HERD RECORDING IN NEW ZEALAND

by

T. N. EDEY

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Massey Agricultural College,
University of New Zealand.

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PREFACE

Recent developments have made herd recording in New Zealand the responsibility of a single organisation, the New Zealand Dairy Board, and since August 1st, 1951, there has been virtually only one system of recording. However, since 1904, when the Department of Agriculture introduced systematic testing in the Weraroa herd, many organisations and numerous systems of recording have contributed to the development of the herd recording movement. The time is opportune, therefore, for a study of this work in New Zealand, embracing the history of production recording, a review of the associated investigational work, and an assessment of the past role and probable future place of herd recording in the improvement of dairy cow production.

To supplement data from published material much information has been obtained from private files and personal interviews. In this respect, grateful acknowledgement is due particularly to Professor W. Riddet for access to his private files relating to herd recording, and for helpful discussion. Thanks are due to the Director and staff of the Herd Recording Department of the New Zealand Dairy Board for their assistance; to Mr. H.G. Philpott, late of the Dairy Division, Department of Agriculture; to Mr. C.M. Hume; to my supervisor, Dr. A. Stewart for helpful guidance and criticism; and to many others for their ready co-operation. This work was completed during the tenure of a Victorian Government Scholarship.

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PART ONE

HISTORY OF HERD RECORDING IN NEW ZEALAND

CHAPTER I

THE ORIGINS OF HERD RECORDING

There are many reported instances of individual and herd production performances being recorded before the introduction of herd recording systems as they are known today. Stewart (1949) cited numerous cases, from 18th and 19th Century English literature, in which records were kept of milk weights and volumes. These were usually daily milk yields from herds or individual cows soon after freshening. Anthony (1942) claimed that the first really effective effort to determine the yearly producing ability of individual cows of a herd was made in 1843 on a large farm in Denmark. "Weekly milk weights" for every cow in the herd were kept throughout the year, and "these were then combined with the total amounts of butter produced by the dairy for the year" to indicate the production of individual cows. This method was soon adopted by several other large farms in Denmark.

In the United States of America, Anthony (ibid) reported that the so-called "churn test" was introduced in 1853. This was a test of butter production, usually carried out for one day, the primary purpose being to give publicity to individual cows. By contrast, the private recording in Denmark was "primarily for economic information instead of for publicity."

The advent of the Babcock test in 1890, and the Gerber test in 1892, made practicable the recording of individual butterfat productions on a large scale. In 1895 a co-operative recording society consisting of thirteen members with three hundred cows was formed at Vejen, Denmark, using the Gerber test to determine the butterfat content of bi-monthly milk samples (Dairy Cow Testing,1935). By 1898 there were over one hundred such societies in Denmark (Anthony,1942).

Other countries were quick to follow the

Danish example - in 1897 the first German society for milk recording was founded, and in the following year similar organisations were operating in Sweden, Norway and Finland. In the United States the first Cow-testing Association was formed in 1905 although Breed Association or "Official" Testing, based at first on the churn test, and later (1894) on the Babcock test, was commenced in 1883. The "Official" testing systems placed the emphasis on individual production, and helped to make fashionable the breeding of record-breaking cows. Considerable publicity surrounded record-breaking productions, even though measurements were frequently taken over periods of only a few days. The Cow-testing Association scheme, on the other hand, was a true herd-recording movement in which a genuine attempt was made to estimate individual and herd productions under normal conditions (Anthony, 1942).

Prior to 1885 there was little specialised dairy farming in New Zealand (Philpott, 1937). With the advent of refrigeration in 1882, and the development of an export trade in the "eighties", interest in dairying increased and a marked expansion in dairy cattle numbers took place. Attempts were made to select milking strains from the existing cattle which were predominantly Shorthorns, and numerous importations of cattle of the specialised dairy breeds were made (Gilmer, 1939). This phase of development continued into the early years of the present century.

It was during this period that the first recorded herd-testing experiments were conducted in New Zealand. Philpott (1937) stated that four sets of Babcock testing equipment arrived in New Zealand in 1892 for use in dairy factories and that from then onwards an increasing number of factories commenced paying for milk on the basis of butterfat content. Previously the volume of milk yielded by the herd had been the criterion of productivity; now the quality of the milk became important. Inevitably, low-testing herds were most affected by the change-over, and many farmers claimed they were being cheated by the factories. The Department of

Agriculture Annual Report (1895), reflecting the most advanced ideas of the time, advised farmers who were dissatisfied "...to go in for Babcock testers so that they can test the quality of milk from each cow and at the same time weigh it and keep a proper record of results.... The keeping of records is of the greatest value to the farmer for without records it is impossible to adopt any new system of dairy farming or to improve on the old one."

Philpott (1937) stated that the first cow-testing experiments in New Zealand were carried out in the Waikato in 1896. Philpott (1951) claimed that this work was conducted in several herds by a Department of Agriculture dairy instructor, using Babcock equipment to determine butterfat content.

Investigations on recording methods were in progress at Weraroa State Farm as early as 1902 (ibid) and in the 1904-05 season systematic herd-testing was inaugurated in the Weraroa herd (Philpott, 1937). The "New Zealand Farmer" (1906) reported that 130 cows were tested there in 1905-06. Philpott (1951) stated that for three years the milk from every cow was weighed at each milking, and samples were tested for butterfat content each day. The accuracy of estimates of production based on weighings and samplings performed at various intervals up to two months were compared. It was concluded that monthly weighings and samplings gave a reasonably accurate estimate, and it was chiefly on this evidence that the Association System, introduced in 1909, was made a monthly test. The system evolved at Weraroa was applied by the Department of Agriculture to a number of private farms in the Manawatu in 1905-06. In the following year farmers began testing their herds privately at Warea (Philpott, 1937) New Plymouth and Palmerston North ("New Zealand Farmer", 1907).

It is clear that the early phases of recording in New Zealand followed the Danish rather than the American pattern, and as a result emphasis was on lactation records of the herd rather than individual records of short duration. Recording was considered a guide to culling uneconomic producers,

not as a publicity measure for the pedigree breeder, and it was not until after the Certificate of Record System was introduced in 1912 by the Dairy Division of the Department of Agriculture that interest centred on individual yields of high producers for their value in assisting sales of pedigree animals.

CHAPTER II

THE ASSOCIATION SYSTEM

Private recording, together with the investigations of the Department of Agriculture referred to in Chapter 1, prepared the way for the formation of the first cow-testing association at Dalefield (Wairarapa) in 1909. Philpott (1937) was of the opinion that the introduction of systematic herd recording in New Zealand was the direct outcome of a visit to Denmark in 1908 by Mr. David Cuddie, then Director of the Dairy Division. Mr. Cuddie was so impressed by the development and influence of the herd-testing movement in that country that on his return he strongly advocated its inception in New Zealand. As a result the Dalefield Association was formed with the assistance of the Department of Agriculture, and during 1909-10, the first season, 815 cows were tested in twenty seven herds (Singleton,1910).

Under the Association System the farmer recorded individual weights and took samples at each milking over a four-milking period each month. The samples, which were not necessarily in proportion to the milk yield, were tested for butterfat content at the local dairy factory by the dairy company or an officer of the Department of Agriculture using the Babcock test, and each month farmers were supplied with production details for each cow (Hume,1946). Monthly summaries were also published in the local press (Singleton,1910). There was no rule making compulsory the recording of all cows in the herd. At that time milking was done chiefly by hand and herds were small by present-day standards. Weighing and sampling were, therefore, not too onerous.

In the 1910-11 season Associations each consisting of about twenty five members and one thousand cows were formed at Kaupokonui, Stratford, and Cambridge. In the four Associations, 4,155 cows were tested in that season, those in milk seven months or more averaging 224 lbs. of

butterfat (Singleton,1911a).

From the earliest stages the Department endeavoured to leave as much as possible of the responsibility of organisation in the hands of the testing farmers. Official policy was defined as follows: "After continuing for two years to control an illustration Association in any selected district the Department relinquishes the running of the work in that particular locality and proceeds to organise further Associations in other districts..." ("N. Z. Journal of Agriculture",1912). No charge was made for the service during the first two seasons, but when, as sometimes occurred, it was found necessary to extend the illustration period, a charge of two shillings per cow per annum was made.

The Dairy Division encouraged the formation of independent testing Associations amongst the shareholders of dairy companies. Singleton (1911) stated that in such cases the testing member provided scales and sampling bottles, the samples being delivered to the local factory for analysis. The Government supplied the necessary forms, thus helping to ensure some degree of uniformity. Frequently the initiative of the factory manager was an important factor in the establishment of these Associations, and since in most cases the dairy companies were co-operatives, there was little difficulty over the testing of samples. Fees could be collected simply by deducting the amount due from the monthly milk or cream payment (Philpott,1937). Such private units were operating independently of the Dairy Division at Thames Valley and Eketahuna in 1912 ("N. Z. Journal of Agriculture",1912).

The growing realisation of the importance of herd recording was evident from the agricultural literature of the day. Such opinions as: "...if we are to improve our position we must avail ourselves of every possible means to increase our output and decrease the cost of production. Nothing else will produce so much result in this direction at so small an outlay as regular and constant weighing and testing" (Burgess,1912), were common.

It is interesting to note that even at this time Danish farmers were interested in "production-tested" sires. The "N. Z. Journal of Agriculture" (1913) reported that "...in Denmark a bull is regarded as useless for breeding purposes if he does not possess a milking pedigree both on the side of the dam and of the sire for generations back." This attitude was not evident in New Zealand where the emphasis was placed on the pedigree bull, with purity of blood rather than performance records in his antecedents, as the key to herd improvement (see Singleton, 1913).

The number of cows recorded increased rapidly for the first few years, and in the 1913-14 season totalled twenty five thousand. The War of 1914-18 seriously checked the work, however, and the number of cows recorded declined. Nevertheless in 1918-1919 Associations were operating in Northland, Waikato, Taranaki, Hawkes Bay, Wairarapa, Manawatu, Canterbury and Otago. The check imposed by the War was only temporary, for even the limited amount of recording done at that stage had demonstrated to many farmers the usefulness of accurate measures of lactation yields. Following World War I a rapid expansion of the dairying industry took place due to the stimulus of high butter and cheese prices together with Government schemes for soldier settlements. The total cows in milk increased from 711,000 in 1917-18 to 1,125,000 in 1928-23 (N. Z. Dairy Board, 1950). "Shortage of labour and the increased reliability of small petrol engines gave a tremendous impetus to the installation of milking machines" (Hamilton, 1944), a development which was partly responsible for an increase in average herd size on established farms. In addition, many new farms were taken up for dairying and these contributed to the increase in cow population.

Hume (1946) stated that many new recruits to the industry were keen to start dairying using the most up-to-date aids to efficiency then known. These included herd recording, and the number of cows recorded increased from 17,000 in 1918-1919 to 45,564 in 1921-22 (see Appendix I).

However this demand for up-to-date methods also resulted in the widespread adoption of machine milking and it was found that with machines additional labour was required in the milking-shed for weighing and sampling. This was inconvenient in busy periods and many farmers who commenced recording at the beginning of a season soon abandoned it.

The Association Testing Movement was hampered in its early years by unsettled industry conditions, the chief factor being the labour shortage during and immediately following World War I. Numerous Associations lapsed at various times and others found difficulty in providing a satisfactory service. Dairy Companies did much to foster the work, and Singleton (1922) reported that "quite a number of Dairy Companies are now conducting on their own behalf herd testing associations." Singleton (1920), discussing these independent units, stated that some of them had the services of a testing officer who was really in the employ of the dairy company. In some cases a testing officer was shared by two or three small Associations, and occasionally all the work was done by the factory manager. An officer was sometimes appointed by the Dairy Division at the dairy company's expense, and in small Associations these officers also did some instructional work. Eight such Associations operated in 1920-21. Singleton (ibid) also stated that the Dairy Division assisted many tottering Associations in return for the use of the dairy factory testing room and appliances and a guarantee of two shillings per cow per season from the dairy company. In the 1919-20 season twenty seven Associations were operated by the Dairy Division despite the fact that Government policy was to withdraw as rapidly as was practicable in favour of private enterprise (Philpott, 1937).

With such instability in the Movement, and the accompanying lack of uniformity and supervision, it was inevitable that the quality of the work suffered. In the post-war years the demand for dairy cattle was keen and production figures were frequently quoted at sales. Hume (1946)

claimed that subsequent perfofmances frequently threw serious doubts on the reliability of the herd-test records quoted, and the Movement was to some extent discredited. Thoughtful farmers realised, however, that it was the system of herd-recording and not the principle which was at fault. Many of the weaknesses which became apparent in the Association System were overcome by the introduction of the Group Herd Testing System in 1922 (see p.12).

The chief advantage of the Association system was its low cost to the farmer, which seldom exceeded 2/6d per cow per season (Philpott,1937). However, the disadvantages of the system were considerable. For two days each month it slowed down the milking routine, and gave additional work to the milkers at the busiest period of the year. This applied especially to machine milked herds, where, in addition to increased labour, more equipment was necessary. The information obtained was intended solely for the individual farmer's own use and the system depended entirely upon the conscientiousness and integrity of the testing member. Once the records began to be used for publicity in the saleyard, there was considerable incentive to falsify returns. Soon after the Great War, therefore, circumstances demanded a system which allowed of a reasonable degree of accuracy and supervision whilst being more economical of the farmer's labour and time. The Association system was, therefore, gradually replaced by the Group system which more nearly fulfilled the requirements of that time.

Table I shows the change-over to the Group system, but it is evident that considerable numbers of cows continued to be recorded by the Association system (see also AppendixII) which, from 1930, came to be known as the Association Own-Sample Test. The system had, however, fulfilled a valuable function in popularising herd recording. In 1923-24, the peak season of the Association test, 108,070 cows were recorded, but subsequently it was superseded by the more convenient Group system, for which it had laid the foundation.

The Association Own Sample Test has persisted

in isolated districts where there have been insufficient cows to warrant the forming of a Group Herd Test unit. In similar circumstances a very limited number of cows have been recorded by the Dairy Company system in which the dairy factory tests samples sent in by the farmer, but all the calculating work is left to the farmer himself.

TABLE I: Herd-Testing Statistics showing transition from Association to Group Systems 1921-1930

Season	Group	Association	Dairy Company	Total
1921-22	-		45,564	45,564
1922-23	7,500	67,835	9,490	84,825
1923-24	43,144	96,198	11,872	151,214
1924-25	100,005	87,695	9,100	196,850
1925-26	105,227	59,345	5,204	169,776
1926-27	109,827	56,823	3,500	170,150
1927-28	164,610	56,699	2,821	224,130
1928-29	212,480	45,586	1,528	259,594
1929-30	242,688	40,667	376	283,731

-After Singleton (1929b)

The number of cows recorded annually by the Association system has declined steadily and over the five seasons 1945-46 to 1949-50 inclusive, has averaged only 5,080 cows per season, representing less than 1.5 per cent of all cows recorded (N.Z. Dairy Board,1950) (See Appendix II).

CHAPTER III

THE GROUP HERD TEST MOVEMENT (1922-1951)

1. The Period of Independent Associations 1922-26

The Group Herd Test System owes its existence largely to the efforts of a number of progressive farmers in the Waikato. Cuming (1936) stated that in 1921, at a time when a number of enthusiastic members of the Morrinsville Farmers' Union were investigating improved methods of herd recording, another member of that organisation returned from a visit to Australia with particulars of a group system which had been in operation in the northern districts of New South Wales for almost a decade. This method was an adaptation of the original Danish system, the recording officer travelling from farm to farm weighing the milk of the individual cows and determining the fat content of the milk samples on the farm. The method was strongly recommended to the Hamilton branch of the Farmers' Union and sufficient support was received to form the Waikato Farmers' Union Herd Testing Association in 1922. The farmers formed themselves into groups of twenty-seven members and made a levy on a per cow basis to finance an officer who visited each herd for a two-milking period each month (Hume,1946).

In 1922-23, the first season of its existence, the Association operated six groups in the Waikato, and recorded the milk and butterfat yields of 6,900 cows (Philpott,1937). "The organisation aimed at providing production figures for the members which would be complete and reliable, and at the same time be acceptable to the buying public.... Many difficulties arose, the major one being finance. Considerable expenditure was necessary before an Association could operate, and the only way in which credit could be obtained was through a 'Joint and Several' (agreement) with the Bank, signed by a number of public spirited members" (Hume,1946).

In view of these financial difficulties the Waikato Farmers' Union Executive decided, prior to the close of the 1922-23 season, that their finances could not support the expanded organisation which would be necessary for the subsequent season. After consultation with the New Zealand Co-operative Dairy Company (Hamilton) it was decided to form a new Association, membership of which was to be open to the suppliers of any Co-operative Dairy Company. The New Zealand Co-operative Herd Testing Association, as the new organisation was named, took over the assets and liabilities of the Farmers' Union Herd Testing Association in July, 1923. The new Association had its finance guaranteed by the above Dairy Company, and of its Management Committee of eight members, four represented the Dairy Company and four were elected by the members of the Association. During the first two seasons the Dairy Company allowed their officers to manage the Herd Testing Association, Mr. A. E. Missen supervising the work in the first season, after which Mr. C. M. Hume took charge (Hume, 1930).

At that time there was keen competition between private and co-operative dairy companies for suppliers, and until 1929 the N. Z. Co-operative Herd Testing Association would record only the herds of farmers supplying co-operative factories (Hume, 1951). This led to many financial difficulties. Each group of twenty-seven members constituted a separate financial unit, and when a member transferred his supply to a private company without prior notification to the testing Association his testing fees were lost, and these bad debts made the difference between profit and loss for the group. "Some units had a large number of cows and indeed refused to accept a small herd, thus enabling them to operate at an annual cost of approximately four shillings per cow. Others, however, had to accept a percentage of small herds to fill the group and their costs went as high as eight shillings per cow. Some dairy companies then stepped into the breach giving a subsidy on each cow tested and guaranteeing the

Association's bank account. In such cases the dairy company had representation on the Management Committee of the Association" (Hume, 1946).

A typical group, of twenty-seven members, would have approximately 1,300 cows under test, and an Association could comprise from one to eighty such groups. The Association was controlled by a Management Committee elected in part by the members, and in part by the dairy companies. Typically this Committee consisted of eight members, two of whom retired each year, but were eligible for re-election. The Association employed a Secretary or Manager who was responsible for the operation of the component groups, the checking of testing officers' returns, and the calculation of herd averages. "Rough" sheets giving details of monthly milk weights and butterfat content samplings were returned by the recording officer to the Association office where calculations were completed. Each farmer was then sent a copy of his monthly returns. In a few cases the recording officer completed the calculations while on the farm, giving one copy to the farmer and returning a carbon copy to the Association office for checking and filing (Hume, 1929a). This method had the advantage of avoiding transcription errors, but was liable to errors in calculation, and was later abandoned. For butterfat testing either the Gerber or the Babcock test was used, and both methods are still permissible. Sampling for butterfat content was originally done with a dipper, an equal volume being taken from night and morning milkings. Hume (1931a) stated that the inaccuracy of this method was recognized, and in the early years of Group recording, testing officers of the N. Z. Co-operative Herd Testing Association, operating in the Waikato, carried out approximate proportionate sampling with the dipper by taking one dipperful from each cow at night and the correct proportion from the morning's milk. In the 1926-27 season, three groups commenced proportionate sampling using pipettes. In addition to the proportionate sample for each cow, a herd composite sample

was taken which was tested for butterfat content, to act as a check on the average butterfat test obtained from the individual cows. This method gave increased accuracy, and Hume (ibid) stated that by 1930 it was in general use in the N.Z. Co-operative Herd Testing Association's area.

Following the formation of the first Association in the Waikato in 1922-23 the Group Movement spread rapidly. In 1923-24 independent Associations were operating in the Bay of Plenty, Wairarapa, Feilding and Northern Wairoa districts, and in 1925-26 the work began in Taranaki, Otago and Southland (Philpott, 1957).

The principle that each group within an Association operate as a separate financial unit was abandoned by the N.Z. Co-operative Herd Testing Association (Waikato) in the 1925-26 season. In an attempt to distribute costs more equitably, a flat rate of five shillings per cow was levied (Fulton, 1925). However, this penalised the large herds to such an extent that many of them stopped testing, and in the 1926-27 season a sliding scale of fees was introduced (Fulton, 1926).

The rapid expansion which took place in the first few seasons added to the financial difficulties of the movement (Hume, 1946). Each new group required one more testing officer's salary and travelling expenses, another full set of equipment, and additional clerical work. Originally, fees were collected by orders on the dairy company over the nine-month recording season. In the 1924-25 season, however, payments of one shilling per month over the five flush months were collected, and bad debts through transfer of supply were thus greatly reduced (Fulton, 1926). In 1926 the N.Z. Co-operative Herd Testing Association introduced a twelve-month recording season but most other Associations could offer only a nine-month service ("Dairy-farmer," 1926).

Recording procedure varied considerably between

Associations although most of them were modelled on the N. Z. Co-operative Herd Testing Association. As the movement developed, its policy was to place the interests of the industry before those of the individual members, an example of this being the introduction in 1936 of the "all cow" rule (Hume, 1946). The original rules permitted the farmer to exempt 10 per cent of his herd from recording, but it was soon realised that unless all cows were included no valid average production figures could be obtained. There was considerable opposition to this principle, for many farmers wished only to record for one season or to record only new cows and heifers. A single lactation was regarded as a satisfactory index of productivity. In addition, many members who recorded continuously objected to having sick cows, "slips", and empty cows included in the herd average. Nevertheless the "all cow" rule was introduced although it was decided to make no charge for the recording of sick, empty or otherwise abnormal ("B" Class) cows. This policy of demanding that all relevant information be revealed has been the cause of much criticism from those with a narrow conception of the function of herd recording, but it is now more generally appreciated that knowledge of the herd average is an essential factor in herd improvement work.

Considerable publicity was given to herd recording by the daily press and in farming journals. Monthly group averages, and averages for the lowest and highest herds in each group were published by many newspapers. However, in order to discourage undesirable inter-herd competition, individual herd results were treated as confidential, no names being published. For the same reason competitive awards were discouraged and later prohibited under the uniform rules of Group Herd Testing (see p. 24)

Whilst the progress of the Group Movement was rapid, it was realised that there was little room for complacency. The "Dairyfarmer" (1925) which at that time was the official organ of the N. Z. Co-operative Herd Testing

Association exemplified this attitude when it strongly criticised a statement by the then Director of the Dairy Division, which claimed that the herd recording situation was "very satisfactory". In the same year the "N. Z. Dairy Exporter" (1925) commented, "...the room for improvement is still the most noticeable feature of this work. Only fourteen per cent of the herds are yet under test but as this percentage is increased a lift up toward the level of 250 lbs. of butterfat per cow which is what is being aimed at should be recorded."

In 1925 the N. Z. Co-operative Herd Testing Association inaugurated a system of registering and marking certain heifer calves. For many years it had been apparent that the widespread use of inferior bulls of nondescript breeding ("scrub" bulls) was retarding herd improvement. Many calves from such bulls were being sold or saved for replacements whilst the daughters of good bulls from above average herds were being slaughtered. Under the Marked Calf Scheme, which is discussed in detail in Chapter VIII, the daughters of registered purebred bulls and recorded dams of a certain standard were identified by ear tattoo. It was hoped that these stock would command such a premium on the market as to induce farmers to rear rather than slaughter their surplus eligible heifer calves. This was the first attempt to provide a service other than actual production recording, and at that time it appeared a sound method of providing superior young stock to replace the low producers culled on the basis of their herd-test records.

2. The Period of Control by the Dominion Group Herd Testing Federation and the Central Executive 1926-1936

By June, 1925, eight independent Associations were operating in different parts of the Dominion, but in the absence of a co-ordinating body there was little attempt to preserve uniformity of method. Most of the Associations

were in financial difficulties, and since herd recording was subsidized in many other dairying countries an approach was made to the Government for a subsidy of a shilling per cow to be paid to any organised Group Herd Testing Association in the Dominion (Fulton,1925). This move was supported by resolutions from the Chambers of Commerce of Auckland, Hamilton and Rotorua, which considered the work of such national importance as to warrant their support. The deputation stressed: (1) the value of herd recording to the nation, and (2) that the loss made in recording the small herds at a reasonable cost to their owners was weighing too heavily on the owners of the large herds. In addition, protection was sought for the Calf Marking Scheme, then in operation by the N. Z. Co-operative Herd Testing Association in the Waikato (Hume,1946).

Although the Minister of Agriculture was sympathetic it was made apparent that no subsidy could be granted until the eight Associations then operating were united, and that protection could be given to the Calf Marking Scheme only if it was available to dairy farmers throughout the Dominion.

It is noteworthy that four co-operative dairy companies in the Waikato had agreed to give a subsidy of sixpence per cow to the N. Z. Co-operative Herd Testing Association (Waikato) provided a suitable Government subsidy was obtained (Fulton,1925). When the latter was refused, the N. Z. Co-operative Dairy Company (Hamilton), which had greatly helped the Group Movement since its inception, granted a subsidy of threepence per cow for the 1925-26 season (Fulton, 1926).

(a) <u>The Dominion Group Herd Testing Federation (1926)</u>

When Associations became established in all the main dairying districts the need for some representative organisation to ensure uniformity of work, and the pooling of accumulated experience and progressive ideas, became apparent. The introduction of Calf Marking made the need more obvious.

Finally, the reasons given by the Government for refusing a subsidy precipitated action in which the Executive of the N. Z. Co-operative Herd Testing Association (Waikato) were the prime movers, the foundation work being done principally by Messrs. Dynes Fulton (Chairman) and C. M. Hume (Manager). In Wellington during July, 1926, a meeting was called for the purpose of forming a central controlling organisation. The meeting resulted in the formation of the Dominion Group Herd Testing Federation, all except one Association joining. Mr. Dynes Fulton was the first president (Cuming, 1936). Hume (1951) stated that the formation of the Federation was made possible through the acceptance by all Associations of the "one Association - one vote" principle. Had the N. Z. Co-operative Herd Testing Association, which then recorded more cows than all other Associations together, insisted on proportional representation, the smaller Associations would have refused to affiliate.

In 1926 the Government was asked again: (1) for a subsidy and (2) to introduce legislation providing that any system of marking calves for breeding and butterfat backing should be carried out only by Associations affiliated to the Federation. Both requests met with some success. The Government brought in an amendment of the Stock Act, in 1927, which gave reasonable protection to the Marked Calf Scheme. This was accepted by the Federation as the maximum protection available at that time, but it was recognized that an absolute monopoly on calf marking was necessary for really effective control (Cuming, 1936). In addition, the Government granted a subsidy of £10,500 in the 1927-28 season, for the purpose of reducing the cost of recording under Group Herd Test and Association Own Sample systems. It was therefore a direct subsidy to all farmers recording under these systems. To administer the subsidy a Subsidy Allocation Board was set up comprising a Chairman appointed by the Government, a representative of the Department of Agriculture, and nominees of the Dairy Produce Board, National Dairy Association and

South Island Dairy Association. When allocations were made at the end of the 1927-28 season one shilling per cow was refunded to each recording farmer (Hume, 1946). Each Association's funds were therefore reduced by the costs of making the refunds, and their financial position was worse than before (ibid). However, the subsidy encouraged more farmers to test, and some new Associations were formed. The Allocation Board administered the subsidy for two seasons.

