnation on account of disease of carcases of cows drafted out of herds;
(*c*) the reduction of the yield of milk among unhealthy cattle.

(i) *Losses under heading* (*a*).

It is possible to make a rough estimate of the amount of the loss under the first of these heads upon the following lines:—

Reasons have been given in a previous note (appendix 2) for supposing that the average milking life of a dairy cow under present conditions extends over 4½ years. It is assumed for the purpose of this estimate that if it were not for the occurrence of accident and disease, cows would yield milk on the average for nine years, *i.e.*, would die at the age of 12 years. It appears from figures given in the Cambridge and Reading* inquiries into the length of life of dairy cattle that about one-sixth of the cattle lost to milking herds die or are sent to kennels, &c. The prices paid and received for animals drafted into and out of herds are naturally subject to considerable variation. It seems, however, to be generally accepted that heifers drafted into herds are worth approximately £25, and that the price received for cattle drafted out is about £15. There is, of course, no figure for the average price which would be received for cows if they were kept in the herd until 12 years of age. It would undoubtedly be lower than the price received to-day. The following passage is quoted from the Ministry of

* See appendix 2.

Agriculture and Fisheries report on the marketing of cattle and beef (economic series, no. 20, p. 23):—*

> "In addition to meat from steers and heifers reared and grown for beef production, a large percentage of home-produced beef comes from cows. The quality range of this supply is very wide, extending from palatable beef of good quality to the roughest and coarsest meat marketed. The upper range is drawn from well-finished cows that have had one or, at most, two calves. After the third lactation, there is a rather rapid decline in quality in the meat yielded by cows, until, in the case of old cows, a time is reached when, on account of age and long service, the meat is not marketable in the form of joints. Meat from these old cows is sometimes boned and made up in various forms, or it may be used for animal food such as dog biscuits."

It is here assumed that if cows are kept till the age of 12 years, they will not produce more than £10.

On the basis of these figures, the loss on herd maintenance may be calculated as follows:—

TABLE 1.—Cost of herd maintenance.

A.—*Loss under present conditions.*

	£
Number of cows drafted into herds annually (approximately), 22½ per cent. of 2,763,000 cows, or heifers in milk, is 600,000; at £25 a head these cost	15,000,000
Number of cows sold annually is therefore 500,000 at £15, making a receipt of	7,500,000
The net annual loss is consequently	7,500,000

B.—*Loss if cows attain, on the average, the age of* 12 *years.*

	£
Number of cows drafted into herds annually would be 300,000, costing at £25 a head	7,500,000
Numbers of cows sold annually would be 250,000 at £10 a head, making	2,500,000
The net annual loss is consequently	5,000,000
Reduction of the annual cost of herd maintenance (A—B) is	2,500,000

It is obvious that the above figure has no claim to precision. It is suggested, however, that the prices assumed (which are the most doubtful factor) are likely to exaggerate rather than understate the amount of the loss under this heading.

(ii) *Losses under heading* (*b*).

The losses on account of the condemnation of carcases may be estimated on the basis of figures supplied by the Chief Veterinary Inspector, Edinburgh, according to whom, of animals showing tuberculous lesions on slaughter 10 per cent. are condemned totally, 20 per cent. are condemned in part, the salvage amounting to one-half to three-quarters of the carcase. The remaining 70 per cent. are not affected. He further estimates that between 80 and 90 per cent. of meat condemned is condemned on account of tuberculosis. If it is assumed that 40 per cent. of the carcases show signs of tuberculosis on slaughter (see paragraph 29 of the main report), then the following losses on account of condemnation may be estimated.

* H.M. Stationery Office, 24–40–20 (1929).

TABLE 2.—Cow meat condemned on account of disease.

	Per cent.
Condemned totally on account of tuberculosis, 10 per cent. of 40 per cent., *i.e.*	4·0
Condemned partially on account of tuberculosis, say $\frac{3}{8}$ of 20 per cent. of 40 per cent., *i.e.*	3·0
Condemned on account of other diseases, say $\frac{1}{8}\frac{4}{5}$ of 7 per cent., *i.e.*	1·2
Total percentage of cow carcases condemned	8·2

The number of carcases condemned is 8·2 per cent. of 500,000, *i.e.*, 41,000, and their value at £15 per head is £615,000.

The risk of this loss should be reflected in the price at present paid for cows drafted out of herds. If this sum of £615,000 is added to the previous sum of £2,500,000, the assumption made is that the price of £15 per cow, assumed in table 1, is not, in fact, at present realised, there being, for example, an insurance premium of £1 4*s*. 6*d*. per head payable in respect of each beast. The actual premium paid is generally less than this. The report of the Ministry of Agriculture and Fisheries, already referred to, quotes premiums for cows varying from 4*s*. to 10*s*.

(iii) *Losses under heading* (*c*).

There does not appear to be sufficient information available to support an estimate of the amount of milk lost through the reduction of milk yields on account of disease. It may, however, be pointed out that some part of this loss is already accounted for in the sum of £2,500,000 already given as the loss on account of herd maintenance. Low milk yield is one of the main reasons for drafting animals out of herds to-day. The assumption made in calculating the loss on herd maintenance is that this ceases to be a cause of drafting animals out of herds as soon as disease disappears. It is obviously illegitimate to include both losses on drafting out such animals under one head, and losses on account of their diminished milk yield (if they had not been drafted out) under another, when estimating the total monetary loss from disease.

One assumption made in the above estimates of the loss due to disease is that the selling prices of similar goods are not affected by any change in methods of production. The sums quoted may more accurately be looked upon as the monetary value at to-day's prices of goods which might be produced without any addition to present expenses of production if losses from disease and accident were to be completely eliminated.

APPENDIX 4.

Table showing the percentage wastage of dairy cattle according to the proportion of homebred cows entering the herd.

(Extracted from a report by the School of Agriculture, Cambridge University, on the scheme for inquiry into the causes of removal of cows from dairy herds in the eastern counties.)

Percentage of homebred cows in total entrants.	1928–29.			1929–30.			1930–31.			All 3 years.		
	0–49.	50–89.	90–100.	0–49.	50–89.	90–100.	0–49.	50–89.	90–100.	0–49.	50–89.	90–100.
No. of herds	152	173	222	142	169	226	160	129	199	454	471	647
No. of cows	3,696	4,230	5,539	3,537	3,907	5,540	3,628	2,957	4,782	19,861	11,094	15,861
Sterility	5·60	4·54	3·34	8·51	6·09	5·06	8·68	7·03	5·25	7·58 ± 0·25	5·74 ± 0·22	4·52 ± 0·16
Abortion	0·68	0·40	0·85	0·82	0·92	0·92	0·74	0·95	0·54	0·75 ± 0·08	0·73 ± 0·08	0·78 ± 0·07
Tuberculosis	1·30	0·88	0·76	1·55	0·97	1·08	1·19	1·35	1·34	1·34 ± 0·11	1·04 ± 0·10	1·05 ± 0·08
Johne's disease	0·49	0·31	0·38	0·57	0·33	0·38	0·64	0·81	0·56	0·56 ± 0·07	0·45 ± 0·06	0·44 ± 0·05
Wasters	0·76	0·54	0·45	0·99	0·61	0·49	0·80	0·78	0·50	0·85 ± 0·09	0·63 ± 0·08	0·48 ± 0·05
Garget	0·16	0·28	0·27	0·22	0·33	0·11	0·25	0·17	0·27	0·21 ± 0·04	0·27 ± 0·05	0·21 ± 0·04
Other udder troubles ...	1·46	1·06	0·72	1·16	0·87	0·78	0·85	0·91	0·86	1·16 ± 0·10	0·96 ± 0·09	0·78 ± 0·07
Died	0·70	0·87	0·88	1·19	1·10	0·99	1·79	1·25	1·26	1·22 ± 0·11	1·05 ± 0·09	1·03 ± 0·08
Accident	0·43	0·12	0·14	0·34	0·31	0·36	0·39	0·17	0·25	0·39 ± 0·06	0·20 ± 0·04	0·25 ± 0·04
Miscellaneous	1·19	0·85	0·71	1·19	0·61	0·61	1·52	0·98	0·77	1·30 ± 0·11	0·80 ± 0·08	0·69 ± 0·07
Total disease...	12·77	9·85	8·50	16·54	12·14	10·78	16·85	14·40	11·60	15·36 ± 0·35	11·87 ± 0·31	10·23 ± 0·24
Tuberculin test	0·46	0·21	0·60	0·34	0·69	0·31	1·68	0·81	0·73	0·83 ± 0·09	0·54 ± 0·07	0·54 ± 0·06
Low yielders	5·01	3·22	2·93	5·85	4·09	3·95	4·88	3·96	4·08	5·24 ± 0·21	3·72 ± 0·18	3·63 ± 0·15
Old age	0·78	0·99	1·08	1·10	1·07	0·74	1·43	0·58	0·92	1·10 ± 0·10	0·91 ± 0·09	0·92 ± 0·08
Trade	2·00	2·94	4·15	6·53	5·07	3·79	7·11	5·07	4·94	5·18 ± 0·21	4·26 ± 0·19	4·26 ± 0·16
Total disposals ...	21·02	17·21	17·26	30·36	23·06	19·57	31·95	24·82	22·27	27·71 ± 0·43	21·30 ± 0·39	19·58 ± 0·32

APPENDIX 5.

Statement showing the number of occupiers of agricultural holdings over one acre in extent within an approximate radius of five miles of certain towns, who returned four or more dairy cattle* on the 4th June, 1932 (Ministry of Agriculture's annual census of livestock).

Town or group of towns.	Number of occupiers.
Liverpool, Birkenhead and St. Helens	400
Birmingham, Wolverhampton and Walsall	402
Blackburn	553
Bolton	338
Bradford, Halifax, Leeds and Huddersfield†	1,280
Brighton	36
Bristol	308
Burnley	598
Coventry	324
Croydon	49
Derby	498
East and West Ham and Leyton	14
Gateshead, Newcastle, South Shields and Sunderland	323
Hull	303
Leicester	210
Manchester, Salford and Stockport	502
Southend	53
Middlesbrough	204
Portsmouth	57
Southampton	161
Norwich	135
Nottingham	188
Plymouth	336
Stoke-on-Trent	492
Sheffield	179
Preston	656
Bournemouth	65
Blackpool	244
Oldham	281
Cardiff	193
Rhondda	123
Swansea	79
Total	9,584

* *i.e.*, cows or heifers in milk or in calf.

† The overlap in this group was not so pronounced as in the other groups; the four towns might almost have been considered individually.

Annex to appendix 5.

In submitting the above statement, the Ministry of Agriculture and Fisheries wrote:—

The 5-mile radius was taken in every case from approximately the centre of the town, but, where a parish fell reasonably within the circle, all the occupiers in that parish returning four or more dairy cattle have been included.

Where the circle round one town definitely overlapped that round another, or where the towns adjoin, the towns have been grouped; it would be difficult to allocate certain parts of a parish to one town and other parts to its neighbour.

London has been omitted from the statement. The small numbers of cowkeepers found round the East and West Ham group and Croydon indicate how far it is necessary to go outside London before the area is reached where dairy cattle keepers are found in any numbers.

The imperfections of the figures given in the statement as an indication of the number of producer-retailers in the country are, of course, very obvious; for instance, some cow keepers within the 5-mile radius may not be producer-retailers, while there may be numbers of producer-retailers outside the radius. The figures supplied should, therefore, be used with great reserve.

APPENDIX 6.

Milk-borne epidemics reported in the United Kingdom since the beginning of the twentieth century.

