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Treatment and Control of Chronic Streptococcus Mastitis in Bovines: Results Obtained in Two Herds.

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Introduction.

Various measures for the control of chronic streptococcus mastitis have been recommended by workers in different countries. These are usually based on:—

(*a*) Complete segregation between infected and non-infected animals on a basis of cultural examination of milk samples.

(*b*) Complete elimination from the herd of all animals showing infection.

(*c*) Building up of clean herds recruited from non-infected first calf heifers.

Theoretically no exception can be taken to such measures which appear to have been successful in those herds where they have been applied, but objections may be raised on the ground that they do not pay due attention to the economic and practical aspects of dairy farming. Such methods of dealing with this disease are particularly inapplicable to South African conditions, where laboratory facilities for the bacteriological examination of milk are not available to the great majority of dairy farmers, where the fullest professional assistance cannot always be obtained and where the introduction of drastic measures of control will bring financial ruin to many dairymen.

Three factors which must be taken into account in the promulgation of any scheme of mastitis control in this country are:—

(*a*) The adoption of a trustworthy test which can be performed in areas where laboratory assistance is not available.

(*b*) The institution of methods of dealing with infected animals without having to resort to complete elimination or segregation of all infected cows, or without causing any marked decrease in the milk yield.

(*c*) The ability and eagerness of the owner of the herd to co-operate fully with the professional officer and to carry out conscientiously that portion of the scheme which is allotted to his charge.

In view of these difficulties an attempt was made to ascertain whether it is possible to devise a method of control which would be both practicable and successful under local conditions. A scheme based on regular testing of all animals,

treatment of affected animals and the application of ordinary hygienic measures was formulated and applied to two herds, namely Brakfontein and Dirko in Bedford and Somerset East districts respectively, both over 600 miles from the nearest laboratory.

This preliminary report records the measures applied, results obtained and progress made in the two herds over periods of 14 and 12 months respectively. It is not claimed at this stage that the disease has been eradicated or even brought under proper control. Since it is impossible to determine with accuracy when an infected udder has really been freed from infection, as many such udders have a tendency to show what Steck calls a " cultural latency period ", an assertion that the disease has been effectively checked or eradicated can only be justified after the animals have repeatedly yielded negative results to a reliable test over a reasonably long period. For this reason and in view of the encouraging results obtained so far it was considered expedient to issue this report at the present juncture and to follow it up in due course with one or more supplementary reports.

Herd History.

Brakfontein herd is one of the oldest and most famous Friesland herds in South Africa. All the dairy cows and heifers are high class pure-bred registered animals. The owners never encountered serious trouble with mastitis until about six years prior to the commencement of this control scheme. The introduction of infection into the herd is ascribed to the acquisition at that time of a number of cows some of which were obviously infected. Since then the disease has been spreading consistently and has defied all efforts of the owners to check it. According to the latter a small fortune has been spent on various kinds of drugs, ointments, infusions and vaccines, but with no apparent beneficial effect. Not being provided with a reliable diagnostic method it is evident that the owners confined treatment to obvious clinical cases. Notwithstanding all their efforts a number of cows had to be eliminated every year on account of advanced induration of the udder, while the milk of many others had to be discarded on account of the presence of pus in it.

Although Dirko herd is not such an old established herd as Brakfontein it too is composed of high class pedigreed and registered animals, and has been built up largely on Brakfontein stock. The history of mastitis in this herd also dates back about five years and it was similarly acquired by the introduction of infected cows. For the first four years the disease apparently did not give rise to much concern, but the substitution of machine for handmilking at that stage was followed by a large number of cases of acute mastitis which subsequently became chronic. While it is not desired to incriminate machine milking for the spread of the disease in this herd, the change over in the method of milking does, however, suggest itself as a probable explanation for this sudden flare up of mastitis. It appears likely that a number of cows had the disease in a latent form prior to the introduction of the machine and that the change over provided the necessary predisposing factors which caused a latent infection to assume a very active form. A vacuum pressure of 14 lb. per square inch was being maintained. Such a high pressure is considered to be injurious to udder tissue and the best pressure which is least likely to damage the gland is the lowest consistent with efficient milking. This usually varies from 10 to 13 lb. per square inch. Further, one of the teat cups was found to be defective and there can be no doubt that this was responsible for a lot of damage to the udders before the defect was remedied.

Brakfontein and Dirko herds are both tested regularly for tuberculosis and contagious abortion, and are free from these diseases.

Measures Applied.

This report covers the period between April, 1940, and June, 1941, for Brakfontein and June, 1940, to June, 1941, for Dirko.

Local conditions and the great value of every heifer and cow not only as milk producers but also as breeders had to be considered when deciding on the steps to be taken in dealing with the disease in these two herds. Drastic measures, such as total elimination of all animals showing a degree of induration of the udder which is likely to render it unresponsive to curative treatment, could therefore not be applied, and it is obvious that such considerations must have a retarding effect on the progress of the scheme.

After the first test at Brakfontein the following general measures were decided on for this herd and were also subsequently applied to the Dirko herd:—

(1) Complete elimination from the dairy herd of all cows showing very advanced induration of the udder. These were never to be brought into the stable but were to be kept in a separate camp and to be used for breeding purposes only.

(2) Regular testing for mastitis once every six to eight weeks of all cows and heifers in the dairy herd.

(3) Segregation in the stable between infected and clean animals.

(4) Treatment by means of infusions of all infected and suspected quarters.

(5) The application of proper hygienic measures in the stables.

Diagnosis.

The sole diagnostic method on which reliance was placed to determine whether a quarter was infected or not was microscopic examination of smears made from individual quarter samples of foremilk after incubation overnight. Subsidiary tests such as determination of alkalinity (pH) of milk by means of the B.D.H. Universal Indicator and physical examination of the udder were also performed in some instances, but the main purpose of these was to determine whether the cases concerned were clinical or latent and what degree of fibrosis was present in clinical cases.

Cultural examination was carried out in one batch of samples mainly for the purpose of determining the type of infection present in the two herds. This indicated that *Streptococcus agalactiae* was the organism chiefly responsible although type II Streptococci were also encountered in some of the samples.

The technique for microscopic examination has already been fully described by one of us (S.W.J.v.R.). Certain difficulties may be encountered in doing this test under field conditions. These, however, are not insurmountable and incubation of the samples, preparation, staining and examination of the smears can all be carried out on the farm. The advantages of this are:—

(1) The owner is immediately acquainted with the results of the test.

(2) The necessary rearrangement and segregation of the cows in the stable can be made without undue delay.

(3) In case of doubt additional samples can be taken and the test repeated.

(4) Where desired clinical examination of infected udders can be made.

(5) The veterinarian can discuss with the owner the result of the test as it affects each individual cow and prescribe the most suitable line of treatment to be adopted in every case.

The samples are taken at the afternoon milking and are immediately placed in an ordinary egg incubator which is brought to and kept constant at 100° F. by the owner for a day or two before the test is to be carried out. Smears are prepared after the samples have been incubated at this temperature for 15 to 18 hours. When dry they are stained with Newman's stain.

A positive diagnosis is made in all cases in which long chain streptococci are found. In order not to overlook and exempt from treatment any infected quarters in these two herds short chain streptococci which show the other morphological characters of mastitis streptococci are also classed as positive. It is thus possible that a small number of quarters which do not actually harbour pathogenic organisms are wrongly regarded as infected, but the soundest policy to follow in dealing with mastitis is rather to treat several healthy quarters than risk an infected one being passed over. It will be observed in the appendix that for the same reason treatment is sometimes applied to negative quarters, usually those showing increased cellular content or increased alkalinity of the milk, or fibrosis of the quarter. Increase in cells and in alkalinity may be due to physiological factors such as advanced lactation, or may result from infusion treatment. Those cases in which such a reason for the abnormality cannot be established must always be viewed with suspicion, and not infrequently the presence of an abnormally large number of cells or increased alkalinity is followed sooner or later by the shedding of streptococci in the milk, e.g. Brakfontein Nos. 1A, 3C, 42A, 45C; Dirko 10B, 17B and C.

The first, fifth and ninth tests at Brakfontein and the fourth and eighth tests at Dirko were carried out by both authors and the remainder by only one of us (J.A.T.).

The ninth test at Brakfontein was duplicated in that samples of the strippings as well as of the foremilk were taken from every quarter. The total positives detected in this manner was seven. There was agreement between the two in three positive cases. The strippings revealed two positives which were negative in the foremilk, while the latter detected two which were not shown up by the strippings.

In the beginning only cows in milk were tested but, as will be observed in the appendix, dry cows were also included later on. A negative result obtained from the examination of the mammary secretion of a dry cow cannot be regarded as definite evidence that the animal is free from mastitis since infection in dry animals is frequently in a stage of latency. The advantage, however, lies in the fact that it is sometimes possible to detect infected quarters in this manner and thus to treat them before they come into milk again.

Curative Treatment.

At present the only satisfactory known curative treatment for streptococcus mastitis is irrigation of the infected quarters. Treatment in these two herds has accordingly been confined to such infusion therapy.