Meanwhile, the Group Herd Testing Federation was making strong endeavours to place the recording movement on a sounder basis. Members felt that the Federation should be regarded as the organisation in control of herd recording, and as such should administer all subsidies. The Dairy Produce Board, which for a number of years had taken a sympathetic interest in herd recording, actively supported this viewpoint and recommended to the Government that the subsidies be granted to the Federation. However, in July 1929, after prolonged discussion, the Minister of Agriculture set up the New Zealand Herd Testing Central Executive to act as a link between the Group Herd Testing Federation and the Department of Agriculture.

(b) <u>The Central Executive and the Federation</u>

The Central Executive consisted initially of eight members:

The Director General of Agriculture The Director of the Dairy Division Chairman of the N. Z. Dairy Board Professor Wm. Riddet	Appointed by the Government

Four Representatives of the Dominion Group Herd Testing Federation (one to be Chairman).

Later (1930), the President for the time being of the New Zealand Breeds Federation (formed in 1926) joined the Executive. The first Chairman of the Central Executive was Mr. Dynes Fulton who had also been Chairman of the N. Z.

Co-operative Herd Testing Association and the Dominion Group Herd Testing Federation since the inception of those organisations in 1923 and 1926 respectively. Mr. Fulton, who retained these three offices until his retirement in 1933 was the outstanding figure in the first decade of the Group Herd Testing Movement.

One of the first acts of the Central Executive " ... was to place the Government subsidy on a basis that would give more assistance to the district Associations in building up their finance while at the same time reducing the cost of testing to the dairy farmers" (Cuming,1936). The Executive had powers to lay down the policy for Group Herd Testing but the Management Committee of the Federation was responsible for its implementation. In 1929, on the recommendation of the Federation, the Central Executive obtained finance to permit the appointment of a Federation Supervisor of herd testing whose duties included the following:

1. To submit a report on the various recording organisations with suggestions for improvement of system, standardization of practice, and curtailment of costs.
2. To consider and assist the formation of new organisations.
3. To check the work of testing officers.
4. To deliver lectures and general propaganda.
5. To assist the Association Own Sample System where that system was preferred or where economically it was the most suitable system.

The Federation was responsible for the work and expenses of the Supervisor, but all questions of policy were submitted to the Central Executive (Herd Testing Central Executive,1929). Mr. C. M. Hume was appointed to the position.

For some years after the formation of the herd-testing Federation the herd recording movement made rapid progress. The number of cows tested increased from 170,000 in 1925-26 to 284,000 in 1929-30 (see Appendix I). Although the finances of most of the Associations were rather insecure

until the 1928-29 season, the position improved with the advent of the Central Executive. "Grants became available for the full cost of new plant for new Associations and for entirely new groups within existing Associations. This gave a real impetus to the Movement, and in 1931 the Group service was available in every dairying district in the Dominion. Twenty-eight Associations were operating and all of these were affiliated with the Federation." (Hume,1946). A meeting was held annually, at which the Council of the Federation (one delegate from each affiliated Association) elected the President for the ensuing year, and the Management Committee of six members. The President, ex-officio, and the Management Committee, were the governing body of the Federation. Membership in the Federation was not compulsory but grants from Government subsidies were paid only to member Associations and calf marking was entirely under Federation control. These advantages were such that there were few break-aways, only one of which was of any consequence. This occurred in July, 1932, when a section of the Taranaki Association formed the independent Central Taranaki Association and applied for affiliation to the Dominion Group Herd Testing Federation. The new Association was considered unnecessary and affiliation was refused. The breakaway organisation was thus excluded from Government subsidy benefits and from the Federation's Calf Marking Scheme. After one season's operation the Central Taranaki Association was disbanded and its members rejoined the Taranaki Association (Hume,1933). The fact that such breakaways could occur emphasised the need for more rigid control of the Movement if it was to attain its maximum effectiveness.

The Group Movement had made considerable progress during the years 1922-30 despite the economic uncertainty of that period. It had received much support from returned soldiers and new farmers in the years following World War I but this support had been sporadic to some extent because of the financial difficulties in which many farmers found themselves

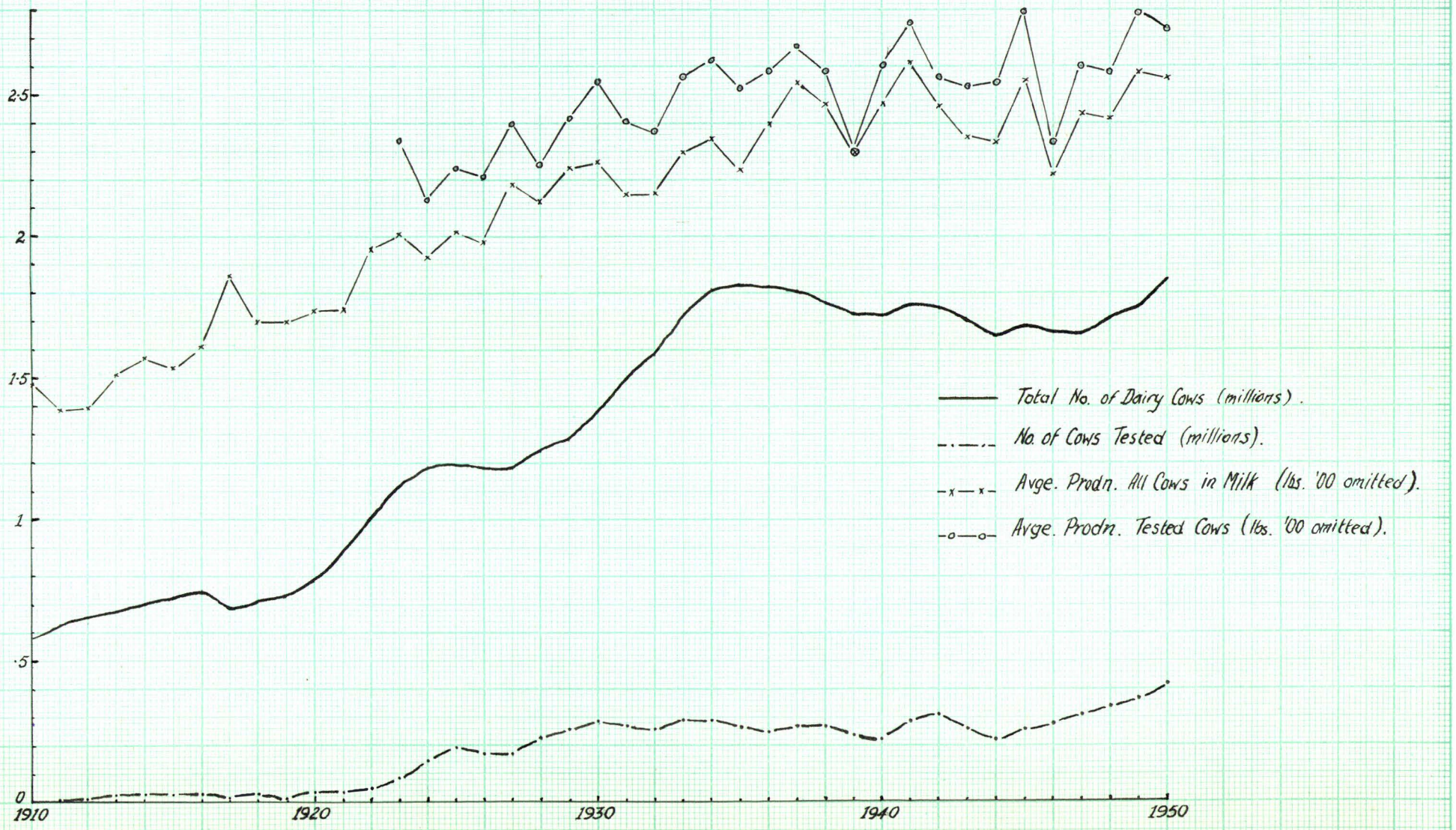

FIGURE 1. Statistics of recorded cows and cows in milk * for the period 1910-1950. For detailed figures, see Appendices I and II.

*Until 1916, figures were for "cows in milk and dry".

in the early twenties. Many of them had bought farms at high land values and were seriously affected by the abrupt fall in prices in 1921, one result being that they could not afford to test at all, or tested for one season and then withdrew. However the number of cows recorded rose sharply when economic conditions improved, when a subsidy was obtained (1927), and when the propaganda for recording became more effective. Not only did the number of cows under test increase greatly but per cow production improved despite the rapid increase in total cow population (See Fig. I). This trend continued until the 1929-30 season when 20.4 per cent of all cows in milk were recorded (N. Z. Dairy Board, 1950) and many people predicted the attainment of a Dominion per cow average of 300 lbs. of butterfat with 40 per cent of all cows under test within a few years. Economic depression supervened, however, to the detriment of herd recording.

In 1930 the Federation Supervisor toured the Dominion, visited all Associations, and reported to the Federation on their progress. He addressed many farmers' meetings, assisted in settling disputes concerning boundaries, and gave advice to Associations where advice was needed. He was able to report a considerable degree of uniformity of methods "brought about by the action of the Department of Agriculture supplying the test sheets and by assistance and advice so freely given to new Associations by the New Zealand Co-operative (Herd Testing) Association in the early days of the Movement and latterly by the Federation" (Hume, 1930). Nevertheless there were numerous differences in methods, usually of a minor nature, between Associations, and the Supervisor recommended that the Federation adopt a uniform set of rules. This was done at the 1930 Annual Meeting of the Council of the Federation. The rules were designed as a guide to affiliated Associations, to be used in conjunction with local rules. In addition the Federation clearly defined the conditions governing the Marked Calf Scheme and the issue of Production Cards.

These latter could be issued by affiliated Associations for "Group" tested cows which were positively identified by tattoo or approved "owners marks" (Hume,1931b).

On the recommendation of the Supervisor the requirements for marked calves were changed in 1930. Formerly, to be eligible, a calf had to be the offspring of a registered purebred bull and a tested dam of a certain standard. From 1st July, 1931, the purebred (certified) sire was required to be the son of a tested dam of a certain standard (see p.149). This was an important development for it had become increasingly obvious that because a bull was registered he was not necessarily a sire of high producing daughters. The nondescript herds of mixed breeding, so common until the late twenties, had largely been "graded up" by the use of purebred dairy bulls, and Hume (1929b) produced some evidence that the difference in production between pedigree and grades had narrowed considerably. Where formerly much propaganda was directed against the "scrub" bull, inferior pedigree bulls or "pedigree scrubs" were now named as one of the greatest menaces to the industry ("N. Z. Dairy Exporter",1928). The certified bull scheme was an attempt to identify bulls with at least some minimum of butterfat backing.

It was an aim of the Central Executive to have herd recording independent of Government subsidy as soon as possible, but with the onset of the depression in 1930, financial assistance was needed more than ever if the number of cows recorded was to be maintained. The Federation was financed from the proceeds of a levy on affiliated Associations of one half-penny per cow for all cows tested, returns from the Marked Calf Scheme (one shilling per calf), and by a grant from the Central Executive. The total amounts granted each year to assist herd recording are shown in Table II.
The Central Executive used the Government subsidy for three main purposes:

1. For grants up to fifty pounds per group to provide equipment

TABLE II: Subsidies to the Group and Association Own Samples herd recording systems during the seasons 1927-28 to 1934-35 inclusive.

		Group Herd Test	Association Own Samples
Season	Amount of Subsidy	pence per cow	pence per cow
1927-28	£10,500	12	6
1928-29	10,500	11	5½
1929-30	8,500	9	4½
1930-31	8,000	4	2
1931-32	7,700	6	3
N.Z.Dairy Board	6,000	5	2½
1932-33	6,000	3½	2
1933-34	6,000*	2½	1
1934-35	5,000*	1½	nil

Adapted from N.Z. Dairy Board, (1937).
* From Herd Testing Central Executive Minutes, (1933; 1934

for new Associations or new groups within existing Associations.

2. For extra assistance to Associations warranting special consideration.

3. The remainder to be used to reduce the cost of testing to farmers.

In addition, the expenses of the Federation Supervisor were charged against the subsidy (Herd Testing Central Executive, 1931).

At the beginning of the economic depression of the early thirties, the Federation and the Central Executive realised that special efforts would be necessary to prevent herd recording going into decline at a time when its expansion could be most beneficial. The best methods farmers could use to offset low dairy produce prices were to reduce their costs of production and increase their outputs. It was thought that herd recording, by identifying low producers and serving as a guide to better farm management could be an important factor in attaining these ends. Special steps were therefore taken to induce more farmers to record. They included:

1. Reducing the cost of recording to the farmer. For this purpose the Central Executive obtained in 1931-32 a special

grant of £6,000 from the Dairy Board which subsidised "Group" recording by 5d per cow and "Association" recording by 2½d per cow (see Table II).

2. Propaganda for recording was intensified. In the 1931-32 and 1932-33 seasons the Federation Supervisor visited every dairying district in the Dominion, meeting farmers and addressing numerous meetings. He stressed the need for recording to allow culling of uneconomic cows, and advocated the widespread use of fertiliser and better grazing management as the first essentials for reducing costs of production and increasing output. Hume (1932) claimed that "the meetings held during the last two winters have been responsible for the movement holding its position".

3. Special attention was paid to farmers in financial difficulties, and efforts were made to impress Government and private lending institutions with the value of recording, so that they would give special consideration to recording clients and encourage others to put their herds under test. The current slogan was "you cannot afford not to test".

Reference to Appendix I will show that the organisers of the Movement were very successful in maintaining the number of cows recorded. In the 1933-34 season, with 297,647 cows under test, a peak was reached which was not exceeded until the 1941-42 season. It has been said "that many dairy farmers turn to herd testing only when faced with difficult times" (N.Z. Dairy Board,1941), but considerable credit must be given to those who were able to convince farmers that they should record when their first inclination was to reduce their costs by ceasing to record.

There is, however, another aspect of the effect of the depression, namely the great increase in dairy cow numbers which occurred at that time. Many existing herds were expanded, and sheep and cropping farmers changed

to dairying or introduced dairy herds as side-lines in an effort to supplement incomes (Hamilton, 1944). The results were twofold; first, the percentage of cows under test fell from 20.4 per cent in 1928-29 to 14.5 per cent in 1934-35, and secondly, per cow production which had been increasing steadily (see Appendix I) became almost stationary due to the conversion of inferior land to dairy-farming, and to the relaxation of culling standards. Hamilton (1944) traced the reversal of these trends following the upward trend of prices after 1934-35 when "the number of cows in milk showed a drop of approximately 83,000 in four years and the number of suppliers declined by approximately 8,000...." In this period of recovery the percentage of cows under test showed an increase although no distinct increase in per cow production was evident.

(c) The Dairy Industry Commission (1934)

The achievements of the Group Herd Testing Movement in the twelve years of its existence, to 1934, were considerable, but its leaders realised that the movement still lacked the support it deserved. They felt that full support would be withheld until herd recording was made a truly national movement. At that time there were four systems of recording, Certificate of Record (C.O.R.) and Government Official Herd Test (O.H.T.) administered by the Dairy Division, Group Herd Test, controlled by the Federation, and Association Own Sample under the jurisdiction of the Dairy Division and the Central Executive. The Central Executive was representative of all dairying interests, but there were definite limitations to its power, especially since it depended upon the Federation for the implementation of its policy. The Federation itself was a purely voluntary organisation and breakaways from existing organisations and the establishment of unnecessary Associations could not be prevented. There was also considerable difficulty in adequately safeguarding the Calf Marking Scheme, because the

Federation did not have a monopoly on this work. The Federation decided, therefore, to try to effect some improvement.

Since 1929 the Central Executive, the Department of Agriculture, and the Federation had been working in close co-operation, and it was hoped that a method of combining their testing activities could be found. Arrangements were therefore made for the Chairman of the Federation and the Federation Supervisor to give evidence before the Royal Commission which had been appointed to investigate methods of assisting the dairy industry. The meeting took place in June 1934, and the Federation representatives laid great stress upon the importance of having a united and effectively controlled herd recording movement.

In the Report of the Dairy Industry Commission (1934) the value of herd testing was summarised in these words :

> Herd testing is recognised as one of the most progressive movements for increasing the efficiency of dairy herds and dairy farm management. It creates an intelligent interest shared by the farmer, his family and employees in each animal in the herd; raises butterfat production per cow and per acre thereby reducing costs of production; and provides a check at monthly intervals on the efficiency of milkers, cows, feeding, season, and farm and herd management. It is the basis of constructive cow selection and herd replacement, and discloses to finance institutions and other lenders the comparative efficiency of individual production units on the dairy farm. It is, therefore, a movement which is worthy of the greatest commendation.

The Report outlined the limitations of the existing organisations and made a series of recommendations which were summarised as follows:

1. That there be set up a New Zealand Herd Testing Council which would prescribe standards and methods and which would control all testing in New Zealand.
2. That all Herd-Testing-Associations be registered with and be affiliated to the Herd Testing Council.
3. That the Council consist of eight members (similar in composition to the Central Executive).
4. That the Council receive an annual grant of not less than £4,000 toward the cost of administration and research.
5. The present levy of ½d per cow be continued (This referred to the levy paid by Associations to the Federation for administration purposes).

Some of these recommendations were opposed,

however, by the Dairy Breeds Federation. Insofar as recording was concerned, this organisation, formed in 1926, was interested in pedigree cows only, and it asked that the C.O.R. and O.H.T. systems remain under the jurisdiction of the Dairy Division, although it supported absolute control of group herd-testing work by the Dominion Group Herd Testing Federation. As a result, no action was taken by the Government despite the fact that the number of cows under C.O.R. and O.H.T. in the 1933-34 season was only 2,983 in 248 herds as against 275,000 cows under Group Herd Test for 5,500 dairy farmers (Report of Dairy Industry Commission. 1934). Over 10,000 pedigree cows were under Group Herd Test at this time (ibid) but in general, the long-established and most influential breeders supported the C.O.R. and O.H.T. systems which did not insist upon the "all cow" rule, and which provided, in their opinion, more reliable records because they were based on a three-milking test (see p.80). Hume (1934) was of the opinion that the main reason for the Breeds Federation's opposition to unified control was the fear that the Group Herd Test rule insisting upon the recording of all cows in the herd would be applied to breeders supporting the C.O.R. system. Hume (ibid) commented that in view of the soundness of that rule their fears were no doubt justified.

The Dominion Group Herd Testing Federation endorsed the recommendations of the Commission but it was felt that "if the active co-operation of the Breed Societies could not be obtained there should be a forward movement at least to the extent of strengthening the Central Executive or the Federation" (Bell,1935). A resolution to this effect was sent to the Central Executive in February,1935. The Central Executive endorsed the principles of the resolution, and on 2nd May, 1935, a deputation waited on the Executive Commission of Agriculture. This latter was established in 1934 with far-reaching powers to co-ordinate the work of the Producer Boards (Dairy, Meat, Poultry etc.)(N.Z. Dairy Board, 1949). The deputation stressed the need for:

1. A strengthened controlling organisation with statutory powers.
2. Continued financial assistance from the Government.
3. The need for research into the data obtained from testing.

The Executive Commission of Agriculture decided that since unification of Herd Recording as recommended by the Dairy Industry Commission was not acceptable, a Herd Testing Council as proposed was not necessary. The alternative of strengthening the Federation was discarded because it "would almost surely perpetuate the present organisation" (N.Z. Dairy Board, 1935). The Executive Commission, in June, 1935 therefore suggested that the Central Executive go out of existence and "Dairy Board have vested in it power of control of Group Herd Testing and the expenditure of Government subsidy and other funds". This suggestion was supported by the Department of Agriculture and the Group Herd Testing Federation. The Dairy Board agreed to this change on certain conditions, the principal of which were:

1. That the Government provide £3,000 per annum for administration and supervision at least up to March 31st, 1941, when the question of finance would be reviewed (i.e. a total of £15,000).
2. A sub-committee be set up representative of all bodies interested in testing, which, whilst under the Board's control, could supervise and administer Group Herd Testing in the Dominion.

After prolonged discussion with the Treasury, the Dairy Board finally agreed to the following financial arrangement on October 16th, 1935:

Government Grants -	1936-37 financial year	£3,000
	1937-38 " "	3,000
	1938-39 " "	2,500
	1939-40 " "	2,000
	1940-41 " "	1,500
	Total	£12,000

In addition the Dairy Board would receive approximately £1,000

from the residue of the 1934-35 subsidy, approximately £830 comprising the assets of the Federation, and an estimated £500 per annum from Federation levies, totalling £2,500 for the five seasons 1936-37 to 1940-41 inclusive. This gave an estimated total of £16,330 to assist the Dairy Board to finance herd recording until March 31st, 1941 (N. Z. Dairy Board, 1937).

During the period of control by the Group Herd Testing Federation and the Central Executive, herd recording had evolved to a stage where the testing farmer was no longer directly subsidised. The development of the Group Movement had, however, been greatly helped by the Government assistance provided in the period 1927-36. In the application of herd recording to farm practice, increasing emphasis had been placed on the importance of selecting registered sires with butterfat backing, but in general, herd records were still primarily used as a guide in culling, and few appreciated the full role of herd recording in herd improvement through breeding and feeding. Bell (1935a) stated that "the average dairy farmer supporting herd testing is not vitally concerned in the interpretation of his results for the betterment of dairy farm management generally." There was apathy and occasionally hostility (Dominion C.H.T. Federation, 1931) to investigational work. It was obvious that farmers would have to be educated to the broader implications of herd recording work before they would be prepared to provide finance for what many of them considered to be "record-keeping of an unessential nature" (ibid). The change-over to N. Z. Dairy Board control was opportune, therefore, since the Dairy Board had the necessary finance, authority and influence to continue the work of production recording whilst expanding its activities in the investigational field.

3. The Period of Dairy Board Control 1936-51

The "Herd Testing Regulations 1936" were

gazetted on February 27th, 1936, and the N.Z. Dairy Board assumed control of Group Herd Testing from April 1st of that year (N.Z. Dairy Board, 1937). The New Zealand Dairy Board was a statutory body which was originally set up by the Government in 1933 to control the marketing of dairy produce. It was then called the New Zealand Dairy-produce Control Board. The Board passed through many vicissitudes in the next twelve years, being twice reconstituted and finally, in 1936, was relieved of its marketing function (N.Z. Dairy Board, 1949). It was recognised as the elected head of the dairy industry and formed a liaison between the industry and the Government.

In 1936 the Board consisted of five members, four elected by the industry and one by the Government. It was financed by a levy of one fiftieth of a penny per pound on butter, and one hundredth of a penny per pound on all cheese produced. Its funds were used for the benefit of the producers on such projects as dairy research, advertising dairy produce, "Milk for Schools" and herd recording (N.Z. Dairy Board, 1937). The Board was therefore well situated to administer herd recording, having an assured source of revenue, the support of the industry, and close liaison with the Government. The "Herd Testing Regulations 1936" gave the Board the necessary statutory power to control adequately the Group Herd Testing Movement and the marking of stock of any approved standard of merit.

(a) <u>The Transition Period 1936-39</u>

The Dairy Board took over the staff of the Dominion Group Herd Testing Federation, set up a Herd Recording Department, and made the Federation Supervisor, Mr. C.M. Hume, Supervisor of Herd Recording. The Board was thus enabled to continue the general policy of the Federation.

A Herd Recording Council was set up by the Dairy Board comprising:

The Director General of Agriculture.

Two members of the N.Z. Dairy Board.

One nominee of the N.Z. Dairy Breeds Federation.

Four nominees of the Dominion Group Herd Testing Federation together with three co-opted members:

Professor W. Riddet (Massey Agricultural College).

Dr. E. Marsden (Department of Scientific and Industrial Research).

Mr. W.M. Singleton (Director, Dairy Division).

The chief duties of the Council were "to advise the Board on all matters relating to herd recording in New Zealand in the exercise of functions defined by the Board" and "to free the Board from the routine work ... involved in the control of the Group Herd Recording Movement" (N.Z. Dairy Board, 1937).

At a preliminary meeting, held on 27th November, 1935, the Council elected as Chairman Mr. G.H. Bell, a foundation member of the Central Executive, its Chairman since September, 1933, and President of the Dominion Group Herd Testing Federation since 1933. Policy in relation to herd recording was formulated and as a result the Dairy Board decided that the Federation should continue to function, as it provided "the necessary machinery for holding the annual herd-testing conference, for the collection of levies and for the election of nominees to the Herd Recording Council" (Herd Recording Council, 1935). Herd improvement was to be effected:

"1. ... by systematic and efficient recording of production, by the marking and registering of selected calves, by the elimination of unpayable cows, by the eradication of scrub bulls, by the encouragement of the use of pedigree bulls bred on the best productive record and by any other means deemed necessary or expedient" (N.Z. Dairy Board, 1937).

2. By standardisation, extension and improvement of herd recording.

3. By making available, information which could be derived from herd-testing data (ibid).

Policy included provision for the annual licensing of Herd Testing Associations as from 1st July, 1936, which immediately precluded the formation or operation of a recording organisation considered unnecessary by the Dairy Board.

The first official meeting of the Herd Recording Council was held on 7th May, 1936. In the first year twenty-seven licenses were issued, seventeen in the North Island and ten in the South Island, and for that season (1936-37) the Federation's rules governing herd-testing, calf marking and production cards were accepted by the Dairy Board as the rules to govern the operation of Associations. Certified Bull Certificates and Heifer Calf Registration Certificates were to be in the name of, and issued by the New Zealand Dairy Board.

The Herd Recording Council also recommended and the Dairy Board approved, the appointment of a Technical Officer whose chief duty was to carry out investigations on data collected through herd recording. Mr. A.H. Ward, who as Secretary of the New Zealand Co-operative Herd Testing Association (Hamilton) had laid the foundation for a Sire Survey Scheme (N.Z. Dairy Board,1937) was appointed. Under the Dairy Board he was able to continue this work, and in June,1937, the Herd Recording Council approved the draft of a comprehensive Sire Survey Scheme. This development is discussed elsewhere (see Chapter X). Briefly, however, for some years evidence had been accumulating which showed that a large proportion of the sires in use in the industry were lowering production in the herds they headed. Once the importance of the sire was recognized, the demand for some method of testing bulls was a logical, though rather delayed development. The institution of a Sire Survey Scheme was due more to the foresight of the Movement's leaders than the demands of the commercial farmers.

Over the years a considerable volume of data had accumulated as a result of herd recording, but very little analytical work had been done. Apart from actual production data there was little statistical information which could be of use to the industry. For example, no reliable information was available on the merits of bull breeding herds, the causes of herd wastage, or the managerial practices associated with high production. There was thus wide scope for the Technical Officer's work and in the ensuing years numerous surveys were conducted in an attempt to obtain information on various aspects of dairy production.

After the Dairy Board assumed control of herd recording, there was renewed pressure for the extension of the work. It was felt that as the elected head of the industry the Dairy Board was in a strong position to promote herd recording, and various interested organisations vigorously advocated drastic reforms, particularly within the pedigree industry. A resolution came from the Dominion Group Herd Testing Federation's 1936 Council, that testing be placed on a more national basis, and the Farmers' Union approved a similar resolution (Hume, 1936a). In September, 1936, a Conference was held of representatives of the Dairy Board, the Herd Recording Council, the Executive Commission of Agriculture and the Farmers' Union. Acting on the conclusions reached, the Herd Recording Council sent a number of resolutions to the Dairy Board for submission to the Board's Dominion Conference and the Dairy Breeds Federation. These included:

1. Prevention, from 1st July, 1938, of the transfer of bulls ineligible to sire marked calves (see p. 149).
2. Prevention, from 1st July, 1938, of the sale of registered heifer calves and yearlings other than the progeny of Certified Bulls.
3. Publication of production records of all pedigree cows under test, the penalty for exemption being cancellation of registration of the animal.