Place.	Year.	Cases.	Probable source of infection of the milk.	Reference.
		DIPHTHERIA.		
Twyford and Ruscombe, Wokingham R.D.	1904	98	Cow disease ...	Public Health, December 1906, p. 145.
Leith	1904	Epidemic	„ „ ...	Public Health, January 1905, p. 246.
„	1909	9	(?) „ „ ...	Public Health, January 1912, p. 148.
Belfast	1912	Epidemic	Undetermined ...	Lancet, March 30, 1912, p. 900.
London and Croydon ... ... Lambeth Met. B. Penge (Croydon C.B.) Camberwell Met. B. Lewisham Met. B. Beckenham U.D. Croydon C.B.	1913	119	Human or bovine...	13th report of medical officer, Local Government Board, 1913–14, p. 30, and British Medical Journal, June 6, 1914, p. 1261.
Worthing M.B.	1913	52	„ „ ...	Medical officer of health's annual report, 1913, p. 102.
Nine Scottish towns	1916 or 1917	217	„ „ ...	Medical Officer, June 2, 1917, p. 180.
Manchester C.B.	1917–1918	11	Human source ...	Medical Officer, May 4, 1918, p. 146.
West Mersea, Lexden and Winstree R.D.	1921	30–40	„ „ ...	Medical Officer, September 24, 1921, p. 139.
Reigate M.B.	1921–1922	15	„ „ ...	British Medical Journal, November 11, 1922, p. 906, and Medical Officer, January 26, 1924, p. 38.
Cheshire ... ... Hale U.D. Bowdon U.D. Altrincham U.D. Bucklow R.D.	1924	100	Undetermined ...	Chief medical officer's annual report, 1924, p. 56.

Blean R.D.	1928	26	(?) Human source...	Chief medical officer's annual report, 1928, p. 117.
Cardiff C.B....	1928	7	Human or bovine...	Lancet, December 8, 1928, p. 1201.
Reigate M.B.	1928–1929	22	Human source ...	Medical Officer, July 12, 1930, p. 13.

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London, Finchley U.D.	1904	500	(?) Cow disease ...	British Medical Journal, March 12, 1904, p. 602.
Liverpool C.B.	1904	59	Human source ...	Public Health, August 1904, p. 687.
Lancashire, Little Woolton, Liverpool C.B.	1904	30	Undetermined ...	Lancet, April 8, 1905, p. 946.
Gloucester R.D.	1904	65	Human source ...	Lancet, June 4, 1904, p. 1616.
Leith	1905	Over 40	„ „ ...	Public Health, April 1905, p. 445.
Cambridge M.B.	1905	78	„ „ ...	British Medical Journal, April 29, 1905, p. 948, and Public Health, September 1905, p. 795.
Brighton C.B.	1905	236	Undetermined ...	Public Health, September 1907, and Lancet, May 26, 1906, p. 1493.
Guildford M.B.	1908	14	(?) Human source...	Public Health, November 1908, p. 56.
Dublin	1908	37	Undetermined ...	Lancet, September 5, 1908, p. 720.
Cheltenham M.B.	1908	29	Human source ...	Public Health, November 1908, p. .
London and Surrey ... ... Westminster Met. B. Chelsea Met. B. Wandsworth Met. B. Kingston-on-Thames Met. B.	1909	400	(?) Cow disease ...	British Medical Journal, July 3, 1909, p. 45, and Public Health, December 1909, p. 77.
Crumpsall, Manchester C.B.	1909	107	Human source ...	Public Health, January 1911, p. 143.
Small industrial burgh, Scotland ...	1910	81	Undetermined ...	Public Health, January 1911, p. 138.
Glasgow	1912	12	Human source ...	British Medical Journal, January 4, 1913, p. 45.
Woodbridge R.D.	1913	64 + 13 secondary cases	Undetermined ...	Report of medical officer, Local Government Board, appendix A, no. 3, p. 6.
Lutterworth R.D....	1917	Considerable outbreak	(?) Cow disease ...	Medical Officer, April 14, 1917, p. 123.
Edinburgh	1921	30	Human source	Medical Officer, May 24, 1924, p. 227.
Broxburn (W. Lothian)	1923	Outbreak	Not reported ...	British Medical Journal, May 9, 1923, p. 992.
Burslem U.D.	1923	„	Undetermined ...	Chief medical officer's annual report, 1923, p. 48.

Place.	Year.	Cases.	Probable source of infection of the milk.	Reference.
Heywood M.B.	1924	39	Human source ...	Chief medical officer's annual report, 1924, p. 54, and Lancet, July 4, 1925, p. 19.
Lytham St. Annes U.D.	1925	43	„ „ ...	Chief medical officer's annual report, 1925, p. 45.
Keswick U.D.	1925	15	„ „ ...	Chief medical officer's annual report, 1925, p. 44.
Bedford M.B.	1926	72	Not discovered ...	Chief medical officer's annual report, 1926, p. 50.
Northampton C.B.	1926	95	Undetermined ...	Chief medical officer's annual report, 1926, p. 51.
Reigate R.D.	1928	88	Human source ...	Medical Officer, July 12, 1930, p. 13.
„ „	1929	129	„ „ ...	Medical Officer, July 12, 1930, p. 13.
Glasgow	1930	7	„ „ ...	Medical Officer, August 9, 1930, p. 56.
Stannington Sanatorium, Castleward R.D.	1931	170	(?)	

SCARLET FEVER AND SORE THROAT.

Brighton C.B. and Hove M.B.	1930	71 S.F., 100 sore throat	Human	Chief medical officer's annual report, 1930, p. 58.

ENTERIC FEVER.

Mid Sussex (combined district of East Sussex)	1899–1910	58	Human source ...	Lancet, September 10, 1910, p. 793. Public Health, October 1910, p. 2.
Croydon C.B.	1903, 1908, 1910	6	(?) „ „ ...	Public Health, May 1910, p. 287.
Greenock	1904	Outbreak	... ...	Lancet, February 17, 1906, p. 430.
Bristol C.B.	1904–7	3 epidemics (due to 1 carrier)	Human carrier ...	Public Health, November 1908, p. 40.
Hamilton	1908	Outbreak	„ source ...	British Medical Journal, April 18, 1908, p. 963.
Llandudno U.D.	1909	„	(?) „ „ ...	Public Health, January 1910, p. 136.

Yorkshire, West Riding. (Three sanitary districts, names not given)	1911–1912	56	Human source ...	Public Health, September 1912, p. 444.
Willington (Durham) U.D.	1910	74	„ „ ...	Annual report of medical officer, Local Government Board, 1911–12, p. xvii.
Harwich M.B. and Tendring R.D. ...	1912–1913	44, 25	„ „ ...	Annual report of medical officer, Local Government Board, 1912–13, p. xviii.
Glasgow	1909, 10, 11 and 12	33	(?) „ „ ...	Public Health, December 1913, p. 71.
Wisbech and Walsoken U.D.	1916	68	... ...	Annual report of medical officer, Local Government Board, 1916–1917, p. xiv.
South Shields R.D.	1916	20	Human source ...	Annual report of medical officer, Local Government Board, 1916–1917, p. xiv.
Shelley U.D., Shepley U.D. and Derby and Cumberworth U.D.	1909–1912	55	... ...	Annual report of medical officer, Local Government Board, 1912–13, p. 186.
Taunton M.B.	1909	21	Human	Public Health, June 1910, p. 344.
Exeter C.B.	1909	37	„ source ...	Public Health, June 1910, p. 338.
(?)	17 years up to 1909	230	(?) ...	Public Health, January 1919, p. 41.
Barnes U.D....	1910	13	(?) Human	Public Health, June 1910, p. 332.
Wandsworth Met. B.	1910	Unknown	„	Public Health, June 1910, p. 332.
Glasgow	1910	99	„	British Medical Journal, April 11, 1908, p. 889.
Dublin	1908	130	(?) „	Public Health, April 1909, p. 243.
Llanelly R.D.	1917	Outbreak	Insanitary	Medical Officer, October 13, 1917, p. 126.
Hunstanton, Docking U.D.	1917	22	Human	Public Health, January 1919, p. 41.
Towyn U.D....	1918	17	„	Medical Officer, February 7, 1920, p. 58.
Sheringham U.D. and Erpingham R.D.	1919	35	(?) „	Medical Officer, May 28, 1921, p. 228.
Rochford R.D.	1922	3	Polluted ditch water	Medical Officer, March 1, 1924, p. 91.
Campbeltown	1923	Epidemic	Human	Medical Officer, June 2, 1923, p. 270, and British Medical Journal, June 2, 1923, p. 953.
Camborne Urban District	1923	21	„	Chief medical officer's annual report, 1923, p. 42.
Penzance „ „	1923	22	„	Chief medical officer's annual report, 1923, p. 42.
Sevenoaks R.D.	1924	24	(?) Cheese	Chief medical officer's annual report, 1924, p. 50.
London, Bethnal Green Met. B. ...	1924	65	Undetermined ...	Chief medical officer's annual report, 1924, p. 53, and British Medical Journal, April 18, 1925, p. 751, and Medical Officer, April 25, 1925, p. 184.

Place.	Year.	Cases.	Probable source of infection of the milk.	Reference.
TYPHOID AND DYSENTERY ORGANISMS.				
Aberdeen	1925	Over 300	Undetermined ...	British Medical Journal, August 1, 1925, p. 229.
Edinburgh	1926	5	Human	British Medical Journal, December 4, 1926, p. 1049.
Glasgow	1926	80	(?)	Lancet, April 16, 1927, p. 817.
Gravesend M.B.	1927	40	Undetermined ...	Chief medical officer's annual report, 1927, p. 31.
PARATYPHOID B.				
Chorley M.B.	1924	52	Human	Chief medical officer's annual report, 1924, p. 53, and Public Health, May 1925, and British Medical Journal, March 21, 1925, p. 563, and Medical Officer, March 28, 1925, p. 141, and Lancet, April 4, 1925, p. 748.
Wigan C.B.	1925	8	Carrier	Medical Officer, May 23, 1925, p. 238.
Newark-on-Trent M.B. and R.D. ...	1927	39	Human	Chief medical officer's annual report, 1927, p. 32.
Tenterden M.B.	1927	48	„	Chief medical officer's annual report, 1927, p. 34.
Hemel Hempstead M.B. and R.D. and Watford R.D.	1927	166	„	Chief medical officer's annual report, 1927, p. 34, and British Medical Journal, November 26, 1927, p. 1002, and August 4, 1928, p. 216.
London ... ... Kensington Met. B. Fulham Met. B. Wandsworth Met. B. Paddington Met. B.	1928	400	Undetermined ...	Chief medical officer's annual report, 1928, p. 115, and British Medical Journal, August 18, 1928, p. 316, and May 11, 1929, p. 871.

Carshalton U.D. Leatherhead U.D. Dorking U.D. Beddington and Wallington U.D. Sutton and New Malden U.D.				
Essex—				
Epping U.D. and R.D.	1931	218	Human	Chief medical officer's annual report, 1931.
Loughton U.D.	...	13		
Walthamstow M.B.	...	25		
Chingford U.D.	...	2		
Ilford U.D.	...	2		

DIARRHŒA AND SICKNESS.

Bakewell R.D.	1908	Over 30	Bovine	Public Health, November 1908, p. 59.
Blackburn, Withnell U.D.	1914	172	Cow disease ...	Public Health, October 1914, p. 21.

GASTRO-ENTERITIS.

Aberdeen	1909	Epidemic	(?) Human	Public Health, February 1910, p. 181.
„	1919	1,000	(?) „	Medical Officer, February 2, 1924, p. 42. Journal of Hygiene, August 1923, XXI, 4, p. 451.
„	1923	110	Undetermined ...	Medical Officer, February 2, 1924, p. 43. Journal of Hygiene, XXII, 1, October 1923, p. 89.

SICKNESS DUE TO CONTAMINATED MILK.