It is not possible for any one of the authors to supervise treatment and control measures on the farms, and therefore this task was entrusted to the owners after the demonstrations had been given by us. The procedure is for the officer applying the test to discuss the results with the owner immediately after completion of the microscopic examination and to prescribe to the owner the treatment to be adopted in the individual cases and the control measures which are considered necessary.

Mastitis will tolerate no half measures. Recurrence of infection in quarters that had apparently been cleaned provides many disappointments to the optimistic owner. Considerable patience, perseverance and thoroughness of application are essential for a successful fight against this disease. Full credit must be given to the owners of these two herds for displaying in a marked degree all these qualities and for their rigid observance of the various methods prescribed from time to time. As indicated by Roemmele and others active co-operation of the farmer is essential in the control of mastitis, and whatever success has been achieved up to the present must largely be ascribed to the whole-hearted support given by the owners of the two herds.

The drugs used, their concentrations and the time they are left in the quarters are shown in Table 6.

In general there are three factors which determine the strength of the solution injected into the udder and the period for which it is left in the quarter:—

(*a*) For cows that are in full lactation and in which it is not desired to terminate the secretion of milk a strong solution is infused and left in the quarter for a short period. In these normal milk yield is usually restored within a few days after the last infusion has been given.

(*b*) Cows which are dry or are approaching the end of the lactation period receive a weaker solution which is left in the udder for a longer period (12 to 24 hours). This stops lactation until the next calving when the normal secretion of milk is resumed.

(*c*) Quarters which show advanced induration or display no inclination to respond to treatment can be rendered permanently functionless by injecting a solution 3 to 5 times stronger than that recommended for (*b*) and leaving this in for 24 hours.

The solutions are made up in rain water which has been boiled and allowed to cool to body temperature before the infusion is made. When a number of animals are to be treated it can be prepared in bulk but the necessary steps must be taken to maintain it at or slightly above body temperature. Two quarters are treated simultaneously.

The apparatus used for irrigating consists of three pieces of rubber tubing, two milk syphons and a funnel. The two lengths of rubber tubing which contain the milk syphons at one end are joined to the third tube connecting them with the funnel by means of a Y-piece consisting of glass which enables one to watch the rate of flow into both quarters (Fig. 1). It is advisable to have various sizes of milk syphons since it is imperative that the teat should not be injured by forcing a big tube through a small teat orifice.

The infusion apparatus is first sterilized by boiling and a pot of water is kept boiling on a paraffin stove in the stable while the treatment is being carried out. To prevent the spread of infection by means of the teat syphons these are placed in the boiling water after every quarter has been irrigated.

Before infusion the udder is cleaned by wiping thoroughly with a cloth soaked in a 1 :5,000 solution of chlorine after which the teat orifice is cleaned with alcohol or iodized methylated spirits. Next the udder is stripped, massaged and stripped again. A preliminary infusion of approximately 250 ml. of the solution is then given, followed by further massaging and stripping of the quarters. After this the quarters are filled by allowing the solution to run in under gravity, the funnel being held at the level of the cow's back or slightly higher. No attempt is made to cause undue distention of the quarter by forcing more fluid in than it can comfortably hold and the infusion is stopped as soon as the cow shows uneasiness. The quarters are again gently massaged, and stripped after the fluid has been in for the required period. They are subsequently stripped three times daily until the normal milk flow is restored.

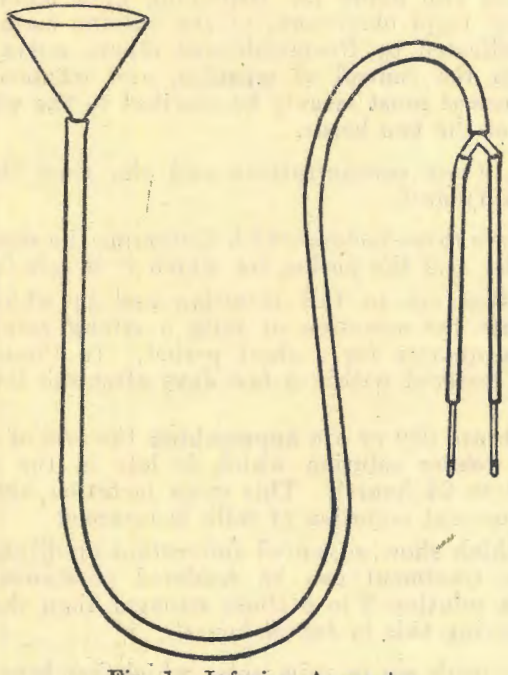

Fig. 1.—Infusion Apparatus.

Stable Hygiene.

There is only one stable available on each of the farms. It is therefore not possible to impose complete segregation of clean and infected cows in separate stables, and the following control measures are applied :—

(1) Arranging cows and heifers in three groups in the stables, viz., *Group A.*—Those that have been consistently negative and cannot reasonably be suspected of being infected. *Group B.*—Suspicious cases such as those showing clinical evidence of mastitis or animals that have been treated and may subsequently show a recurrence of infection. *Group C.*—*All* cows showing infection and having to undergo treatment.

(2) At Brakfontein separate milkers are assigned to Group C, while in the other two groups the clean animals in Group A are milked first. The milking machine at Dirko has three units. Two of these are used

simultaneously, the cups of the third being held in a chlorine solution until one of the other two is taken off and placed in the solution. The units are thus used in rotation. The Group A cows are milked first and Group C last. After milking all cups are thoroughly cleansed and placed in an antiseptic solution, while the whole outfit is taken to pieces twice weekly for cleaning and sterilisation.

(3) In neither of the two herds do the cows sleep in the stable and there is no segregation outside the stables, the cows all grazing in the same camps. They are brought in for milking at 8 a.m., 4 p.m. and 12 midnight.

(4) Introduction of cows from other herds is limited and when this has to be made the newly introduced cows are isolated until they have been tested.

(5) Hands of milkers are washed in a 1 : 5,000 chlorine solution before milking every cow.

(6) Udders are kept clean and all superfluous hair is clipped at intervals. The teats and particularly teat openings are wiped before and after milking with a cloth soaked in the above chlorine solution.

(7) Stable floors are washed regularly and no milking on the floors is permitted.

(8) An attempt is made to control flies by the proper disposal of manure and by killing flies in the the stables with arsenical bait.

Method of Recording.

A record book is maintained for every herd and in this is entered very concisely the dates of testing, results of tests, and the treatment applied, as indicated in the Appendix.

In the herd record book column 1 contains the serial numbers of the cows, and column 2 the name, registration number and brief details such as age, number of calves and date of last calving. For obvious reasons the names and registration numbers are omitted in the Appendix and it will further be observed that the published records include only those cows or heifers which gave a positive reaction in one or other of the tests. The inclusion in the records of all those animals which gave negative results throughout the series of tests is considered superfluous. Such negative cows are therefore denoted by the missing serial numbers.

For the sake of brevity the four quarters of the udder, namely, right fore, right hind, left fore and left hind are denoted by A, B, C and D, respectively, in column 3, and this system of marking is followed throughout our work.

In the fourth and subsequent columns is given under the date of each test the treatment applied and the result of the test. The treatment recorded under any date actually denotes the course of treatment which was applied in the interval between the previous and the present tests. Thus the treatment described under date 26.8.40 refers to that applied between 24.6.40 and 26.8.40. A special code is used for indicating briefly the type of drug used, the concentration in which it is injected, the period for which it is left in the udder, the intervals between treatment and the number of irrigations given. The key to this code is supplied at beginning of the appendix.

The word " sterilise " may be misinterpreted to suggest freeing the udder from infection, whereas it is actually used throughout this work to denote that the quarter in question has been rendered permanently functionless, and " cure " is used to indicate that the infection has apparently been killed.

Results.

The results of all tests and of the treatment carried out during the period under review are summarized in Table 1.

Table 1.

Summary of Results of All Tests and of Treatment.

	Brakfontein.	Dirko.
Total number of cows tested	103	78
Total number of cows found infected	70 (68 %)	38 (48·7 %)
Total number of cows clean	33	40
Total number of quarters infected	153 (37·1 %)	87 (27·9 %)
Total number of quarters treated	147	67
Total number of quarters sterilized	6	3
Total number of quarters cured	132 (89·8 %)	50 (74·6 %)
Total number of quarters still infected at last test	7	11
Total number of cows still infected at last test	5	8
Infected quarters eliminated through deaths or other causes	8	10

Accurate evaluation of the results obtained is extremely difficult and the following factors must be reckoned with in any attempt to assess the degree of success or failure achieved in mastittis control and treatment:—

(1) Quarters infected with mastitis streptococci do not discharge these organisms continually in their secretions.

(2) One negative test does not justify the conclusion that the quarter is free from infection. It merely indicates that the quarter was not secreting streptococci in the milk at the time the sample was taken.

(3) A positive result given by a quarter which was negative at the previous test does not imply that infection took place in the interval between the two tests. Infection may have taken place months previously.