4. Dairy Board to have control of all forms of recording, excepting C.O.R. testing as carried out by the Dairy Division.
5. Dairy Board to provide, through its annual levy one third of the total cost of herd recording (Herd Recording Council, 1936c).

When these resolutions were submitted to the Dairy Breeds Federation the need for a scheme to provide superior replacement stock was stressed. Since 1925 the Group Herd Testing Movement had vigorously supported the use of registered purebred sires, and more recently had placed emphasis on the need of such sires having butterfat backing. It was therefore essential that the purebreds be superior to the grades if improvement in commercial stock was to continue. A limited amount of evidence was presented suggesting an unsatisfactory level of production in the purebred as compared with the grade stock. It was also stated that the Herd Recording Council was prepared to evolve an improved Group Herd Test method for purebred stock. Statistics showed that whereas 12,854 pedigree cows in 1,053 herds were Group Herd-tested in 1935-36, less than 3,000 cows owned by 230 breeders were recorded under the Government O.H.T. and C.O.R. systems (Hume, 1936b).

The Dairy Breeds Federation considered the proposals at their meeting on 12th November, 1936, and in general pronounced the scheme impracticable. The merits of the comparisons between pedigree and grade stock have been discussed in detail (see p.166) but in the absence of conclusive evidence that registered stock were not superior to grade stock it was not possible to obtain the approval of the Breeds Federation for such drastic measures as were suggested. Whilst numerous breeders supported "Group" recording methods and Dairy Board policy, many of the most influential members of the Breed Societies held tenaciously to the Government systems which were better authenticated (see p.80) and did

not insist on the "all-cow" rule. The firm belief of these breeders in the innate superiority of registered purebred cattle was not easily shaken and consequently they failed to see the need for the suggested changes. They objected particularly to the clauses restricting the sale or transfer of stock without butterfat backing, on the grounds that recording facilities were not available to all owners of pedigree herds. However the meeting agreed, in principle, that the recording of registered purebreds should be compulsory, but it was almost a unanimous decision that all recording should be free (Hume, 1936c). The Herd Recording Council, on the other hand, held firmly to the principle that "in any system of assistance to the herd recording movement at least 50 per cent of the cost of testing should be a direct charge on the testing members" (Herd Recording Council, 1937a).

Despite the fact that the Herd Recording Council was representative of all branches of the industry, including the breeders, the Council and the Breeds Federation were at variance on many points. Their differences were so fundamental that Hume (1936c) concluded that "the task of building a scheme of permanent value which would prove acceptable to all the Breed Societies is well-nigh insuperable". A stalemate had been reached, and Hume (1937a) recommended that it could best be broken by obtaining irrefutable evidence of the need for: (a) universal recording, and (b) an improvement in the standard of herd sires. "The industry would then demand that something be done."

The required move came from the industry in March, 1937, when the Dairy Board's Ward Conference in Gisborne carried a resolution "that the Board give consideration to the establishment of herd testing as a national service, if necessary with financial assistance from the industry as a whole, and that this matter be discussed at the Dominion Conference". The Dominion Conference, in February, 1938, supported this remit and instructed the Board to investigate

the position. The problem was in turn referred to the Herd Recording Council. In September, 1938, the Council appointed a sub-committee to examine the entire situation concerning national testing, and to present a report to the next meeting. This sub-committee brought forward the Herd Improvement Plan which was unanimously approved by the Council in February, 1939.

(b) The Herd Improvement Plan (1939) and its Implementation 1939-43.

The Plan was summarised as follows:

(a) The New Zealand Dairy Board to institute a Dairy Board Herd Improvement Plan.
(b) The Government to assist financially in co-operation with the Dairy Board in giving effect to this Plan.
(c) The Dairy Board to approach the Breed Societies in order to secure their co-operation in the Plan to provide an improvement in the standard of herd sires.
(d) The Minister of Marketing to be approached with the request that increased efficiency should not be completely offset by increase in the per cow index on which the Guaranteed Price is based (N.Z. Dairy Board, 1939).

After the Minister of Marketing had agreed to the last-mentioned clause the Dominion Conference in April, 1939, approved the Plan and the herd recording movement entered a phase of intensified activity. It will be noticed that the term "national herd testing" was replaced by "Herd Improvement Plan" to emphasise the broader implications of the scheme. The Dominion Conference recommended that the Dairy Board increase its levy by one-hundredth of a penny on butter and one two-hundredth of a penny on cheese to meet its share of the cost of the Plan. In the first two seasons (1939-40 and 1940-41 the Government and the Dairy Board each provided £15,000 per annum (N.Z. Dairy Board, 1939). Details of the subsequent financing of the Plan are shown in Appendix VII.

In the preamble, which outlined the need for such a far-reaching plan, stress was laid on several salient points including:

1. The inefficiency of the primary production side of the

dairy industry as compared with the manufacturing and marketing sections.

2. The need to increase the net financial return to the average dairy farmer.
3. The average production per cow had been practically stationary for the past six seasons.
4. The average production of pedigree cows under Group Herd Test was no higher than that of grade animals tested under similar conditions (N. Z. Dairy Board, 1939).

The Plan provided for "reorganisation of the existing Herd-Testing Associations to secure higher efficiency at least in the clerical and calculating work". There was considerable variation in the standard of work done by the twenty-eight Associations in existence. They varied greatly in size, and costs were sometimes kept low to the detriment of accuracy in the calculating work. In some Associations the clerical and calculating work was done on a contract basis and in others, Secretaries were employed on a part-time basis. Consequently Association Secretaries differed greatly in their knowledge of, and interest in, herd recording. In addition, the policy of Management Committees varied considerably, and some could see little merit in statistical and investigational work. They held that the sole function of their organisation was to record production.

The merits of decentralisation, however, should not be overlooked. The herd recording movement was the product of co-operative enterprise depending for its success on the ability of a nucleus of enthusiasts and the support of a large number of testing members. Farmers in each district were anxious to have their own recording organisation and members of the Management Committees of the numerous Associations felt a definite responsibility to the herd recording movement. The enthusiasm of many farmers was given an outlet and much valuable honorary work was done. This was a notable feature of herd recording in New Zealand,

for in many enterprises of this nature there is a tendency to depend entirely on Government leadership and control, and the individual sense of responsibility amongst farmers lacks the opportunity for expression.

However, with a policy of greater centralisation decided upon, the first step was to amalgamate the twenty-eight existing organisations into six Herd Improvement Associations. Meetings were called at central places and the Management Committee of each Association was invited. Decisions on amalgamation could therefore be made then and there by each Association. Within two or three weeks meetings had been held throughout the Dominion, and with one exception - the Hokianga Association (Herd Recording Council,1939c) - all Associations had accepted the Herd Improvement Plan. Herd Improvement Associations were formed for Northland, Auckland, Bay of Plenty-East Coast, Wellington-Hawkes Bay, Taranaki and the South Island. Each Association elected one representative to the Herd Recording Council (Hume,1946).

Efforts to secure the co-operation of the Breed Societies were, however, more protracted and less successful. It was an important part of the Plan that the standard of herd sires be raised and the transfer of bulls without satisfactory butterfat backing be prevented. Endeavours were made to induce the Breed Societies to refuse registration of transfers of bulls without the required butterfat backing. However, some Societies refused to accept Group herd-test figures for this purpose, contending that a record based only on samplings from two consecutive milkings each month was not sufficiently reliable. They placed great value on the better authenticated C. O. R. and O. H. T. systems (see p. 80)and on the Government certificate which went with them. They therefore wanted the Government systems extended, and insisted on C. O. R. and O. H. T. records for purposes of registration of transfer. The Herd Recording Council (1939c) pointed out that these systems were heavily subsidised by the

Government, and in this respect the breeders were receiving preferential treatment. Less than 3,000 cows were under Government test whilst over 12,000 registered purebreds were Group herd-tested at that time. With such a large majority of breeders dependent on "Group" records the Council could not agree to any system which would prejudice such breeders in the raising and transfer of their bulls. For the Council to support the Breed Societies' proposals would have shown lack of confidence in their own system of recording and would have forced breeders recording by the Group system to place their purebred cows under Government test, in order to have their bulls eligible for transfer. Most members of the Council believed that it was a sounder principle to have all pedigree cows recorded by a practicable though relatively imperfect system than to compel breeders to record under a better authenticated system which possibly could not be operated on a large scale on account of the high costs involved. The Breeds Federation plan was therefore rejected by the Herd Recording Council (1939c).

The Council then set up a sub-committee to evolve a system of recording which would meet the wishes of the breeders. This sub-committee proposed a "special pedigree group test for pedigree herds", which involved monthly samplings from two consecutive milkings, but incorporated as many as possible of the checks available with a three-milking period, without necessitating the testing officer's presence for more than two milkings each month. The cost was to be the same as for ordinary "Group" testing (Herd Recording Council, 1939d).

For the Breeds Federation, Dermer (1939) raised strong objection to the proposed system on the grounds that:

1. It did not cover a three-milking period.
2. It would tend to do away with the C. O. R. and O. H. T. systems.
3. No control would be exercised by the Breed Societies.
4. It would be compulsory to test all cows in the herd.

A series of discussions between sub-committees of the Herd Recording Council and the Jersey Society then took place, and finally in June, 1940, a satisfactory agreement was reached. Its basis was that no bull would be transferred unless it qualified either as a "Stud" bull or a "Breed" bull. The qualifications for a "Stud" bull were as follows:

(a) The sire a "Stud" bull and the dam tested under C.O.R. or O.H.T. and reaching a defined minimum production or entered in the Dairy Board Lifetime Merit Register; or

(b) The sire to be an official survey sire whose all-daughter average reached a minimum standard.

To qualify as a "Breed" bull, the bull's dam must have produced under C.O.R., O.H.T. or "Special pedigree group-test" in accordance with Certified Bull Certificate Standards (Herd Recording Council,1940c). This involved recognition by the Breed Societies of the Dairy Board's Lifetime Merit Register (see p.157) and sire survey scheme.

However, these proposals were never implemented. At their Annual Meeting in 1941 the Jersey breeders approved the principle of "restricting the transfer of pedigree bulls to those which are eligible to sire marked calves" (Herd Recording Council,1941b) but it was never enforced. The Society refused to accept Group Herd Test records and they claimed that since it was not practicable to provide an authenticated recording service for every breeder in the country they could not restrict transfer of bulls (Herd Recording Council,1941c). The Friesian breeders, on the other hand, adopted the proposals, and in the 1941-42 season many of the registered Friesian cows previously "Group" tested were placed under the "Special pedigree group test". The Shorthorn and Ayrshire Associations however, refused to restrict the transfer of registered bulls.

The Herd Improvement Plan also stressed the need for a rigorous propaganda campaign "for the dissemination of information among dairy farmers on present methods of

scientific breeding and herd management." Provision was made for the appointment of six Consulting Officers, who, though on the staff of the Dairy Board, were attached to the six Herd Improvement Associations. The services of these officers were to be available to all dairy farmers, whether they recorded their herds or not. As the name implies, the main duty of these officers was to consult with the successful dairy farmers in their district and pass on details of superior farming methods to other farmers. In addition, they played an increasingly important part in collecting data for the Herd Recording Council's investigational work. They acquired an intimate knowledge of their districts and were in a position to locate farms from which accurate information could be obtained.

Under the Herd Recording Plan, therefore, efforts were made to obtain more information from the farmer, and in return to bring the resources of scientific knowledge to bear on his problems. Hume (1938) stated that the most reliable data came from continuously recorded herds and suggested that the industry should give financial assistance in return for such data. The Herd Recording Council recognized the soundness of this principle and in June, 1939, introduced a sliding scale of discounts on fees for continuously tested herds, ranging from 10 per cent on fees for the third and fourth successive season, to 20 per cent for the sixth and subsequent consecutive seasons (Herd Recording Council, 1939c).

In 1939 the Herd Recording Council set up a Technical Committee consisting of Professor W. Riddet (Chairman), Mr. C. M. Hume and Mr. A. H. Ward, representing the N. Z. Dairy Board; Dr. J. F. Filmer, Dr. C. M. S. Hopkirk, and Mr. W. M. Singleton, representing the Government; with Dr. J. T. Campbell and Messrs. R. A. Candy (Chairman of Herd Recording Council), and W. N. Paton (Department of Agriculture) as co-opted members (N. Z. Dairy Board, 1940). The main duties of this committee were to "determine the data to be collected,

form of collection and methods of analysis" and to "investigate and advise contracting parties regarding the basis on which the Effective Average Production of cows in milk may be most accurately computed" (Herd Recording Council, 1939b). The committee was responsible for planning the Herd Recording Council's investigational projects, and the success of this work has been due in no small measure to the fund of technical knowledge available to the Council through its technical committees.

Following on the adoption of the Herd Improvement Plan and the consolidation of the Group Movement it was decided that the Dominion Group Herd Testing Federation was no longer necessary, and accordingly the Federation wound up its affairs in June, 1939. In the thirteen years of its existence it had fostered the spread of the Group Movement throughout the Dominion, and, just as the Association Own Sample Test prepared the way for the more complete Group herd test system, so the Federation made possible the Herd Improvement Plan (N. Z. Dairy Board, 1939).

With the adoption of the Herd Improvement Plan, herd recording entered a new phase. Every effort was made to increase the number of cows recorded, while at the same time investigational and educational work were to receive greater emphasis than before. The leaders of the herd recording movement were convinced that future improvement could best be achieved by the identification and widespread use of superior sires. Combined with a scheme to achieve this objective there was to be an attempt to reduce disease losses and herd wastage in general, and an intensification of efforts to improve the standard of dairy-farm management. The Plan had no sooner been launched, however, than World War II commenced and herd recording activities were considerably curtailed. Shortage of manpower and materials often threatened to cause a complete breakdown of testing services (Hume, 1940). A women's herd testing reserve was formed and

trained, and helped greatly to overcome the shortage of recording officers. Nevertheless there was a marked decrease in the number of cows recorded in the 1942-43 season (see Appendix I) and, partly because of this, some survey work had to be abandoned.

(c) An Industry Stocktaking - the 1943 Report:

In February 1943, the Herd Recording Council appointed a sub-committee "... to make a critical review of the sire survey work carried out to date and to prepare a plan to put into effect in the dairy industry the steps necessary to attain the goal indicated as appropriate from sire surveys ...." (N. Z. Dairy Board, 1943). This offered an opportunity for a complete review of dairy cow production trends since the establishment of herd recording on a large scale. A comprehensive report was prepared, in which were analysed the factors responsible for past improvement, and the steps necessary for future progress. The factors responsible for past improvement are summarised in Table III.

TABLE III: Summary of factors involved in improvement of per cow production from 1920 to 1943.

	Estimated lbs. increase	% of total
Selection of daughters of highest producing dams	2	3.3
Elimination of low producers	8	13.1
Change in breed composition including grading up through use of pedigree sires	16	26.2
Improvement due to determined factors	26	42.6
Improvement in plane of nutrition of stock including increases in length of lactation and undefined factors	35	57.4
Total Increase 1920 - 43	61 lbs.	100.0

- After N. Z. Dairy Board, (1943)

Since it had been tacitly assumed by many people that increases in per cow production had been largely

due to an improvement in the genetic merit of the national herd, the conclusions of the sub-committee were of great importance (N.Z. Dairy Board,1943). They were as follows:

> The rate of improvement in per cow production has gradually diminished over the past twenty years and is at present practically stationary
>
> The observed improvement in per cow production in New Zealand since 1920 has been mainly due to improved feeding due to topdressing, better pasture management, conservation of additional winter feed and the like, with its associated increase in length of lactation and to the rapid change in the breed composition of herds, rather than to selection and elimination of low producers.
>
> .....
>
> The improvement possible on the basis of selection of replacements from the higher producing dams is very slow due to:
>
> (i) Regression of daughters toward the mean - on the average only 15% of the dam's advantage (over the herd average) is passed on to the progeny.
> (ii) Heavy culling for disease necessitates saving approximately one-third of replacements from cows below the herd average.
> (iii) Rapid expansion in herd-numbers by approximately 1,000,000 cows since 1920 has further limited the scope available for selection.
> (iv) Not more than 30% of cows have ever been tested and therefore two-thirds of farmers do not know which are their highest producing cows.
>
> The farmer has therefore been reliant upon the herd sire as the chief means of ensuring that herd replacements will be of superior producing ability to the culls they replace.
>
> The 1078 sire surveys conducted to date indicate that only one in three of the bulls surveyed has improved production in the herd in which he has been used, and the net result is that these bulls have been completely unable to improve production.
>
> .....
>
> We believe that the present position has arisen because the grade herds in which these bulls have been used now approximate the same level of production as the pedigree stock from which the herd sires are drawn.
>
> The difficulties confronting the pedigree breeders in attempting to raise production have been similar to those of the grade herd, but complicated by the pedigree breeders' dual allegiance to type and ancestry as well as performance, and his reluctance to cull rigorously on a basis of performance.
>
> The facts disclose a very disquieting position in the industry, and one which can be viewed with complacency by neither the Industry nor the Breed Societies concerned.

In assessing the importance of herd recording in the production increase under discussion, it should not be overlooked, however, that recording had been concerned in more than merely indicating which cows to cull and from which cows to breed. It had played an important part in indicating the superiority of the specialist dairy breeds over dual purpose types, and the advisability of using registered

purebred dairy sires in place of "scrub" bulls. In addition, recording had been an important factor in inducing farmers to improve their farm and shed management practices and the plane of nutrition of their herds.

The sub-committee, in their report, made a number of recommendations. With the object of rapidly increasing the average production of pedigree stock the Breed Societies were urged:

1. To foster the use of "proven" sires in pedigree herds.
2. To enforce selective registration on the basis of performance.
3. To obtain universal recording in pedigree herds, allowing the owner to exclude any cow from the annual herd average only on cancellation of its registration.

For improvement in grade herds the report recommended:

1. The surveying of as large a proportion as possible of herd sires while the sires were still living, and the widespread use by artificial insemination of the best proven sires in grade, and particularly pedigree herds.
2. Continuous recording of a high proportion of herds with individual identification of heifer calves to facilitate sire survey.
3. The publication of all official sire surveys irrespective of the results.

It was considered that education and publicity were fundamental to the success of the scheme and specific recommendations were made for the provision of bulletins, films, lectures and demonstrations to fulfil this need (N.Z. Dairy Board,1943).

(d) The Period Since 1943.

One immediate result of the Herd Recording Council's 1943 Report was the greater attention focussed on artificial insemination as a factor in herd improvement. Work had already been commenced at Massey Agricultural College and Ruakura Animal Research Station. Problems of technique, at least in the local application of artificial insemination, were solved fairly quickly but progress was retarded by the

great difficulty experienced in obtaining proven sires of the required standard, viz. sires with an all-daughter average exceeding 400 pounds of butterfat (N.Z. Dairy Board, 1943). Consequently the work remained on an experimental basis until the 1950-51 season when four commercial groups were operated by the Auckland and Taranaki Herd Improvement Associations in co-operation with Ruakura Research Station (N.Z. Dairy Board, 1950).

In response to the recommendations concerning the Breed Societies, representatives of the Dairy Breeds Federation and the Department of Agriculture met in October, 1944. It was decided to introduce a rule, in 1946, making it compulsory to record all cows in herds where some cows were recorded by C.O.R. or O.H.T. methods ("N.Z. Dairy Exporter", 1944). In addition, resolutions were carried indicating support for sire survey work and the building up of lifetime production registers for cows under C.O.R. and O.H.T. Owing to administrative difficulties the recording of all cows in herds under Government test was never enforced. No separate sire survey scheme was introduced, and although recently the Dairy Board's Herd Recording Department have been surveying sires on the basis of O.H.T. and C.O.R. results, this could be done only for bulls used in herds where all cows were recorded. It can scarcely be said that the Breed Societies have given a strong lead to their members by advocating continuous herd recording as a basis for sire survey. For many years they opposed the principle that all cows in the herd should be recorded and it is unfortunate that when they finally accepted the "all cow" rule the Department of Agriculture was unable to provide the necessary service to record all the cows offered.

During the period under review two administrative changes of importance occurred. Firstly, in 1945, Mr. C.M. Hume retired from the position of Herd Recording Supervisor and Mr. A.H. Ward was appointed Director of Herd Improvement. Mr. Hume was one of the founders of Group Herd Testing in New Zealand and, under various titles and

administrations was the chief executive of the Movement from 1923 to 1945. There is no doubt that his energy, enthusiasm and ability were major factors in the successful development of herd recording. Secondly, in 1947, the Technical Committee, the Herd Recording Council's technical advisory body, was replaced by a Standing Advisory Committee having a similar function. Co-opted members of the Herd Recording Council who previously had served on both the Council and the Technical Committee, now served only on the Standing Advisory Committee. Members with specialist technical knowledge were thus relieved of the comparatively routine work of the Council, though their services were still available to the Council.

Reference has already been made (see p. 46) to the disrupting effect of wartime conditions on herd recording services resulting in a rapid decline in the number of cows recorded to 216,000 in the 1942-43 season. Since 1943, however, there has been an increase in the number of cows recorded each year, particularly in the post-war period. This is shown in Table IV (see also Appendix I).

TABLE IV: Herd-recording statistics 1941-50.

Season	No. of Cows Recorded	As% of all cows in milk
1941-42	305,715	17.4
1942-43	216,076	12.6
1943-44	223,652	13.6
1944-45	258,808	15.4
1945-46	284,459	17.1
1946-47	318,652	19.2
1947-48	342,335	20.0
1948-49	365,440	20.8
1949-50	424,004	23.3

(Extracted from N. Z. Dairy Board, 1950)

In the years immediately following World War II many ex-servicemen commenced dairy-farming, and, in general, they wanted their herds recorded. They were helped by the Herd Recording Council's discounts to Returned Servicemen of 50 per cent of the fees in the first year and 40 per cent in

the second year of recording (see p.89). In the 1947-48 season, 1126 members, or more than one-fifth of all recording farmers received the discount (N.Z. Dairy Board,1948). This did not, by any means, account for all the increase in the number of cows recorded, for there was a general demand for more recording and, due to shortage of labour and material, Associations were compelled to refuse many applications for their services. This was in distinct contrast to the period before the War when it had been necessary to canvass for membership. Candy (1949) stated that since it was necessary to apply, and often to wait some time for admission, the service was more keenly appreciated and members tended to make more intelligent use of the recorded information. In addition, the costs of recording have risen steeply, and although the cost in terms of pounds of butterfat has varied very little through the years, the rise in absolute cost would be a deterrent to farmers who did not make good use of recording services. It is interesting to note (see Appendix VI) that recording costs to the farmer have kept closely parallel to butterfat payouts and that in terms of pounds of butterfat, recording is no more expensive at present (1951) than it was during the depression years of 1930-34.

The 1948-49 season marked the tenth year of the Herd Improvement Plan and whilst abnormalities due to the War, and variations due to season, made it impracticable to make comparisons within the ten-year period, Ward (1949) showed that average yearly production per cow for all cows in milk for the decade ending with the 1948-49 season was between thirteen and fourteen pounds of butterfat higher than for the previous decade. Candy (1949) claimed that in view of the great difficulties due to labour shortage and fertiliser rationing experienced during the War period it was unlikely that this increase was due to better feeding, and attributed most of the improvement to breeding. It is impossible to apportion the causes accurately but it is probable that a considerable proportion of the improvement was due to

environmental factors. A comparison of recorded cows in milk one hundred days or more shows that in the same period the improvement was only nine pounds (N.Z. Dairy Board,1950). Further, the increase in production was greater in unrecorded herds where accurate dam selection and culling could not have been practiced. Improvement in these herds must have resulted from the chance selection of a good bull, the purchase of a proven bull, or a rise in the standard of herd nutrition and management. Until high quality herd sires are available in large numbers it is unlikely that there will be any considerable raising of the genetic production level in these herds, and it is probable, therefore, that most of the gains of the past decade were due to improved environment.

The campaign for herd improvement through breeding is still gaining momentum and as more herds are recorded, and more bulls surveyed, gains from this source will become more important. Nevertheless, in most of the Dominion's herds at present, the level of production is such that the most rapid and economical gains can still be made by the adoption of improved herd management methods.

CHAPTER IV

THE RECORDING OF PEDIGREE CATTLE

1. Introduction of Pedigree Recording

In countries where there is a clear distinction between registered and unregistered dairy stock, separate recording schemes for the registered animals have usually been adopted. The United States of America, the Netherlands, Australia and New Zealand are typical examples. In the two former countries the introduction of schemes for the recording of pedigree cows was due to the breed societies, whereas in the latter two it was primarily the work of Government officers (Dairy Cow Testing, 1935).

The recording of pedigree cows first became important in the United States where, in 1884, the "churn test" (see p. 2) was adopted by the American Jersey Cattle Club as a standard for the Jersey breed. It was also used to some extent by other dairy breeds (Anthony, 1942). Anthony (ibid) has stated that the test was essentially of short duration usually lasting a day, two days, or a week. High, and frequently fraudulent records of individual cows were used for publicity by breeders and Breed Societies. The introduction of the Babcock Test in 1890 provided a more accurate measure of fat content, but at first it was employed only to determine fat content of samples collected in tests of short duration. In 1894, the Babcock determination was adopted by the Holstein Friesian Association for an official seven-day test and, later, for a thirty-day test. Such short-term records were then considered an accurate measure of producing ability.

Unfortunately, the craze for record-breaking in many spheres of human activity extended to production records, and no expense was spared in attempting to obtain phenomenal seven-day and thirty-day yields. The publicity

given to recording by the Breed Societies hastened its more widespread adoption, but the era of short-term individual records for breed and herd publicity lasted well into the present century. In the United States it was not until 1925 that a rational herd test based on lactation yields was introduced for pedigree cows (Anthony, 1948).

Origins in New Zealand.

Although the first purebred dairy cattle were landed in New Zealand in 1848 (Philpott, 1937) it was not until the advent of refrigeration and the establishment of an export trade in butter during the 1880's that an impetus was given to specialised dairy farming (ibid). The importation of specialised dairy cattle and the grading up of the predominating dual-purpose Shorthorn stock by means of sires of these dairy breeds gained momentum. An increasing interest in purebred stock was reflected in the publication in 1886 of the "New Zealand Herd Book" for all breeds except the Shorthorn (for which a herd book already existed), and the formation of Breed Societies as follows:- Jersey, 1902; Ayrshire, 1909; Friesian, 1910; and Milking Shorthorn, 1913 (Gilmer, 1939).

In New Zealand, however, the Breed Societies did not display the same interest in production recording as was evident in the United States. There was not the same intense competition between rival dairy breeds, due probably to their numerical weakness and their lack of centralisation. The formation of Breed Societies in New Zealand post-dated that of their American counterparts by about thirty years, and Gilmer (ibid) stated that as late as 1909 purebred Shorthorns, mostly of dual-purpose type, made up 56 per cent of all purebred cattle, Jerseys comprising less than 9 per cent. Average annual registrations of purebred dairy cattle in the five year period 1911-1915 are shown in Table V.

The Table gives an indication that at that time registered stock represented but a small proportion of the

Dominion herd, which numbered 650,000 dairy cows in 1912 (N.Z. Dairy Board,1950).

TABLE V. Average annual registrations by N.Z. Breeders' Associations in the period 1911-15.