Leeds C.B.	1929	83	High bacterial content of milk	Lancet, November 9, 1929, p. 996.
Roundhay				
Moortown				

Place.	Year.	Cases.	Probable source of infection of the milk.	Reference.
		SORE THROAT.		
Woking and Horsell, Woking U.D. ...	1903	Epidemic	Undetermined ...	British Medical Journal, February 6, 1904, p. 302, March 12, 1904, p. 619, March 26, 1904, p. 756.
Glasgow	1904	39	(?) Cow disease ...	Lancet, June 18, 1904, p. 1742.
Colchester M.B.	1905	500–600	„ „ ...	British Medical Journal, April 27, 1905, p. 1165.
Brighton C.B., Hove M.B., and Portslade (Steyning East R.D.)	1929	1,000 families 65 deaths	Human disease ...	Chief medical officer's annual report, 1929, p. 82.
		B. GAERTNER.		
Newcastle-on-Tyne, Longbenton U.D.	1913	523	... ...	Proc. R. Soc. Med. Epidem., Sect. VII, 1913–1914.
Withnell U.D. and Chorley M.B. ...	1914	317	... ...	Special report, medical officer of health, Lancashire.
Newcastle-under-Lyme M.B.	1914	468	... ...	Food poisoning and food infection (Savage), p. 80.

APPENDIX 7.

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SCHWARTZE, E. W., MURPHY, F. J., AND COX, G. J., 1931. The effect of pasteurisation upon the vitamin C content of milk in the presence of certain metals. J. Nutrition, Springfield, Ill. **4**: 211–225.

MANN, H. C. Corry, 1926. Diets for boys during the school age. Spec. Rep. Ser. Med. Res. Counc., **105**.

HESS, A. F., 1920. Scurvy past and present. 8vo, Philadelphia (1920).

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STIRLING, L. D., AND BLACKWOOD, J. H., 1933. The nutritive properties of milk in relation to pasteurisation. Bull. Hannah Dairy Res. Inst. **5**.

APPENDIX 8.

Returns prepared by the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland, showing the extent to which veterinary inspection of dairy cattle is undertaken by local authorities.

(a) *Routine inspection of dairy herds (statement furnished by the Ministry of Agriculture and Fisheries, compiled from information supplied by district inspectors).*

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Bedford... ...	Nil	5	Nil	There has been no inspection of dairy herds in this county.
Berkshire ...	Nil	7	Nil	Appointment of one, possibly two, whole-time veterinary officers, now under consideration.
Buckingham ...	...	...	...	Sampling at farms.
Cambridge ...	...	...	Nil	No routine veterinary inspection of dairy cattle carried out.
Chester	1 chief veterinary officer and 5 assistants	...	One inspection per annum	So far staff not large enough to do more than one inspection.
Cornwall ...	...	...	Nil	No routine veterinary inspection of dairy cattle carried out.
Cumberland ...	*4	Nil	Herds on farms (1,133) supplying raw milk at least once, in many cases twice, per annum. Herds on farms (804) supplying butter once per annnm	The routine inspections are carried out by the whole-time staff only. General inspection of the herds and detection of cases giving tuberculosis milk. Search for emaciated animals and collection of samples of sputum whenever available. * Includes one veterinary inspector, recently appointed for sheep scab.
Derby	2	19	No routine examination carried out. The two whole-time inspectors deal only with section 4 cases	Two whole-time veterinary inspectors have recently been appointed by the local authority, but for the milk and dairies order. They would deal with the tuberculosis order, if necessary, in the course of their duties under the first-named order.

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Devon	...	...	No routine veterinary inspection of dairy cattle carried out	Appointment of one whole-time veterinary officer is now under consideration by the Devon local authority.
Dorset	...	...	Nil	Two to four veterinary inspectors(whole-time) are about to be appointed to inspect dairy herds twice a year.
Durham... ...	5	...	About three times per year	No routine inspection under tuberculosis order of 1925. Inspection made under milk and dairies order.
Essex	1	19	Nil	Mr. Medlock has just taken up the appointment chief veterinary officer, Essex, and has not yet formulated his scheme. Up to now county council has only provided for inspections in two districts with a view to ascertaining the cost. This came to an end a year ago.
Gloucester ...	...	16	Twice yearly.	
Hereford ...	1	...	Nil	
Hertford ...	Nil	10	Twice a year ...	More than twice yearly when thought necessary.
Huntingdon ...	...	6	Nil	No systematic inspection. Each inspector paid an inclusive fee for all duties under diseases of animals and milk and dairies orders, but no returns were rendered. At present under review with routine inspections proposed.
Isle of Ely ...	...	...	Nil	No routine veterinary inspection of dairy cattle carried out.
Isle of Wight ...	Nil	3	Nil	
Kent	1	20	Nil	Whole-time veterinary officer. Controlling action taken in cases of reported tuberculosis and has also inspected herds as time allows, but under no system.
Lancaster ...	Nil	Nil	Nil	No routine inspection of dairy cattle carried out.

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Leicester ...	1	10	Half-yearly (previously one inspection annually)	This system starts 1st April, 1934, when the chief veterinary officer will administer tuberculosis order of 1925, and the part-time staff will carry out routine inspections.
Lincoln (Holland) ...		7	No special periods	These veterinary inspectors only visit on report cases of tuberculosis or on reports of adverse samples of milk. *Re Kesteven.*
Lincoln (Kesteven) ...		10	No special periods	The 10 veterinary inspectors include a partnership, *i.e.*, Messrs. Porter, Smith, and Foster. The former also acts for Lindsey.
Lincoln (Lindsey) ...		10	Twice yearly ...	Six months intervals.
London (County of)	2	...	Quarterly ...	By the diseases of animals veterinary inspectors.
London and Middlesex	1	...	Quarterly.	
Norfolk	...	...	Nil	No routine veterinary inspection of dairy cattle carried out.
Northampton ...	...	...	Inspections vary. In districts directly controlled by the county council, half-yearly inspections are made. In certain areas where local sanitary authorities act as "agent" for the local authority, by arrangement, inspections are made three or four times yearly.	
Northumberland	...	...	Nil	No routine inspection. Positive samples taken under milk and dairies order are followed up.
Nottingham ...	1	7	No routine inspectors	Inspections are made as the result of biological test and reported cases.
Oxford	...	...	...	Sampling at farms.
Rutland ...	...	3	Half-yearly.	
Salop	...	17	No regular inspections	Veterinary inspector only called upon when case notified by police. Appointment of whole-time inspector to be considered in the near future.
Soke of Peterboro'	Nil	1	Quarterly inspection of all dairy cows, plus many additional inspections	

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Somerset ...	1	...	Nil	Only deals with reported cases.
Hampshire ...	Nil	10	Nil	In borough of Southampton inspection of all herds twice annually.
Stafford ...	...	24	No regular inspections	One whole-time veterinary inspector has been appointed but has not yet taken up his duties. The appointment of a number of whole-time assistants (possibly five or six) is being considered.
Suffolk	...	...	Nil	No routine veterinary inspection of dairy cattle carried out.
Surrey	4	...	Four times a year	Post of chief veterinary officer at present not filled.
Sussex (East) ...	2	2	Herd inspections are made when time permits; about 110 herds examined each quarter	Whole-time staff has been in action for about two years, but all herds have not yet been inspected once. Part-time staff has not been employed.
Sussex (West) ...	1	5	Nil at present ...	Whole-time officer has only recently taken up duty.
Warwick ...	...	15	Nil	No routine inspection. Inspections limited to examinations of tuberculosis reports and contacts, plus examinations to trace origin of tuberculous milk when found in samples taken by other local authorities chiefly.
Westmorland ...	Nil	Nil	Nil	No routine inspection of dairy cattle carried out.
Wiltshire ...	3	...	The scheme has not been going a year; the aim is to inspect dairy herds twice a year.	
Worcester ...	...	...	Nil	
Yorks., E.R. ...	1	Nil	No inspections are carried out in this county	This county on the advice of its veterinary officer does not consider dairy inspection necessary.

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Yorks., N.R. ...	3	...	...	No routine inspection under tuberculosis order of 1925.
			Twice	Inspections made under milk and dairies order.
Yorks., W.R. ...	1 chief, 8 assistants	Nil	Great majority twice a year, minority four times a year	
Anglesey ...	No routine	veter	inary inspection o	f dairy cattle.
Brecknock ...	...	1	Yearly	Mr. A. J. Cattell, M.R.C.V.S., has concentrated on tuberculosis inspections during the past two years.
Cardigan ...	Nil	Nil	Nil	Local veterinary inspectors employed to deal with cases when reported by owner or through contaminated milk. All dairy stock on farms inspected as contacts to suspected case.
Carmarthen ...	Nil	Nil	Nil	
Carnarvon ...	No routine	veter	inary inspection o	f dairy cattle.
Denbigh ...	No routine of dairy	veter cattle.	inary inspection	Local authority are contemplating the appointment of whole-time veterinary inspector, to enable them to arrange routine inspection of dairy cattle.
Flint	No routine	veter	inary inspection o	f dairy cattle.
Glamorgan ...	3	...	Yearly	One chief veterinary inspector and two assistants employed. Only able to inspect all dairy stock once a year. Farms reporting cases are visited several times.
Merioneth ...	No routine	veter	inary inspection o	f dairy cattle.
Monmouth ...	Nil	Nil	Nil	Local veterinary inspectors employed to deal with cases when reported by owner or through contaminated milk. All dairy stock inspected as contacts to suspected case.
Montgomery ...	No routine of dairy	veter cattle.	inary inspection	Local authority are contemplating the appointment of whole-time veterinary inspector to enable them to arrange routine inspection of dairy cattle.

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Pembroke ...	Nil	Nil	Nil	Local veterinary inspectors employed to deal with cases when reported by owner or through contaminated milk. All dairy stock on farms inspected as contacts to suspected case.
Radnor	Nil	Nil	Nil	
Aberdeen ...	1	...	Once a year.	
Angus	1	...	In burghs once per month. In landward portion of county, quarterly.	
Argyll	...	4	One per year in Mull and Lorn district and two in other three districts.	
Ayr	4	Nil	Twice yearly ...	So far the staff have not managed to get all herds done twice in the year; the number not done twice is about equal to the number of herds done three times or more. Over 1,400 dairies in the county.
Burgh of Ayr (no dairies)				
Burgh of Kilmarnock	...	1	Quarterly (two dairies only).	
Banff	1	...	Approximately three visits per year.	
Berwick... ...	...	5	In burghs, four times per annum. In landward areas, three times per annum, unregistered, two per annum.	
Bute	...	2	Three times a year for registered dairies. Once a year for other premises where cattle are kept.	
Caithness ...	1	...	Four inspections per year.	
Clackmannan ...	...	1	Three times per annum for registered herds. Once per annum for unregistered herds.	

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Dumbarton ...	2	...	Four times a year.	
Dumfries ...	2	...	Twice a year for about 600 registered dairies and once for about 400 other premises where cattle are kept.	
Dumfries, Burgh of	...	1	Three times a year.	
East Lothian ...	...	1	Three times per annum.	
Fife	1	...	Twice yearly.	
Inverness ...	...	1	Quarterly inspections burghs of Inverness and Kingussie. Three inspections per year mainland	There have been no inspections in outer islands.
Kincardine ...	...	5	Registered twice per annum. Unregistered once per annum.	
Kirkcudbright	1 *1	...	Once a year for all herds and as often again as possible	*To enable all herds to be examined once during 1933 and 1934. Mr. J. Macmonemy has been appointed whole-time from 1st January to 31st March.
Lanark	2 *2	...	Three times a year	*Two extra whole-time veterinary inspectors employed each year from 1st November to 30th April.
Burgh of Airdrie	...	1	Quarterly.	
Burgh of Hamilton	...	1	Not less than quarterly.	
Burgh of Rutherglen	...	1	Monthly.	
Burgh of Motherwell and Wishaw	...	1	Monthly.	
Burgh of Coatbridge	...	1	Quarterly.	
City of Glasgow	5	...	Eight times a year	Meat inspection and other duties are done by the veterinary department.
Midlothian ...	2	...	Registered dairies thrice per annum. Unregistered about once in each two years.	