(4) There is as yet no method of determining with any degree of accuracy when a quarter became infected or how long it had been infected before the presence of streptococci in it was established.

(5) After a course of treatment an infected quarter may appear to be cured on account of the absence of streptococci from its milk and the normal physical and chemical characters of the milk, but in many such apparently cured quarters the shedding of streptococci in the milk is resumed after an interval of variable duration.

(6) It is not possible to determine whether such recurrence is due to reinfection of a quarter which had been completely cured or whether it is an indication that bacterial activity was merely temporarily inhibited in the quarter and had again been resumed after the effects of treatment had passed off.

(7) Generally it can be assumed that infection was not killed but only inhibited if the reappearance of streptococci is shown within a few months after treatment was suspended.

In view of these complications it is necessary to study in greater detail the results obtained in the individual tests as summarised in Table 2 and in the graphs in Figure 2 (*a*) and (*b*).

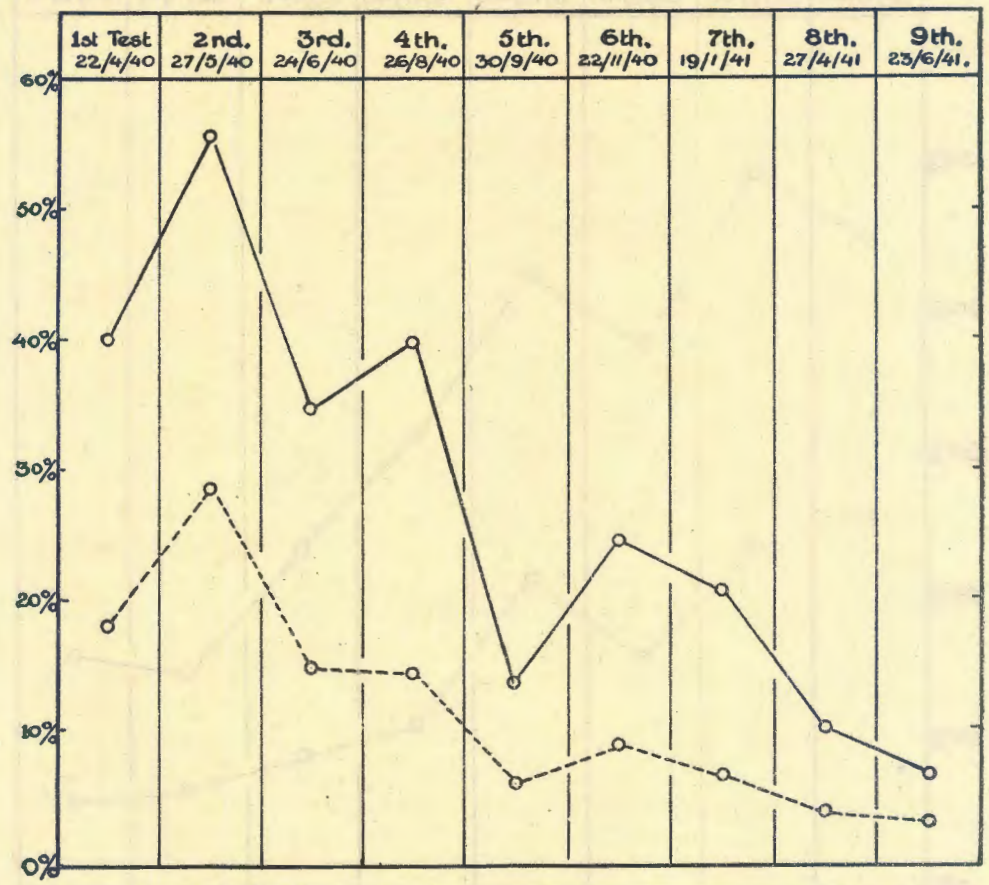

Fig. 2 (*a*) (Brakfontein).—Percentage cows and quarters found infected at every test. (The straight line denotes percentage cows infected and the broken line percentage quarters infected.)

At Brakfontein the highest percentage infection in both cows and quarters was revealed in the second test, namely 55·7 per cent. cows and 28·5 per cent. quarters. The first test at Dirko showed the highest percentage (25·8) quarters infected while the highest percentage (48·2) of cows was detected in the second test. Although in the first half of the period under review both herds showed unexpected increases in the number of animals and quarters infected in some tests (which will be explained later) there was, on the whole, a steady decline and at the last test in June, 1941, the infection had dropped to the following level, viz.:—Brakfontein, 6·3 per cent. cows and 2 per cent. quarters; Dirko, 15·7 per cent. cows and 5·4 per cent quarters. Dirko still shows a higher percentage infection than Brakfontein for two reasons:—(*a*) It has not been

under control for the same period. (*b*) As can be seen in the appendix several of the infected cows at Dirko were not treated. This exemption was granted because they were under test for milk yield and butterfat content, and it was not desired to interfere with these tests by subjecting them to treatment.

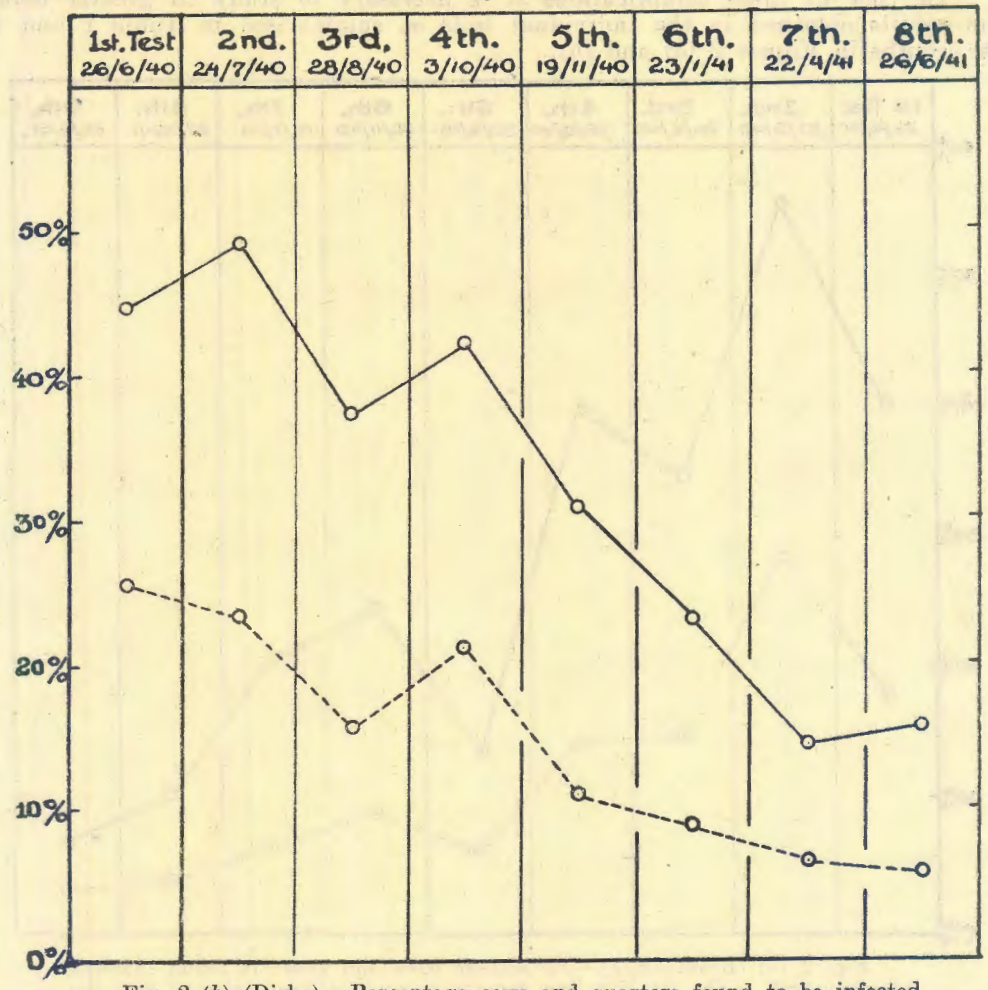

Fig. 2 (*b*) (Dirko).—Percentage cows and quarters found to be infected at every test. (The straight line denotes percentage cows infected and the broken line percentage quarters infected.)

When the first test was performed at Brakfontein the technique for doing the test under field conditions was by no means perfect, and in addition there is a strong suspicion that the incubator on that occasion did not maintain a constant temperature throughout the night with the result that many positive cases probably remained undetected. Further, for reasons already stated, it is not possible for even the most perfect method of diagnosis to reveal all infected quarters in one single test. Repeated testing at intervals is the only manner in which one can hope ultimately to detect every infected quarter. To illustrate this careful consideration of the results shown by the infected cows in the appendix is recommended. Many of the quarters such as Brakfontein Nos. 1A, 3 A.B.D.

TABLE 2.

Summary of the Results Obtained in the Individual Tests.