Breed	Period	Males	Females
Jersey	1911-15	559	632
Friesian	1911-15	167	279
Ayrshire	1911-15	62	213
Milking Shorthorn	1915	50	362

However, the use of purebred bulls in commercial herds was becoming more widespread, and recording was looked upon by some breeders as a useful advertising medium for their bulls (Jersey Herd Book,1909). Some private recording was practiced in the first decade of this century (see p.4), and herd-testing in grade herds extended rapidly after its introduction in 1909. The short-term official tests in which the recording officer remained on the farm for the duration of the test, and which were so popular in America, were never important in New Zealand. There were two possible reasons for this: first, by the time the Breed Societies were formed, short-term tests were no longer generally accepted as true indicators of long-time producing ability (Singleton,1911); and secondly, at that time, the pioneering nature of farming in New Zealand limited the demand for, and practicability of such a service.

In 1909, however, the Jersey Association did introduce a seven-day official test and in the Jersey Herd Book 1910, a Register of Merit containing the records of eight cows was published. The qualifying standards were twelve pounds of butterfat for cows and ten pounds for heifers for the seven-day test period. The work apparently received little support, for when the Register was published for the last time, in 1914, only forty-three cows had qualified in the five years which had elapsed since the test was inaugurated.

Gilmer (1939) stated that the "pedigree breeders

made their selections on outward appearance, on flow of milk, and on nearness of relationship to much valued individuals", and certainly, there is little evidence of any demand from the breeders for a herd recording system at that time. Similarly, there seems to have been little demand from commercial farmers for bulls with butterfat backing, though with the spread of herd-recording such a demand was anticipated. In 1911, Singleton (1911b) wrote: "The time is not far distant when our most progressive dairymen will, when purchasing a head for their dairy herd, demand not only a pedigree but (also) records...." Indeed, it was estimated that in 1913, less than 5 per cent of all cows were mated to purebred dairy bulls (Singleton, 1913). The indications are, therefore, that the introduction of a pedigree recording system in 1912 was due not to popular demand but to the initiative of the Dairy Division of the Department of Agriculture.

2. The Government Systems, Their Introduction, Methods and Early Progress

(a) The Certificate of Record System (1912).

In view of the anticipated increase in the importance of pedigree cattle in New Zealand and the desirability of fostering the use of purebred bulls, officers of the Dairy Division appreciated the need for an authenticated system of recording. A visit to Denmark in 1908 by the Division's Director, Mr. D. Cuddie, had led to the introduction in 1909 of systematic herd-recording at Dalefield (see p.6), but because of the competitive nature of the pedigree industry a better authenticated system was necessary for the recording of registered purebred cows. Singleton (1911b) described the American official short term and semi-official yearly-tests and recommended the latter to New Zealand breeders as a better indicator of producing ability and persistency. The semi-official tests were so-called because the recording officer was usually present for only one or two days each month.

One of the chief explanations advanced for the low average production of commercial cattle in New Zealand was the short lactation period of many cows (Singleton, 1912), due, probably, to a combination of poor feeding and breeding. It was considered that persistency could be improved by grading up the commercial herds with purebred bulls, and since a 365-day test permitted cows to demonstrate their ability to milk for long periods its adoption was advocated (Singleton, 1916). Philpott (1951) stated that the official attitude at that time was that any measure, such as the recording and publication of high lactation productions for individual cows, which would promote the use of purebred dairy bulls was considered worthwhile. This view was also held by Singleton (1911b) who wrote: "A semi-official record of a cow for one year may be quoted legitimately by breeders when selling any progeny of this cow; and the one season's testing may influence ... the price of... sons and daughters, not to mention... animals whose relationship is farther removed."

Cuddie (1912) reported that details of a recording scheme had been prepared by Singleton, and in June, 1912, these were submitted to the Friesian and Ayrshire Breed Societies. The main points of the proposed scheme were:

1. The Department will assist in the semi-official testing of only such cows as are properly and duly registered in the New Zealand Herd Book of the breed to which they belong.
2. When a breeder desires to have a cow tested for a semi-official record he must intimate his desire to the secretary of his Breeders' Association....
3. Every cow in order to qualify for a semi-official record must drop a calf within fifteen months of the commencement of her test; and no four-year-old or mature cow can be accepted for test unless she has dropped a calf within fifteen months of the commencement of the test.
4. The owner will agree to weigh or cause to be weighed each and every milking of the cow during her lactation period .... Within a week after the end of the month the owner shall forward an ink copy of this record to the Director of Dairy-produce, Wellington ....
5. The inspecting officer of the Department is to have the right at any time to visit the farm on which a cow is under test. He shall take the weights and samples of four consecutive milkings as nearly as possible every month .... The samples of milk will be tested for butterfat by a department officer, and the monthly fat production ... estimated by taking the total weight of milk for the month ... and the

butterfat test of the composite sample of the four milkings.

6. The owner shall at the end of the lactation period or test forward a report of the yearly production of milk taken from the monthly records on a form supplied by the Department and shall make an affidavit before a Justice of the Peace that this is true and correct.
7. The annual production will be obtained by totalling the production ... for each month during one lactation period, and not exceeding twelve months ....
8. The names of heifers and cows which produce up to the minimum ... pounds of butterfat required by their class will be given a semi-official record.

The age classes varied according to breed, but the initial standards for Friesians, for example, were:

Age	lb. Fat
Two years or under at commencement of test	240.5
Three years old at commencement of test	277.0
Four years old at commencement of test	313.5
Five years or over at commencement of test	350.0

The results of cows failing to qualify for certificates were not published. The fee for the service was two pounds per cow (Singleton, 1922).

The scheme was accepted immediately by the Friesian breeders, and, in the same season by the Jersey Association. The Ayrshire, Milking Shorthorn and Red Poll Associations joined in 1913, 1914, and 1920 respectively (Philpott, 1937). The semi-official test became known, about 1915, as the "Certificate of Record" or "C.O.R." test.

The initial response by breeders to the new system was considered very satisfactory, and in the first year forty-eight Friesians and sixty-six Jerseys received Certificates. Cows were entered by sixty-two breeders. Appendix IV shows, however, that little progress was made in the next few years. The shortage of labour during the 1914-18 War was probably one reason for the slow development of the movement. Another factor of some importance was the formation of the Milking Shorthorn Association in 1913, and the publication of their first herd book in 1915. Singleton (1915) reported that this latter event caused a renewed demand for Shorthorn bulls whose progeny were eligible for entry in the herd book,

and some breeders who did not understand the position concluded that the Shorthorn was taking precedence over the specialised dairy breeds. They were disappointed with the demand for their registered dairy breed bulls and some showed their lack of confidence by withdrawing from testing. This was, however, a temporary phase.

An annual summary of results of cows qualifying for certificates was published in the "N. Z. Journal of Agriculture", and considerable publicity was given to the leading producers of the various age-groups for each breed. The average breeder recorded only two or three cows annually and Singleton (1916) stated that few cows were recorded more than once. A single lactation record was considered a satisfactory index of producing ability at that time.

The Dairy Division placed great emphasis on the use of records to discover bulls bred from high producing dams and bulls with high producing daughters. A record was kept of all sires with a least four certificated daughters from different dams. These were known as "C. O. R. Bulls".

As early as 1916 there was criticism of the 365-day testing period, with a 15-month re-calving requirement. It was contended by some breeders that this system bore little relationship to normal New Zealand dairying, where the season lasted nine to ten months, because it created conditions so abnormal that "three calves only were dropped in four years". Singleton (1916) raised the following points in defence of the existing system:-

1. Since less than eight cows in every hundred tested were tested more than once, the suggestion of three calves in four years was merely theoretical.

"2. Instead of throwing cows out of their season for an indefinite number of years every cow tested could be served in sufficient time to ensure that the second calving after the testing season would fall within the period of usual dairy farm practice.

"3. ... a twelve-month milking period gives the persistent

milking strains an opportunity of demonstration."

The issue was continuously debated until, in 1930, a 305-day test was inaugurated.

It was inevitable that the publicity given to high C.O.R. performances of individual cows would attract the attention of overseas buyers. This had been quoted by Cuddie (1912) as one of the merits of the scheme. Thus, at a time when the dairy industry could ill afford to lose good purebred stock Singleton (1916; 1920) reported that a remunerative export trade had been built up.

Following World War I there was a considerable expansion of C.O.R. testing, reaching a peak in 1924 when 933 certificates were issued, a total which has not been exceeded in the 365-day division. This expansion was part of the general rapid development in herd recording occurring at that time, especially in the Department's Association System for grade cattle (see p.6). Some of the C.O.R. testing officers were diverted to Association units and because of the resulting shortage of testers during the period 1919-21 some applications for C.O.R. testing had to be refused. To relieve this position the Dairy Division proposed, and the Breeders' Associations agreed, that the sampling period be reduced from two days to one. Under the new system, which came into force in the 1921-22 season, the testing officer was present for a preliminary milking to check stripping of the cows, accuracy of milk weights, and time of milking. Then, at the subsequent two or three milkings - according to whether the cow was milked twice or three times daily - the officer checked milk weights and took samples. A sample from each milking was tested for butterfat, and the butterfat yield for the day was obtained by totalling the yields of each milking (Singleton, 1922). Under the original rules (see p.57) a composite sample comprising equal quantities from four milkings was taken and each sample was not necessarily in proportion to the weight of milk sampled. The new method was therefore more accurate. The shortened sampling period allowed each officer

to visit more herds, and to some extent reduced the cost of recording (see p.68).

From January, 1920, the rules were amended to allow for the issue of Second Class Certificates for cows which fulfilled the butterfat requirement but failed to drop a calf within 455 days of commencement of the test, provided that "she dropped a mature calf during the period between the 456th and 485th days inclusive after commencement of test" (Singleton, 1919). This was a concession to breeders who wished to use such records for advertising.

After 1924 there was a marked decline in the number of breeders supporting the C.O.R. system, and in the number of cows recorded. In view of the rapid growth of the Group Herd Testing Movement at this time (see Table I, p.11) the lack of interest in semi-official recording shown by the pedigree breeders is difficult to explain. In 1927 less than two hundred breeders, testing an average of about three cows each, supported the C.O.R. system (Singleton, 1928). Their reluctance to test may be explained in part by their not needing to record in order to sell their stock. There was a general demand for registered purebred bulls and breeders were able to sell their stock on pedigree whether they had butterfat backing or not. Gilmer (1939) wrote of this phase: "the long period of phenomenal demand for registered sires ... had encouraged the establishment of numerous small herds of registered stock in which little constructive breeding was attempted and the proportion of inferior bulls bred was high." This was evidenced by the subsequent complaints about pedigree "scrubs" (see p.25), and the growing demand in the "thirties" for bulls with sound butterfat backing. The Dairy Division did not take a strong stand in impressing breeders with the need for recording large numbers of their stock. Singleton (1927) deplored the fall in numbers of cows recorded and the emphasis placed on single record-breaking lactations, but in the same year, when the Official Herd Test (see p.65) was introduced, no attempt was made to make the recording of all

cows in the herd compulsory. Many statements and figures were published which could not help but give the breeders a sense of complacency. Thus, Singleton (1927) made a comparison of the average yields of C.O.R. cows in 1915 and 1926 which showed an increase of over one hundred pounds of butterfat in most classes for the thirteen year period. But in discussing the 1915 season's results the same writer (Singleton 1914) stated "... for the first season's testing many breeders found themselves unprepared .... Of 255 cows entered, 244 were tested, and of these 113 have fully qualified. A number of cows entered commenced their test at an unfavourable period of the year, some commencing even in January. It is obvious that records made under such circumstances do not do the cows justice." Table VI, which included the results for Jerseys and Friesians in 1914 and 1915 demonstrates the misleading nature of a comparison of the 1913 and 1926 results.

TABLE VI. Comparison of production of Jerseys and Friesians gaining first class Certificates of Record in various years.

Class	1913		1914		1915		1926	
	No. of Cows	lbs. Fat	No. of Cows	lbs. Fat	No. of Cows	lbs. Fat	No. of Cows	lbs. Fat
Jerseys								
Two-year	19	325	36	335	39	371	237	412
Three-year	17	380	22	413	21	448	61	491
Four-year	11	392	12	399	14	470	33	527
Mature	20	413	46	471	20	491	81	543
Friesians								
Two-year	13	337	25	401	27	405	54	423
Three-year	14	416	21	458	23	475	17	497
Four-year	4	380	8	441	6	473	11	586
Mature	17	432	24	482	15	491	28	549

Adapted from Singleton, (1916; 1927).

In all cases the 1914 and 1915 results show a considerable advantage over the 1913 figures which would be due chiefly to improved management, feeding and selection of cows to be recorded. The increase in average production, from being well over one hundred pounds between 1913 and 1926 is reduced

to about fifty pounds between 1915 and 1920.

By 1929, however, there were definite signs of a change in thought. Singleton (1929) quoted figures to show that the average production of C. O. R. cows had been stationary for the preceding six years, and later (Singleton, 1929a) commented: "there is room for appreciable extension in testing of these (purebred) animals as it would appear that the number of registered purebreds with authenticated yields represents too small a proportion of the herd-book entries."

Direct pressure for more recording of pedigrees came from the Dominion Group Herd Testing Federation. Following widespread complaints from grade farmers concerning the quality of purebred bulls and the shortage of bulls with butterfat backing, representatives of the herd-testing Federation attended the 1929 Dairy Breeds Federation Conference to stress the need for a more progressive breeding policy, and an improvement in the standard of herd sires ("Dairyfarmer", 1930). As a result, the breeders set up a sub-committee to look into the matter of more testing of pedigree cows, but the results, as reflected by the numbers of cows recorded under the Government systems, were negligible.

In 1930 a 305-day Certificate of Record system was introduced at the request of the Jersey Breeders' Association. This followed a strong trend in favour of this shorter period in the U. S. A. (Singleton, 1930). The new test was expected to find greatest support from small farmer-breeders because the 305-day period conformed more closely to commercial dairy-farm practice. It stipulated a thirteen month calving interval (or fourteen months for a second class certificate) which, unlike the fifteen month interval permitted for the 365-day C. O. R. would enable cows to calve each spring. Fees, and rules of conduct, were the same as for the 365-day system. The qualifying standards for certificates were as follows:-

Age	lb. Fat
Two years or under at commencement of test	250.5
Three years old at commencement of test	287.0
Four years old at commencement of test	323.5
Five years or over at commencement of test	360.0

The initial response to the new division was poor, only seventy-two cows owned by twenty-seven breeders obtaining first class certificates in the first year (Singleton,1931). In the next ten years only about seven hundred cows qualified (see Appendix III). It is likely that many breeders continued to support the 365-day test because the longer lactation period made the records of their cows more impressive than the corresponding figures for 305-day lactations. Probably, buyers paid little attention to lactation length, and some breeders who would have supported the 305-day test because of its closer adaptation to seasonal dairying, were forced, for economic reasons, to remain in the 365-day division.

In the same season (1930) the butterfat standards for the 365-day division were raised. This followed much discussion as to whether or not standards should be eliminated altogether. It was argued that the records on the certificate should speak for themselves but it was finally decided, however, to raise the standards so that the following applied:-

Age	lb. Fat
Two years or under at commencement of test	275.5
Three years old at commencement of test	312.0
Four years old at commencement of test	345.5
Five years or over at commencement of test	385.0

(Singleton,1930)

Another change, about this time, was the

introduction, in 1933, of a 3rd Class Certificate of Record "for those cows which qualified for First or Second Class Certificate of Record in all respects save subsequent calving" (Singleton, 1933). From 1936, however, only two classes were issued, First Class for cows fulfilling all requirements, and Second Class for cows failing only on the calving requirement (N. Z. Dairy Breeds Federation, 1936). Since 1936 there has been no change in the C. O. R. system.

(b) The Government Official Herd Test.

In 1927 an Official Herd Test (O. H. T.), designed for use in herds where at least one cow was already under C. O. R. test, was introduced by the Dairy Division. It was stated (Singleton, 1927a) that the main purpose was to help breeders "... to ascertain what cows are worth the care and expense of a C. O. R. test". Whilst the new test was meant primarily for pedigree cows, breeders with grade cattle in their herds could, under certain conditions, have their grades recorded under the O. H. T. system.

The name of the system was later (1933) changed to "Government Official Herd Test" (G. O. H. T.) chiefly to avoid confusion with other systems, particularly the "Ordinary Herd Test" as the Association Own Sample system was sometimes called (Singleton, 1933a). However, the abbreviation "O. H. T." has continued in common usage.

In the early years of Government recording the testing of selected animals by the C. O. R. system had been considered to supply ample information to breeders. Purebred cattle were believed to be superior to grade and crossbred animals, and the chief need was a system which would draw attention to the best of the purebreds (see p. 57). However, during the 1920's, the need for a herd-test for purebred herds became apparent, and since the C. O. R. system was too expensive for this purpose the O. H. T. was introduced. However, since it was not made compulsory to record the whole herd, much of the potential value of the new system was lost.

The C. O. R. system already provided for the recording of selected animals; another such system could give little added advantage. Philpott (1951) stated that it is probable that many new pedigree breeders, then supporting the Group Herd Test would have commenced semi-official testing if a true herd-test had been provided. But since they wished to record their whole herds and were not prepared to compete in Certificate of Record and Official Herd Test with breeders who recorded only a few specially selected individuals, they continued to support the Group Herd Test. The numerical strength of breeders using the Government systems, therefore, remained practically unchanged by the introduction of the Official Herd Test (see Appendix III).

The method of recording was as follows:- Sampling, weighing, and testing were carried out during the normal monthly visit of the C. O. R. testing officer. At the first milking during his visit the officer checked the milking time and efficiency of stripping. At the remaining milkings of the twenty-four hour period he took weights and samples. The owner took no milk weights. Monthly butterfat yield was calculated from the weights and samples taken by the testing officer. The testing period was 305 days. Where no cows were entered under the C. O. R. system, registered cows could be tested under O. H. T. after payment of the C. O. R. entry fee (8 guineas in 1927). The fee for O. H. T. at that time was five shillings per cow (Singleton, 1927a)

3. The Government Systems since 1927.

(a) Development.

The development of the two Government herd tests can be followed from Appendix III. In the first season that the O. H. T. operated (1927-28), 1550 cows were recorded and Singleton (1928) concluded that since in 1928 an average of 3.2 cows per testing member was recorded under C. O. R. as compared with 3.4 the previous year, the Official Herd Test had not adversely affected entries for C. O. R. The

number of cows under O.H.T. rose quickly to about two thousand in the 1928-29 season, but the total number of cows recorded annually by the Government systems consistently remained below three thousand until 1939. This represented a small proportion of the Dominion's registered purebred cows, which, in 1928, totalled 29,000 (N.Z. Official Year Book,1930). Many cows were recorded only once, so the number of living cows with semi-official records would be higher than the above. In addition, a considerable, but unknown number of pedigree cows was recorded under the Group Herd Test. The total number of recorded purebred cows was, however, insufficient to supply the industry with bulls having satisfactory butterfat backing (see Table VII p.77).

It is noticeable that there was no decline in numbers of cows recorded during the economic depression of 1930-34. Possibly, the increasing insistence of commercial farmers on butterfat backing for their bu ls, and the increasing propaganda for sire survey made continued recording advisable, despite financial stringency. Increasing efforts were made to popularise recording in pedigree herds. In 1933 Singleton (1933a) urged breeders who entered cows for C.O.R. to place the remainder of their sound cows under O.H.T. In 1934 the Dairy Industry Commission recommended, without success, that the sale of purebred bulls without butterfat backing be prevented (Report of Dairy Industry Commission, 1934), and f rom 1936 onwards the Herd Recording Council made strenuous endeavours to have more pedigree cows recorded as part of their plan to provide an improvement in the standard of herd sires (N.Z. Dairy Board,1939). However, it was not until the 1939-40 season that a definite upward trend in the number of cows recorded began. It was first apparent in the numbers recorded under the O.H.T. and the 305-day C.O.R. systems. The 305-day C.O.R. division received little support during the first decade after its introduction but from 1941 onwards it gained considerably in popularity.

Despite acute shortages of farm labour, the

increasing demand for recording was maintained throughout World War II and during the post-war years. The Dairy Division experienced great difficulty in obtaining sufficient staff to handle the increasing numbers, and some requests for O.H.T. and C.O.R. services had to be refused. In 1945 a rule was introduced making it compulsory for breeders with one or more cows under C.O.R. to record the remainder of their herd under O.H.T. ("N.Z. Dairy Exporter",1944). In registered purebred herds where no cows were entered for C.O.R., O.H.T. services could be obtained only if the whole herd was recorded and the normal C.O.R. entry fee of eight guineas paid. However, the Dairy Division was unable to obtain the necessary staff to record the additional cows and the "all cow" rule was not enforced except in herds where no cows were entered for C.O.R. In an attempt to facilitate the service, O.H.T. clerical work was decentralised after the war, four district Departmental offices being equipped for the purpose. All C.O.R. returns continued to be handled by the Wellington office. The magnitude of the increase in demand for recording can be gauged from the fact that in 1939 less than 3,000 cows owned by 238 breeders, were recorded by Government systems, whilst in 1950, over 21,000 cows owned by 785 breeders were recorded. The inability of the Dairy Division to provide an adequate service under these conditions was an important reason for pedigree testing being placed under the control of the New Zealand Dairy Board in 1951 (see p.85).

(b) Costs.

Singleton (1922) stated that when the Certificate of Record system was introduced in 1912 the testing fee was two pounds per cow. This was raised soon afterwards to three guineas but a considerable Government subsidy was necessary to support the scheme. A further increase to five guineas was made in 1921 to defray increasing costs, but due to the fact that most breeders recorded only one or two cows the expenses were very high. Singleton (ibid)

reported that in an effort to induce each breeder to submit more cows to C.O.R. test the scale of fees was readjusted in April, 1922, the fee being ten guineas for the first cow entered and three guineas for each subsequent entry. The change was partially effective and, in 1925, the initial fee was reduced to eight guineas. However, in 1927 the average breeder recorded only 3.4 cows and the Department of Agriculture contributed about two-thirds of the costs of Certificate of Record testing (Singleton, 1927).

The Report of the Dairy Industry Commission (1934) drew attention to the high cost of Government recording. In the 1933-34 season the recording of about 3,000 cows cost £6,900, of which the Government provided over £2,300. In the same season, the Government subsidy for the recording of 300,000 cows by Group Herd Test was £5,000.

Despite Government assistance, the breeders' recording costs, especially for C.O.R., were high. However, liberal subsidies were given by some Breed Societies (see p. 74) to encourage C.O.R. testing. The Official Herd Test, on the other hand, at five shillings per cow, was comparable in cost with the Group Herd Test. There were a number of reasons why semi-official testing was costly to operate, of which the main ones were:

1. Few cows were recorded in each herd, but regardless of the number, the recording officer was present for a twenty-four hour period.
2. Recording officers did not receive free lodging.
3. Breeders' farms were scattered, involving high transport costs.
4. The detailed checking of C.O.R. milk weights and general authentication of records entailed high clerical costs.

During the last decade, rising costs of pedigree recording have not been matched by higher fees. In 1949 the O.H.T. fee was raised to ten shillings per cow and the initial C.O.R. fee to ten guineas, but in recent years most

of the added cost of these services has been borne by the Government. Thus in the 1949-50 season total costs were £48,000; approximately £18,000 was collected in fees, and the Government provided the remaining £30,000 (Fawcett,1951). This represented a subsidy of over thirty shillings per cow, whereas Government assistance to the Group Herd Test movement in the same season was £20,000, which supported, in part, investigational work of benefit to the whole industry. The unreasonably high cost of operation of semi-official testing was a major reason for its abandonment in 1951 (ibid).

(c) The Publication and Interpretation of Results.

It is impossible to judge accurately from C.O.R. and O.H.T. results, the trend of production of pedigree cows. Quite apart from the fact that through the years only a small proportion of all registered cows has been recorded under these systems, the method of publication of results has, in general, been such as to give little accurate information on production trends.

A comparison which has been made frequently is that between the average of cows gaining first class Certificates of Record, in different years. It has been tacitly assumed that such a sample reflects the production trends of all pedigree cows. Even if such an assumption were admissible the comparisons between different years have been biassed. Thus Singleton (1939) in his annual summary of herd recording favourably compared the average yield of cows qualifying for first class certificates (365-day) in 1937 and 1938 with the corresponding figures for 1923. Such a comparison could be criticized for four reasons:

1. It made no allowance for seasonal differences and improvement in farm management practices.
2. It disregarded the fact that the qualifying standards for C.O.R. were raised by thirty-five pounds, as from 1930, thus changing the basis of comparison.
3. The introduction, in 1927, of the Official Herd Test

"to ascertain what cows are worth the care and expense of a C. O. R. test" would have, presumably, some effect on the average production of cows gaining Certificates of Record thereafter.

4. In an increasing pedigree population the recorded sample remained approximately the same size and would, therefore, be more highly selected.

Appendix IV shows the average production of Jersey and Friesian cows which have received 1st Class C. O. R. 's and in studying the production trends it is necessary to consider the above four points. The figures show a considerable increase in production through the years, due to improved feeding and management, more careful selection of cows entered for C. O. R. test, and improvement in genetic worth, but it is impossible to assess the relative importance of these factors.

Details of the average production of cows under Official Herd Test have not been published by the Dairy Division since the 1938-39 season. Full details have been issued to the individual Breeders' Associations but these latter do not publish details of records below a certain standard. For example, the Friesian Association does not publish O. H. T. records of mature cows below 360 lbs. of butterfat. Thus, not only are cows selected for recording, but only selected records are published. Average production figures from these sources are therefore of limited usefulness. In the use of production records as an aid to selecting stock the poor records are at least as important as the high ones and their suppression for reasons of breed prestige is to be deplored.

4. The Breed Societies and Herd Recording

Since the introduction of systematic herd recording in New Zealand, official policy has encouraged the use of registered purebred sires in commercial herds.

The rate of improvement through breeding of the national herd has been influenced considerably by the margin of superiority of registered purebreds over the grade cattle. The objects of the N.Z. Dairy Breeds Federation (formed in 1926) include promotion of the interests of the dairy industry through " ... the use of purebred bulls and the elimination of scrub bulls" and " ... methods of estimating and increasing the productive capacity of dairy cattle" ("The Land of Efficiency", 1926). The Breed Societies have been vitally concerned therefore with production recording. When semi-official testing was instituted by the Dairy Division in 1912, the Breed Societies were given a prominent role in its administration. Entries had to be made through the appropriate society and the utilisation of records for herd improvement and propaganda was left to the breeders' organisations. But whereas in some countries, for example the United States, the Breed Societies have taken the lead in organising pedigree recording, in New Zealand the breeders' organisations have followed the lead of the Dairy Division, and in some cases progressive changes have had to be made despite them. Nevertheless the New Zealand Breed Societies have devoted considerable energy and expense to furthering various phases of herd improvement through production recording.

By 1914 the Friesian, Jersey, Ayrshire and Milking Shorthorn Associations were supporting the Certificate of Record system. In 1914 the Jersey Association included in its Herd Book a Register of Merit for C.O.R. cows, and in 1925 a separate publication, the Advanced Register of Merit, the first of which incorporated all results to that date, was produced. The Advanced Register of Merit has since been published annually. The Friesian Association has issued an annual "Production Record" which was first produced as a consolidated edition in 1927.