County.	Veterinary staff.		Frequency of inspection.	Remarks.
	Whole-time.	Part-time.		
Moray ... } Nairn ... }	...	4	Four inspections per year.	
Orkney	...	1	Two inspections per year.	
Peebles	...	1	Twice yearly ...	There is also a consultant veterinary inspector employed (part-time).
Perth and Kinross	...	11	Not known ...	Inspections are made under milk and dairies act.
Renfrew ...	2	...	Three times a year is being attempted this year.	
Greenock, Burgh of	...	1	Six times a year	Not many dairies remain in the burghs.
Paisley, Burgh of	...	1	At least four times a year	
Ross and Cromarty	...	3	Two inspections per year	
Roxburgh ...	...	4	Twice per annum	Appointment of a whole-time veterinary inspector for Roxburgh and Selkirk jointly is being considered.
Selkirk	...	1	Registered dairies once per quarter. Unregistered once a year	
Stirling... ...	2	...	Thrice per annum	The appointment of a third veterinary inspector is being considered.
Sutherland ...	...	1	Two inspections per year	
West Lothian ...	1	...	Twice per annum	
Wigtown ...	1 *1	...	Up to now no annual inspection has been completed, but the veterinary inspector examined as many herds as he could.	* Mr. Gibson has been given a temporary whole-time appointment from 1st February to 30th April, 1934, to do a general inspection.
Shetland ...	...	1	Two inspections per year.	

(b) *Frequency of veterinary inspection of dairy cattle under the milk and dairies (Scotland) act*, 1914 (*statement furnished by the Department of Health for Scotland*).

County.	Minimum number per annum.
Aberdeen—	
Landward area	1
Burghs	1–12

County.	Minimum number per annum.
Angus—	
Landward area	4
Burghs	3–12
Argyll—	
Landward area	1–2
Burghs	2–12
Ayr—	
Landward area	2½
Burghs	4
Banff—	
Landward area	3
Burghs	3–4
Berwick—	
Landward area	3
Burghs	4
Bute—	
Landward area	3
Burghs	4
Caithness—	
Landward area	4
Burghs	4
Clackmannan—	
Landward area	3
Burghs	3
Dumfries—	
Landward area	1
Burghs	1–4
Dumbarton—	
Landward area	4
Burghs	4
East Lothian—	
Landward area	3
Burghs	4
Fife—	
Landward area	2
Burghs	2–12
Inverness—	
Landward area	3–4
Burghs	4
Kincardine—	
Landward area	2
Burghs	2–4
Kirkcudbright—	
Landward area	1
Burghs	1
Lanark—	
Landward area	3
Burghs	3–12
Midlothian—	
Landward area	3
Burghs	4–12

County.	Minimum number per annum.
Moray and Nairn—	
Landward area	3
Burghs	4
Orkney—	
Landward area	1
Burghs	4
Peebles—	
Landward area	3
Burghs	3
Perth and Kinross—	
Landward area	2–4
Burghs	1–12
Renfrew—	
Landward area	3
Burghs	4–12
Ross and Cromarty—	
Landward area	2–4
Burghs	2–4
Roxburgh—	
Landward area	2
Burghs	2–4
Selkirk—	
Landward area	4
Burghs	4
Stirling—	
Landward area	3
Burghs	3–4
Sutherland—	
Landward area	2
Burghs	2
West Lothian—	
Landward area	2
Burghs	4
Wigtown—	
Landward area	1
Burghs	1–4
Zetland—	
Landward area	2
Burghs	4

APPENDIX 9.

Particulars of the number of licences held for the production or bottling of graded milks in England and Wales and Scotland.

(Abstracted from the fourteenth annual report of the Ministry of Health.)

(1) *England.*

Type of licence.	Number of licences in force on the 31st March.		
	1931.	1932.	1933.
Principal licences:			
Certified milk	165	188	208
Grade A (tuberculin tested) milk ... including licensees who bottle milk at the farm	195 44	212 60	207 65
Grade A milk	547	620	641
Pasteurised milk	209	234	281
Bottling licences (for premises other than farms):			
Grade A (tuberculin tested) milk ...	159	207	236
Grade A milk	321	367	399

(2) *Wales.*

Type of licence.	Number of licences in force on the 31st March.		
	1931.	1932.	1933.
Principal licences:			
Certified milk	9	8	8
Grade A (tuberculin tested) milk ... including licensees who bottle milk at the farm	43 20	45 22	51 24
Grade A milk	35	32	31
Pasteurised milk	10	9	14
Bottling licences (for premises other than farms):			
Grade A (tuberculin tested) milk ...	43	49	52
Grade A milk	7	5	6

(3) *Scotland.*

(Extracted from the fourth annual report of the Department of Health for Scotland.)

Year.	Number of licences in force on the 31st December.		Number of cows owned by licensees.	Estimated annual yield in gallons.
	Certified milk.	Grade A "T.T." milk.		
1927	44	50	...	...
1928	52	56	...	...
1929	64	76	5,800	...
1930	67	77	5,992	3,800,000
1931	87	98	7,492	4,700,000

APPENDIX 10.

Certain particulars of legislation relating to cattle diseases and the milk supply in countries overseas.

1. THOUGH there are many interesting points of resemblance and of contrast in the legislation relating to milk and to diseases of cattle in different countries, it is unnecessary to enter into these in any detail. Much of such legislation, however it may diverge in certain particulars from that in force in this country, is based on comparable principles, and may be reviewed in general terms.

2. A typical milk code first lays down a definition of what may be sold under the name of milk or as one of the products of milk. This definition may be in terms of specific chemical and physical properties, or in terms of the treatment to which the milk, or milk product, may be subjected, or may require that milk should qualify in both respects. Next, the registration of distributors and, perhaps, of producers of milk is likely to be required. Standards of hygienic conduct are also set up both for the milking of cows and the subsequent handling of milk, and regulations are made regarding the sanitary conditions of buildings in which milk is produced, stored or handled. Finally, the consumption or sale of milk from cows infected with certain diseases is prohibited, and the employment of men, who are suffering from, or have been in contact with, certain human diseases in positions in which there is a danger that they may contaminate milk, is also prohibited. Similarly, the regulations made in connection with the diseases of animals have many provisions in common. They normally provide for the notification, through the appropriate administrative channels, of certain diseases, and for the application of measures for the control of disease, among which are generally included the isolation of animals exposed to infection, the control of the movement of animals in infected areas, the slaughter of infected animals and, in some cases, the inoculation or treatment of infected animals and of animals exposed to infection.

3. Of more importance for our purpose are certain schemes relating to such subjects as the clinical examination of cattle, the reduction of bovine tuberculosis, and the grading and treatment of milk, which have no exact counterpart in Great Britain. In the following paragraphs we briefly review some of the more important of such schemes.

(i) *Milk legislation in the United States of America.*

4. In the United States legislation relating to milk is confined to states and municipalities, the latter being responsible for the greater part of the effective legislation. As a result, there is a great multiplicity of systems in existence. The federal government, however, undertakes the task of co-ordinating the regulations made by the different municipalities, by means of the promulgation of standards and the dissemination of information, which play such an important part in every field of American administrative activity.

5. The principle of all municipal regulations is the establishment of defined grades of milk. Of these grades there are a great variety. The definition of a grade may extend over any of the following points:—

(1) the health of the cows from which the milk is derived, under which heading it may be required that the cows should have passed a tuberculin test or that they should be subjected to veterinary examination;
(2) the management and sanitary condition of the farms on which the cows are kept;
(3) the medical examination of employees by whom the milk is handled, whether on the farm or at subsequent stages in its distribution, with a view to establishing their freedom from any infection likely to be conveyed by milk;
(4) the treatment which the milk has, or has not, undergone, including such operations as refrigeration, pasteurisation and bottling, and the state in which it is delivered;
(5) the chemical constitution of the milk;
(6) the bacterial condition of the milk, at different stages of its distribution.

6. Grades are maintained by the municipalities in one of two ways. Under the permit system, each dairy operating in any town must obtain a permit from the municipality to sell milk of any grade, and all milk must be sold under some grade. It is a condition of this permit that the producers and distributors of the milk should submit to the inspection required. Failure to comply with the conditions required for the sale of milk of any grade, whether revealed by inspection or as a result of chemical or bacteriological examination of the milk, may be punished by the revocation of the permit. The alternative system of grading is sponsored by the federal government, which has published a milk ordinance constituting a standard code for adoption by states, counties, or cities. Under this ordinance, if it is adopted, the health officer of a city is required to announce from time to time, as the result of the inspection of premises and the examination of milk samples, the grade of milk which is being supplied by all producers and distributors of milk ultimately consumed within the city. All milk must be sold under the name of the grade to which it is assigned. Milk producers or distributors, who, as the result of the inspections and examinations carried out in accordance with the code, are found to have violated the regulations defining the grade of milk which they are selling in any particular, and who do not correct the fault immediately, are obliged to sell their milk under the name of the lower grade to which their methods are appropriate. They are, however, entitled subsequently to apply for a further inspection with a view to having their supplies of milk reinstated in the higher grade. An important section of the ordinance provides that, within twelve months of its coming into force, no milk of the lower grades may be sold, except according to one version of the code, during temporary periods of degrading. In this way the less satisfactory sources of supply are either eliminated or brought up to the required hygienic standard.

7. In addition to the grades of milk defined by the milk codes of cities and states, there is a further grade, namely, certified milk, which is defined by a private association, the American association of medical milk commissions. "Certified milk" is a trade name, and its use is confined to those producers whose methods comply with the stringent requirements of the association and who are supervised by the local medical milk commission. Certified milk is adopted as a grade both in the milk ordinance published by the federal government and under the regulations of many towns which have not adopted that ordinance.

8. An interesting feature of many of the grading systems in force in the United States is that milk which is subsequently to be pasteurised must be derived from herds which are free from tuberculosis. This argues a lack of faith in the efficacy of commercial pasteurisation as a means for destroying the tubercle bacillus. But the demand for pasteurisation in the United States has arisen more from fear of the dangers of milk-borne epidemics, than from fear of milk-borne tuberculosis. For though milk-borne epidemics do not appear to be relatively much more common there than they are in this country, bovine tuberculosis is very much rarer. The estimated degree of infection of dairy cattle with tuberculosis is to-day no more than 1·4 per cent., compared with 40 per cent. in this country. The prevalence of milk-borne epidemics may be judged from the following table (table 1), in which are given the numbers of such epidemics reported by state and city health officers during the years 1924 to 1930.

TABLE 1.

Milk-borne epidemics reported by state and city health officers of the United States for the years 1924 *to* 1930, *inclusive.*

Disease.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	Total.
Typhoid	34	31	49	23	25	28	27	217
Paratyphoid A.	0	1	2	0	0	0	0	3
Paratyphoid B.	1	1	0	2	0	1	0	5
Diphtheria	1	1	2	2	2	0	0	8
Septic sore throat	1	6	6	0	3	8	9	33
Scarlet fever...	5	4	5	5	8	11	2	40
Miscellaneous	2	0	4	4	3	2	6	21
Total	44	44	68	36	41	50	44	327

9. Greater emphasis is also placed on the danger of infection with undulant fever from milk than would be justified in Great Britain. About 1,300 cases of this disease are reported annually in the United States. Of these, not more than half are said to be attributable to the consumption of infected milk. Other sources of infection are the consumption of the flesh of infected swine and contact with infected material on the part of those whose occupations expose them to this risk. Even though the incidence of milk-borne undulant fever in the United States appears to be considerably higher than in Great Britain, it is extremely low in comparison with the prevalence of infection in milk. The disparity can be accounted for on one of the following assumptions: first, that infection is only contracted by man from a rare and virulent strain of *Brucella abortus;* secondly, that man only succumbs to particularly massive infection; and, thirdly, that the great majority of human beings have a high degree of immunity from the disease.

10. For whatever reason, pasteurisation is very generally undertaken in America as part of the system of distributing milk to urban consumers. This is brought out in the following table (table 2):—

TABLE 2.

The extent of pasteurisation in cities in the United States in 1924 *and* 1930.