1. Herd.	2. Number and Date of Test.	3. Number of Cows Tested.	4. Number of Cows Clean.	5. Number of Cows Infected.	6. Number of Quarters Tested.	7. Number of Quarters Clean.	8. Number of Quarters Infected. (a) Total.	(b) Showing Infection for First Time.	(c) Infection Persisting from Previous Test.	(d) Recurrence of Infection.	(e) Infected Quarters of Cows Tested for First Time.	9. Number of Cows Tested for First Time.	10. Number of Quarters Apparently Cured by Treatment.
Brakfontein.	1. 22.4.40	75	45	30 (40%)	284	233	51 (17·9%)	0	0	0	51	75	0
	2. 27.5.40	70	31	39 (55·7%)	270	193	77 (28·5%)	60	10	0	7	5	12
	3. 24.6.40	76	50	26 (34·2%)	296	253	43 (14·8%)	18	19	3	3	8	59
	4. 26.8.40	78	47	31 (39·7%)	307	264	43 (14%)	10	13	11	9	9	29
	5. 30.9.40	80	69	11 (13·7%)	313	296	17 (5·4%)	4	9	4	0	4	33
	6. 22/11/40	85	64	21 (24·7%)	334	306	28 (8·3%)	6	6	15	1	4	11
	7. 19·1·41	83	66	17 (20·5%)	328	307	21 (6.4%)	7	7	7	0	1	15
	8. 27.4.41	90	81	9 (10%)	356	345	11 (3·1%)	2	6	3	0	9	14
	9. 23.6.41	79	74	5 (6·3%)	313	306	7 (2%)	4	2	1	0	1	8
Dirko.	1. 26.6.40	29	16	13 (44·9%)	116	86	30 (25·8%)	0	0	0	30	29	0
	2. 24.7.40	27	14	13 (48·2%)	108	83	25 (23·1%)	9	16	0	0	4	12
	3. 28.8.40	27	17	10 (37%)	103	87	16 (15.5%)	2	13	1	0	3	12
	4. 3.10.40	26	15	11 (42·3%)	103	81	22 (21·4%)	3	10	4	5	4	6
	5. 19.11.40	59	41	18 (30·5%)	231	206	25 (10·8%)	7	8	0	10	24	14
	6. 23.1.41	61	47	14 (23%)	239	219	20 (8·3%)	10	5	2	3	7	17
	7. 22.4.41	63	54	9 (14.3%)	245	231	15 (6·1%)	7	6	2	0	1	13
	8. 26.6.41	51	43	8 (15·7%)	204	193	11 (5·4%)	2	4	5	0	1	3

and 45 C showed clinical evidence (increased alkalinity and cellular elements) in the first test but streptococci were not detected in their milk until several months later at the 3rd or 4th test. This justifies the assumption that many of these quarters were infected prior to the first test but that they were not discharging mastitis streptococci continuously, and were therefore not discovered for some time.

Effect of Control Measures.

In Table 2 column 8 (*b*) refers to those quarters which gave negative results in all previous tests and show infection for the first time in the test concerned. Since there is no method of accurate differentiation between recent and old infections, except in those cases in which the latter show clinical evidence, it is not possible to state what proportion of these apparently new infections are in fact old standing cases. The figures given in this column would therefore wrongly suggest that a very large number of new cases appeared during the period under review and so cast a doubt on the efficacy of the method introduced for preventing the spread of the disease. Many of these " new " infections showed clinical evidence of mastitis months before the streptococci were detected, while others belong to udders which have been showing infection in one or more of the other quarters previously. In view of these considerations it can be assumed that only a very small number of cows or heifers could have become infected after the control measures were introduced.

Closer study of the incidence of infection in the first calf heifers will furnish the only reliable indication of the degree of success which has attended the introduction of preventive measures. According to the figures in Table 3 a total of 70 first calf heifers were tested in the two herds, 44 being clean and 26 infected. Some of these calved before the institution of control measures (April, 1940, at Brakfontein and June, 1940, at Langford) and the remainder subsequently. Distribution of these two groups is given in Table 3.

Table 3.

Infection in First Calf Heifers.

	Heifers Calved before First Test.			Heifers Calved after First Test.		
	Total.	Positive.	Negative.	Total.	Positive.	Negative.
Brakfontein.....	16	11	5	18	3	15
Dirko.....	14	7	7	22	5	17
Total.....	30	18 (60 %)	12 (40 %)	40	8 (20 %)	32 (80 %)

Eighteen (60 per cent.) of the 30 heifers that calved before the first test, were infected, while of the 40 that calved subsequently only 8 (20 per cent.) were shedding streptococci. In this connection the possibility of a preparturient infection must not be disregarded since it is an accepted fact that heifers may contract infection with mastitis streptococci long before calving. It is therefore highly probable that some of the 8 latter animals also actually became infected long before the preventive measures were put into effect.

Recurrence.

Table 2 and the graphs (Fig. 2) show that a high infection (e.g. the fourth test at Brakfontein and second at Dirko) is sometimes followed by a very appreciable and encouraging drop in the percentage infection at the next test, but instead of this decline being maintained it is followed by a rise. On cursory examination this appears very disheartening especially to the owner. Such a recrudescence is, however, not as alarming as would appear at first sight and can be accounted for by the fact that a high percentage infection is generally followed by treatment of all infected quarters. Most of these yield a negative result at the subsequent test and are therefore not subjected to further treatment. When next tested many such quarters which were apparently cured and therefore exempted from further treatment again discharge streptococci with the result that there is an increase in the percentage infection.

" Apparently cured " in Table 2 column 10 is applied to those quarters which were positive at the previous test, were then treated and yield a negative result at the test in question. It is not suggested that such cures indicate complete eradicaion of infection from the quarters concerned, and the figures given in column 10 may therefore give an exaggerated impression of the effectiveness of curative treatment. The milk of many of these quarters shows a reappearance of streptococci in subsequent tests with the result that the quarters have to be subjected to a further course of treatment. Such recurrences are shown in column 8 (*d*). The value of curative treatment can be better assessed by a comparison between the figures given in columns 8 (*d*) and 10. This indicates that the number of " recurrences " is very much smaller than the number of " apparently cured ", and leads to the inevitable conclusion that with every course of treatment the infection is entirely killed in the great majority of quarters treated.

Treatment Required.

An indication of the treatment which is necessary to cure various quarters and of the tendency displayed by some quarters to suffer a recurrence after they have apparently been cured is provided by Table 4.

A " course of treatment " refers to the treatment applied between two tests and it may consist of 1, 2, 3 or even 4 infusions. Details of these are given in the appendix. Column 2 in Table 4 shows the courses of treatment which had to be applied to various quarters before they ceased secreting streptococci. It will be noticed for instance that one quarter has had to be subjected to six courses of treatment. This is No. 61D (Brakfontein). It was positive continuously from the first to the sixth test and received six courses of treatment consisting of 18 infusions before it became negative. To prevent a recurrence two further courses of 6 infusions were given between the 7th and 9th tests. This quarter has therefore been irrigated 24 times during the cow's first lactation period. Her second calf was born on 16.6.41 and despite the vigorous treatment and a degree of induration this quarter is in full milk again in the second lactation. This heifer yielded 8,077 lb. milk with an average of 3·87 per cent. of butterfat for 300 days in her first lactation while undergoing this treatment.

When is a Quarter Cured?

Many of the " cured " quarters were found in subsequent tests to have resumed the secretion of mastitis streptococci in their milk and have therefore had to receive further treatment. The number of quarters which thus relapsed

as well as the number of times they showed such a recurrence are indicated in column 3 (Table 4). It will be seen from this that the great majority (39 out of 44) relapsed only once and were presumably cured by the treatment applied subsequently.

TABLE 4.

Treatment Required by Different Quarters.

	Brakfontein.			Dirko.			Total for the Two Herds.		
	Clinical.	Latent.	Total.	Clinical.	Latent.	Total.	Clinical.	Latent.	Grand Total.
1. Number of quarters treated.....	90	57	147	36	31	67	126	88	214
2. Number of quarters cured by—									
(*a*) One course of treatment.....	43	38	81	7	25	32	50	63	113
(*b*) Two courses of treatment.....	19	11	30	7	1	8	26	12	38
(*c*) Three courses of treatment...	13	2	15	3	1	4	16	3	19
(*d*) Four courses of treatment....	4	0	4	5	0	5	9	0	9
(*e*) Five courses of treatment....	1	0	1	1	0	1	2	0	2
(*f*) Six courses of treatment.....	1	0	1	0	0	0	1	0	1
3. Number of quarters which showed recurrence—									
(*a*) Once.....	17	13	30	7	2	9	24	15	39
(*b*) Twice.....	2	0	2	2	0	2	4	0	4
(*c*) Three times.....	1	0	1	0	0	0	1	0	1

N.B.—The number (32) representing the difference between the total number treated (214) and the cures recorded (182) is comprised of quarters that are still infected or have been eliminated, e.g. by death or sterilisation.

In this table too " cured " is subject to the qualification that one is hesitant to state at this stage that the infection has been completely killed in the quarters concerned. Such a claim will only be justified after the secretion from those udders have shown freedom from mastitis streptococci in a number of tests conducted over a reasonably long period after irrigation of the quarters has ceased.