The Advanced Register of Merit (1925) contained the names of eight Champion Butterfat Bulls (C.B.B.) a title

given to Jersey bulls having five or more daughters, from different dams, which produced at least double the amount of butterfat required to win a first class Certificate of Record. An official lead in recording the names of bulls with tested progeny had been given by the introduction, in 1913, of the Dairy Division's "C.O.R. bull" class (see p. 59). Whilst the classifications were of some value in drawing attention to the use of butterfat records in the selection of sires, they had shortcomings as measures of a sire's worth for several reasons. The number of daughters required was small, and only one record of each was required. Only the best daughters were considered, no account being taken of the production records of the remaining tested daughters. The corresponding Friesian classification (Production Record, 1927) had the merit that the records of all daughters tested under C.O.R. were included regardless of production, but since only the most promising animals were entered for C.O.R. the sire register could not be regarded as providing an adequate progeny test. However, with minor modifications, such sire classifications have been a constant feature of Breed Society production registers. Despite their shortcomings they have served a useful purpose in stressing the importance of progeny testing.

In the early years of semi-official testing, the Breed Societies did much to popularise its adoption by breeders but, in general, they encouraged the making of a few high individual records which would give favourable publicity to their breed, thus increasing stock sales and exports. Little was known of the heritability of productive characters, and a single high record of one individual frequently was used to advertise, as potential high producers, all that individual's relatives. Since 1915 the Jersey Association has awarded Gold, Silver and Bronze Medals to the three highest producers in each C.O.R. age-group, and other breeds have similar awards. In addition, numerous

cash awards have been made for unusually high records. In 1917 the Friesian Association gave five pounds for any cow producing more than double her C.O.R. standard, and in 1916 twenty-five guineas was given by the Jersey Association for the first Jersey producing over 850 pounds of butterfat. More recently liberal subsidies have been given for C.O.R. testing. From 1934 to 1945 the Friesian Association paid five guineas of the entry fee for the first cow entered for C.O.R., and the Jersey breeders have been similarly subsidised for many years (N.Z. Jersey Cattle Breeders' Association Minutes; N.Z. Friesian Association Minutes). Insofar as they encouraged breeders to record, these various measures were commendable. Particularly was this so in the early days of semi-official recording when single records were accepted as a sound index of productive ability, and were of value in drawing attention to the merits of pedigree animals. Similarly, the classification of bulls on the production of selected daughters was an attempt to progeny test in the light of the knowledge at that time. These attempts to encourage the recording of individual cows and to progeny test sires were progressive measures when they were adopted more than thirty years ago. But the Breed Societies have persisted with the same measures practically to the present day, despite the knowledge which has accumulated in the last twenty years on the need for continuous herd recording, and the adequate progeny testing of bulls on the production of all recorded daughters. With the exception of the Friesian Association, which has for the past decade accepted Special Pedigree Group Test records for certain purposes (see p. 45), the Breed Societies have recognised only semi-official records for their various production registers, and until 1946 the recording of selected cows was permitted by both Government systems. Prior to 1944, when the Jersey Association suggested the introduction of the "all-cow" rule for O.H.T. recording ("N.Z. Dairy Exporter", 1944) the Breed Societies gave no indication of their being aware of the need

for true herd testing in pedigree herds.

The preservation of dairy type has been an important function of Breed Societies in New Zealand. Dairy type standards were originally set in the show-ring but in the past relatively few animals have been exhibited. To supplement this function of the show-ring, type classification schemes were introduced in which qualified classifiers, appointed by their Breed Society, visit breeders' herds and rate individual animals according to their type. The first such scheme was introduced by the Jersey Association in 1928, the Friesian Association adopting a similar plan in 1938. The Jersey Association's scheme was originally on an entirely voluntary basis, but from 1946 it was made compulsory for breeders who classify, to submit all mature cows not already classified (Ward et al, 1948). Since 1950, breeders requiring the classification service have had to submit all animals in milk over the age of one year nine months, those under three years nine months being provisionally classified and then officially classified as mature cows ("N. Z. Dairy Exporter", 1951b). As from 1st July, 1952, no bulls from unclassified dams will be accepted for entry in the herd book (ibid), which will make classification virtually compulsory for all breeders.

It is apparent that the increasing adoption of herd recording by breeders has not lessened the attention being paid to type. It is yet too early for an assessment of the effect of type classification schemes on production. Ward et al (1948) have shown that whilst there is an association between Jersey type ratings and production, the overlap in productive ability between the various classifications is such that "type by itself cannot be used as a reliable guide to producing qualities." Overseas work confirms this conclusion. Thus, Tyler and Hyatt (1949) found that the relationship between the type rating of a cow and:

1. her first butterfat record,
2. the butterfat record begun nearest the date of classification,

3. the average of all her butterfat records, was low. Since present evidence indicates that the repeatability of type ratings based on single observations is low (Johnson and Lush, 1942), the relationship between type and production is improved considerably by averaging successive type ratings. The Jersey Association's scheme, however, is based on a single (the highest) classification and there is a distinct danger that undue emphasis on selection for type on such a basis may so weaken selection for high lifetime production as to retard the work of production improvement.

Summarising, it can be said that whilst the Breed Societies have given steady support to semi-official recording, they have usually been content to follow the rather conservative leadership of the Dairy Division. Their policy has frequently shown more concern for the immediate benefit of their members than for the general good of the industry, this being exemplified particularly by their resistance to the recording of all cows in the herd. Great emphasis has been placed on a few selected, authenticated records which have been used, along with type classifications, for purposes of publicity. In the past the Breed Societies have performed a valuable service by recording details of pedigree, publishing herd books, and fostering the use of purebred bulls. In the future their greatest duty is to ensure that their members continuously produce sires capable of raising production in the Dominion's commercial herds.

5. Pedigrees under Group Herd Test

There is a paucity of information on the recording of pedigree cows by Group Herd Test, for until recently no separate statistics were available. During the 1920's, however, many grade farmers who recorded under Group Herd Test commenced stud breeding and by 1934 it was estimated (Report of Dairy Industry Commission, 1934) that over 10,000 registered cows were "Group tested" annually. In 1935-36, the first season for which definite figures are available, 12,854 cows in 1,053

herds were so recorded. Table VII, giving the statistics in the seasons for which they are available, clearly shows the great expansion of pedigree recording under the G.H.T. system.

TABLE VII. The numbers of registered purebred cows under Group Herd Test annually (Combined statistics for C.O.R. and O.H.T. systems in parenthesis).

Season	Number of Cows Recorded		Herds	
1933-34	10,000	(3,065)		(248)
1935-36	12,854	(2,521)	1,053	(237)
1937-38	14,696	(2,842)	1,097	(260)
1942-43	17,960	(3,131)	1,133	(285)
1946-47	28,399	(9,725)	1,983	(597)
1947-48	32,580	(11,393)	2,181	(659)
1948-49	34,961	(14,753)	2,251	(714)
1949-50	41,114	(18,631)	2,591	(753)

- N.Z. Dairy Board, unpublished material.

In view of the strong support given to Group Herd Testing by so many breeders, it is difficult at first to understand the past opposition of the Breed Societies, particularly the Jersey Society, to this system. Certainly more adequate authentication was necessary to make the Group Herd Test a reliable test for stud cows, and in 1936 the Herd Recording Council had indicated its willingness to evolve a satisfactory "pedigree group test" (Hume, 1936b) to replace the Government Official Herd Test. But the greatest objection of many breeders to the "Group" system lay in the fact that it was insisted that every cow in the herd be recorded (Hume, 1934). In general, the most influential members of the Breed Societies were long-established breeders who supported C.O.R. testing, and had built up a lucrative source of income based on appearance and a few selected records. Thus, Hume (1946), in discussing this subject stated, " ... the destiny of our Dairy Industry is really in the hands of less than 300 breeders - for that number provides practically all the pedigree bulls which go into the industry. The majority of these breeders are not Group supporters."

Many of these breeders resisted any scheme which

would permit the compilation of a herd average. However the rapid increase in popularity of the Official Herd Test accompanied by a decline in O. P. R. entries in recent years probably indicates a changing viewpoint amongst pedigree breeders. The number of cows tested by each breeder under the Government systems approximately doubled in the period 1944-1950 (see Appendix V).

In 1941 the Friesian Association agreed to refuse transfer of bulls lacking a defined minimum of butterfat backing, and in order to provide better authenticated Group Herd Test records for registered Friesians, the Herd Recording Council introduced, in September, 1941, a Special Pedigree Group Test. This provided for at least one check test per season, which consisted of the testing officer remaining on the farm for two further milkings immediately after the normal visit. When the Friesian Association introduced an Advanced Registry scheme in 1944, records made under the above test were accepted. Further, the Jersey Association has, for some years, accepted records made under Special Pedigree Group Test in fulfilment of the entrance requirements for the Jersey Oaks competition ("N. Z. Dairy Exporter", 1949). In general, however, the Breed Societies have refused to accept Group Herd Test records for official purposes on the grounds of insufficient authentication.

Although the number of pedigree cows recorded under Group Herd Test has been relatively large, a high proportion of them have been in herds containing both pedigree and grade cattle, where stud breeding was probably secondary to butterfat production. During 1942-43, in 1,133 herds from which pedigree cows were "Group" tested, there were, in addition to the 17,960 registered purebreds, 57,456 grade cows (N. Z. Dairy Board, 1943a). It is clear that pedigree breeders supporting the Group Herd Test have not exerted an influence on the Breed Societies proportionate to their numerical strength.

6. Accuracy of the Various Methods

All methods of herd recording used in New Zealand

were dependent upon periodic samplings, and were, therefore, only estimates of actual production. The C.O.R. estimate was obtained from daily (actual) milk weights and monthly sampling for butterfat percentage; O.H.T. results were calculated from a monthly butterfat test and monthly milk weights obtained from two milkings preceded by a check milking; G.H.T. estimates depended on monthly (two milking) milk weights and butterfat samplings. It might have been expected that these three systems would have given widely divergent results, but Campbell (1946) found close agreement between them.

Comparing actual production from 148 lactations with results obtained by normal Group Herd Test methods, Campbell found that a substantial proportion of the error in the latter was associated with fat percentage. Most of the error in fat percentage was associated with testing at monthly intervals only. All three systems, therefore, had the common weakness that they depended on a monthly butterfat test. The error associated with monthly, as compared with actual milk weights was not nearly so important. A comparison of actual production and production figures (fat yield) obtained in fifty lactations by C.O.R., O.H.T., and G.H.T. methods, gave average percentage errors of 3.94, 4.62 and 4.64 respectively. The corresponding figures for percentage of cases within ± 5 per cent of the actual yield were 68 per cent (C.O.R.), 64 per cent (O.H.T.). and 64 per cent (G.H.T.). Although the range of errorw as a little greater for G.H.T. and O.H.T. the concentration of cases within ± 5 per cent of the true result was not widely different (Campbell, 1946).

It appears, therefore, that the great emphasis placed on the accuracy of milk weights for C.O.R. testing was not highly effective in increasing the accuracy of the estimate of butterfat yield because of the considerable error involved in testing fat percentage at monthly intervals. It should be emphasised, however, that the above results were obtained under conditions where no attempt was made to deceive the recording officer or otherwise falsify the results. Under

practical conditions, where considerable incentive for dishonesty may exist the Government systems offered greater prospects for authenticity. Particularly did this apply to the C.O.R. system in which the recording officer's milk weight returns were used as a check against the owner's daily milk weights, detailed graphs being plotted where necessary. The O.H.T. three-milking visit, and the Special Pedigree Group Test four-milking check tests, served the same purpose in a manner less efficient, but more practicable on a large scale. A weakness of the Group Herd Test lay in the fact that there was no limit to the number of cows per herd which one testing officer must record. The demands of weighing and sampling the milk from up to two hundred cows per milking would leave an officer little time to supervise the milking process.

However, in grade herds, where the sale of stock is not an important source of revenue, the incentive to falsify records is not as great as in pedigree herds. Further, where great publicity value was conferred on single lactation records of selected cows, elaborate precautions to ensure authenticity may have been justified.

With selective testing discarded, however, and replaced by true herd recording (see p.87) in which the emphasis is on lifetime productions and herd averages, the need for expensive authentication measures should no longer be of such importance as in the past.

7. Summary

Prior to 1920 the number of purebred cows recorded each year was so small that recording cannot be regarded as having played an important part in the improvement of pedigree herds. In 1918 there were eight thousand registered cows of milking age (N.Z. Official Year Book, 1918), and at that time only about two hundred cows per annum were obtaining Certificates of Record (Philpott, 1937). Breeders were genuinely of the opinion that a single record provided an adequate measure of producing ability, and the high cost of

C. O. R. testing did little to encourage the recording of large numbers of cows. The few records obtained in each stud may have had some influence on the selection of bulls, but their primary purpose was to expedite the sale of registered stock. The superiority of the registered purebred over the grade stock was unquestioned.

There is little specific information concerning pedigree recording, other than Official Testing, in the decade 1920-1930. Doubtless many purebred cows were recorded under Group Herd Test, but statistics are not available to indicate the popularity of the Group system with pedigree breeders. The number of cows recorded by the C. O. R. system remained small, and the Official Herd Test, introduced in 1927, received only limited support. Throughout this period the number of registered purebreds increased steadily (see Table VIII) and little selection among potential pedigree replacement heifers could have been practiced.

TABLE VIII. Numbers of registered purebred dairy cattle during the period 1918-28 (Includes beef Shorthorns).

Year	Cows and Heifers Two years and over	Dairy Cattle Total Registered
1918	7,999	16,825
1921	14,221	28,989
1924	20,587	48,943
1928	29,128	62,684

N. Z. Official Year Books.

Numbers of inferior pedigree bulls were supplied to commercial farmers who supported Group Herd Testing and the shortcomings of such animals became increasingly apparent in those herds which were continuously recorded. Opinions were voiced that the high grade stocks were improving more rapidly than the purebreds, although little statistical evidence was available (see p. 25).

In the "thirties" Government recording remained static whilst the number of pedigrees under Group Herd Test increased steadily (see Table VII, p. 77). Dissatisfaction

with the general standard of purebred herd sires received some factual support from the investigations of Ward (1936) (see p166). Ward's report threw some doubt on the superiority of pedigrees over recorded grades but it was insufficient to convince the influential breeders, most of whom supported the C.O.R. and O.H.T. systems. The number of cows continuously recorded in the herds of many of these breeders was so small as to give a poor basis for a constructive breeding policy aiming at high levels of production (see Appendix III). In these herds the emphasis on breed type probably reduced the intensity of selection for production. The unsatisfactory situation was reflected by the early sire surveys which indicated the need for a rapid improvement in the standard of herd sires provided by the stud breeders (N.Z. Dairy Board, 1943).

In the last decade the records of pedigree animals have become a greater force in shaping the policy of breeders. All systems have undergone rapid expansion, until, in 1950, approximately 60,000 registered purebreds were recorded (see Table VII, p77). The latest figures (Monthly Abstract of Statistics, 1951) indicated that the pedigree population has also increased markedly, there being approximately 70,000 registered cows of milking age in January, 1951. It is apparent, therefore, that a high proportion of all pedigree cows is now recorded annually. The number of cows recorded per breeder by the Government systems has also increased rapidly in recent years (see Appendix V) indicating a departure from selective recording. The action of the Friesian Association (1941) in refusing to transfer pedigree bulls lacking satisfactory butterfat backing, represented an important step forward in the use of recording for breed improvement, but unfortunately other Breed Societies have not as yet enforced similar legislation.

In view of the incomplete nature of the records it is impossible to follow accurately the trend of production of New Zealand's purebred stock. Only a small number of selected cows have been recorded under the C.O.R. and O.H.T.

systems and until recently no separate statistics were available on pedigrees under Group Herd Test. Whilst improvement has undoubtedly occurred, it is not possible to gauge its magnitude nor to compare the improvement with that made in grade herds. Recent N.Z. Dairy Board (1951) figures indicate, however, that the pedigrees under G.H.T. in the 1949-50 season produced an average of seventeen lbs. of butterfat more than recorded grades (see Table IX).

TABLE IX. Analysis of breed production figures for Pedigree and Grade cows under Group Herd Test 1949-50.

	Pedigree.			Grade		
Breed	Number	lb. Fat	Days	Number	lb. Fat	Days
Ayrshire	5,853	272	245	4,807	265	236
Friesian	3,298	304	256	12,993	287	242
Jersey	24,845	255	260	217,778	272	238
Shorthorn	3,014	256	236	7,784	247	225
Total	36,310	289	249	243,392	272	238

N. Z. Dairy Board, (1951) unpublished.

In 1943 the Herd Recording Council concluded that recorded grade cattle approximated the same level of production as the Dominion's pedigree bull-breeding herds (N. Z. Dairy Board, 1943), but the more recent figures may indicate that there is still a margin of production in favour of the registered purebreds, at least in herds recorded under Group Herd Test. However, Table IX shows that the pedigrees in these latter herds were in milk, on the average for a longer period than all grade cows. This probably indicates that better environmental conditions existed in herds containing pedigree cows, but no comparison of production or lactation length of pedigrees and grades within the same herds in the 1949-50 season has been made to check this possibility.

No complete evaluation of the effects of herd recording in pedigree herds can be made because in the past, the "all cow" rule has not been enforced in herds recorded by the Government systems. With the placing of all herd-recording under N. Z. Dairy Board control, however, it is expected that

complete records will be obtained for a large proportion of the Dominion's pedigree herd, and a true assessment of the present comparative merit of pedigrees and grades will be possible. The era of the recording of selected cows is at an end. The claim for the superiority of the pedigrees, built on single records of selected cows must now stand the test of production recording of all cows in the herd.

In the past, a great difficulty in assessing the results of herd improvement programmes has been the lack of information on production trends in pedigree herds. However, with pedigree population statistics being collected again (Monthly Abstract of Statistics, 1951) after a lapse of over twenty years, and the probability that a large proportion of the registered purebred cows will be continuously recorded, the effect of current plans for improvement of this section of the national herd may, in the future, be more readily gauged.

CHAPTER V

RECENT DEVELOPMENTS AND CURRENT ORGANISATION

1. The Amalgamation of All Systems

From time to time various attempts have been made to have herd recording placed under unified control. In 1934 the Dairy Industry Commission (Report of the Dairy Industry Commission, 1934) recommended that a Herd Testing Council be set up to administer all systems of testing, but because of the opposition of the Breed Societies to this proposal no action was taken (see p. 30). In 1936 the Herd Recording Council proposed the replacement of the Government Official Herd Test by a "special pedigree group test" (Herd Recording Council, 1936b). This proposal was rejected by the Breed Societies. Later, Hume (1946) criticised the duplication of services provided by the Government and Group Herd Test systems and advocated their amalgamation. Finally, in 1951, unification was effected when the C.O.R. and O.H.T. systems, hitherto administered by the Dairy Division were abandoned, leaving the N.Z. Dairy Board in control of all herd recording. Fawcett (1951) gave four reasons for this development: (i) manpower; (ii) locomotion; (iii) cost; and (iv) inadequate service. With the rapid increase in demand for recording in the post-war years the Dairy Division found increasing difficulty in obtaining sufficient field and clerical staff and motor vehicles to provide a satisfactory service for their widely scattered clientele. At the same time the Group Herd Testing system was providing a satisfactory service to more pedigree breeders than were patronising official testing, and had at its disposal tabulating machinery which greatly reduced the number of clerical workers required. In addition, for many years the Government systems had been heavily subsidized, the Government providing £30,000 of a total cost of £48,000 for the C.O.R. and O.H.T. systems during the 1949-50 season (Fawcett, 1951). This provided for

the recording of 21,000 cows, respresenting a subsidy of almost thirty shillings per cow. In the same season the Government grant to the Group Herd Testing movement - which recorded 400,000 cows including 41,000 pedigrees - was £20,000. Much of this grant was used to finance investigational work which yielded information of value to the industry as a whole.

For these reasons the Minister of Agriculture decided to terminate Government recording, and on 3rd January, 1951, the N.Z. Dairy Board was asked to take control of all herd recording ("N.Z. Dairy Exporter",1951a). The Board agreed and on January 29th a meeting of representatives of the Department of Agriculture, Herd Recording Council and Breed Societies was held, at which preliminary details for the change-over were discussed. It was proposed that a Pedigree Testing Committee be set up on which each Breed Society would be represented, and the suggested date of the change-over was 1st August, 1951. Following an unsuccessful appeal by the Breeds Federation to the Minister of Agriculture for the continuation of Government testing, the decision to abandon the C.O.R. and O.H.T. systems was made finally on 1st March, 1951.

At its meeting on March 2nd, the Herd Recording Council resolved "that as from August, 1951, there shall be two systems of herd recording offered by the Herd Improvement Associations, (a) the ordinary Group Herd Test and (b) an Official Pedigree Test which shall include a minimum of two check tests ...." (Herd Recording Council,1951a). Further, to advise the Council on all matters connected with pedigree testing a Pedigree Testing Committee was set up comprising:

The Chairman of the Herd Recording Council (Chairman).

The Director of Herd Improvement.

The Supervisor of Government Herd Recording.

A Manager representing the Herd Improvement Associations.

A representative of each of the four major Breed Associations.

A representative of the Department of Agriculture.

The Administrative Officer, Herd Recording Department (as Secretary) (ibid).

The breeders were thus given strong representation and have, in fact, more control over the Official Pedigree Test than they had over the C.O.R. and O.H.T. systems.

The Official Pedigree Test was based on the rules of the existing Special Pedigree Group Test (see p.42). In response to the demands of the Breed Associations for better authentication of records, however, the number of check-tests was increased from one to two per season. Further check-tests could be obtained if payment was made for the additional service. In accordance with long-standing Group Test policy all cows in the herd must be recorded.

2. Current Organisation of Herd Recording

The present mechanism of administration of herd recording is shown schematically in Figure 2. The New Zealand Dairy Board, through the licences issued by the Herd Recording Council controls all herd recording activities, the Council being assisted on technical matters by the Standing Advisory Committee, and on pedigree recording by the Pedigree Testing Committee. The six Herd Improvement Associations which carry out the recording are licenced by the Herd Recording Council and operate under the Council's uniform rules. The Associations, which are Incorporated Societies, have direct representation on the Herd Recording Council. Each Herd Improvement Association has a Management Committee, elected jointly by the dairy companies and the herd-testing groups, and levies fees on its members according to the costs of recording. To enable certain information to be collected and supplied to the Dairy Board's Herd Recording Department, the Associations are assisted financially by the Board.

Since the institution of the Herd Improvement Plan in 1939 herd recording has been financed equally by Government and Dairy Board grants (see Appendix VII). In

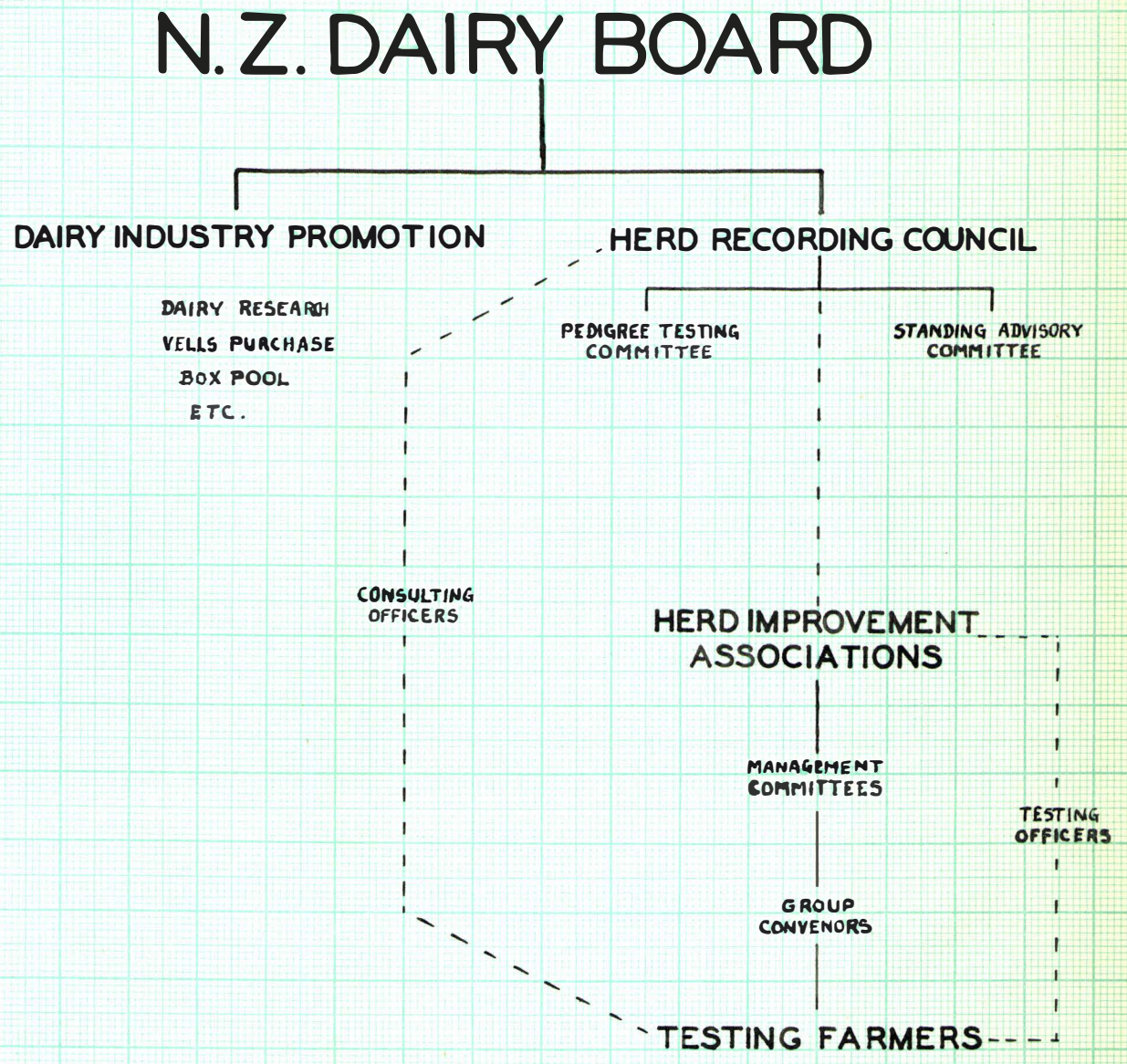

FIG.2. SCHEMATIC REPRESENTATION OF THE ORGANISATION OF HERD RECORDING IN NEW ZEALAND.

addition to financing all investigational work from these grants, the Dairy Board makes various direct contributions towards reducing the cost of recording. These are:

1. The grant towards clerical work made each year since 1939-40 to Herd Improvement Associations. Until the 1947-48 season a payment of ten shillings per herd plus sixpence per cow was made. Since the 1948-49 season five shillings per herd and threepence per cow has been paid (Herd Recording Council, 1948).
2. The grant towards the cost of testing small herds, made to Herd Improvement Associations on the basis of three pounds, ten shillings for herds up to twenty cows, reduced by three shillings for each cow over twenty.
3. The discount for successive testing paid to testing members. This has varied considerably since 1939, the present (1951-52) discount being 5 per cent of testing fees for herds tested successively for at least four seasons (Herd Recording Council, 1951a).
4. The discount to Returned Servicemen, financed by Dairy Board and the Rehabilitation Department. When it was commenced in the 1944-45 season a discount of 50 per cent and 40 per cent of fees in the first two years was given, the rates being reduced in 1950-51 to 33 1/3 per cent and 10 per cent of the first, and second successive year's fees respectively.