Population of cities.	Number of cities reporting.		Percentage of cities in which the percentage of pasteurised milk was—							
			90 to 100.		50 to 100.		10 to 50.		0 to 10.	
	1924.	1930.	1924.	1930.	1924.	1930.	1924.	1930.	1924.	1930.
500,000 and over	9	11	100·0	90·9	100·0	100·0	0·0	0·0	0·0	0·0
100,000 to 500,000	37	56	56·8	53·6	91·9	96·4	8·1	3·6	0·0	0·0
75,000 to 100,000...	19	13	26·3	50·0	73·6	84·6	15·8	15·4	10·6	0·0
50,000 to 75,000 ...	25	37	20·0	40·5	80·0	77·8	12·0	22·2	8·0	0·0
25,000 to 50,000 ...	60	56	20·0	30·4	80·0	80·4	13·3	17·8	5·0	1·8
10,000 to 25,000 ...	105	92	12·4	17·4	45·7	55·4	31·4	33·7	2·9	10·9
Under 10,000 ...	73	79	5·5	11·4	41·1	25·0	27·4	12·0	2·7	63·0

(ii) *The eradication of bovine tuberculosis in the United States of America.*

11. In 1917 the federal government initiated a campaign for the eradication of tuberculosis from livestock in the United States. The tuberculosis eradication division of the Bureau of Animal Industry was then set up with a programme of—

(1) the eradication of the disease from pure-bred herds of cattle;
(2) the eradication of the disease among swine;
(3) the eradication of the disease in circumscribed areas.

In 1928 two more items were added to this programme, namely—

(4) the eradication of avian tuberculosis among fowls; and
(5) the eradication of Johne's disease (which is also known as para-tuberculosis).

12. Emphasis is placed upon the eradication of tuberculosis from pedigree cattle, as such cattle are particularly liable to be moved from one herd to another. The method of eradication is the periodic testing of the herd with tuberculin and the removal of reacting cattle. When two successive annual tests or three successive semi-annual tests are completed in any herd without the discovery of a reactor, the herd receives a certificate of freedom from tuberculosis from the state and federal authorities, which is valid for one year. Such herds are known as accredited herds. Owners entering the scheme sign an undertaking to co-operate with the authorities and agree to keep their herds for the purposes of dairying or breeding. Restrictions are placed upon the entry of animals into herds which either have received a certificate or are in process of qualifying for one. Broadly speaking, animals may not be introduced into such herds unless they originate from an accredited herd or are subjected to adequate isolation and testing.

13. The area plan of eradication, which is not confined to pure-bred cattle, was first put into operation a few years after the accredited herd plan. The area for the purposes of the plan is generally a county, but may be a smaller unit, for example, a township. Testing under the scheme begins

in any area when 90 per cent. of the owners of herds or the owners of 90 per cent. of the cattle in the area have agreed to co-operate with the authorities. When the testing of the herds of the voluntary entrants has been completed, and the reactors have been slaughtered, the movements of cattle which have not been tested are subjected to severe restrictions, the effect of which is to prohibit their removal from the premises on which they are situated. In this way recalcitrant owners are induced to co-operate. When the incidence of tuberculosis has been reduced to not more than one-half of one per cent., the area is declared to be a modified accredited area. A general retest of all cattle in such an area takes place every three years.

14. The testing of cattle under both the accredited herd plan and under the accredited area plan is undertaken by veterinary officers of the federal or state government, or of the county in question. Animals reacting to the test are generally consigned to public stockyards for slaughter. Exceptional animals, however, and animals in heavily infected districts may sometimes be segregated from healthy stock, the former sometimes on farms set aside by the state government or by associations of pedigree cattle breeders. Compensation is paid for reacting cattle slaughtered. The actual terms of compensation vary, being determined by the different local regulations in force, but are in every case based upon a valuation of the animal before slaughter. The federal government makes a contribution to this compensation based upon the following rules:—

(1) no payment shall exceed one-third of the difference between the appraised value of an animal and the salvage value;
(2) no payment shall exceed the amount paid or to be paid by the state, county or municipality;
(3) in no case shall any payment be more than 35 dollars for any grade animal, or more than 70 dollars for any pure-bred animal; and
(4) no payment shall be made unless the owner has complied with all lawful quarantine regulations.

The distribution of the loss occasioned by slaughter is of interest. The average valuation of all cattle slaughtered since 1919 has been 107·96 dollars, of which 30·78 dollars has been recovered from the sale of the carcase, leaving a net loss of 77·18 dollars. This has been borne in the following manner: by the state governments 31·99 dollars, by the federal government 20·42 dollars, leaving 24·77 dollars to be borne by the owner of the animal. At present, owing to the low price of cattle, the figures are very considerably less.

15. Partly, no doubt, on account of the high compensation paid, but also as a result of the increasing insistence in municipal milk regulations on freedom from tuberculosis in herds supplying milk for urban consumption, eradication has made substantial progress in the United States. To-day, 1,577 counties out of a total of 3,073 are modified accedited areas, and over 34 million animals are under supervision by the tuberculosis eradication division. Six surveys of the incidence of bovine tuberculosis in the United States have been carried out by the Department of Agriculture, and these show a remarkable diminution in its incidence in recent years. The estimated percentage of cattle infected with tuberculosis has been as follows in the years named:—

1922	4·0
1924	3·3
1926	2·8
1928	2·0
1930	1·7
1932	1·4

It is confidently anticipated that the operation of the measures now in force will reduce the incidence of the disease to a very low level and will prevent any danger of its subsequent recrudescence. These successful results have not been achieved without considerable expense. In the last ten years

the federal, state and county authorities have, between them, spent approximately 150 million dollars on the eradication of tuberculosis.

(iii) *The eradication of bovine tuberculosis in Canada.*

16. There are four schemes under which attempts are being made to eradicate bovine tuberculosis in Canada. The first in point of time, but perhaps the least successful, provided for the free testing of cattle with tuberculosis in herds supplying milk for consumption within any municipality which enforced certain regulations regarding milk within its area, and applied for assistance in the control of bovine tuberculosis and for the compensation of owners of tuberculous cows slaughtered as a result of the test. The regulations of the municipality were bound to require, in addition to a minimum hygienic standard for dairies supplying milk within its boundaries, that no dairy should sell unpasteurised milk within the municipality after two years had elapsed from the date of the first test with tuberculin of the cattle belonging to the dairy in question, unless a veterinary inspector certified that such cattle were free from tuberculosis. Cattle in dairies the milk from which was sold to dairy companies equipped with adequate pasteurising plants who pasteurised the milk in question, were not necessarily tested with tuberculin. Cattle in other dairies were tested with tuberculin and examined clinically by a veterinary inspector of the dominion government. Cows discovered to be suffering from open tuberculosis were required to be slaughtered forthwith. Cows reacting to the test, but not suffering from open tuberculosis, might either be slaughtered or retained in the herd. If the latter alternative was chosen, milk from that dairy was required to be pasteurised. Compensation was paid for cows slaughtered, up to one-half of their appraised value in the case of cows with open tuberculosis, and up to two-thirds of their appraised value in the case of other reacting cows. Cows bought by owners of herds which were under control were required to pass the tuberculin test before being placed with healthy cows.

17. This plan was brought into operation in 1916, and by 1924 thirty municipalities were receiving assistance under it. By that time, however, it was clear that satisfactory results could not be expected from it, and no further municipalities have been admitted under it. The reasons for the comparative failure of this scheme were the reinfection of tested herds by contact with untested herds selling pasteurised milk, and the reinfection of herds by cattle bought from outside sources to replenish wastage. It was also suspected that reacting cattle were being deliberately sent into herds under control with a view to securing compensation.

18. The second scheme to be adopted as part of the campaign against bovine tuberculosis was the accredited herd plan. This scheme is only open to owners of herds in which not less than five animals are pure-bred and not more than two-thirds of the total cross-bred. Herds under this scheme are tested by the veterinary inspectors of the federal Department of Agriculture. Accredited herds are those in which no reactors are found at two successive annual tests or three successive semi-annual tests. Every herd owner entering the scheme undertakes, in consideration of the assistance given him in the testing of his herd, to observe various hygienic precautions against the spread of tuberculosis, to introduce no animal into his herd except under conditions which secure that it shall be free from tuberculosis and to remove all reacting animals from his herd for immediate slaughter. Compensation is paid for animals slaughtered up to two-thirds of their appraised value, subject to a maximum compensation which has been varied from time to time. The United States and the Dominion of Canada have each agreed to accept a certificate of accreditation issued by the other as though it were issued by itself. The number of accredited herds has increased rapidly in recent years, and in 1932 there were 5,533.

19. Herds which are excluded from the accredited herd plan may become supervised herds. This plan is not the subject of any official regulations, but is based upon an agreement with the Department of Agriculture signed by the owner of the herd in question. Under this agreement, in consideration for his herd being tested with tuberculin by the department, the herd owner undertakes to carry out the instructions of the department's veterinary officer, to slaughter all reacting cattle and to take necessary precautions against the reintroduction of tuberculosis into his herd either by the purchase of new stock or in other ways. No compensation is paid for cattle slaughtered. Under this plan 4,855 herds had been tested by 1932, at which time 1,842 herds were awaiting test. As the restricted area plan, to which we next refer, extends, supervised herds are comprehended in the larger scheme and are no longer dealt with as individual herds.

20. The restricted area plan was brought into operation by an order in council dated the 4th May, 1927. It provides that, on the application of a provincial government, and with the consent of two-thirds of the cattle owners in the proposed area, the Dominion government may declare an area a restricted area. Under the restrictions which are thereupon imposed on the movements of cattle into such an area, cattle which are neither drawn from accredited herds, nor pass a tuberculin test, are prohibited from entering the area except for immediate slaughter. Cattle within the area are tested with tuberculin as soon as possible after the area is proclaimed, and thereafter as often as is required by the veterinary director-general. Reactors to the test are slaughtered without delay, and compensation is paid to their owners up to two-thirds of their value, subject to a maximum compensation. Under this plan 1,627,473 cattle had been tested by the year 1932, and 1,242,379 animals were being supervised under it. In many restricted areas the incidence of tuberculosis had been reduced to very small proportions. In the province of Prince Edward Island, for example, the whole of which constitutes a single restricted area, the incidence of tuberculosis was in 1929 no more than 0·15 per cent.

21. The extent of the effort which is being made in Canada to control bovine tuberculosis may be judged from the fact that in the year ended the 31st March, 1932, nearly one million tests were carried out on over 800,000 animals. Among these, nearly 20,000 reactors were discovered and slaughtered, and compensation amounting to 665,000 dollars was paid for them out of public funds. As in the United States, a very hopeful view is taken by those in charge of these operations of the prospect of reducing tuberculosis to manageable proportions.

22. In addition to the efforts which it is making to eradicate bovine tuberculosis, the Dominion government has instituted a plan under which it is hoped eventually to reduce the incidence of contagious abortion. This plan resembles the supervised herd plan in that it is based on an agreement between the herd owner and the Department of Agriculture, under which, in return for assistance in making blood tests of his cattle, the owner undertakes to carry out the instructions of the department's veterinary officer. The methods of eradication employed, however, are different. The method of the isolation of the reacting section of the herd and its gradual elimination as uninfected young stock are reared is contemplated as an alternative to the method of immediate slaughter in the eradication of this disease. The sale of reacting animals is also permitted, but only into herds already infected with the disease, and on disclosure of the fact that the animal has reacted, to the intending purchaser. At the end of the year 1931–32 only 81 herds were under supervision, of which 70 had already been tested and 11 were awaiting test.

(iv) *The control of the milk supply and of cattle diseases in Denmark.*

23. The milk supply of Copenhagen is drawn from farms which are subject to a monthly veterinary inspection. This inspection refers not only to the health of the cows, but also to the cleanliness of the cows and of the

cowshed, and the methods of milking, feeding and management generally. The veterinary surgeons undertaking this work are employed by the Copenhagen dairy companies which receive the milk, and send a certificate to the company concerned on the completion of every inspection. The dairy company is obliged to produce a certificate of inspection every month for each of the farms from which it receives supplies to the health committee for Copenhagen. In this way it is secured that no milk reaches Copenhagen from cows which have not been adequately supervised. The cost of this supervision is borne immediately by the distributing companies and is ultimately added to the retail cost of milk. In addition to these measures, the health committee also undertake the examination of milk shops in the city and the sampling of milk sold therefrom. It does not appear that this sampling is principally concerned with the discovery of tuberculous milk and milk infected with other organisms likely to be injurious to human health.