The period for which treated cows in both herds have not been discharging streptococci in their milk is as follows:—

Number of treated quarters	negative	for	2	months	:	20.
,, ,, ,,	,,		3	,,	:	6.
,, ,, ,,	,,		5	,,	:	22.
,, ,, ,,	,,		6	,,	:	2.
,, ,, ,,	,,		7	,,	:	19.
,, ,, ,,	,,		8	,,	:	17.
,, ,, ,,	,,		9	,,	:	1.
,, ,, ,,	,,		10	,,	:	26.
,, ,, ,,	,,		11	,,	:	8.
,, ,, ,,	,,		12	,,	:	25.
,, ,, ,,	,,		13	,,	:	36.

It will thus be observed that the majority of quarters (95 out of 182) have now been free from infection for 10 to 13 months and have consistently given negative results in the tests conducted during that period. It can therefore be assumed that the infection has been killed in most or perhaps all of them. A reappearance of streptococci in the milk of any of these quarters would suggest a reinfection rather than a recurrence.

In the 87 quarters which have not been discharging streptococci for periods varying from 2 to 9 months the possibility of a dormant infection which may again become active at any time cannot be disregarded and it would be premature to assume at this stage that these quarters are clean.

Clinical and Latent Infection.

A differentiation into clinical and latent groups has been made in Table 4. All quarters showing other evidence of mastitis such as fibrosis of the udder, increased alkalinity of or an excessive number of cells in the milk in addition to the shedding of streptococci are regarded as clinical while those merely discharging streptococci and showing no other abnormality of either the milk or gland are classed as latent. Thus at Brakfontein 57 out of 147 treated quarters and at Dirko 31 out of 67 were latent. It is evident from the figures in this table that the latent group responded to treatment far more readily than the clinical quarters. Thus 63 out of 78 recorded cures in the latent group were freed from infection by only one course of treatment while the majority (54 out of 104) of the clinical quarters required more than one course. Similarly the 15 latent cases that did show a recurrence of infection after an apparent cure only relapsed once.

A good criterion whether a cure was permanent or not is the absence or presence of streptococci in the milk of a cow which was treated in a previous lactation and had since calved. In these two herds 32 cows excluding the first calf heifers calved during the period under review. Eleven of them did not show infection in the preceding lactation and are still clean and five that were negative previously became positive after calving. The remaining 16 were found to be infected, were treated and apparently cured at various times during the previous lactation, and 10 of them are still clean while 6 showed a recurrence after calving and had to be subjected to further treatment.

Incidence of Infection in Different Lactation Periods.

The number and percentage animals found infected in the various lactation periods are given in Table 5. A great increase in the percentage infection is shown from the first to the fourth lactations. Instead of this rise being maintained and showing increased incidence with age a noteworthy drop is shown in the fifth lactation, and, although this is followed by another rise, the figures for the 7th and subsequent periods suggest that infection reaches its peak during the 4th lactation. This would, however, be an erroneous inference and does not justify the conclusion that old cows are more resistant to infection than younger ones. Physical examination reveals that a very large proportion of udders which are apparently not discharging streptococcci in their milk and are therefore classed as negative nevertheless show a greater or lesser degree of fibrosis. It must therefore be presumed that such udders were infected at one time and that either the treatment applied by the owners or auto-sterilisation was responsible for killing the infection in them.

TABLE 5.

Incidence of Infection among Cows in Different Lactation Periods.

Lactation Period.	Brakfontein.		Dirko.		Total.		Percentage.	
	Clean.	Infected.	Clean.	Infected.	Clean.	Infected.	Clean.	Infected.
First	20	14	24	12	44	26	62·9	37·1
Second	8	10	2	7	10	17	37	63
Third	0	14	4	7	4	21	16	84
Fourth	0	10	1	6	1	16	5·9	94·1
Fifth	1	7	3	1	4	8	33·3	66·7
Sixth	0	6	1	1	1	7	12·5	87·5
Seventh and over	4	9	4	5	8	14	36·4	63·6

Efficiency of Drugs Used.

Selection of the drugs used for infusion therapy has been confined to the acridine group. Published reports suggest that there is no unanimity of opinion amongst workers who have compared the efficacy of the various acridine derivatives which have been recommended for mastitis. In general it appears that no one of these flavines enjoys a marked superiority over the others.

In Table 6 " quarters cured " refer to those which were previously positive, received a course of treatment and have been negative in all tests subsequently. Formerly infected quarters which were negative in one or more tests after treatment and then showed a reappearance of streptococci constitute the group " apparently cured then recurred ". This naturally necessitated the application of one or more additional courses of treatment for the latter class. As " failures " are described quarters which were still positive at the first test following one course of treatment and therefore also required further irrigation before a negative result was obtained. For instance No. 61 (Brakfontein) failed five times in D quarter and thus required six courses of treatment before she was cured. It is obvious, therefore, that many quarters are considered more than once in this table. Hence the discrepancy between the number of quarters considered in Table 6 and those enumerated in Tables 1 and 4.

These being two very valuable herds the primary object of the therapeutical measures adopted is to stamp out the infection as rapidly as possible without inflicting any unnecessary damage on the glandular tissue, rather than to experiment with a number of drugs in order to test their comparative value. Besides the economical aspect there are many other factors, such as the degree of fibrosis present, individual idiosyncrasy, stage of lactation, age of cows, etc., which render accurate comparison of drugs in an ordinary private herd almost impossible. Any attempted assessment of the value of a drug for mastitis must therefore take due cognisance of these factors. Table 6 for instance reveals an apparently anomalous position in that courses of three infusions of Entozon 1 : 1,250 effected a far greater percentage of cures than courses of four infusions of the same drug given in the same concentration and left in the udder for the same period. Further consideration, however, reveals that in the former 36 of the 80 treated quarters had a latent infection while in the latter only 7 out of 41 quarters were latent; and it is thus obvious that this group containing as it does a far higher percentage of clinical quarters than the former would be more difficult to cure.

TABLE 6.

Results Obtained with Different Solutions.

Drug.	Concentration.	Time Left in Quarter.	Number of Infusions.	Interval between Infusions.	Quarters Treated.	Quarters Cured.			Quarters Apparently Cured then Recurred.			Failed.		
						Clinical.	Latent.	Per Cent.	Clinical.	Latent.	Per Cent.	Clinical.	Latent.	Per Cent.
Entozon.....	1 : 1,250	5–15 mins.	3	7 days	80	19	25	55	6	7	16·25	19	4	28·75
„	1 : 1,250	5–15 mins.	4	7 days	41	11	4	36·6	6	1	17·1	17	2	46·3
„	1 : 1,250	15–30 mins.	2	10 days	10	1	5	60	0	1	10	3	0	30
„	1 : 1,250	1 hour	2	10 days	69	23	15	55·1	5	2	10·1	23	1	34·8
„	1 : 1,250	1 hour	3	10 days	19	6	4	52·6	1	0	5·3	9	0	42·1
„	1 : 2,000	6 hours	4	7 days	15	9	0	60	1	0	6·7	5	0	33·3
„	1 : 1,500	12 hours	2	10 days	13	7	0	53·8	0	0	0	6	0	46·2
Acriflavine....	1 : 10,000	30 mins.	2	10 days	25	11	2	52	4	1	20	7	0	28
Acriflavine and Dextrose....	1 : 10,000	30–60 mins.	3	10 days	17	9	2	64·7	1	0	5·9	5	0	29·4
Rivanol.....	1 : 1,250	5–10 mins.	3	7 days	36	5	10	41·6	3	3	16·8	14	1	41·6
„	1 : 2,000	6 hours	4	7 days	7	3	1	57·1	0	0	0	3	0	42·9
„	1 : 2,000	12 hours	3	7 days	16	8	0	50	1	0	6·3	7	0	43·7
Euflavine.....	1 : 10,000	15–30 mins.	3	10 days	14	8	5	92·7	0	0	0	1	0	7·3

The record in the appendix will show too that one type of drug was not persistently employed in the same animal, and that particularly in quarters that showed obstinacy or a tendency towards a reappearance of streptococci after an apparent cure treatment was frequently changed over to another drug or a variation was made in the strength of the solution or the time for which it was left in the udder.

In view of all the complicating factors it is not proposed to offer a detailed analysis of the available data or to submit definite conclusions on the comparative merits of the various drugs. The column containing the percentage cures in Table 6 does, however, indicate that when due allowance is made for the many influencing factors the results obtained thus far correspond with the findings of other workers, namely that there does not appear to be a great difference between the various flavines as regards efficacy.

The results obtained with Rivanol are, however, not as satisfactory as those produced by the other agents and the concentrations in which this drug was used were responsible for rather severe, although only temporary, local reactions.