Since the installation of tabulating machinery by the Dairy Board in 1949, the Herd Recording Department has been able to assist the Herd Improvement Associations with the preparation of final testing returns. The present mechanism is as follows:- The Herd Improvement Association sends to the Herd Recording Department a mid-season (January) return for all herds under test giving the number, name, breed, age, herd book number (for registered animals) and calving date of each cow. This information is punched on cards - one card for each cow - and the cards filed according to herds. After the end of the season (31st July), the Herd

Recording Department receives a production return for each cow which is then recorded on the appropriate card. The cards for each herd are then sorted into age groups - two-year-olds, three-year-olds, cows between four and nine years, and cows ten years or over - and the figures for each group totalled. These totals are then sent to the Herd Improvement Association where age-class averages and herd averages are computed and entered on the summary page of the final sheet. The season's production record for each cow is automatically tabulated from the card on to a pre-typed sheet, the final copy, as sent to the farmer containing a detailed statement for each cow, a summary of averages for each age group and a "balance of production" section for cows not included in the herd average. Since the 1949-50 season herd averages have been calculated on a lactation instead of a calendar year basis as previously. Under the new rules only those cows calving in the calendar year prior to the year in which the season ends, and in milk more than 100 days, are included (Herd Recording Council,1950). Only the first 305 days of the lactation are included in the average. The preparation of final sheets in this form is possible only through the use of tabulating machinery. This service is provided by the Herd Recording Department in return for herd recording information supplied by the Herd Improvement Associations.

The existing organisation of herd recording, with a central body co-ordinating the work of the Herd Improvement Associations, and virtually only one system of recording, has much to recommend it. The merits of the system are enhanced by the fact that the controlling body, the New Zealand Dairy Board, whilst predominantly a producers' organisation, is adequately endowed with official authority, and securely financed from industry and Government funds. Its statutory authority permits maintenance of the desired degree of uniformity in administration and field methods; its secure financial position makes possible the execution of a vigorous and progressive campaign for herd improvement. The administrative structure,

through the Herd Recording Council, the Pedigree Testing Committee, and the six Herd Improvement Association Management Committees permits of a large degree of producer control and responsibility. At the same time, provision is made, through the Standing Advisory Committee, for the movement to take advantage of the available technical and scientific resources, and in addition the work received a measure of support, both moral and material, from the Government. Thus, possibilities exist for close co-operation between all parties interested in herd recording, and a sound basis exists for future expansion.

PART TWO

SURVEYS AND INVESTIGATIONS FACILITATED BY HERD RECORDING

CHAPTER VI

CLASSIFICATION AND CRITICISM OF SURVEY TYPES

The chief role of surveys is to give definition to current problems and provide the background knowledge for more detailed investigations. Yates (1945) wrote that "survey work is no substitute for experimental research in agriculture or in any other field. Agricultural experimental research and survey work should proceed hand in hand."

In New Zealand, prior to 1936, little or no attempt had been made to define the many problems associated with farm production of milk and butterfat, and consequently these problems had received scant attention from agricultural and veterinary research workers. However, since the New Zealand Dairy Board assumed control of Group Herd Testing in 1936 the herd recording movement has been able to provide the necessary organisation to facilitate the collection of a large and varied quantity of data relating to herd, sire, and calf wastage, dairy cow and calf nutrition, and the effects of various shed and farm management practices on production. This data has provided much useful information for the dairy industry as well as indicating the need for more detailed investigations of certain problems.

Of necessity, most of the surveys have been conducted in recorded herds, and a random sampling of the whole industry has not, therefore, been achieved. However, the data obtained from recorded herds has, in the opinion of the N. Z. Dairy Board, been sufficiently representative to indicate trends within the industry, and the fact that production details have been available for all herds under survey has greatly enhanced the value of the information, for in many cases it has been possible to relate herd conditions, management practice, and district differences to differences in production.

Various survey techniques have been employed by the N. Z. Dairy Board to obtain information, and the types of

survey may be classified as follows:-

Type I. Information provided directly by the farmer:

(a) On forms distributed and collected through the local dairy company.

(b) On forms distributed and collected through the Herd Improvement Association office.

Type II. Information collected by the recording officer:

(a) From his own observations.

(b) From verbal information given by the farmer.

(c) From records entered by the farmer on a form provided; transcribed, or checked and collected by the recording officer.

Type III. Information collected by the consulting officer:

(a) From his own observations.

(b) From verbal information given by the farmer.

(c) From records entered by the farmer on a form provided; transcribed, or checked and collected by the consulting officer.

Type I Surveys (information provided directly by the farmer): The usefulness of these surveys is limited by the fact that many farmers are averse to filling in forms of any kind because of an innate dislike of clerical work and a suspicion of the use to which the information might be put. Usually, the aim in this type of survey is to obtain returns from a large sample of dairy-farmers so that results typical of the whole industry can be presented. To obtain returns from the maximum number of farmers, the questionnaires to be completed must be brief and simple, the information readily available to the farmer, and suited to accurate and concise description. Further, the farmer should be assured that the returns will be treated as confidential and that the knowledge gained will be of value to the industry. The outstanding example of a Type I(a) Survey is the Effective Average Production survey (see p.137) for which each year since 1941, more than 80 per cent of the Dominion's

dairy farmers have furnished returns of the number of cows milked on the night of January 15th. These returns are collected by the dairy companies and forwarded to the N.Z. Dairy Board's offices in Wellington. This survey owes its success to the extreme simplicity of the questionnaire (only one number to be filled in), the publicity given to its importance, and the co-operation of a large proportion of the dairy companies.

Type I(b) Surveys in which the farmer completes and returns to the Herd Improvement Association office a more detailed type of questionnaire is, like all N.Z. Dairy Board surveys except Type I(a), confined to recorded herds. It has been used, in particular, to obtain information on management practices and carrying capacity on the farms of continuously testing members. The great difficulty in a voluntary survey of this type is to persuade sufficient farmers to furnish returns. The most reliable data are obtained when selected farmers, accustomed to keeping accurate farm records, are requested to provide information.

The estimated average superiority of recorded cows over all cows in the Dominion is about fifteen to twenty lbs. of butterfat and the superiority of continuously recorded herds over all recorded herds is approximately twenty lbs. of butterfat (Ward et al,1950). Hence, continuously recorded herds provide a sample averaging approximately thirty-five to forty lbs. of butterfat per year better than all herds in the Dominion. Whilst much valuable information can be obtained from these above-average herds containing approximately 20 per cent of all cows (N.Z. Dairy Board,1950), the problems and management practices pertaining to the remainder of the Dominion's herds are of greater importance from the national viewpoint. However, since these are, in general, not recorded, no convenient mechanism exists for collecting information from them.

Type II Surveys (conducted by testing officers): The employment of testing officers to collect information is convenient since

an officer makes monthly visits to recorded herds and can readily forward additional information along with the monthly testing returns. The chief limitation of the method lies in the calibre of the testing officers. Under New Zealand conditions herd-testing is an occupation for which little training is necessary, and whilst there is a small percentage of officers who regard it as their permanent vocation the majority find other employment after one or two years in the field. Throughout the history of the Group Herd Test Movement the persistent endeavour to minimise the farmers' testing costs has generally resulted in low wages for testing officers. This has made it difficult to retain the best type of worker. Consequently, the average New Zealand testing officer is insufficiently qualified and in many cases not sufficiently interested to make accurate, independent observations or collect detailed information from the farmer. It is interesting, if fruitless, to speculate whether or not it would have been better to make the recording officer's position more attractive in the hope of securing, and training, a type of officer capable of collecting reliable survey information, even though it meant more expensive recording, and probably, fewer cows under test. It is noteworthy that in Denmark the testing officers undergo a minimum of two months training and that besides recording production, they collect data on herd feeding practice (Ward, 1946). Because of the shortcomings of a proportion of the recording officers, Type II(a) Surveys could be expected to yield reliable data only in the case of a few experienced and conscientious individuals, and then only if the observations were objective. These conditions are largely fulfilled in the current investigation on the inheritance of milking temperament (see p. 135).

The accuracy of Type II(b) Surveys depends upon the astuteness of the testing officer in soliciting information from the farmer, the reliability of the farmer's memory, and the care taken by the testing officer in checking the answers

given. Results may be poor if detailed retrospective information is required, especially if, as frequently occurs, the questions are asked during the busy period when milking is in progress. Good results may be obtained, however, by employing selected, reliable testing officers to survey selected farms.

Many of the weaknesses of Type II(b) Surveys are avoided by using a Type II(c) Survey in which the testing officers merely collect and check information recorded by the farmer on forms provided for the purpose. The use of a Shed Sheet to give wastage and mating data is the best known example of this type, and where the farmer keeps the entries up-to-date and carefully follows instructions, reliable data can be obtained provided that gross transcription errors are not made by the recording officer.

Type III Surveys (conducted by consulting officers): When the first N.Z. Dairy Board Consulting Officers were appointed in 1939, it was intended that their function should be primarily advisory, and it was not expected that a large proportion of their time would be spent on investigational work (Riddet, 1951). However, as the Herd Recording Council's investigational programme developed it became obvious that little reliable data concerning certain important problems could be obtained directly from farmers or through testing officers, and the task of conducting surveys was largely given to the consulting officers. These men are carefully selected before appointment, trained to make accurate observations and have the necessary acquaintance with farmers and Herd Improvement Association personnel to enable them to select farms for survey. Also, their appointments are relatively permanent, giving continuity and uniformity in any one district.

Many of the N.Z. Dairy Board surveys, including some involving collection of data by consulting officers, extend over a number of years Where necessary the first year's results can be treated as exploratory so that in

subsequent years co-operating farmers are thoroughly familiar with the type of information required by the consulting officers and take care to keep accurate records. An example is provided by the special mastitis survey in the Canterbury and Manawatu districts (N. Z. Dairy Board, 1945) which extended over the years 1942-1945 inclusive and was based on data collected by methods III(a), (b) and (c). Whilst, in general, increasing the duration of a survey will enhance the reliability of the data obtained, extended surveys have one disadvantage when they are conducted by consulting officers. Any farmer who is co-operating in such a survey is in regular contact with the consulting officer and is receiving information and advice on farm management practices. If the consulting officer is successful in improving the farmer's methods season by season, another unknown variable is added to the conditions under which each year's data is obtained. The importance of this consideration depends on the rapidity with which farm management practice alters and the relationship between management and the factor under study. For example, a rapid annual improvement in herd nutrition would on present evidence (N. Z. Dairy Board, 1945) be expected to have little influence on annual incidence of mastitis but might significantly influence the early wastage of calves if that were under survey (N. Z. Dairy Board, 1949).

In survey work under the aegis of the N. Z. Dairy Board, therefore, there are two main alternatives:

1. To obtain data of doubtful accuracy from a large and relatively representative sample of the national herd by employing testing officers or requesting the farmers concerned to collect the data.
2. Employ experienced field officers to obtain detailed and reliable information from a small and highly selected sample of farms.

Both methods however are subject to the disadvantages mentioned above. The data collected by the first method should be corroborated by random field checks to determine the extent of

the errors involved in data supplied directly by farmers or through testing officers. Because of their greater reliability, surveys conducted by consulting officers have been most commonly employed by the N. Z. Dairy Board. Although data collected in this way cannot be interpreted statistically as being derived from a random sample of herds, the result may be applied, with caution, to indicate general trends within the industry.

CHAPTER VII

SURVEYS CONDUCTED BY NEW ZEALAND DAIRY BOARD

Having systematised the types of survey, it is of interest to study the actual investigations carried out by the New Zealand Dairy Board from the point of view of method of collection and analysis of data, validity of results, and the value of the work to the herd recording movement and the dairy industry. Detailed commentary on the results has not been included since, in general, these have been published in full in the Annual Reports of the N.Z. Dairy Board.

During the first fifteen years the subjects of the investigations have fallen into three main divisions: first, a study of wastage in dairy stock; secondly, surveys of farm and herd management methods; and, thirdly, production surveys based on herd-test records. These sections are discussed in turn.

I. WASTAGE IN DAIRY STOCK

The term "wastage", when applied to dairy stock in New Zealand is interpreted by the Dairy Board to include all stock culled, lost or otherwise disposed of from individual herds. It thus embraces not only deaths and culling through injury and disease, but also animals sold for dairying and losses through culling for low production and old age. Many of the problems caused by high wastage have long been recognised by dairy-farmers, but it is only within the last two decades that efforts have been made to determine the magnitude and relative importance of the various causes of loss. Without this knowledge, purposeful planning to reduce wastage losses was difficult in the extreme. During the 1929-30 season Fawcett (1931) conducted the first extensive investigation into causes of wastage when, with the assistance of the Dominion Group Herd Testing Federation he collected data covering 128,000

recorded cows. The results, from this selected sample of herds, covering only one season, showed total eliminations in the herds studied of 10.3 per cent of all cows " ... a position below that expected in the average herd" (ibid). In Fawcett's data 49 per cent of the wastage was for low production, 13.7 per cent for "mammitis", and 11.5 per cent for "breeding troubles". Fawcett emphasised that considerable loss of production resulted from disease which was not severe enough to warrant culling. This survey, though incomplete, gave the first concrete evidence of the relative importance of the causes of herd wastage.

The Dairy Industry Commission (1934) received evidence that on the basis of a cost of eightpence per pound of butterfat, mastitis, contagious abortion and sterility caused an annual loss of approximately £2,380,000. The Commission recommended that a campaign for tuberculosis eradication be undertaken, to be followed by a general campaign of animal disease control (Report of the Dairy Industry Commission,1934). Meanwhile the Department of Agriculture, with limited facilities at its disposal, was investigating the causes of the various animal diseases, but it was not until after the Dairy Board assumed control of herd recording in 1936 that a concerted attack was made on the problem of dairy cattle wastage.

Following numerous resolutions from farmers' meetings throughout the Dominion, drawing the attention of the authorities to the prevalence of livestock disease, the subject was discussed at all Dairy Board Ward Conferences held in the 1936-37 season and resolutions were passed asking the Board to investigate and, if possible, to improve the position. There is evidence of a general movement to combat animal disease about this time. In 1937 the Government set up an Animal Research Bureau representing the research organisations, the producers and the Government, with jurisdiction over all research on animal diseases (N.Z. Dairy Board,1937). However, this body never became functional. In 1937 the Dairy Board offered to pay

£2,500 per annum for five years towards a wastage investigation, provided the Government gave a two-to-one subsidy (N.Z. Dairy Board,1937b). The Government accepted the proposal, and since the industry had no definite figures on the incidence of disease, the Herd Recording Council (1937b) decided that in the 1937-38 season a complete analysis of all disposals and losses from recorded herds should be made. The material for the survey which was thus inaugurated has been collected each year since, although only analysed for the period 1937-43 and again in 1949-50. The information collected by the Dairy Board has been treated under three main classifications:

1. Herd Wastage.
2. Sire Wastage.
3. Calf Wastage.

1. HERD WASTAGE.

The data for the general survey on herd wastage have been collected from the following sources:-

(i) The winter culling returns which were filled in by the testing officer at the first visit of the season, and included details of all cows culled subsequent to the last visit of the previous season (or, in herds not recorded the previous season, subsequent to May 31st). In most herds these returns would include cows culled in June, July and early August, as well as any cows culled after calving, but before undergoing their first test; for example, cows lost through milk fever or grass staggers.

(ii) Monthly testing returns which contained full details of all cows in the herd and which included the reason for the loss of any cow during the current season (N.Z. Dairy Board,1939a).

This was a combined Type II(b) and (c) Survey (see p.94), special forms known as Shed Sheets being supplied to farmers who were encouraged to record all wastage and mating details for their herds. The testing officer then obtained

his information from these sheets, supplementing it where necessary by verbal enquiry. The data collected by the testing officers was forwarded through the Herd Improvement Association offices to the Herd Recording Department in Wellington where it was analysed. Although the data has been collected each season since 1937-38, analyses were not made for the seasons 1943-44 to 1948-49 inclusive. In analysing the returns only those which were incomplete or obviously incorrect were rejected. Table X shows that effective returns have been obtained from a considerable proportion of all tested herds.

TABLE X. Number of herds submitting effective herd wastage returns as a percentage of all tested herds.

Season	Number herds submitting effective returns	% of all tested herds
1938-39	2177	51
1939-40	2653	64
1940-41	4459	84
1941-42	4424	80
1942-43	2700 *	70 *
1949-50	4591	66

N. Z. Dairy Board Ann. Repts. and Unpub. Data.

* Estimated.

It was emphasised (N. Z. Dairy Board, 1939a) that herds under Group Herd Test represented a section of the industry which was probably slightly better than average so far as incidence of disease and general wastage was concerned. For instance, in many cases it was reasonably certain that herds were withdrawn or withheld from testing on account of serious trouble with mastitis, sterility, or abortion in the early part of the season. Further, the report of the N. Z. Dairy Board (ibid) stated that "no method of collection is likely to ensure 100 per cent efficiency in the collection of wastage for all farms. The tendency, therefore, will inevitably be for such returns as these to understate slightly the incidence of disease in the herds concerned in the collection of such data, partly through incomplete information being

retained by the member in regard to winter culling, and partly due to the fact that the herd sometimes completes testing before the season has been fully completed." This latter point was especially applicable in drought seasons.

However, since the chief purpose of the surveys was to determine the order of importance of the various causes of loss, the data obtained were analysed with a view to giving this information as accurately as possible. In cases where there was more than one cause of culling the farmer was asked to specify the chief cause. Where two factors such as "low production" and "mastitis" were responsible in almost equal degree the animal was included under "mastitis" since it was probable that the disease was a strong contributing cause to the low production. A similar qualification applied when "sterility and abortion" was coupled with "low production" (N.Z. Dairy Board, 1938a).

From the analysis of results (Ward, 1945) the average wastage figures for the seasons 1938-39 to 1942-43 inclusive may be summarised as follows:-

Low Production		5.63 per cent
Disease	(Mastitis 3.72) (Sterility and) (Abortion 2.63)	8.24 " "
Other Causes		2.95 " "
Total		16.82 per cent

Thus "low production" appeared to be the greatest single cause of wastage. Low production is a purely relative term, however, and as a culling point it operates as a buffer for increasing and decreasing herd size. In interpreting the figure obtained, consideration must be given to the numerous environmental factors which may contribute to low production and which may cause a cow to be recorded as "culled for low production" when in reality some other factor such as sub-clinical disease may be the cause of the low level of production.

In addition to the wastage data compiled from the culling returns collected by testing officers, further investigations were made by the N. Z. Dairy Board into specific wastage factors such as mastitis and sterility.

(a) Mastitis.

There have been four main mastitis investigation projects.

(i) The brom-thymol-blue test project 1938-39.

(ii) The large scale field survey 1941-50.

(iii) The detailed field survey conducted by consulting officers in the years 1942-45.

(iv) The penicillin response survey 1948-49.

(i) The brom-thymol-blue test project: In 1938 Dr. Hucker of New York State Agricultural Experimental Station, a prominent mastitis research worker, visited New Zealand and advocated the use of the brom-thymol-blue test as a field measure for detecting mastitis. In February, 1938, the Herd Recording Department and the Department of Agriculture began experiments in four herds to ascertain the efficacy of the test under New Zealand conditions, and the possibility of its widespread use by testing officers on their normal visits. The investigation was rapidly expanded to include 8,450 cows, at which stage it was decided that a service could be given to all testing farmers. The Dairy Board and the Government jointly provided £8,000 to equip all testing officers with the necessary apparatus. It was hoped to give a useful service to the farmer by detecting mastitis, and to obtain reliable data on the incidence of the disease.

The service operated in the 1938-39 season when over 90,000 cows were tested for mastitis, but it was then concluded that the brom-thymol-blue test was not sufficiently reliable to supply accurate detailed data, and while the service remained available to farmers willing to pay for it, the work was abandoned as a major project (N. Z. Dairy Board, 1939).

(ii) The Field-survey 1941-48: This survey came in response to the need to discover what factors were associated with various levels of mastitis incidence. Confirmation was needed for the statement, frequently made, that good herd management practices were associated with lower incidence of the disease. Consequently, in 1941, a Type II Survey was instituted. Testing officers were paid a fee of 2/6d for each herd from which they collected information. Co-operating farmers were provided with forms on which to record all cases of clinical mastitis occurring between visits of the testing officer. At each monthly visit the tester completed his copy of the form from the farmer's copy and from verbal information given by the farmer. Mastitis was defined as precisely as possible and was recorded as "chill" (mild) or "severe" on the milkers' advice. The testing officers taking part were unselected and the information obtained was therefore subject to the inaccuracies discussed under Type II Surveys (see p. 95). The data would represent a minimum incidence of clinical mastitis according to the farmers' interpretation of the term, and probably were sufficiently accurate for comparing incidence according to large groups of cows.

Concurrently with the mastitis survey, the co-operating farmers completed a "Shed Organisation Form" giving details of the type of milking plant, the milking technique, and general shed management. It was then possible to investigate the relationship between mastitis incidence and the various shed practices.

In each of the three seasons (1941-42, 1942-43, 1943-44) for which the data were analysed returns from more than one thousand herds were obtained. Results were published for the following analyses:-

Mastitis incidence according to district (N.Z. Dairy Board, 1943); production level (ibid, 1942; 1944); make of milking machine used (ibid, 1943; 1944); and month in which infection was first detected (ibid, 1943). Mastitis

incidence in non-stripped herds (ibid,1945). Mastitis incidence according to shed practice in renewing inflations (ibid,1944). Mastitis incidence in herds badly affected with sore teats compared with all herds (ibid,1943).

The last-named analysis was the only one which showed a significant positive result. However, the survey provided useful information on mastitis incidence which formed a background for later, more detailed work. Although this survey was continued until 1948, no further analyses were published and in the 1948-49 season the method of collection of information was altered and herds which had provided data for the mastitis investigation were incorporated in the Penicillin Response Survey (see p.109).

(iii) The Detailed Field Survey 1942-45: The purpose of this survey was "to study field conditions associated with clinical mastitis and to investigate particular factors, such as conditions of management in herds showing a high, as compared with a low incidence of mastitis, general differences in feed conditions between such groups, and also any other factors associated either with a high general incidence or a low general incidence of clinical mastitis." (Ward et al,1945). In addition further study was to be given to the inheritance of susceptibility to mastitis.

Two consulting officers, one in the South Island (Canterbury) the other in the Wellington-Hawkes' Bay (Manawatu) area collected data from eighteen and fourteen herds respectively, the former paying special attention to shed hygiene and milking machine conditions, and the latter to herd management practices in relation to nutrition. The farms were selected to give a wide range of soil, pasture, and climatic conditions, and wide variation in shed and farm management practices.

Co-operating farmers were asked to keep full details of all cases of clinical mastitis and to notify the consulting officer immediately a new clinical case was observed.

Clinical mastitis was defined as follows: "all quarters which are abnormal or which are giving abnormal milk. This includes any quarters showing discoloured milk, clots, sediment, or watery milk; also any quarters showing hardness, pain, swelling or other similar abnormal condition" (ibid).

All quarters of all cows were tested by leucocyte count (a microscopic examination indicating degree of infection) at the beginning and toward the end of each season, and usually at several other times during the season. In addition, samples were taken and tested from all freshly reported clinical quarters. This gave information on the degree of sub-clinical infection at any time, and, from the cultured samples taken from clinical quarters the type of infection could be determined. In this way the year-to-year incidence of clinical mastitis was obtained. Herds were grouped into "high", "Average", and "low" incidence groups on the basis of the first year's information, and their subsequent history followed. Using these data, the production records of the herds, and the information collected on shed management practices, the following analyses were made and published in the N.Z. Dairy Board Annual Report by Ward et al (1945):-

1. General incidence of mastitis in each sample of herds.
2. Incidence of staphylococcal and streptococcal mastitis.
3. Clinical quarters before and after December 31st.
4. Incidence of "fresh" cases each month.
5. Incidence of mastitis according to age of cow.
6. Incidence of mastitis according to performance of machines.
7. Comparative incidence of mastitis in stripped and non-stripped herds.
8. Incidence of mastitis according to shed hygiene.

With selected herds and two experienced consulting officers, reliable information was practically assured in this survey. Most of that which could be statistically analysed was included in the above studies. However, the

assessment of "shed hygiene" and "performance of machines" could only be made by a system of gradings, which reduced the possibility of accurate analysis. In any case, the number of herds involved was too small to permit general conclusions to be drawn regarding the incidence of mastitis according to shed hygiene and performance of machines, and the comparative incidence in stripped and non-stripped herds. The survey also provided data for further work on the inheritance of "susceptibility" to mastitis which had been commenced earlier by Ward (1938). Ward's investigation, leading to the conclusion that hereditary factors contribute towards "susceptibility" to mastitis, was further analysed by Lush (1950) who supported the conclusions reached. However, following the success of penicillin in the treatment of mastitis (Filmer,1949), the need for research on this disease declined and further studies on its inheritance have not been made in New Zealand.

In addition to the above quantitative data a considerable volume of information was collected on herd nutrition in the Manawatu herds in an attempt to discover whether feeding practices and mastitis incidence were related. Pertinent facts on soil type, quality and composition of pastures, pasture management, supplementary feed provision, drainage, water supply, changes of diet, and weather conditions were kept. However, since no numerical values could be placed on most of this information, it could not be statistically analysed and all that could be drawn from it was a tentative conclusion by Nielsen (Ward et al,1945) that certain practices were likely to reduce the incidence of mastitis.

(iv) The Penicillin Response Survey 1948-49: With the introduction of penicillin as a field measure for control of mastitis, a survey was planned to investigate the results of different methods of application of this drug. The aims of the survey were:

1. To follow, during the 1948-49 season the mastitis history

of quarters affected with clinical mastitis at any time during the 1947-48 season and treated with penicillin at drying off in 1948.

2. To determine whether treatment at drying off of all quarters of affected cows was more effective than treatment of only the affected quarters.
3. To explore the possibility of reducing the reservoir of infection in a small sample of herds by treating all quarters of every cow at drying off.
4. To compare the subsequent loss of production of treated clinical quarters and untreated clinical quarters.
5. To determine the percentage of cures of treated quarters (Ward, Castle and Lawry, 1949).

About 500 herds were selected from the herds which had been included in the Mastitis Field Survey (1941-48). The testing-officer type of survey (IIc) was abandoned in favour of returns supplied directly by farmers on a special form (Type Ib). The co-operating farmers were accustomed to supplying information concerning mastitis and the forms allowed ample space for comment and description of symptoms. Castle (1951) claims that the design of forms is an important factor in the success of such surveys; in general, farmers and consulting officers prefer to comment at length on their observations, and although returns of that nature take more time to analyse, more accurate interpretation can be achieved than is possible with stereotyped, abbreviated data. Two hundred and seventy-six herds were finally included in the investigation and they were divided as follows into four groups according to treatment with penicillin on drying off:

1. In 73 herds only quarters which had been clinical at any time during the 1947-48 season were treated.
2. In 87 herds all quarters of cows which had a clinical quarter during the 1947-48 season were treated.
3. In 15 herds all quarters of every cow were treated.
4. In 101 herds no cows were treated on drying off but all

clinical quarters were treated during the 1948-49 season. The quality of the information was good, and veterinary advice was obtained, where necessary, on its interpretation (Castle, 1951). In the published results (Ward, Castle and Lawry, 1949) it was admitted that the number of herds in Group 3 was too small to give conclusive results in one season, but for the other treatments an adequate sample was obtained. Briefly, results indicated that despite treatment at drying off, quarters which had previously been affected with clinical mastitis were approximately twice as liable to become clinical during the following season as the other quarters of the cow. There was inconclusive evidence, however, that treatment of all quarters of all cows at drying off gave better results than no treatment at drying off. In comparing the subsequent loss of production from treated (1948-49) and untreated clinical quarters (1947-48) the "between-seasons" effect was eliminated by comparing the differences between the herd average and the average production of affected cows in each season. This affords a good example of the value of the herd average in this type of investigational work.