24. Measures have been taken in Denmark against the spread of bovine tuberculosis for many years. But the part played by the government has not been very great. The method of eradication most frequently adopted is that put forward by Professor Bang, formerly chief of the civil veterinary service in Denmark. Under this scheme animals with clinical symptoms of tuberculosis are destroyed and calves are separated from the infected herd at birth and reared in isolation on pasteurised milk. These calves, as they reach maturity, are not drafted into the original herd, but form a separate herd, occupying separate buildings and pastures. Ultimately, the herd built up from uninfected young stock replaces the old infected herd entirely. The period during which a tuberculosis-free herd is being built up may be shortened by dividing the original herd into two sections, namely, reactors to the tuberculin test and non-reactors. There is, however, always the danger that non-reactors at the first test may react at subsequent tests.

25. The measures which have been taken by the government include the constitution of a fund, to which it contributes 100,000 crowns annually, for defraying the expenses of farmers who have their herds tested with tuberculin. Farmers can benefit from this fund if they undertake effectively to separate reactors to the test from non-reactors. The Danish law also requires that clinical cases of bovine tuberculosis should be slaughtered, subject to compensation, and that skimmed milk and butter milk should be heated to 80° C. before being returned to farms for feeding to stock. These measures, though they seem to have been successful in saving Denmark from that increase in the incidence of bovine tuberculosis which has been apparent in other countries since the beginning of this century, did not excite much enthusiasm among the farming community. In recent years, however, there has been a definite development of interest in the eradication of tuberculosis. This has been stimulated in part by the activities of the co-operative dairies, in part by the formation of tuberculosis associations among the farmers themselves. These private activities have been useful in the same way as the area scheme in the United States and Canada, which we have already described. Official data on the success of the present movement are not available, but it is generally believed that it has been considerable. The outstanding example of the success of Bang's system is to be found on the island of Bornholm in the Baltic, where infection was never very heavy. As the result of the activities of the twenty dairies buying milk in the island, it has been reduced to such an extent that in 1928, out of the 3,797 herds supplying milk, 3,171 were free from tuberculosis.

(v) *State-assisted associations in the Netherlands for the reduction of tuberculosis.*

26. Attempts are being made in the Netherlands to eradicate bovine tuberculosis through the action of voluntary associations of farmers. These associations in many cases receive assistance from government and provincial funds. Associations which do not receive such assistance generally make

rather less exacting demands upon their members than are laid down as the condition of receiving government support. Associations receiving government support must comply with the following conditions:—

(*a*) All cattle belonging to the participating member must be submitted at least once a year to a veterinary examination and treatment with tuberculin. The latter must be made according to rules to be defined by the director of the veterinary service.

(*b*) Participating members are bound to promote the breeding of their young cattle, free of tuberculosis.

(*c*) Animals, which, as a result of the veterinary examination, appear to be suffering from, or which are seriously suspected to be suffering from, open tuberculosis, must be destroyed without delay by the association in co-operation with the inspector of the veterinary service.

(*d*) Animals belonging to participating members which, as a result of the veterinary inspection, defined under section (*a*) of this clause, show a positive reaction on the tuberculin treatment, must, with the assistance of the association, be marked as soon as possible, in accordance with the rules to be laid down by the director of the veterinary service.

The government, on its part, pays to the association a sum of 25 florins for each animal with open tuberculosis which is promptly slaughtered. In addition, some provincial governments contribute a further 25 florins under this heading. The government also contributes towards the cost of inspection the sum of half a florin for each animal inspected, provides free supplies of tuberculin for testing and assists in the testing of samples of milk, saliva or fæces for the presence of tubercle bacilli.

27. About 150,000 animals have been brought within government-assisted schemes. There is a certain amount of prejudice against the scheme arising from the provision that all reacting animals must be marked. On the other hand, the authorities attach considerable importance to this provision.

(vi) *The control of bovine tuberculosis in Germany.*

28. In Germany reliance is placed upon the elimination of the open cases of tuberculosis disclosed by a clinical examination and the reacting of calves in isolation as the means of preventing the spread of bovine tuberculosis. Farmers willing to adopt these methods join an association for this purpose and undertake to submit their herds to a periodic examination, for the cost of which they are responsible, and to submit samples of their milk for examination at a state institution. Cows discovered to be suffering from open tuberculosis are slaughtered and compensation is paid to the owner out of funds contributed by all members of the association in proportion to the number of cattle owned. About 15 per cent. of the cattle population is subject to the scheme. The increasing incidence of tuberculosis in herds not under control is said to prevent any improvement in the incidence of tuberculosis attributable to the scheme from being reflected in statistics such as those of the percentage of tuberculous animals discovered on slaughter. But even in herds subject to the scheme, no very high degree of success is claimed. For example, in one memorandum on the subject which we received, it is concluded that "the scheme is apt to keep losses on account of tuberculosis within limits which can be borne economically."

(vii) *The control of bovine tuberculosis in Norway.*

29. Bovine tuberculosis is less common in Norway than in most European countries. Of 351,119 animals examined with tuberculin in the early part of this century, 5·57 per cent. reacted. Infection was found to be concentrated in certain districts, particularly in the eastern parts of Norway.

The measures adopted to control bovine tuberculosis are held to have succeeded well, and to-day the disease causes little loss to Norwegian farmers.

30. These measures fall into three groups. In the first place all herds in which the presence of bovine tuberculosis is established are placed under comprehensive quarantine regulations. Under these regulations it is provided, among other things, that milk from tuberculous animals may only be sold if boiled or pasteurised. Tuberculous animals for this purpose are animals in herds in which the presence of tuberculosis has been established, except in herds which have been tested with tuberculin and in which measures to isolate reacting cattle have been taken, in which case reacting animals alone are considered tuberculous. The presence of tuberculosis in a herd is established through the reports of farmers themselves and of veterinary surgeons, whether in public employment or in private practice, all of whom are bound to notify the appropriate authorities of any instance of tuberculosis which they may discover, through the reports of inspecting authorities at slaughterhouses, and as a result of tests of milk for tuberculosis undertaken by public health authorities.

31. Secondly, there is a scheme in existence for the examination of herds with tuberculin at the public expense. Such examinations are undertaken in suitable cases on the application of the owner, so far as funds voted by the Storting permit. Animals found to react to the tuberculin test and non-reacting animals with clinical symptoms of tuberculosis must be marked, and, unless the veterinary surgeon in charge decides otherwise, must be slaughtered within three weeks of the examination. Partial compensation is paid for animals slaughtered. Owners must undertake to carry out the instructions of the veterinary authorities. Failure to do so makes the owner liable to refund any money expended by the government under the scheme on his behalf, together with interest thereon.

32. Finally, the owner may undertake the tuberculin test of his herd at his own expense. By so doing the owner avoids the special obligations falling upon those whose herds are tested at the government expense, but, should reactors be discovered, incurs the general disabilities attaching to the ownership of an infected herd. In particular, he is obliged either to pasteurise the milk from his whole herd, or to segregate reactors from the remainder and pasteurise milk from the reacting section of his herd.

APPENDIX 11.

Numbers of infected milk samples in county boroughs drawing supplies of milk from the West Riding of Yorkshire.

—	Total number of samples examined.											Number of samples found to be tuberculous.										
	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931	1932.	1933.
Barnsley	...	...	...	...	2	4	2	7	5	48	67	...	...	...	...	...	3	2	...	...	6	2
Bradford	61	48	80	188	185	274	273	282	237	253	234	1	1	2	16	7	12	7	5	6	5	6
Dewsbury...	...	...	...	...	...	1	...	2	5	14	38	...	...	...	...	...	...	...	...	...	...	1
Doncaster	...	...	...	...	...	...	...	...	...	20	21	...	...	..	...	...	...	...	...	...	2	...
Huddersfield	53	72	62	67	34	31	20	87	208	179	142	7	5	3	4	...	2	...	8	10	3	6
Leeds	58	59	64	35	37	48	56	49	103	107	...	5	1	5	5	1	...	2	1	2	3	...
Rotherham	...	...	...	...	...	...	...	8	22	52	63	...	...	...	...	...	...	...	1	3	10	5
Sheffield	...	235	198	256	255	286	248	186	288	87	179	...	12	22	25	20	22	21	11	24	12	19
Wakefield	...	5	...	14	9	11	14	20	10	20	32	...	2	...	1	1	...	2	4	...	1	3
York	2	...	4	2	7	9	2	9	25	23	...	...	...	...	...	...	2	...	...	1	1	...
Manchester	...	4	2	7	3	7	7	6	12	12	26	...	...	...	...	...	...	3	...	...	1	1
Oldham	...	...	...	...	...	...	...	...	...	9	5	...	...	...	...	...	...	...	...	...	...	...
Salford	...	16	16	17	41	58	48	41	40	31	40	...	...	1	1	4	4	1	1	2	...	1
Total	174	439	426	586	573	729	670	697	955	855	847	13	21	33	52	33	45	38	31	48	44	44

NOTE.—All samples referred to are taken from the mixed milk of individual farms situated in the West Riding of Yorkshire.

APPENDIX 12.

An example of rules drawn up for the management of a herd in which an attempt is being made to eradicate bovine tuberculosis.

Be sure that the tuberculin used is of assured potency and purity.

Do not test the same cattle at shorter intervals than six months, except for a very special reason.

Avoid testing with Johnin, or vaccinating against epizootic abortion, within two months of doing the next test with tuberculin.

If using the subcutaneous method, guard against the cattle being frightened or excited prior to or during the test, in order to avoid getting a misleading rise in temperature.

When using the double intradermal test, inform the veterinary surgeon that your society insists on his using the following technique:—

The test is carried out in two stages:—

1. A preliminary or sensitising injection.
2. The test dose or diagnostic injection.

The tuberculin employed is "old" ("concentrated" or "undiluted") tuberculin of known potency, or the new "synthetic" tuberculin prepared at the Institute of Animal Pathology, Cambridge, and not the dilute tuberculin employed for the subcutaneous test.

Technique.

An area of from 2 to 6 square inches is prepared about the centre of the side of the neck by shaving or clipping. When many cows are being tested it is convenient to use the left side of one and the right of the other. A fold of skin is taken between the forefinger and thumb of the left hand, and a short strong steel dental needle, not less than 1 cm. in length, is introduced into the fold. It is desirable to insert the needle obliquely, so that the point reaches the deeper layers of the derma. A syringe of 1·0 cc. capacity, charged with tuberculin, is then attached to the needle, and 0·1 cc. of the tuberculin is injected. Considerable pressure is usually necessary, and if the injection is made easily it should be suspected that the needle has penetrated to the subcutaneous tissue. When the injection has been made correctly, the tuberculin is felt as a small pea-like enlargement when the fingers are passed lightly over the site. Failure to detect such an enlargement suggests that the tuberculin has been injected below the skin, and a second injection should be given in a fresh site. It is always advisable to ascertain that the syringe and needle are working efficiently. This may readily be done by charging the syringe with liquid, thrusting the needle into a piece of rubber and then forcibly compressing the piston. No fluid should escape either past the plunger or at the junction of the needle with the syringe.

The second or test dose is given 48 hours after the first or sensitising dose, and also consists of 0·1 cc. of tuberculin. It should be injected into *exactly the same spot* as the first or sensitising dose, that is, into about the centre of the swelling produced by that dose.

Observations and measurements.

After preparing the area, and before the first injection, the fold of skin is grasped between the forefinger and thumb of the left hand, and the thickness of the fold is measured by means of callipers. This measurement varies from 3 to 6 mm. in calves, from 4 to 10 mm. in cows and from 11 to 16 or more in bulls.

After taking the preliminary measurement, the sensitising dose is injected.