From a cursory examination of Table 6 it would appear that Euflavine is far superior to the three other drugs mentioned, but in justice to the latter it must be pointed out that a comparison at this stage will not be equitable since Euflavine has only been used during the last five months of the period under review and it is highly probable that several of the quarters which are now regarded as cured by this drug will subsequently have to be relegated to the "apparently cured then recurred" class. Nevertheless the fact that only one out of 14 quarters treated proved a failure in that it was still positive at the test following the course of treatment must be regarded as very satisfactory.

When dextrose was used in conjunction with acriflavine the perliminary irrigation of the sinus was carried out by infusing about 150 ml. of 5 per cent. dextrose, but according to the percentage of failures this procedure does not appear to possess any special advantages over the use of acriflavine alone.

It will be observed that there are great variations in the duration for which solutions are left in the udder. For the treatment of cows in full lactation the recommended period is usually 5 to 15 minutes but in these investigations it was extended to ½ hour, 1 hour and 6 hours. Retention of the fluid in the udder for six hours did not cause a cessation in milk secretion but it may produce a severe though only temporary reaction in some cases. Since individual susceptibility to the effects of udder infusion is an important factor and one cow may show evidence of severe local reaction to treatment which is well tolerated by others, it is not advisable to employ a method which is likely to have unfavourable sequelae even in a small percentage of cases, particularly when retention for 6 hours does not appear to yield any better results than the shorter periods. On the other hand the results suggest that the retention period may be extended from 15 minutes to 30 or even 60 minutes without harmful effects provided the quarters are not over-distended.

Therapeutic treatment is usually regarded as being most successful at the end of lactation or when the cow is dry since the solution can then be left in the udder for much longer than when cows are in full milk. In these two herds, however, the retention period never exceeded 12 hours, but the results obtained from this were not very satisfactory. It should, therefore, be extended to 18 or 24 hours. Entozon is not likely to produce a marked disturbance in such cases but the same does not apply to rivanol and this drug should not be used in a concentration stronger than 1 : 4,000 for a long period treatment.

When a large number of quarters of cows in full milk are subjected to repeated irrigations it is inevitable that a smal percentage will become functionless either permanently or for the duration of that lactation period. The total number of quarters which were unintentionally sterilised in this manner is, however, very small, namely 3 at Brakfontein and 1 at Dirko. This represents approximately 2 per cent. It is not possible to state at this stage whether the quarters concerned have been rendered permanently functionless or not. The next lactation period will decide their fate. One of the cows (No. 72, Brakfontein) calved on 5.5.41 and her right fore quarter (A) which has been functionless since June, 1940, is again yielding its normal supply and does not show any indication of atrophy or induration.

Effect of Treatment on Milk Yield.

Accurate determination of the effect of udder infusion on the milk yield is not possible since the pathological changes produced by the disease itself are complicating factors particularly in clinical mastitis. It is an accepted fact that treatment does produce a marked temporary drop in the milk yield of lactating cows but recovery is usually rapid and according to Stableforth and Scorgie the yield may be expected to be approximately normal within a week after the course of two treatments has been given. The question which, however, is of primary importance to the milk producer, is the ultimate rather than the immediate effect of udder infusion on milk secretion, and the available records of the Brakfontein herd indicate that the secretory capacity of all quarters excepting those showing advanced induration is rapidly restored after treatment with the result that during the remainder of that lactation period the milk yield is usually sufficient to compensate for the temporary reduction caused by treatment, particularly if only one or two quarters are treated.

Thirty-four of the affected cows at Brakfontein completed a lactation period while they were being tested and treated for mastitis, and the official record of the milk yield for the 300 day milk test period and the average butterfat percentage are furnished in columns 4 (*b*) and 7 (*b*) respectively in Table 7. The yield and average fat percentage over the same period during the lactation preceding that in which mastitis tests and treatment were applied are recorded in columns 4 (*a*) and 7 (*a*) respectively. The number of quarters treated and number of infusions given can be obtained from the appendix since the serial numbers in Table 7 correspond with those in the appendix.

The actual difference in yield during the 2 periods would not furnish a reliable indication of the effect of treatment since this does not take into account the variations in yield produced by advancing age. It is generally accepted that yield increases with age until the fifth or sixth lactation after which there is a gradual decline. For this reason the actual difference in yield between the two periods is not given, but using the correction tables supplied by Sanders the yield which would normally have been expected from each cow in her most recent lactation has been determined and is recorded in column 5 while the difference between the actual yield and this expected yield is shown as an increase (+) or decrease (−) in column 6. For instance cow No. 5 gave 2,067 lb. more milk in her last lactation than was expected from her while in No. 11 the actual yield was 143 lb. below the expected yield.

Eighteen of the 34 affected cows for which data are available produced more than their expected yield. The aggregate increase is 29,665 lb. which represents an average increase per cow of 1,648 lb. of actual over expected yield. This,

however, is off-set to a certain extent by the fact that the remaining 16 animals produced a total of 19,496 lb. less than their expected yield. The 34 cows on the whole thus gave 10,169 lb. more than their expected milk yield, which represents an average excess per cow of 299 lb. of actual over expected yield. In assessing the economic importance of this increase one must take into account the possibility that without treatment there would have been a depression in milk yield on account of the infection so that none or very few of the animals would have attained the expected yield if they were not treated. The actual gain is, therefore, probably far greater than it would have been if systematic diagnosis and treatment were not carried out.

TABLE 7.

Effect of Treatment on Milk Yield.

1.	2.	3.	4.		5.	6.	7.	
			Milk Yield in Lbs. over 300 Days.				Average Fat Percentage.	
No. of Cow.	Number of Lactations.	Type of Mastitis.	(*a*) In Preceding Lactation.	(*b*) In Lactation during Treatment.	Yield Expected in 4 (*b*) after Age Corrections have been made.	Increase or Decrease in 4 (*b*) over Expected Yield.	(*a*) For Preceding Lactation.	(*b*) For Lactation during Treatment.
			lb.	lb.	lb.	lb.		
5	8	Clinical	11,506	13,194	11,127	+ 2,067	3·892	4·492
9	7	Latent	16,198	17,167	15,974	+ 1,193	3·570	3·409
11	7	Clinical	13,681	13,349	13,492	— 143	3·687	3·899
12	5	Clinical	10,978	7,976	11,307	— 3,331	3·274	3·652
13	6	Latent	14,471	15,220	14,572	+ 648	3·563	3·332
16	3	Clinical	9,471	10,121	10,295	— 174	4·069	3·964
17	4	Latent	15,629	15,726	16,504	— 778	3·441	3·073
18	4	Clinical	16,508	18,752	17,432	+ 1,320	4·042	3·982
19	4	Clinical	13,827	15,697	14,601	+ 1,096	3·682	3·652
20	4	Clinical	13,194	12,530	13,933	— 1,403	3·623	3·565
22	3	Latent	14,035	16,483	15,256	+ 1,227	3·577	3·239
23	4	Clinical	13,761	15,442	14,532	+ 910	3·661	3·514
27	4	Clinical	14,899	17,944	15,733	+ 2,211	3·552	3·345
28	4	Clinical	16,524	18,131	17,450	+ 681	3·410	3·343
29	3	Latent	12,512	14,763	13,601	+ 1,162	3·799	3·838
31	3	Clinical	14,602	16,988	15,872	+ 1,116	3·810	3·675
32	3	Clinical	13,302	15,213	14,459	+ 754	3·490	3·692
33	3	Clinical	13,574	10,579	14,755	— 4,158	3·584	3·863
34	3	Latent	13,418	15,475	14,585	+ 890	3·732	3·811
35	3	Clinical	12,044	12,790	13,092	— 302	4·325	4·151
36	3	Clinical	13,541	14,396	14,719	— 323	3·727	3·758
38	2	Clinical	9,082	9,681	10,226	— 545	3·972	3·845
41	2	Latent	11,038	14,985	12,429	+ 2,556	3·699	3·636
42	2	Clinical	8,952	11,537	10,080	+ 1,457	3·871	3·989
43	2	Clinical	7,871	6,960	8,863	— 1,903	4·133	3·733
44	2	Latent	10,533	15,199	11,860	+ 3,339	3·632	3·703
46	2	Clinical	9,246	10,315	10,411	— 96	3·712	3·854
49	2	Clinical	9,890	9,530	11,136	— 1,606	3·721	3·577
73	3	Clinical	14,270	15,096	15,511	— 415	4·166	4·073
75	5	Latent	13,674	16,288	14,084	+ 2,204	4·072	4·113
78	6	Clinical	16,244	15,754	16,358	— 604	3·404	3·358
79	6	Clinical	16,100	15,384	16,213	— 889	3·337	3·617
81	3	Clinical	12,918	11,207	14,033	— 2,826	3·800	3·682
85	5	Clinical	9,160	14,269	9,435	+ 4,834	3·827	3·553

Twenty-five of the 34 cows had clinical mastitis and a significant feature is the fact that of the 16 animals whose yield did not come up to expectation only one (No. 17) had the disease in the latent stage, the remaining 15 being all clinical cases. Some of the latter, such as Nos. 12, 33, 43 and 81, show marked clinical changes which suggest that it is the pathological effect of the disease on the udder rather than the treatment which was responsible for the reduction in the yield of these cows.