(b) Sterility and Abortion

In the five seasons 1938-39 to 1942-43 inclusive about 15 per cent of wastage in the herds sampled was due to "sterility and abortion" (N. Z. Dairy Board, 1945). The losses from these two factors were combined because of the difficulty of separating their effects. Secondary infections following abortion play an appreciable part in raising the incidence of "empty" cows.

As in the case of mastitis, the first requirement of research workers in the investigation of sterility problems was reliable information on the incidence of the complaint and its relationship (if any) to such factors as district, age of cows, herd management and production level. To obtain this information the Herd Recording Department

organised the following surveys:-

(i) The farmer survey of 1938-39 and 1939-40.

(ii) The consulting officer survey of 1940-41 to 1943-44 inclusive.

(iii) Data collected with the Calf Wastage and Nutrition Survey 1946-47.

(i) The farmer survey 1938-40 (Type Ib): In the 1938-39 season fifty-seven testing members were selected to provide detailed breeding records on their herds. During 1939-40 data were collected from ninety herds, the complete information on all matings of each cow being recorded in special books. In addition during the second season, the Department of Agriculture made semen examinations on the bulls in use in forty-five of the ninety herds surveyed (N. Z. Dairy Board, 1940).

Since the information the farmers were asked to record was of a type which most keen farmers keep for themselves, it is probable that the data obtained was reasonably complete. The semen-testing of the bulls in forty-five herds made it possible to exclude the effects of sire sterility, although the fact that some of the bulls were examined only once during the season (Blake, 1940) reduced the value of the tests, since the fertility index of a bull could vary considerably within one season (Blake, 1941).

The herds concerned were confined to one district, the Waikato (Ward, 1940), the mating results to two seasons, and the semen-testing to one season. In addition, the number of herds involved was relatively small and herds were, in some cases, chosen because they were experiencing infertility problems. Therefore, generalisations concerning the level of fertility in the national herd could not be made with safety, but the data, when analysed (N. Z. Dairy Board, 1939; 1940) served to define the nature and the magnitude of the problem, facilitating the more comprehensive studies which followed.

(ii) The consulting officer survey of 1940-44: This survey was planned to give information similar to the earlier sterility survey, but with increased accuracy, and from a more representative sample of herds. Each of the six consulting officers (one in each Herd Improvement Association) arranged for full information to be kept on matings in approximately forty herds where bulls were segregated from the herd and hand mating practiced. The farmers recorded all matings, and the breeding records of cows not in calf or aborted were available at the end of the season. The information was then collected by the consulting officers, i.e. a Type III(c) Survey. In the first season (1940-41) 231 herds were included, but due to wartime difficulties the number fell to 188 herds in 1943-44. However the survey continued for four seasons and yielded a considerable volume of reliable information which served "to ascertain the general nature and extent of the sterility problem as obtaining in typical dairy herds in this country" (N.Z. Dairy Board,1944). Many of the analyses taken from the 1938-40 survey were repeated with the data obtained in the survey under discussion, and there was good agreement in the results. As examples of the type of information obtained, the following were some of the analyses published:-

1. Influence of age of cow (N.Z. Dairy Board,1941).
2. Size of herd and fertility (ibid,1940).
3. Fertility and herd production level (ibid,1941).
4. Influence of abortion on fertility (ibid,1941).
5. Influence of seasonal conditions on fertility (ibid,1940).
6. Comparison of fertility rates of second and subsequent services based on fertility at first service (ibid,1944).

In these analyses the fertility index was calculated from the number of services per conception, along with the percentage of cows "empty" at the end of the season (N.Z. Dairy Board, 1944). An index of this nature had the advantage that in assessing sire fertility the influence of sterile cows was removed, but since the data for matings to "empty" cows was

included in most of the tables, a correction to include these in the fertility index could if desired, easily be made.

(iii) Data collected with the Calf Wastage and Nutrition Survey 1946-47: This project was designed "as a check on the earlier data and as a follow-up to the investigations ... on temporary sterility" (N.Z. Dairy Board,1947). Farmers co-operating in the Calf Wastage and Nutrition Survey (see p. 119) were asked to keep full records of matings, abortions and dry cows. The consulting officers visited each farm during the spring and autumn and collected data from the Shed Sheet (Type IIIc Survey). Information over a two-year period from 389 herds in all Herd Improvement Associations was available for analysis, this providing a representative sample of reliable data. Analyses not previously made, and published by N.Z. Dairy Board (1947) included:

1. Subsequent breeding history of cows "empty" following the 1945-46 breeding season.
2. Conception rate of cows "empty" in 1945-46 but fertile in 1946-47.

The collection of fertility data is being continued, and from the three surveys discussed complete breeding and fertility information is now (1951) available from some herds for a period of over ten years. It is intended to continue the collection of this material although it may not be regularly analysed, for it is now considered that sufficient general information on the subject has been obtained. However, such data will make possible a future study on the inheritance of sterility, and preliminary work on this aspect of the problem is now in progress (N.Z. Dairy Board,1951).

Fertility surveys made possible an assessment of the effect on subsequent fertility of vaccination with "Strain 19" against contagious abortion. The widespread use of this vaccine (Filmer,1949a) made it desirable to determine

whether or not calfhood vaccination resulted in decreased fertility of yearlings and two-year olds. Ward et al (1948) reported that herds were selected from amongst those which had taken part during the previous three years in the Calf Wastage and Nutrition Survey. For these herds data were available on calf rearing practices including whether or not the calves had been vaccinated. Fertility information had also been recorded. A survey of fertility within herds before and after the adoption of vaccination, involving 114 herds for fertility in yearlings and 83 herds for fertility in two-year old heifers indicated that the use of the vaccine did not lower fertility (ibid).

This example illustrates the way in which an analysis can be built up from several different sets of data. It demonstrates the value of accumulating over a number of years, reliable information from a large number of herds, on as many phases of management, wastage and production as is practicable. It is then possible to take out surveys as the need for them arises instead of having to collect separate data on every new problem. There are, of course, certain cases where special field investigations have to be made, but this in no way detracts from the value of a large volume of general information which can be drawn upon as required.

(c) Other Causes of Herd Wastage.

The three factors already discussed account for nearly three-quarters of herd wastage. The relative importance of the other disease factors was discussed by Ward (1945) but except for determining their general order of importance as causes of wastage, the Dairy Board has done no detailed investigational work on them. The wastage from bloat, tuberculosis, grass staggers and milk fever represent only 5 per cent of total wastage (ibid). However, cullings from these causes do not measure the economic losses they entailed since there is no record of the number of cases occurring and

subsequently recovering, or the loss of production involved. More extensive investigations of these problems may, therefore, be justified.

Further work on tuberculosis does not come within the present sphere of Dairy Board activity since the problem is one best controlled by Government legislation. In the case of bloat, however, no extensive field investigation of the conditions under which this ailment occurs has been reported, and a more precise definition of the conditions associated with bloat in New Zealand could, conceivably, stimulate world-wide research on this problem. It would be essential, however, that such an investigation should include a large sample of farms and the necessary uniform definition of environmental conditions would be difficult to achieve. Consequently the resulting data would be difficult to analyse. Similar considerations apply to milk fever, grass staggers and paralysis. It should, however, be possible to obtain information on the incidence of these minor diseases which would permit an assessment of their economic importance.

2. SIRE WASTAGE.

Commencing in 1938-39 and extending over four seasons a survey was conducted to obtain information on the sires in use and causes of sire wastage in the industry's recorded herds. During March and April each season all testing officers were instructed to collect from each herd visited details of sires used in that season and the reason for wastage of any sires. The simplicity of the information required in this Type II(b) Survey meant that fairly accurate returns could be expected.

The proportion of herds furnishing details in the first season is not available but Table XI indicates the results in subsequent years.

TABLE XI. Numbers of herds supplying effective sire wastage returns as a percentage of all recorded herds.

Season	No. of herds supplying returns	No. of bulls in use	% of recorded herds represented
1939-40	3,130	5,395	78
1940-41	4,630	7,772	87
1941-42	4,205	7,065	75

- N. Z. Dairy Board Annual Reports.

When the data was analysed to show the age and breed of sires in use the breed analysis compared favourably with the actual proportions of pedigree cattle registered in the respective herd books (N. Z. Dairy Board, 1939a). This suggested that the data was fairly representative of the industry as a whole.

The analysis of sires "lost, sold or culled" was of particular value since it gave, for the first time, definite information on the causes of sire wastage and showed that much of the loss was avoidable. The two factors "danger of inbreeding" and "culled on account of age" accounted for about 25 per cent of all wastage. It is almost certain that culling for the former would have been much lighter had farmers been aware of the actual degree of inbreeding likely to occur in their herds and the limits beyond which it was thought advisable, by competent authorities, to inbreed. Similarly, unnecessary losses occurred because of the belief of many farmers that a bull was too old for use at six years of age. Thus in 1938-39 thirty-two per cent of bulls culled for age were disposed of by their sixth year and 60 per cent by their eighth year (ibid). In the 1941-42 season the corresponding figures were 47 per cent and 72 per cent. A better appreciation by farmers of the facts concerning the fertility and activity of bulls at different ages (see p. 118) would have considerably lessened the incidence of culling on account of age. The need for better management of herd sires was revealed in the high wastage from "accident and injury" and

"fence-breaking and dangerous."

Investigations on Bull Fertility.

In the sterility surveys discussed previously (see p.111) details of individual matings of a large number of bulls were obtained. The records of a large and reasonably representative sample of these bulls during four seasons showed that "under natural conditions the fertility of the average bull does not show any definite decline until about nine years of age" (N.Z. Dairy Board, 1944). In view of the belief, then widely held (Ward, 1945a) that the fertility of bulls declined seriously after about their fifth year, this was an important finding, for it meant that good bulls could be used to advanced ages with greater confidence, and helped to dispose of the argument frequently advanced against sire survey that by the time a bull was proven he was too old for further use.

The Dairy Board's wastage statistics indicated that only about 10 per cent of sire wastage was due to sterility. Further investigation of this problem lay beyond the province of the herd recording organisation.

3. CALF WASTAGE.

To the dairy farmer, wastage of calves from birth to the stage at which they should normally come into production is an important consideration, for it may seriously limit the scope for selection in choosing replacement stock. Difficulties experienced in rearing calves vary greatly from farm to farm and district to district. Factual information on the extent of calf wastage and the factors causing or influencing it, was sought by the Dairy Board in a series of investigations commenced in the 1939-40 season. These were:

(i) The herd wastage survey, 1939-40.

(ii) The calf wastage survey, 1940-41 to 1943-44.

(iii) The calf wastage and nutrition survey, 1945-46 to 1947-48.

(i) Data collected with the Herd Wastage Survey 1939-40: The history of 1,025 calves identified by tattoo in 75 herds was available from the wastage survey (Type IIb) described previously (see p.102) (N.Z. Dairy Board,1940). The sample of herds was very small, the information was incomplete after identification of the calves, and there was no record of losses occurring between birth and identification. Therefore the project served merely as a preliminary indication of the probable extent of wastage in calves and yearlings.

(ii) The Calf Wastage Survey 1940-41 to 1943-44: In the first season (1940-41), the six consulting officers (one in each Herd Improvement Association) collected detailed information on the calving record of every cow in 221 herds, as well as details of the fate of all calves born. Wartime conditions reduced the number of herds under survey to 128 by 1943-44. The consulting officers arranged with the farmers to keep the necessary records on forms provided, the information being checked and collected periodically (Type IIIc Survey). A summary of results for four seasons (N.Z. Dairy Board,1944), showed that in recorded herds nearly 80 per cent of bull calves were sold as "bobby calves" whilst almost 75 per cent of heifer calves were reared. A sample of 35,000 calves gave a sex ratio of 52.2 bulls to 47.8 heifers and indicated that twinning occurs in about 1 per cent of all calvings.

Actual causes of death of calves intended for rearing were not recorded in this investigation, but this information was obtained later (see (iii) below).

(iii) The Calf Wastage and Nutrition Survey 1945-46 to 1947-48: The previous two surveys provided some information on the extent of calf wastage, but the need remained for more precise knowledge of the causes of loss, the times at which losses occurred, and the factors associated with various levels of wastage. In 1945, therefore, each of the six consulting

officers organised a reasonably typical group of approximately one hundred herds (a total of 561). Ward (1946a) stated that it was inevitable that there would be a bias in favour of the high producing herds because of the difficulty of getting satisfactory data concerning herds under poor management or poor conditions. The first season's work was regarded as exploratory and gave co-operating farmers the opportunity to become thoroughly familiar with the data required. A number of weaknesses in the technique were discovered and remedied with the result that reliable returns were obtained in the second and third years of the survey. In addition, many of the farmers were co-operating in the fertility survey, which provided supplementary information.

The farmer was provided with a form on which he recorded details of calf wastage in yearlings, calf nutrition, and general herd nutrition. The consulting officer visited every farm twice each year, in the spring and autumn, and collected the recorded information from the farmer's form. In many herds a double check on calf histories was available, (1) from a separate sheet on which the farmer recorded the name of the dam of each calf saved for rearing and (2) from the Allocation Sheets for calves identified by tattoo. Also, where possible, the consulting officer personally counted the number of calves being reared. If the details supplied from these three sources did not coincide a check was made to detect the discrepancy (Lawry, 1951). In addition to collecting the above records, the consulting officer at each visit made notes on pasture conditions and the condition of the stock.

In this manner, well authenticated data on calf wastage and nutrition from a large and well distributed sample of herds, admittedly better than average, were obtained. When analysed (N. Z. Dairy Board, 1947) this gave information not only on the causes of wastage but the ages at which loss from the various causes occurred.

In analysing causes of calf wastage, herds were divided into three production grades, "above average", "average" and "below average", relative to their group average (approximately 25 herds in a locality). Although over 20,000 calves were included in the survey, over half of them were in the "above average" group, and of the total wastage of 1,214 calves, only 292 were in the "below average" and 340 in the "average" group. Each of these were subdivided amongst seven causes of loss, so that whilst the number of herds in the survey were considerable, the conclusions on causes of calf wastage were actually based on rather small numbers in each class (N. Z. Dairy Board, 1947).

Many of the analyses, were, of necessity, based on the subjective observations of consulting officers on such factors as hygiene and conditions of grazing. These were graded "good", "average" and "poor", and in view of the great difficulty in assessing grazing conditions it is likely that there were considerable variations in any one officer's gradings and even greater differences between officers. The same applied, in lesser degree, to gradings of "hygiene". It should be stressed that long practice is required to obtain uniform subjective gradings under relatively uniform conditions. With conditions varying as they do throughout the Dominion, highly repeatable results could not be expected. Furthermore, because the sample comprised above average herds, the number classed as "poor" was relatively small and it could not be conclusively stated that wastage was lower with better grazing or more hygienic feeding conditions. Other analyses, presented at the conclusion of the survey (N. Z. Dairy Board, 1949) included calf wastage according to: (1) level of cow nutrition, (2) autumn condition of heifers, (3) level of nutrition of calves during their first winter, and (4) nutrition up to mating, based on "good", "average", and "poor" gradings in each case. These also, suffer from the weaknesses of subjective techniques.

However, the Herd Recording authorities are fully aware of the above considerations, and the methods discussed are the only practicable ones by which information of this nature can be obtained on a large scale. Experience gained in numerous past surveys makes it possible to guard against gross inaccuracies and to use modifications calculated to enhance the value of survey material. Thus, in the calf wastage and nutrition survey attempts were made to increase the accuracy of gradings by making them at a specific time of the year, although this was made difficult by the large number of herds supervised by each officer. Farms were graded "good, "average", and "poor" according to management and husbandry conditions, and each farm was reclassified each year to allow for any improvement or deterioration which might have occurred between seasons (Lawry, 1951). Finally, consulting officers have regular conferences at which efforts are made to obtain uniformity in all work such as the grading systems employed in surveys. In the four cases mentioned above (page 121) the consistent differences in wastage found between "good" "average" and "poor" groups were analysed statistically and proved, in most cases to be significant (N. Z. Dairy Board, 1949).

4. CONCLUSIONS.

The tasks of defining the magnitude of wastage in dairy stock and of determining the relative importance of the various causes of loss have been largely completed for the present. In addition, some information has been accumulated on the factors associated with various levels of wastage in different classes of stock.

It is difficult to assess the effects of the Dairy Board's investigations into herd wastage. As yet it appears to have stimulated little research on disease problems, although with the success of penicillin and "Strain 19" the urgency of the need for such research has been considerably reduced. It can be argued, inconclusively, that factual

evidence of the importance of mastitis as a wastage factor hastened the exploitation of penicillin as a preventative and curative measure. The widespread use of "Strain 19" may have been similarly hastened, and certainly, a valuable service was performed when an analysis of accumulated data showed that this vaccine was not detrimental to fertility.

The sterility problem in cows has now been well defined, and, with the exception of a study of the inheritance of the complaint, future work lies more in the sphere of the veterinarian than the survey expert.

Of the data collected on sire wastage and fertility, the most valuable was that which showed that on the average, sire fertility declined little with age until after the ninth year. This finding was important because it came at a time when the use of proven bulls to advanced ages for both normal mating and artificial insemination was being advocated.

The calf wastage returns were of note chiefly because they indicated a fairly consistent association between good husbandry conditions and low calf wastage.

The most recent herd wastage survey analysis (1949-50) indicates that despite the success achieved in decreasing disease wastage, the replacement rate remains relatively unchanged. Whether this state of affairs will persist is a matter for conjecture. In the past great stress has been laid on the economic loss from disease, the high wastage rate, and the consequent short herd life of the average cow. Although the recent theoretical work of Rendel and Robertson (1950) led to the conclusion that " ... longevity as such can be shown to have little economic value compared with high yield", these workers emphasise that "it does not follow that freedom from disease and constitutional well-being are not important characters". Wastage through disease and accident is obviously of considerable importance since it not

only causes direct financial loss but it also limits the amount of culling possible. Consequently, any success achieved by the New Zealand Dairy Board in decreasing wastage in dairy cattle is of great importance to the dairy industry.

II. MANAGEMENT AND HUSBANDRY SURVEYS

1. NUTRITION SURVEYS.

Since so many dairy farming problems are connected in some way with nutrition, a number of attempts have been made to collect information on feeding practices in New Zealand herds. In general, these have been related to the effect of nutrition on some particular factor such as mastitis or calf wastage. The predominance of grassland farming in New Zealand has made difficult the collection of precise information on the plane of nutrition and its influence on other factors.

The first surveys conducted by the Herd Recording Department were designed to determine the methods and practices of those dairy farmers who had achieved and were maintaining high levels of production (Ward, 1941). More recent work has been confined to specific problems such as calf nutrition.

The three main surveys yielding information concerning problems of hutrition were:

(i) The Nutrition Survey 1940-41.

(ii) The Mastitis Survey 1942-45.

(iii) The Calf Wastage and Nutrition Survey 1945-48.

(i) The Nutrition Survey 1940-41: The Nutrition Survey 1940-41 was planned as a Type III(c) Survey "to give some broad definitio of the feeding and management policies associated with the higher-producing herds in each district" (N. Z. Dairy Board, 1942). The consulting officer attached to each of the six Herd Improvement Associations selected approximately forty farmers who were supplied with forms on which to keep records of feeding conditions and practices, service dates, and condition of cows at service. The consulting officer visited each farm at least

three times a year to make observations on pasture conditions and the condition of the cows.

By grading the cows at calving "good", "fair" or "bad" according to condition it was hoped to make a subsequent study of the lactation curve according to condition at calving (Technical Committee,1940). However, in February 1942, owing to wartime difficulties the survey was abandoned (Technical Committee,1942). It proved impracticable to analyse the detailed reports of the consulting officers, and consequently no summaries of results for the 1940-41 season were published.

(ii) The Mastitis Survey 1942-45: The work of Nielsen (see Ward et al,1945) in attempting to relate herd nutrition practices to mastitis incidence has already been discussed (see p.107).

(iii) The Calf Wastage and Nutrition Survey 1945-48: The method adopted in this survey was discussed in detail in an earlier section (see p.119). Briefly however, detailed information was collected by consulting officers from a large sample of herds, on calf wastage and certain phases of herd nutrition and calf rearing. Numerous analyses were made relating various feeding practices to wastage and, in general, it was found that good management and feeding conditions were closely associated with low levels of wastage (N.Z. Dairy Board,1949).

A future project arising from this survey will be the examination of production records of heifers with known nutritional history. An attempt will be made to compare the effect of "good" as compared with "poor" rearing methods on future production and length of working life. The necessary information will be available in the production and wastage returns (Lawry,1951).

2. FARM MANAGEMENT PROJECTS.

The Herd Recording Council has attempted to foster herd improvement through better husbandry methods. In 1939 six consulting officers were appointed chiefly for the purpose of securing the more widespread adoption of good farming practices. To aid the extension programme, attempts were made to determine the factors related to high production, but early projects such as the Nutrition Survey of 1940-41 (see p.126) had to be abandoned during the War. More recently, this type of investigation has been resumed in two main projects:

(a) The farm-management survey 1948 -.

(b) The Production Investigation Project 1948 -.

(a) The Farm-Management Survey 1948 -.

Ward et al (1950) stated that "field research into better methods of feeding and management of dairy stock usually resolves itself into a study of the practices prevalent on the more efficient farms and their general comparison with those on the less efficient." In 1948, in an attempt to gain general information on the association of popularly accepted farming practices with high production, farmers receiving the continuous testing discount (see p.89) were asked to complete and return a questionnaire giving details of area of farm, stock carried, artificial fertilisers used, amount of hay and silage saved, supplementary feeding and other farm practices. In the first seasoh, satisfactory returns were received for 1,890 herds. These herds produced, on the average, about eighteen lbs. of butterfat more than the average of all recorded herds and the sample studied would be, therefore, thirty-five to forty lbs. of butterfat per cow better than the average for all herds in the Dominion. published results (Ward et al,1950), demonstrating the degree of association of various practices with higher per cow and

per acre production should prove a useful guide to farmers and extension workers. The survey is continuing and data from each herd is being recorded on cards, the analysis then being performed mechanically.

These studies are of special interest in that they demonstrate some change of emphasis in herd recording, from production per cow to production per acre.

The work of Mitchell (1949), and Hamilton and Mitchell (1950), which suggested that production per acre was more closely associated with carrying capacity than with production per cow has aroused considerable interest in New Zealand. It has led to the claim that higher per acre production might be achieved by carrying more cows, even at the expense of per cow production. In support of this thesis Mitchell (1949) claimed that the efficiency of utilisation of food declined above a certain genetic production ceiling which was placed tentatively at about 270 lbs. of butterfat for his sample of data.

To study further the relationship between production per acre and production per cow together with the associated factor of carrying capacity, Ward et al (1950) made a tabulation of data from 863 herds and this indicated a strong association between per cow and per acre production. An analysis of production per acre and per cow, according to carrying capacity for the same farms, showed that a very strong association existed between carrying capacity and production per acre, but at the same time per cow production showed a slight increase on the farms with high carrying capacity. This indicated that production per cow had not been sacrificed in achieving high carrying capacity.

The relative influence of carrying capacity and per cow production on production per acre will remain unknown until more information is obtained on the relative efficiency of utilisation of feed by dairy cows at different

levels of production. It is, obviously, an important question since the efficiency of dairy farm production may be affected detrimentally by undue emphasis on the wrong policy. The N. Z. Dairy Board's investigations of factors associated with high per acre production may help to determine the correct policy, though the studies of intake by grazing animals now being conducted at Ruakura Animal Research Station (Wallace, 1950) appear to offer the most promising approach to the determination of efficiency of production under free-grazing conditions.

In studying carrying capacity and per acre production great difficulty is experienced in obtaining accurate figures for the area "devoted to dairying" on any farm. Many farms have a "run-off" (an area of land, not adjacent to the farm, on which cows may be wintered or the young stock raised but which is not usually used by the milking herd during the milking season), but even on self-contained units it is difficult to assess the influence of such factors as swamps, bush and plantations on effective grazing area. In addition, carrying capacity of a farm for dairy stock is influenced by purchased feed, and mixed farming pursuits. Consequently, whilst per cow production can be consistently estimated within known limits of accuracy, estimates of per acre production are subject to inconsistent errors of unknown magnitude and therefore must be used with caution as indices for herd improvement studies.

(b) The Production Investigation Project (P.I.P.) 1948 -.

In October, 1947, the Standing Advisory Committee (1947) recommended to the Herd Recording Council that the consulting officers should be relieved, to some extent, from survey work, diverted more to their original role of extension workers, and be given an opportunity to demonstrate their ability to secure an increase in production in their districts.

Beginning in 1948 each of the four most senior

officers selected a number of low producing farms within his district and by 1950 about forty farmers in each area were co-operating in the Production Investigation Project. The task of the consulting officer was, first to determine why each farm was not producing satisfactorily and then to proceed, with the co-operation of the farmer, to overcome the various problems limiting production. It was stressed that the consulting officer should not become, in effect, the farm manager, but should by suggestion and advice encourage better farming practices.

Detailed records and observations are made, and kept up to date for each farm but, in general, the information recorded does not lend itself to analysis. The project is serving three main purposes:

1. It helps the farmers concerned.
2. It helps the consulting officers to become intimately acquainted with their districts.
3. If the project is successful the results will make a useful publicity weapon in inducing other farmers to improve their farming methods.

Some of the herds are now (1951) in their third season on the scheme and although insufficient time has elapsed for the results of improved breeding policies to be evident, Lawry (1951) stated that considerable success has been achieved in raising production. Progress is measured chiefly by comparing the herd average of the co-operating farmer, season by season, with the average of the herd-testing group to which he belongs. This gives an indication of the achievements of one farmer relative to others under similar conditions. It is hoped at some future date to compare the trend of production in co-operating herds with that in other low-producing herds under comparable circumstances (ibid). Meanwhile, however, no results have been published.

3. SHED MANAGEMENT INVESTIGATIONS.

During the recent War the shortage of labour stimulated the adoption of various labour-saving practices and this in turn gave rise to a growing interest in milking efficiency. The effect of various milking techniques on production and efficiency have been studied by the N.Z. Dairy Board and these studies have led to an investigation of milking temperament.

The work relating to shed management may be divided into three main sections:

(a) Non-stripping investigations.

(b) Investigations of milking technique.

(c) Studies of inheritance of ease of milking.

(a) Non-stripping Investigations.

The controversy aroused in the last decade by the widespread adoption of non-stripping made it desirable to determine the effect on production of this practice. Several separate investigations have been made.

(i) The Combined Survey 1941: During November and December 1941 the Dairy Board and the Department of Agriculture surveyed twenty-eight North Island herds, in which non-stripping had been adopted. Ward et al (1942) reported that each herd was visited, seventeen of them during milking, when a study was made of the milking technique. The efficiency of the machines was checked and some information collected on the rate of milking. Production records were available in each herd and it was possible to compare production figures for 300 cows made before and after the adoption of non-stripping. This small-scale project gave the first definite evidence that the change from stripping to non-stripping did not depress production and was a finding of some consequence in view of the saving in time and labour which would result from the universal adoption of non-stripping.

(ii) Analysis drawn from Mastitis Survey 1944: In the large-scale Mastitis Field Survey commenced in 1941 (see p.106) a record was kept of "non-stripped" herds. A study of the production records, "smoothed" for seasonal effects, of 266 such herds before and after the adoption of non-stripping failed to show a significant change in production in either direction (N.Z. Dairy Board, 1944). A further analysis of the available mastitis data on these herds showed neither more nor less mastitis in stripped as compared with non-stripped herds.

These analyses demonstrated once again the value of having a large volume of information on recorded herds, for this made possible the presentation of authoritative information on a topical question without the need for a special survey.