Forty-eight hours later, the fold is again measured at the site of injection. In some tuberculous animals a definite reaction is obtained at this stage, so that a further dose is unnecessary, but, if the swelling is circumscribed, the second injection must be given.

Twenty-four hours after this second or test dose has been injected, the area is again examined and measured. Non-tuberculous animals usually show little increase in thickness of the area. The actual site of injection remains as a sharply circumscribed *pea* or *bean-like area devoid of diffuseness, heat or tenderness.* In tuberculous animals the swellings exhibit varying degrees of diffuseness which may be accompanied by heat and tenderness.

This examination is the most important of all, as at this time a definite conclusion can be reached. The necessity for the second injection is now apparent, for it is frequently found that a certain proportion of animals which failed to react to the sensitising dose are now definitely positive. Particular attention should be paid to the character of the swelling, and the site of the injection should be carefully palpated in order to detect slight degrees of diffuseness which constitute a positive reaction. While the difference in the measurements of a small positive reaction and a non-reactor *may* be trifling, the character of the swelling is of the utmost importance. In tuberculous animals, the site, whatever the measurement may be, is ill-defined, soft or "fluffy" to the touch.

In the case of the Graded Herds, under the scheme of the Ministry of Health, it is necessary to record the measurement at each visit. It cannot be too clearly pointed out, however, that palpation of the area is of far greater diagnostic value than are measurements, and for ordinary purposes measurements may be omitted.

Summary of technique.

1.—(*a*) Preliminary measurement of prepared fold of skin.
(*b*) Injection into the derma of 0·1 cc. concentrated tuberculin.

Forty-eight hours later:—

2.—(*a*) Measurement of site of injection, palpation and observation of the area.
(*b*) Injection of second dose of 0·1 cc. in the same spot as the first.

Twenty-four hours later:—

3. Final measurements and observations of the site of inoculation.

Abbreviations employed in recording the results:—

D = diffuse.
S.D = slightly diffuse.
H = heat.
T = tenderness.
N.S.I = no second injection.
R = reactor.
N = non-reactor.

Clean land.

Before beginning to segregate "clean" from infected cattle, insure that you have sufficient uninfected pasturage on to which to turn the "clean" cattle. Tubercle can remain infective on grass and in dung and soil for some time, how long is not yet known for certain. Probably safety can be assured by keeping all cattle off the land for three months in summer or six months in winter and, in the meantime, well harrowing the land, in order to break up the dung and expose all tubercle to the sun and air, and feeding off the grass closely with sheep. If possible, lime with unslaked lime. It is advisable to keep poultry off the land.

Buildings.

Carefully disinfect, under the direction of a veterinary surgeon, the buildings in which the clean cattle will be housed. It is very desirable to segregate infected cattle in different buildings, if possible. If this is absolutely impossible, have a movable partition made of sheets of corrugated iron fixed on a wooden frame. It should be as high as possible. As the number of infected cows decreases, the partition can be moved along and the vacated stalls disinfected. There should be no door through the partition. The drainage should run from the clean cows past the infected, never *vice versa*. The same applies, of course, to the water supply.

It is essential for the non-reactors to be never allowed to drink water which can have been contaminated by any possibility by the reactors.

Calving infected cattle.

When a reacting cow or heifer calves, it should be arranged for the calf to be delivered direct on to a clean cloth or sheet and removed at once. It should be kept from all contact with its mother and from the soiled litter of her box. If the herd owner has had a non-reacting cow calve within 4 days, before or after, the calf from the reactor should be given some of the colostrum from that non-reacting cow in order that it may not miss entirely the natural aid to resistance to disease, especially of the alimentary tract, which it should have acquired through its own mother's first milk.

Rearing of calves.

It cannot be impressed too strongly on herd owners the importance of rearing calves and young stock in airy and sunny surroundings, with ample nourishment and a clean dry bed. They are then much more likely to be resistant to any chance infection of tuberculosis or any other disease. They should never be given any milk from the reacting cows. If possible, the men attending the reactors should have nothing to do with the non-reactors and young stock. If this is impossible, then they should always milk and tend the reactors last.

Care must be taken that calves are not fed on skim milk or whey from creameries and cheese factories, as, being from bulked milk, it is almost certain to contain tuberculosis.

Care of cattle at grass.

It is essential that non-reactors should not be turned into fields recently used by reactors. In taking any steps to eradicate either tuberculosis, Johne's disease or abortion, it is of the first importance that animals should be prevented from contaminating the ponds and streams from which they drink with their fæces and urine. The water should be so fenced off that the cattle can only get their heads to it, or else the water pumped out into a tank. This applies especially to stagnant ponds. Owners should guard against infection from running water which may have come through an infected area. If the boundary fences are weak, or of such a nature as not to prevent contact with a neighbour's cattle, a second fence should be provided. A two-strand wire fence, under which sheep can go, at least 6 feet from main fence, is sufficient.

Importance of care.

The above precautions may seem tiresome and expensive, but they are not nearly so much so as a reinfection after a herd has been nearly or completely cleared. To succeed (an even seriously infected herd can be cleared in 3 years), it is necessary to carry out the above instructions rigidly.

Disposal of reactors.

If reactors are rigidly segregated from the clean cattle, there is no necessity to dispose of them, but in the case of cattle of no particular value to the herd it is much wiser to do so, as there is always the possibility of the disease becoming acute and of their becoming "wasters."

The recommendations in this scheme have been drawn up with the best possible veterinary advice.

APPENDIX 13.

Human and cow population and rateable value in Great Britain.

(a) *Human and cow population and rateable value by counties in England and Wales.*

A.C. = Administrative County.
C.B. = County Borough.

County or county borough.	Population, 1931.	Rateable value on 1st April, 1930, for general county purposes	Rateable value for general county purposes per head.	Number of cows in milk or in calf and heifers in milk, 4th June, 1931.	Rateable value for general county purposes per cow.
(1)	(2)	(3)	(4)	(5)	(6)
ENGLAND.		£,000.	£		£
Bedford (A.C.)	220,474	1,157·9	5·3	10,911	106
Berks (A.C.)	214,181	1,339·5	6·3	24,723*	55
Reading (C.B.)	97,153	683·1	7·0		
Berks (A.C. and C.B.)	311,334	2,022·6	6·5	24,723	82
Buckingham (A.C.)	271,565	1,664·1	6·1	28,753	58
Cambridge (A.C.)	140,004	776·0	5·5	8,107	96
Chester (A.C.)	675,190	3,710·0	5·5	127,001*	29
Birkenhead (C.B.)	147,946	910·4	6·2		
Chester (C.B.)	41,438	290·5	7·0		
Stockport (C.B.)	125,505	711·7	5·7		
Wallasey (C.B.)...	97,465	791·6	8·1		
Chester (A.C. and C.B.'s) ...	1,087,544	6,414·2	5·9	127,001	50
Cornwall (A.C.)	317,951	1,211·6	3·8	78,467	15
Cumberland (A.C.)	205,790	783·0	3·8	50,761*	15
Carlisle (C.B.)	57,107	334·2	5·9		
Cumberland (A.C. and C.B.) ...	262,897	1,117·2	4·3	50,761	22
Derby (A.C.)	614,926	2,605·4	4·2	73,641*	35
Derby (C.B.)	142,406	760·6	5·3		
Derby (A.C. and C.B.)	757,332	3,366·0	4·4	73,641	46
Devon (A.C.)	458,664	2,644·0	5·8	105,915*	25
Exeter (C.B.)	66,039	549·5	8·3		
Plymouth (C.B.)	208,166	1,633·6	7·8		
Devon (A.C. and C.B.'s)	732,869	4,827·1	6·6	105,915	46
Dorset (A.C.)	239,347	1,459·9	6·1	63,040	23
Durham (A.C.)	924,050	3,260·5	3·5	30,285*	108
Darlington (C.B.)	72,093	436·6	6·1		
Gateshead (C.B.)	122,379	494·8	4·0		
South Shields (C.B.)	113,452	475·6	4·2		
Sunderland (C.B.)	185,870	795·2	4·3		
West Hartlepool (C.B.) ...	68,134	312·4	4·6		
Durham (A.C. and C.B.'s) ...	1,485,978	5,775·1	3·9	30,285	190

* Including cows in associated county boroughs.

County or county borough.	Population, 1931.	Rateable value on 1st April, 1930, for general county purposes.	Rateable value for general county purposes per head.	Number of cows in milk or in calf and heifers in milk, 4th June, 1931.	Rateable value for general county purposes per cow.
(1)	(2)	(3)	(4)	(5)	(6)
ENGLAND—*continued.*		£,000.	£		£
Ely, Isle of (A.C.)	77,705	247·8	3·2	5,952	32
Essex (A.C.)	1,198,601	6,580·4	5·5	43,914*	150
East Ham (C.B.)	142,460	676·3	4·7		
Southend-on-Sea (C.B.) ...	120,093	1,165·8	9·7		
West Ham (C.B.)	294,086	1,381·0	4·7		
Essex (A.C. and C.B.'s)	1,755,240	9,803·5	5·6	43,914	225
Gloucester (A.C.)	335,801	1,462·5	4·4	52,851*	28
Bristol (C.B.)	396,918	2,638·3	6·6		
Gloucester (C.B.)	52,937	336·3	6·4		
Gloucester (A.C. and C.B.'s) ...	785,656	4,437·1	5·6	52,851	84
Hereford (A.C.)	111,755	506·2	4·5	33,935	15
Hertford (A.C.)	401,159	2,788·4	7·0	17,604	153
Huntingdon (A.C.)	56,204	194·6	3·5	6,018	32
Kent (A.C.)	1,194,115	8,107·3	6·8	40,345*	201
Canterbury (A.C.)	24,450	183·3	7·5		
Kent (A.C. and C.B.)	1,218,565	8,290·6	6·8	40,345	206
Lancaster (A.C.)	1,794,857	9,005·3	5·0	134,149*	67
Barrow-in-Furness (C.B.) ...	66,366	338·8	5·1		
Blackburn (C.B.)	122,695	688·9	5·6		
Blackpool (C.B.)	101,543	1,287·8	12·7		
Bolton (C.B.)	177,253	973·3	5·5		
Bootle (C.B.)	76,799	480·5	6·3		
Burnley (C.B.)	98,259	559·6	5·7		
Bury (C.B.)	56,186	322·4	5·7		
Liverpool (C.B.)	855,539	6,437·6	7·5		
Manchester (C.B.)	766,333	6,598·3	8·6		
Oldham (C.B.)	140,309	715·3	5·1		
Preston (C.B.)	118,839	630·2	5·3		
Rochdale (C.B.)	90,278	500·8	5·5		
St. Helens (C.B.)	106,793	394·5	3·7		
Salford (C.B.)	223,442	1,118·7	5·0		
Southport (C.B.)	78,927	894·8	10·8		
Warrington (C.B.)	79,322	329·6	4·2		
Wigan (C.B.)	85,357	362·7	4·2		
Lancaster (A.C. and C.B.'s) ...	5,039,097	31,639·1	6·3	134,149	236
Leicester (A.C.)	302,683	1,242·7	4·1	42,437*	29
Leicester (C.B.)...	239,111	1,589·4	6·6		
Leicester (A.C. and C.B.) ...	541,794	2,832·1	5·2	42,437	67
Lincoln, Parts of Holland (A.C.)	92,313	300·4	3·3	8,298	36
Lincoln, Parts of Kesteven (A.C.)	110,059	412·3	3·7	14,653	28
Lincoln, Parts of Lindsey (A.C.)	263,472	1,036·6	3·9	37,465*	28
Grimsby (C.B.)	92,463	434·9	4·7		
Lincoln (C.B.)	66,246	401·9	6·1		
Lincoln, Parts of Lindsey (A.C. and C.B.'s)	422,181	1,873·4	4·4	37,465	50
Middlesex (A.C.)	1,638,521	13,255·8	8·1	6,029†	2,200
Norfolk (A.C.)	321,870	1,110·8	3·5	42,212*	26
Great Yarmouth (C.B.) ...	56,769	312·5	5·5		
Norwich (C.B.)	126,207	617·1	4·9		
Norfolk (A.C. and C.B.'s) ...	508,846	2,040·4	4·0	42,212	48
Northampton (A.C.)	217,114	925·5	4·3	28,661*	32
Northampton (C.B.)	92,314	599·0	6·5		

* Including cows in associated county boroughs.
† Including cows in the county of London.