The average butterfat percentage for the two periods recorded in column 7 shows that fat content of the milk was apparently not affected to any great extent and in no instance was this below the required standard of 3 per cent. Fat percentage has a tendency to decline with advancing age, but notwithstanding this fact 14 of the 34 cows showed an increased fat content during the treatment period while the slight decrease noted in the other 20 is not greater than would normally be expected after due allowance is made for decrease due to advancing age.

An example of the serious effect which mastitis may have on milk yield and of the marked response which some udders show to infusion therapy is provided by cow No. 85 whose milk yield and butterfat percentage over five lactation periods are:—

Lactation.	*Milk Yield.*	*Fat Percentage.*
1	7,229 lb.	4·416
2	9,217 lb.	3·591
3	7,832 lb.	3·421
4	9,160 lb.	3·827
5	14,269 lb.	3·553

According to the history supplied by the owners this animal showed severe clinical mastitis early in the first lactation and it can be assumed that her production was never up to full capacity. Using the correction for age tables supplied by Sanders and basing the yield on that of her fifth lactation (which too cannot be regarded as normal) she should have given at least 11,000 lb. in her first period. Her udder improved somewhat during the following year and this is reflected in the increased milk production, but a bad relapse set in during the third lactation. In this as well as in the fourth lactation she was treated sporadically by the owners who then were not provided with a reliable diagnostic method and based their treatment on the presence of pus in the milk. She commenced her fifth lactation on 20.8.40 and was tested for the first time for mastitis on 26.8.40 when the right forequarter was found to be functionless and the left fore infected. The latter responded to one course of Entozon infusions. Her most recent official test for milk yield was completed in June, 1941, and showed an increase of 5,109 lb. over that of the previous period despite the fact that only three of her quarters were functioning.

It is not claimed that the recovery shown in the fifth lactation is due to the treatment applied after the first mastitis test. It is more likely the result of the irrigations given by the owners during the 3rd and 4th lactation periods. Neither is it suggested that she has been restored to milk production at full capacity. The sterilisation of the one quarter and the fibrosis shown by the others make this impossible. This case, however, illustrates very clearly the difficulties under which owners labour when they lack a reliable test which will detect infection in the early stages and enable proper treatment to be applied promptly. The dam of this animal yielded over 19,000 lb. milk in

300 days as a mature cow and the diagnosis and treatment of the disease in the early stages in the first lactation would probably have enabled the daughter to attain the same level in her fifth lactation.

Summary and Conclusions.

1. An account is given of the results obtained over periods of 14 and 12 months respectively from a scheme applied to two South African Friesland herds and aiming at the eradication of chronic streptococcus mastitis from these herds.

2. The scheme is based on periodic testing of all cows and heifers for mastitis by microscopic examination of smears prepared from incubated samples of milk, the application of infusion therapy to infected and suspected quarters, segregation in the stable between infected and non-infected animals, and the employment of ordinary hygienic precautions in the stable.

3. Details are given of the methods of diagnosis and treatment, of the control measures and the recording of results.

4. For the successful control of the disease the full active co-operation of the owner is essential.

5. Accurate evaluation of the results obtained from curative treatment is rendered impossible by such factors as the tendency of many infected quarters to discharge streptococci intermittently and not continuously, the unreliability of a single negative test, the fact that infection is not necessarily shown immediately after it is contracted, and the tendency of quarters which have been apparently cured to show a reappearance of streptococci in the milk.

6. As a result of infusion therapy systematically applied the infection among the cows in the two herds was reduced from 55·7 per cent. and 48·2 per cent. to 6·3 per cent. and 15·7 per cent. respectively, while the number of infected quarters decreased from 28·5 per cent. and 25·8 per cent. to 2 per cent. and 5·4 per cent. respectively.

7. The preventive measures instituted resulted in the infection in first calf heifers being reduced from 60 per cent. in those that calved before the control scheme was put into operation to 20 per cent. in heifers calving subsequent to its introduction. It is probable that a large proportion of the latter animals were already infected prior to the commencement of the scheme.

8. Infection in some quarters was very obstinate and one case is recorded which required 18 infusions before it stopped secreting mastitis streptococci in the milk.

9. A reappearance of streptococci in the milk of quarters which appeared to have been cured is frequent and this necessitates one or more additional courses of treatment for such quarters.

10. Ninety-five out of 182 quarters which are claimed to have been cured have given negative results consistently for 10 months or more. The remaining 87 quarters have been clean for periods varying from 2 to 9 months.

11. Quarters with latent infection responded to treatment more readily than those with clinical mastitis, and do not show the same tendency to recurrence.

12. The figures available for the determination of the incidence of infection in the different lactation periods are unreliable since many of the older cows have become negative on account of auto-sterilisation or treatment by the owners.

13. For infusion therapy Entozon, Acriflavine, Rivanol and Euflavine were used in various concentrations, and the solutions were left in the udders for varying periods. There does not appear to be much difference between these drugs as regards efficiency though a slightly higher percentage of failures is recorded against Rivanol, while Euflavine promises to be more effective.

14. The periods for which solutions can be left in the quarters of cows in full lactation may be extended from 15 minutes to 30 or even 60 minutes without harmful results.

15. The number of quarters which are unintentionally rendered functionless by infusion is approximately 2 per cent. Some of these, however, resume their secretory activity in the following lactation.

16. The milk yield of the infected cows for the lactation during which they were being tested and treated for mastitis is compared with the expected yield for the same period, the latter being calculated from the yield in the previous lactation by making the necessary corrections for advancing age. Eighteen cows produced more and 16 less than their expected yields. On the whole the 34 cows gave 10,169 lb. (an average of 299 lb. per cow) more than their expected yield.

17. Fifteen of the 16 cows whose yield was not up to expectations had clinical mastitis, and it is probable that the degree of induration rather than the effect of treatment is responsible for the reduction in yield.

18. Butterfat percentage does not appear to be affected to an appreciable degree by treatment.

19. An example is given of the marked depression in yield caused by mastitis and of the ability of some udders with advanced clinical mastitis to recover a great portion of their secretory activity after treatment.

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APPENDIX.

The following is the key to the code used in the appendix:—

Quarters:—

A=right fore; B=right hind; C=left fore; D=left hind.

Smear Examination:—

−=negative for mastitis streptococci.

+=positive for mastitis streptococci.

CE=an abnormally large number of cells or cellular elements (an average of approximately 2 or more per field).

NS=No smear.

Treatment:—

E^1=Entozon 1 : 1250 for 5 to 15 minutes at weekly intervals.
E^2=Entozon 1 : 1250 for 15 to 30 minutes at 10 day intervals.
E^3=Entozon 1 : 1250 for 60 minutes at 10 day intervals.
E^4=Entozon 1 : 2000 for 6 hours at weekly intervals.
E^5=Entozon 1 : 1500 for 12 hours at 10 day intervals.
E^6=Entozon 1 : 500 for 24 hours to sterilise quarter.
A^1=Acriflavine 1 : 10,000 for 30 minutes at 10 day intervals.
A^2=Acriflavine 1 : 10,000 for 30-60 minutes at 10 day intervals.
A^3=Acriflavine 1 : 5,000 for 24 hours to sterilise quarter.
R^1=Rivanol 1 : 1,250 for 5-10 minutes at weekly intervals.
R^2=Rivanol 1 : 2,000 for 6 hours at weekly intervals.
R^3=Rivanol 1 : 2,000 for 12 hours at weekly intervals.
Eu^1=Euflavine 1 : 10,000 for 15-30 minutes at 10 day intervals.

The figures in brackets indicate the number of infusions given. Thus E^1 (4) means 4 infusions of 1 : 1,250 Entozon for 5-15 minutes at weekly intervals.

I.—Brakfontein Herd.

No. of Cow.	Number of Lactations and Date of Last Calving.	Quarters.	22.4.40.		27.5.40.			24.6.40.		
			PH.	Smear.	Treatment.	PH.	Smear.	Treatment.	PH.	Smear.
1	Six 21.11.39	A	7·5	—	E^1 (4)	7·0	CE		6·8	CE
		B	6·8	—		6·8	CE		7·0	+
		C	6·8	—		6·8	—		6·6	CE
		D	6·8	—		6·6	—		6·6	+
2	Six 31.10.39	A	6·5	—		6·5	CE		8·0	CE
		B	6·5	—		6·5	—		6·7	—
		C	6·5	—		6·7	CE		6·8	CE
		D	6·7	—		6·6	CE		6·8	CE
3	Six 17.4.40	A	6·5	—		7·0	CE		7·0	+
		B	6·5	—		6·6	—		7·0	+
		C	6·7	—		6·8	—		6·8	CE
		D	6·6	—		7·0	CE		7·0	+
4	Four 29.6.39	A	6·5	—		6·8	+	E^1 (3)	6·6	CE
		B	6·5	—		6·5	—		6·6	CE
		C	6·6	+	E^1 (4)	7·0	+	R^3 (3)	6·6	+
		D	6·5	—		6·6	CE		6·8	CE
5	Eight 24.8.39	A	6·5	—		6·8	+	E^1 (3)	6·6	—
		B	6·8	—		6·8	+	E^1 (3)	6·5	+
		C	6·8	+	E^1 (4)	6·8	CE		7·5	+
		D	6·5	—		6·8	+	E^6 (3)	7·0	+
6	Five 6.9.39	A	6·4	—		7·0	CE		6·8	CE
		B	6·5	+	E^1 (4)	8·5	+	R^3 (3)		CE
		C	Functionless				NS			NS
		D	6·4	—		7·0	CE		6·8	CE
7	Seven 5.2.40	A		—		6·6	—		6·8	—
		B		—		6·8	CE		7·0	CE
		C		—		6·6	CE		6·8	—
		D		—		6·8	CE		7·0	CE
9	Seven 18.11.39	A		CE	E^1 (4)	6·5	—		6·5	—
		B		—		6·5	—		6·5	—
		C		+	E^1 (4)	6·5	+	R^3 (3)	6·8	CE
		D		—		6·6	—		6·6	—
11	Seven 15.4.40	A	7·5	+	E^1 (4)	6·5	—		6·6	+
		B	8·0	+	E^1 (4)	6·6	+	R^3 (3)	6·6	+
		C	7·0	+	E^1 (4)	6·6	+	R^3 (3)	6·8	+
		D	7·5	+	E^1 (4)	6·6	+	R^3 (3)	7·0	CE
12	Five 8.2.40	A	7·0	—		7·0	+	E^1 (3)	7·0	CE
		B	6·0	—		6·8	+	E^1 (3)	7·5	CE
		C	7·5	—		7·0	+	E^1 (3)	7·0	CE
		D	8·0	CE		6·8	+	E^1 (3)	7·5	CE
13	Six 28.1.40	A		—		6·6	+	E^1 (3)	6·7	+
		B		—		6·5	+	E^1 (3)	6·7	+
		C		CE		6·5	CE	E^1 (3)	6·7	CE
		D		—		6·5	+	E^1 (3)	6·7	+

AKFONTEIN HERD.

26.8.40.		30.9.40.		22.11.40.		19.1.41.		27.4.41.		23.6.41.	
Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.
E^4 (4)	+	E^3 (2)	+	A^1 (3)	+	A^1 (2)	CE				
E^4 (4)	—		CE		CE		CE				
E^4 (4)	—		—		CE		CE		Dead.		
E^4 (4)	CE		—		—		CE				
E^1 (4)	CE		Sterilised		NS		NS		NS		NS
E^1 (4)	+	E^3 (2)	CE		—		+	E^3 (3)	+		CE
	—		—		—		CE		—	Dry	CE
	CE		CE		—		—		—		CE
E^1 (4)	+	E^3 (2)	—		CE		CE		CE		—
E^1 (4)	CE	E^3 (2)	—		CE		CE		CE		CE
	CE	E^3 (2)	CE		CE		+	E^3 (3)	CE	Eu^1 (3)	CE
E^1 (4)	CE	E^3 (2)	CE		CE		+	E^3 (3)	+	Eu^1 (3)	—
	—		—		CE		—		—	Eu^1	CE
	—		—		CE		+	E^3 (3)	+	Eu^1 (3)	CE
E^1 (4)	CE		+	E^3 (3)	CE		—		CE	Eu^1 (3)	CE
	+	E^3 (2)	+	E^3 (3)	+	A^2 (2)	CE		+	Eu^1 (3)	CE
E^4 (4)	+	E^3 (2)	CE		—	A^2 (2)	CE		—		CE
E^4 (4)	+	E^3 (2)	—		CE	A^2 (2)	CE		—		—
E^4 (4)	CE	E^3 (2)	CE		CE	A^2 (2)	CE		CE		CE
E^6 (2)	CE	E^3 (2)	CE		CE	A^2 (2)	CE		—		—
			—		—		—		—		—
calved,			—		—		—		—		+
18.9.40			NS		CE		+	A^3 (2)	+		+
			CE		CE		—		—		—
	—		—		—		—		—		CE
	—		—		CE		—		—	Drying	CE
	—		—		CE		+	E^3 (3)	—	off	CE
	CE		—		—		NS		CE		CE
	—		CE		—		—		CE		CE
	—		—		—		—		CE	Dry	CE
	—		—		—		—		—		CE
	—		—		—		—		—		CE
E^1 (4)	+	E^3 (2)	—		+	A^2 (2)	—	A^2 (3)	+		
E^1 (4)	—		—		+	A^2 (2)	+	A^2 (3)	—	Disposed of.	
E^1 (4)	+	E^3 (2)	—		+	A^2 (2)	—	A^2 (3)	—		
E^1 (4)	CE		—		+	A^2 (2)	+	A^2 (3)	—		
	—		—		CE		CE		CE		CE
	—		CE		CE	Drying	CE	Dry	CE	Dry	CE
	—		—		CE	off	CE		CE		CE
	—		CE		CE		CE		—		CE
E^4 (4)	—		—		CE		—				
E^4 (4)	CE		CE		CE	A^2 (2)	CE		Disposed of.		
E^4 (4)	—		—		CE		CE				
E^4 (4)	CE		—		CE		—				

31-32a

31-32b

I.—Brakfontein Herd

No. of Cow.	Number of Lactations and Date of Last Calving.	Quarters.	22.4.40.		27.5.40.			24.6.40.		
			PH.	Smear.	Treatment.	PH.	Smear.	Treatment.	PH.	Smear.
14	Six 17.2.40	A B C D		— + — —	E¹ (4)	6·5 6·5 6·5 6·5	+ — — —	E¹ (3)	7·0 7·0 7·0 7·0	CE CE — —
15	Four 30.10.39	A B C D	Not tested			8·5 8·5 8·0 8·0	CE + + CE	 R³ (3) R³ (3)	7·0 8·0 7·0	+ — — CE
16	Three 12.12.39	A B C D	6·8 7·0 6·8 6·7	+ — — —	E¹ (4)	8·0 6·6 6·8 6·6	CE — — —		6·5 6·5 6·5 6·5	— — — —
17	Four 25.4.40	A B C D	6·4 6·5 6·5 6·7	— — — —		6·5 6·5 6·5 6·5	+ + + +	R¹ (3) R¹ (3) R¹ (3) R¹ (3)	6·6 6·6 6·5 6·5	— — CE —
18	Four 22.8.39	A B C D		— — — —		6·5 6·5 6·5 6·5	— — — +	 E¹ (3)	6·5 6·8 7·0 7·5	— — — +
19	Four 18.5.40	A B C D		— — — —		6·5 6·5 6·5 6·5	— — + +	 E¹ (3) E¹ (3)	6·8 6·8 6·8 6·8	— — — —
20	Four 12.11.39	A B C D		— — — —		6·8 6·6 8·0 6·8	CE — + CE	 E¹ (3) 	6·5 6·5 8·0 6·5	— — CE —
21	—	A B C D		— — — —		6·6 6·5 6·9 6·5	— — CE —		6·5 6·5 6·5 6·5	— + + —
22	Three 29.9.39	A B C D		— — — —		6·5 6·5 6·5 6·5	— — — +	 E¹ (3)	6·5 6·5 6·5 6·7	— — — CE
23	Four 15.10.39	A B C D	6·5 6·6 6·6 6·6	+ — + +	E¹ (4) E¹ (4) E¹ (4)	6·6 7·0 6·8 7·5	— CE CE CE		7·0 7·0 7·0 6·8	— — + —
26	—	A B C D	Functionless. 8·0 8·0	 — +		8·5 8·5	CE +	 R³ (3)	7·0 7·5	CE CE

TEIN HERD—(*continued*).

26.8.40.		30.9.40.		22.11.40.		19.1.41.		27.4.41.		23.6.41.	
Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.	Treatment.	Smear.
	— CE — —		— CE — —		CE — — —		CE CE — —		— — — —		— CE — CE
R² (4)	CE CE CE CE	Dry		Dry	CE CE CE CE	Dry	CE CE CE CE	Dry	CE CE CE CE	Disposed of.	
	+ — — —	E³ (2)	Sterilised — — —		NS — — —		NS CE — —	Dry	NS CE CE CE	Calved 13.5.41	— — — —
	— — — —		— CE — —		— CE + +	 E³ (2) E³ (2)	— CE + —	Disposed of.			
R² (4)	— — — —		CE CE CE CE		CE — — —		— — — —		— CE — —	Dry	CE CE CE CE
	— + — +	E³ (2) E³ (2)	— — — —		— — — —		— CE — CE		CE CE CE CE		— — CE —
	— — — —		CE — CE CE		CE — CE CE		— — — CE		CE — CE CE	Dry	CE CE CE CE
Dead.											
	— — — —		CE CE CE CE		— — — —	Dry	CE CE CE CE	Dry	— CE — —	Calved 15.5.41	— — — —
E¹ (4)	— + — +	E³ (2)	CE CE — —		CE CE CE CE		— — — —		— — — —		CE — — —
Discarded.											