County or county borough.	Population, 1931.	Rateable value on 1st April, 1930, for general county purposes.	Rateable value for general county purposes per head.	Number of cows in milk or in calf and heifers in milk, 4th June, 1931.	Rateable value for general county purposes per cow.
(1)	(2)	(3)	(4)	(5)	(6)
ENGLAND—*continued.*		£,000.	£		£
Northampton (A.C. and C.B.) ...	309,428	1,524·5	4·9	28,661	53
Northumberland (A.C.)	408,665	1,873·6	4·6	30,463*	61
Newcastle-upon-Tyne (C.B.) ...	283,145	2,262·7	8·0		
Tynemouth	64,913	317·0	4·9		
Northumberland (A.C. and C.B.'s)	756,723	4,453·3	5·9	30,463	146
Nottingham (A.C.)	443,880	1,810·7	4·1	28,117*	64
Nottingham (C.B.)	268,801	1,731·0	6·4		
Nottingham (A.C. and C.B.) ...	712,681	3,541·7	5·0	28,117	126
Oxford (A.C.)	129,059	572·0	4·4	22,526*	25
Oxford (C.B.)	80,540	704·8	8·8		
Oxford (A.C. and C.B.)	209,599	1,276·8	6·1	22,526	57
Peterborough, Soke of (A.C.) ...	51,845	283·7	5·5	1,785	159
Rutland (A.C.)	17,397	80·8	4·6	3,098	26
Salop (A.C.)	244,162	1,067·7	4·4	91,367	12
Somerset (A.C.)	406,319	2,181·2	5·4	121,449*	18
Bath (C.B.)	68,801	555·3	8·1		
Somerset (A.C. and C.B.) ...	475,120	2,736·5	5·8	121,449	23
Southampton (A.C.)	472,022	2,837·6	6·0	48,199*	59
Bournemouth (C.B.)	116,780	1,440·4	12·3		
Portsmouth (C.B.)	249,288	1,660·6	6·7		
Southampton (C.B.)	176,025	1,263·9	7·2		
Southampton (A.C. and C.B.'s)...	1,014,115	7,202·5	7·1	48,199	149
Stafford (A.C.)	703,144	2,486·2	3·5	96,452*	26
Burton-on-Trent (C.B.) ...	49,485	275·8	5·6		
Smethwick (C.B.)	84,354	374·4	4·4		
Stoke-on-Trent (C.B.)	276,619	974·6	3·5		
Walsall (C.B.)	103,102	400·6	3·9		
West Bromwich (C.B.)... ...	81,281	299·5	3·7		
Wolverhampton (C.B.)... ...	133,190	716·6	5·4		
Stafford (A.C. and C.B.'s) ...	1,431,175	5,527·7	3·9	96,452	57
Suffolk, East (A.C.)	207,420	891·2	4·3	22,270*	40
Ipswich (C.B.)	87,557	478·3	5·5		
Suffolk, East (A.C. and C.B.) ...	294,977	1,369·5	4·6	22,270	61
Suffolk, West (A.C.)	106,137	384·0	3·6	8,456	45
Surrey (A.C.)	947,695	8,591·1	9·1	20,795*	413
Croydon (C.B.)	233,115	1,890·6	8·1		
Surrey (A.C. and C.B.)	1,180,810	10,481·7	8·9	20,795	504
Sussex, East (A.C.)	276,881	2,369·6	8·6	38,137*	62
Brighton (C.B.)	147,427	1,515·7	10·3		
Eastbourne (C.B.)	57,435	820·8	14·3		
Hastings (C.B.)...	65,199	649·4	10·0		
Sussex, East (A.C. and C.B.'s)...	546,942	5,355·5	9·8	38,137	141
Sussex, West (A.C.)	223,136	1,629·2	7·3	24,202	67
Warwick (A.C.)	365,323	1,956·5	5·4	39,988*	49
Birmingham (C.B.)	1,002,413	6,015·5	6·0		
Coventry (C.B.)...	167,046	941·3	5·6		
Warwick (A.C. and C.B.'s) ...	1,534,782	8,913·3	5·8	39,988	223
Westmoreland (A.C.)	65,398	376·0	5·7	24,593	15
Wight, Isle of (A.C.)	88,400	572·9	6·5	9,976	57
Wilts (A.C.)	303,258	1,383·6	4·6	86,981	16
Worcester (A.C.)	310,080	1,329·7	4·3	25,776*	52
Dudley (C.B.)	59,579	208·8	3·5		
Worcester (C.B.)	50,497	299·0	5·9		

* Including cows in associated county boroughs.

County or county borough.	Population 1931.	Rateable value on 1st April, 1930, for general county purposes.	Rateable value for general county purposes per head.	Number of cows in milk or in calf and heifers in milk, 4th June, 1931.	Rateable value for general county purposes per cow.
(1)	(2)	(3)	(4)	(5)	(6)
ENGLAND—*continued.*		£,000.	£		£
Worcester (A.C. and C.B.'s) ...	420,156	1,837·5	4·4	25,776	71
Yorks., East Riding (A.C.) ...	169,692	720·3	4·2	24,864*	29
Kingston-upon-Hull (C.B.) ...	313,366	1,569·5	5·0		
Yorks., East Riding (A.C. and C.B.)	483,058	2,289·8	4·7	24,864	92
Yorks., North Riding (A.C.) ...	330,900	1,488·2	4·5	53,944*	28
Middlesbrough (C.B.)	138,489	604·8	4·4		
Yorks., North Riding (A.C. and C.B.)	469,389	2,093·0	4·5	53,944	39
Yorks., West Riding (A.C.) ...	1,530,110	6,829·0	4·5	120,208*	57
Barnsley (C.B.)	71,522	307·2	4·3		
Bradford (C.B.)...	298,041	2,285·4	7·7		
Dewsbury (C.B.)...	54,303	287·5	5·3		
Doncaster (C.B.)	63,308	440·5	7·0		
Halifax (C.B.)	98,122	548·1	5·6		
Huddersfield (C.B.)	113,467	764·9	6·7		
Leeds (C.B.)	482,789	3,028·0	6·3		
Rotherham (C.B.)	69,689	312·7	4·5		
Sheffield (C.B.)	511,742	2,667·3	5·2		
Wakefield (C.B.)	59,115	334·8	5·7		
Yorks., West Riding (A.C. and C.B.'s)	3,352,208	17,805·4	5·3	120,208	148
WALES.					
Anglesey (A.C.)	49,025	154·1	3·1	14,037	11
Brecon (A.C.)	57,771	263·0	4·6	14,989	18
Carnarvon (A.C.)	120,810	558·4	4·6	19,978	28
Cardigan (A.C.)	55,164	160·3	2·9	24,950	6
Carmarthen (A.C.)	179,063	503·3	2·8	56,252	9
Denbigh (A.C.)	157,645	684·8	4·3	27,099	25
Flint (A.C.)	112,849	470·8	4·2	20,940	22
Glamorgan (A.C.)	766,141	2,799·1	3·7	27,027*	104
Cardiff (C.B.)	223,648	1,814·9	8·1		
Merthyr Tydfil (C.B.)	71,099	235·9	3·3		
Swansea (C.B.)	164,825	999·4	6·1		
Glamorgan (A.C. and C.B.'s) ...	1,225,713	5,849·3	4·0	27,027	216
Merioneth (A.C.)	43,198	142·9	3·3	11,513	12
Monmouth (A.C.)	345,623	1,237·5	3·6	18,957*	65
Newport (C.B.)	89,198	598·8	6·7		
Monmouth (A.C. and C.B.) ...	434,821	1,836·3	4·2	18,957	97
Montgomery (A.C.)	48,462	166·4	3·4	23,725	7
Pembroke (A.C.)	87,179	244·8	2·8	34,290	7
Radnor (A.C.)	21,314	144·0	6·8	11,001	13
Total, England and Wales Administrative Counties (excluding London)	22,243,538	117,034·0	5·3	2,364,797*†	49
County of London	4,396,821	55,447·0	12·6		
County Boroughs	13,307,572	85,187·4	6·4		
Total	39,947,931	257,668·4	...	2,364,797	109

* Including cows in associated county boroughs.
† Including cows in the county of London.

(b) *Human and cow population and rateable value by counties in Scotland.*

(*a*) Exclusive of large burghs.
(*b*) Inclusive of large burghs.

County.	Population in 1931.	Rateable value, 1930–31.	Rateable value per head.	Number of cows in milk or in calf and heifers in milk, 4th June, 1931.	Rateable value per cow.
(1)	(2)	(3)	(4)	(5)	(6)
SCOTLAND.		£,000.	£		£
Aberdeen (*a*)	145,594	642·3	4·4	40,336	16
Aberdeen (*b*)	312,853	2,009·3	6·4	...	50
Angus (*a*)	76,970	458·5	6·0	10,797	42
Angus (*b*)	270,190	1,999·4	7·4	...	185
Argyll	63,014	405·6	6·4	18,323	22
Ayr (*a*)	210,299	1,193·8	5·7	48,013	25
Ayr (*b*)	285,182	1,792·6	6·3	...	37
Banff...	54,835	190·5	3·5	11,708	16
Berwick	26,601	123·8	4·7	4,583	27
Bute	18,822	192·5	10·2	2,962	65
Caithness	25,656	86·8	3·4	6,405	14
Clackmannan	31,947	181·1	5·7	1,428	127
Dumbarton (*a*)	79,242	615·0	7·8	6,412	96
Dumbarton (*b*)	147,751	1,061·2	7·2	...	166
Dumfries (*a*)	58,265	284·9	4·9	21,807	13
Dumfries (*b*)	81,060	460·5	5·7	...	21
East Lothian	47,369	325·5	5·9	2,705	120
Fife (*a*)	197,433	1,184·3	6·0	12,543	94
Fife (*b*)	276,261	1,739·2	6·3	...	139
Inverness (*a*)	59,500	230·6	3·9	18,251	13
Inverness (*b*)	82,082	411·2	5·0	...	23
Kincardine	27,441	164·7	6·0	6,229	26
Kinross	7,454	48·0	6·4	1,490	32
Kircudbright	30,341	154·7	5·1	18,260	8
Lanark (*a*)	300,813	1,803·1	6·0	34,000	53
Lanark (*b*)	1,585,968	13,853·7	8·7	...	407
Midlothian (*a*)	87,279	500·1	5·7	8,154	61
Midlothian (*b*)	526,277	5,671·9	10·8	...	696
Moray	40,805	222·4	5·5	6,346	35
Nairn	8,294	48·4	5·8	2,107	23
Orkney	22,075	45·3	2·1	10,622	4
Peebles	15,050	155·0	10·3	1,878	83
Perth (*a*)	85,965	635·5	7·4	16,719	38
Perth (*b*)	120,772	950·6	7·9	...	57
Renfrew (*a*)	103,606	833·3	8·0	12,865	65
Renfrew (*b*)	288,575	2,105·3	7·3	...	164
Ross and Cromarty	62,802	199·3	3·2	15,879	13
Roxburgh	45,787	286·3	6·3	5,791	49
Selkirk	22,608	162·8	7·2	1,206	135
Stirling (*a*)...	107,289	640·5	6·0	10,460	61
Stirling (*b*)...	166,447	1,057·1	6·3	...	101
Sutherland	16,100	74·2	4·6	4,138	18
West Lothian	81,426	406·6	5·0	4,825	84
Wigtown	29,299	120·9	4·1	25,801	5
Zetland	21,410	42·8	2·0	4,895	9
Total—					
Scotland (exclusive of large burghs)...	2,211,391	12,658·9	5·7	397,938	32
Scotland (inclusive of large burghs)...	4,842,554	36,749·1	7·6	...	92

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