(iii) The Effect of Continued Non-Stripping: In 1948 Ward et al (1948) made a further analysis of data collected with the Mastitis Survey to determine not only the effect on production of the cessation of hand-stripping, but also the effect of continued non-stripping over a number of seasons.

In sixty-eight herds production records were available for the seasons before and after the change was made. In view of the difficulty of correcting records for seasonal effects, the production record of each herd was compared with the production of the herd-testing group during the appropriate season. The trend of production was followed for up to six seasons after the cessation of hand stripping, and although the number of herds in each group was rather small, results indicated no loss from continued non-stripping. In fact, production remained unaltered in the first three seasons after the adoption of non-stripping, but due either to improvements in general herd conditions, or to the breeding of stock better adapted to non-stripping (or both), the herd averages showed a significant increase in the fourth, fifth,

and sixth seasons as compared with the group averages (Ward et al,1948).

(iv) Effect of Non-stripping on Efficiency: In the investigation of milking technique (Ward et al,1949) some indication was obtained of the incidence of non-stripping and evidence was produced showing that this practice was an important factor in increasing the number of cows milked per milker per hour (see below).

(b) Investigations of Milking Technique.

During the 1948-49 and 1949-50 seasons comprehensive surveys of various milking techniques were carried out by recording officers in the Bay of Plenty-East Coast Herd Improvement Association area, and by the Dairy Board's consulting officers. In the 1948-49 season the consulting officers made detailed reports on 121 herds, including milking times for individual cows (Type IIIa Survey), and the recording officers obtained milking times for each of 489 herds (Type IIa Survey). The survey was undertaken during February when most cows had been in milk about six months, so that the results obtained may not reflect accurately milking times during the "flush" months. Numerous analyses of results were published (Ward et al,1949) indicating which practices were likely to increase the speed and efficiency of milking.

The investigation was continued by the consulting officers during the 1949-50 season when satisfactory data was obtained from sixty-eight herds. In addition to supplementing the previous season's results, preliminary data were collected for an investigation on the influence of breeding on ease of milking (see p.135). Consequently, herds were selected in which sires had been surveyed for a number of years and details of breeding were available. At one milking, during November or December, milking times (including machine

and hand-stripping times) were recorded for each cow. To check the accuracy of a timing based on one milking, a small sample of herds was checked several times. This check revealed that in general the times for one milking could be accepted for groups of animals, but some individuals showed considerable variation from milking to milking (Ward et al, 1950).

The figures obtained on milking times permitted a study of the relationship between average milking rate on the one hand, and on the other, milk yield, age of cow, annual production and stage of lactation (ibid).

(c) Studies of Inheritance of Ease of Milking.

Using the data collected in the survey just discussed, analyses for each herd were made on the basis of the sire and where information was available for at least eight daughters an average milk yield and milking-rate was calculated. These figures were compared with the average for the herd and for all cows not included in any particular sire group. The comparisons indicated marked differences between daughters of different bulls within herds. To assess the influence of the sire on the milking rates of his daughters in different herds the daughters of three bulls used for artificial insemination were studied. When the daughters of individual bulls in different herds were studied, however, they displayed widely different milking rates. The limited amount of data obtained in this survey indicated, therefore, that whilst there was an hereditary influence, environmental factors were more important in determining rate of milk flow (Ward et al,1950).

The investigation was continued during the 1950-51 season when each consulting officer obtained data from three or four herds. The greatest weakness of the previous year's work was the fact that milking times were based on only one timing. The 1950-51 data, however, were

obtained from three observations. Times taken to milk each cow, from "cups on" to "cups off", and total time each cow was in the bail were recorded during visits in November, January and March. On each occasion times were taken at two successive night milkings. This procedure is expected to give a more reliable measure of milking-time. The herds selected for this investigation contained daughters of proven sires and breeding records were available for some years past. In addition selected recording officers collected information on shed organisation (Lawry, 1951). From this data it is hoped that by making daughter-dam comparisons more definite information on the inheritance of fast-milking qualities will be obtained (ibid). A reliable estimate of the heritability of this character will indicate what degree of emphasis should be placed on selecting for it.

Conclusion

The above investigations of shed management practice, indicating that the milking process can be greatly accelerated, giving more efficient utilisation of labour without loss of production, must have given many farmers added confidence in adopting new methods. It is probable, for example, that the publicity given to the results of the Dairy Board's non-stripping investigations hastened the widespread adoption of this practice. In addition, however, it is generally acknowledged that the visit of Professor Petersen to New Zealand in 1948 was an important factor in the improvement of milking technique. Ward et al (1949) estimated that "the number of sheds in which milking did not involve hand-stripping increased from approximately 25% of all sheds in 1947-48 to 50% of sheds in 1949-50."

The present trend toward the achievement of faster, more efficient milking, by the use of proven shed techniques and close co-operation between the cow and the milker, is one which will do much to reduce the drudgery long

associated with the milking process.

III. PRODUCTION SURVEYS AND SUNDRY ANALYSES

1. EFFECTIVE AVERAGE PRODUCTION SURVEY.

At the commencement of the 1936-37 season the Government assumed control of the marketing of New Zealand dairy produce under the Primary Products Marketing Act (1936). As defined by the Act, the Guaranteed Price to be paid for butter and cheese in the first season, 1936-37, was an average of the prices received in New Zealand during the period of eight to ten years prior to 31st July, 1935. In fixing the price to be paid in subsequent years, however, regard was to be had, among other factors, to "the costs involved in the efficient production of dairy produce" (ibid).

In July, 1938, therefore, a Guaranteed Price Advisory Committee was set up with the task of determining detailed costs of production in terms of pence per pound of butterfat. This Committee recommended to the Government that costs of production be calculated on the basis of an efficient average per cow production of 240 lbs. of butterfat. The Government, however, amended the basis to 250 lbs. of butterfat.

One of the recommendations of the Herd Improvement Plan of 1939 was that "the Government should not adopt any index which would completely offset the increase in efficiency gained by those farmers who avail themselves of the advantages of Herd Improvement." That is, if the effective production of cows was raised " ... then as an incentive to the dairy farmer to strive for increased production no greater amount than 50 per cent of such increased production shall be included in the per cow index on which the guaranteed price is based" (N. Z. Dairy Board, 1939). Under the Herd Improvement Plan a Technical Committee of the Herd Recording Council was set up, and one of

its duties was to determine the basis upon which the "effective average production" of all cows should be computed.

The Committee decided that the average to be determined should be known as the "effective average production of cows in milk", and it was calculated from:

1. The total butterfat supplied to dairy companies and used for manufacturing purposes.
2. The "effective" number of cows in milk i.e. "the total cows carried on the property between 1st August and 28th February following, either in milk or intended to be milked during that period. Such number to be calculated by averaging the monthly total of such cows for the months August to February inclusive" (Technical Committee, 1939).

In order to obtain the necessary data the Technical Committee (1939) decided on the following procedure:-

"(1) To obtain through Dairy Company Secretaries the number of cows in milk at 15th January for all farmers supplying such factories; excluding licensed suppliers of whole milk and/or cream for liquid consumption."
(The Dairy Companies sent out forms which were filled in by the supplier and returned to the factory).

(2) To arrive at the "effective" number of cows mentioned above, information was collected concerning all cows carried on the property either in milk or dry (but intended to be milked during that season) from the herds tested by the Herd Improvement Associations. From an analysis of data from over 5,000 herds, a ratio was calculated between the number of cows in milk in January and the average total number of cows carried during the season (e.g. in 1940-41 season an average of approximately 104.25 cows were carried in the months August to February in order to milk 100 cows in January).

(3) The number of cows in milk on 15th January was multiplied

by the ratio determined in (2), the product representing the "effective" number of cows carried.

(4) The total butterfat production for each supplier was obtained at the end of the season from dairy company secretaries and the Effective Average Production (E. A. P.) calculated from the equation

$$\text{E. A. P.} = \frac{\text{Total fat supplied for manufacturing purposes}}{\text{Effective number of cows carried}}$$

Each season since 1939-40 this data has been collected, analysed and presented in the N. Z. Dairy Board Annual Reports. The method of calculation of Effective Average Production is fairly simple and the method of collection of data has proved reliable. Every year the return for cows milked on January 15th has represented at least 80 per cent of the Dominion's cow population. Licensed town-supply herds are excluded from the survey, and since 1948-49 herds of less then ten cows have also be excluded (N. Z. Dairy Board, 1949). Whilst some farmers and a few dairy companies have failed to co-operate, the sample obtained each season has been considered sufficiently representative to give a reliable Dominion figure.

The calculation of the Effective Average Production appears to be on a sound basis, there being little possibility of gross inaccuracy. The extreme simplicity of the 15th January questionnaire minimises the possibility of error, the total butterfat production is based on actual factofy returns, and the monthly returns of cows carried in recorded herds are reasonably well authenticated.

The original and most important aim of the survey was to provide an efficiency standard of per cow production for the purpose of determining the Guaranteed Price. It is of interest to note that the Effective Average Production has not yet approached 250 pounds per cow, the figure upon which the Guaranteed Price is based, the maximum

so far achieved being 235 pounds during the 1948-49 season. The survey provides, however, a useful standard index of production for the Dominion, which can be used to gauge trends in production in all herds as compared with recorded herds.

In addition to fulfilling its primary purpose, the survey provides valuable information on a number of other aspects. Thus it has been possible to make an analysis of production per cow according to herd size, together with a distribution of all herds of twenty cows or more according to herd size and production level (N.Z. Dairy Board,1949). Ward (1950) presented an analysis of the difference between production per cow "at the pail" and factory production, the basis being a comparison of factory production obtained from Effective Average Production returns with herd test averages for a large sample of herds under Group Herd Test. The survey also yields data on the size of herds and the level of production in the various land districts.

2. SUNDRY ANALYSES.

In addition to the numerous planned investigations already discussed, a number of incidental analyses of data from various sources have been made. Of these the most important have been:

(a) Studies of age distribution.

(b) Analyses of spread of production.

(a) Studies of age distribution.

Since the age of most recorded cows was entered on the test-sheet it was possible to make an analysis of the age distribution of a large sample of the national herd. Thus for the 1940-41 season (N.Z. Dairy Board,1941) an analysis of 182,000 cows indicated that approximately 17 per cent of cows in milk were two-year olds. This figure would reflect fairly accurately the "true replacement rate", and provide,

after allowance was made for animals calving first at three years of age and cows sold for dairying, a check on the herd wastage results.

(b) Analyses of Spread of Production.

Group Herd Test records have been analysed each year to show the manner in which production is spread throughout the season. Two main tabulations give this information:

(i) Monthly production per cow, based on all cows in milk in each thirty-day period: Results are given for each Herd Improvement Association and these demonstrate the typical curve of seasonal production with per cow averages rising to a maximum in November and thereafter declining steadily.

(ii) Unit production per cow: "The unit production per month is calculated by taking the total butterfat production for each month for cows under Group Herd Test and dividing by the maximum number of cows in milk during that season" (N. Z. Dairy Board, 1945). The figure combines the average production per cow in any one month with the percentage of cows actually in milk in that month. The tabulation therefore gives a useful indication of the differences in effective production in the various districts according to the season of the year. Thus, in the North Island, where the median calving date is approximately August 15th (N. Z. Dairy Board, 1946), maximum unit production is usually attained in November, but in the South Island where median calving date is approximately September 14th (ibid) maximum unit production is usually achieved in December. This seasonal nature of production, reflected in the rapid decline in unit and per cow production in the North Island during and after December has been found to have the further effect of depressing the production of late calvers. Thus Ward (1945) found that North Island cows, calving after the end of September produce, on the average, approximately 15 per cent less than earlier calving cows.

IV. CONCLUSION

During the fifteen years which have elapsed since the New Zealand Dairy Board commenced its investigational programme, considerable success has been achieved in obtaining quantitative and qualitative data related to production problems and practices in the dairy industry. Already, in several fields, surveys have demonstrated the desirability of certain practices and hastened modifications of management methods. For example, a study of mastitis incidence (see p.105) showed the importance of this disease as a cause of wastage, and a later survey (see p.109) gave information concerning the relative merits of alternative mastitis treatment techniques using penicillin. N.Z. Dairy Board investigations also demonstrated that non-stripping, an important labour-saving practice, could be adopted without loss of production. The information obtained through surveys such as those mentioned above has given a factual basis to the work of the N.Z. Dairy Board consulting officers, who have become increasingly important in obtaining the widespread application of scientific principles and improved farming practices on New Zealand dairy-farms.

In addition to compiling data concerning the importance of various factors associated with production, a large volume of vital statistics of the dairy cow population has been accumulated. In the light of current developments in animal improvement, such statistics appear likely to be of increasing importance in the future. Lush (1951) stated " ... as we quantize our breeding plans further, we need to know the vital statistics of farm animals more accurately .... To make our plans sounder, we need to know more about the means and likely variations in such things as expectation of life, replacement rates, percentage calf ... crops which can reasonably be expected, generation invervals, and how much each of these can be changed by any changes in management which

are economically possible." In New Zealand the centralised organisation of herd recording, whereby the Herd Recording Department of the N.Z. Dairy Board operates as a clearing-house for information collected through herd recording and associated activities, has functioned effectively. Not only is much useful data available for application in New Zealand, but in the absence of such statistics for dairy cattle populations in other countries, vital statistics pertaining to the New Zealand national herd have frequently been used by overseas workers in theoretical herd improvement studies. For example Robertson and Reindel (1950) used N.Z. Dairy Board figures for calf wastage and sire wastage in a study of the rate of improvement possible through "the use of progeny testing with artificial insemination in dairy cattle"; Donald and El Itriby (1945) quoted New Zealand statistics for "percentage distribution of herd size"; and Robertson and Asker (1951) employed N.Z. Dairy Board (1947) data to estimate "the number of fertile heifers that can be reared from 100 births" in their study of the expansion of a breed of dairy cattle.

The value of the work of the N.Z. Dairy Board in defining the causes of herd wastage, in studying farm management practices, and in compiling vital statistics has already been demonstrated. The trend of future studies of factors associated with herd wastage will probably be determined chiefly by the requirements of animal disease research workers for general information on factors related to different levels of incidence of individual diseases. As yet little specific information has been obtained concerning conditions associated with different levels of production, and current studies in this field seem likely to be protracted. In view of the concerted effort now being made to improve the genetic worth of the national herd by selection and progeny testing, and the probable increasing exploitation of artificial insemination, the continued collection and analysis of vital statistics for

a large sample of herds is of considerable importance. Such information will be essential if an accurate assessment is to be made of the probable effects on future production of projected breeding plans for the national herd or individual units within the national herd.

PART THREE

HERD IMPROVEMENT MEASURES ASSOCIATED WITH HERD RECORDING

CHAPTER VIII

THE MARKED CALF SCHEME

(a) The Need for Calf-Marking.

In the early years of the Herd Recording Movement, two important factors contributing to the initial improvement of recorded herds were: (i) the identification and subsequent culling of the lowest producing cows, and (ii) the use of registered purebred dairy bulls as sires of replacement stock. Many herds, however, failed to make satisfactory improvements in production level, and Hume (1925) discussing the reasons for this, stressed the following facts:-

1. The Herd Recording Movement made no provision for the elimination of cull cows from the industry and that the progressive farmer's culls were too frequently bought by his less progressive neighbour.
2. The continued widespread use of nondescript or "scrub" bulls.

In support of this latter point the "N. Z. Dairy Exporter" (1925a) estimated that only 20 per cent of the sires then in use in herds recorded by the New Zealand Co-operative Herd Testing Association (Waikato) were registered animals.

Persistent efforts to secure the widespread use of purebred bulls had been made for many years by existing herd-recording organisations and breed societies, but as an adjunct to this policy there was a need for more enlightened herd replacement practice. It was obvious that the Dominion's high-producing herds were a potential source of superior replacement stock which could be used to advantage in the poorer herds. In practice, however, the average high producing farmer annually saved about " ... 20 or 25 per cent (of his calves) necessary for replacements" and slaughtered the remainder (ibid) because, in the saleyard, young stock with

butterfat backing did not command a sufficient premium to warrant the rearing of a saleable surplus. The pressing need was, therefore, for a scheme which would save from slaughter, calves with satisfactory butterfat backing, by guaranteeing a sufficient return to make them worth rearing (ibid). This, in turn, entailed identification of such stock and the recognition of their superior worth by a large number of farmers.

In an attempt to satisfy these needs the Calf Marking Scheme was inaugurated in the Waikato during the 1925-26 season by the New Zealand Co-operative Herd Testing Association. The Scheme provided for the marking by ear tattoo, and the certification of heifer calves sired by registered purebred bulls and from dams tested by a group affiliated to the above Association. For their calves to be eligible the dams were required to attain the following minimum standards in one lactation not exceeding 305 days:-

First calvers (up to 2 years 6 months of age at commencement of test) 250 lbs. butterfat.

2nd " (up to 3 years of age at commencement of test) 275 lbs. butterfat.

3rd " or older (after $3\frac{1}{2}$ years, mature) 300 lbs. butterfat.

(N. Z. Co-op. H. T. A., 1925)

A single record sufficed and a cow's highest record could be used to make her daughters eligible for certification.

In the light of present knowledge of the inheritance of butterfat producing qualities, it is clear that the scheme did not have a sound basis. Estimates of a dam's breeding worth based on a sihgle record, frequently a selected one, are now known to be poor. To some extent this was appreciated at the inception of the scheme. There was a suggestion that there should be a minimum butterfat requirement for the sire's dam but Hume (1946) stated that as there were so few bulls with butterfat backing the scheme commenc

without that limitation. It was accepted at the time of the scheme's inception that registered purebred bulls were, in general, capable of raising production and therefore any plan which encouraged their use was considered constructive.

(b) Progress and Subsequent Changes in Method.

In the first season of operation (1925-26), 630 calves were marked by recording officers for 98 farmers, (N.Z. Co-op. H.T.A.,1925) the fee being one shilling per calf. Owners were required to sign a declaration concerning the identity of the calves, and according to the "N.Z. Dairy Exporter" (1934) many eligible calves could not be marked because of uncertain parentage.

After the formation of the Dominion Group Herd Testing Federation in 1926, that organisation assumed control of Calf Marking and obtained a degree of Government protection for the scheme. For maximum effectiveness it was essential that there be one uniform system so that authenticity of identification and certification could be guaranteed. Hence the Federation's endeavours to obtain a monopoly by legislation, and this was partly achieved when the Government made an appropriate amendment to the Stock Act in 1927. However, the Federation lacked the statutory authority to enforce its monopoly.

Statistics on the early progress of the work are of a fragmentary nature for in some cases no records were kept, and in others, Associations which carried out calf marking have long since been defunct. Some idea of the trends can be gained from the following reports however. The "New Zealand Journal of Agriculture" (1928) reported that in 1927 calf marking was being carried out by eight Associations in the North Island, and the "N.Z. Dairy Exporter" (1930) recorded that by the end of the 1928-29 season over 16,000 calves had been marked since the inception of the scheme. Of these, about 11,000 were in the Waikato area. Later, it

was estimated that approximately 14,000 calves would be marked in the 1930-31 season (Hume,1930) and 13,000 in the following season (Hume,1931). Further statistics were not available until after 1936 (see Table XII).

TABLE XII. Statistics on numbers of marked calves since 1925.

Period	Source of Information	Number of Calves Marked	Number of Members
1925-26	N. Z. Co-op. H. T. A. (1926)	630	98
1925-28 (4 seasons)	"N. Z. Dairy Exporter" (1930)	16,000	-
1930-31	Hume(1930) Estimate	14,000	-
1931-32	" (1931) "	13,000	-
1936-37	N. Z. Dairy Board unpublished	8,299	826
1937-38	" " "	7,095	699
1938-39	" " "	5,115	494
1939-40	" " "	3,991	418
1940-41	" " "	2,769	276

Marked stock quickly came to command a premium. The "N. Z. Dairy Exporter" (1930) reported that " ... where sales have been made, these have been at prices appreciably above those ruling for (stock from) untested parents", and Hume (1931) stated: "In the Waikato district in particular a definite premium has been established for marked stock ... the seller can look for (a price of) at least two pounds more than for similar unmarked stock." Occasional special fairs were held exclusively for marked stock, but it appears that the total number of heifers sold in this way was not large. In the Waikato for instance, during the 1928-29 season over 5,000 calves were marked but Fulton (1929) reported that no marked calf fairs were held because insufficient calves were offered.

In 1930 the rules of the Marked Calf Scheme were amended to make it compulsory for a sire of marked calves to have butterfat backing. The new section of the rules stated:

> No calf is eligible for registration unless the sire is a registered pedigree bull and in the case of registered pedigree bulls born on or after 1st July 1931, no calf sired by such a bull shall be eligible for registration unless the sire's dam has produced in accordance

> with the following standards of butterfat:- For cows and heifers under G.H.T., O.H.T. and C.O.R. 305 day test, at 2 years of age at commencement of test, 250 pounds butterfat, plus one-tenth pound of butterfat for each day of age after two years (Dominion G.H.T. Federation, 1930).

Appropriate standards were also fixed for the 365-day test. Bulls eligible to sire marked calves were known as Certified Bulls.

The above change was part of a general reaction, evident at that time, to the frequent occurrence of inferior purebred bulls (see page 25), and with the growing evidence that the pedigree stock were not improving as rapidly as the grades (Hume, 1929), the mere fact that a bull was registered was no longer sufficient to place a hallmark on his progeny. The introduction of a butterfat production requirement for the sire's dam was an improvement, but it is to be noted that reliance was still placed on single records.

The New Zealand Dairy Board assumed control of Herd Recording in 1936 and in accordance with the Herd Testing Regulations 1936, the Dairy Board was given a monopoly on calf marking, with the necessary statutory power to prevent unauthorized organisations from operating similar schemes. The scheme operated in a manner similar to that employed previously by the Dominion Group Herd Testing Federation, but from Table XII (p.149) it is clear that from at least as early as 1936 there was a rapid decline in its popularity. There appear to have been two main reasons for this:

1. The scheme was in part replaced by the calf identification scheme introduced along with sire survey (see p.173).
2. The unsound basis of the scheme was becoming evident. There is evidence (Herd Recording Council, 1942a) that some farmers considered the Marked Calf Certificates as being of little assistance in selective breeding.

The scheme was reviewed by the Herd Recording Council in 1942, and as a result sweeping changes were made. The qualifying standards for the dams of marked calves had not

been changed since 1925, and in the meantime per cow production had increased by approximately fifty pounds (ibid). The Herd Recording Council was faced, therefore, with the alternatives of reviewing the standards or abandoning the Marked Calf Scheme. The latter course was adopted for three main reasons (N.Z. Dairy Board, 1942):

1. The difficulties of equitably increasing standards in view of the varying stages of productive ability in different districts.
2. Selection based on the dam's production only, unless based on a series of records, was recognized as being of little value.
3. The Marked Calf Certificate was expected to carry some assurance of high productive quality and this requirement had not been fulfilled in the past.

Evidence from daughter-dam comparisons of marked calves (see p.155) and from sire survey work indicated that the butterfat backing demanded of certified bulls under the rules of the Marked Calf Scheme was totally inadequate to provide reasonable assurances of above-average dairy merit in their progeny.

In view of the unsound basis of the scheme, the Herd Recording Department preferred to issue a "Certificate of Parentage and Butterfat Backing" which stated that the sire of the calf was a Certified Bull, and the dam a recorded cow. It would then be encumbent on the purchaser to assess the probable quality of the calf from the records given, and to study the environmental conditions under which they were made.

(c) The Merit Calf Scheme.

Following the discontinuance of the Marked Calf Scheme the Herd Recording Council made provision for the issue of "Merit Calf" certificates to the daughters of Official Proven Sires and recorded dams. No specific standard of production was required of the dam. Official Proven Sires were those bulls "fifty per cent of whose daughters under

Official Survey have produced an average of at least 350 lbs. fat" (N.Z. Dairy Board, 1948). This classification was considered sufficiently sound to receive the hallmark of the Herd Recording Movement, in the form of a special ear tattoo, since sufficient information was available to make a good assessment of the likely productive ability of a "Merit Calf" (Hume, 1942).

The chief advantages which could be claimed for the new scheme were:

1. It transferred the emphasis in selection from the dam to the sire.
2. It would encourage farmers to have their herd sires surveyed (ibid).
3. It would tend to make farmers keep their "proven" bulls longer and sell their progeny as "Merit Calves", or if, through danger of inbreeding (or other cause) a farmer wished to dispose of a "proven" bull, there would be a better chance of the bull being sold at a good price and retained in the industry instead of being slaughtered.
4. The changes would eliminate the growing confusion between "marked" and "identified" calves.

Increasing numbers of calves were being identified by tattoo for Sire Survey purposes (see Appendix VIII) and under the new system certificates could be issued for calves already identified by ear tattoo, which (regardless of the production of their dams) became eligible for Merit Calf Certificates subsequent to a satisfactory survey of their sires becoming available (Herd Recording Council, 1942a).

Subsequent events indicated, however, that the demand for any form of calf certificationwas practically at an end. Table XIII shows that only 561 Certificates of Parentage and Butterfat Backing were issued, the last application being in 1947-48 season, and only nine Merit Calf Certificates were issued altogether, none having been issued since

April, 1949 (Lawry, 1951).

TABLE XIII. Certificates of parentage and butterfat backing and merit calf certificates issued annually.

Season	Certificates of Parentage and Butterfat Backing	Merit Calf Certificates
1942-43	281	-
1943-44	187	-
1944-45	80	-
1945-46	-	-
1946-47	6	-
1947-48	7 *	5
1948-49		4 *
Total	561	9

- N. Z. Dairy Board Unpublished Data.

* Last issued

The poor response to these schemes can be seen as a consequence of the increasing emphasis being placed on Sire Survey which entailed large numbers of calves being tattooed as part of the scheme. The Certificate of Parentage and Butterfat Backing had little intrinsic value since the standard for Certified Bulls was low and no specific standard of production was demanded of the dam of the calf. In effect, almost as much information was available concerning identified calves as calves with Certificates and since, in any case, few commercial farmers were interested in s elling young stock there was little demand for certification.

There was even less demand for Merit Calf Certificates. It is probable that only "stud" breeders would wish to sell stock with such qualifications, and their stock would already be adequately identified. In addition, the small number of bulls qualifying as Merit Sires would limit the number of calves likely to be offered for sale. Thus, the salient reason for the decline of these schemes seems to hinge on the fact that once stock were identified so that their parentage and butterfat backing could be checked, there was little need for special certificates giving further information especially when such certificates were of use only

if such stock were to be sold as calves.

(d) The Effects of Calf Marking.

When the Calf Marking Scheme was introduced it was expected to play a major role in eliminating cull cows by providing a large number of superior herd replacements from recorded cows and registered dairy bulls. However, the work did not fulfil its purpose owing to insufficient support.

Whilst the number of calves marked in some seasons was considerable, it appears that relatively few were offered for sale, and, as a proportion of the total number of replacements required, they were relatively unimportant. It was estimated (Hume,1930) that in the 1930-31 season 14,000 calves were marked. These calves would come into milk in 1932-33, in which season there were approximately 290,000 cows in recorded herds. Assuming a low replacement figure of 15 per cent, 43,500 two-year-old heifers would be required, which means that even if all the calves marked in 1930-31 remained in recorded herds they would comprise less than one-third of the necessary replacements. On the same basis, in the 1938-39 season, marked calves would represent only one replacement in every five. It is obvious, therefore, that even if marked stock were superior to unmarked, their influence in raising production could not be very great. Since some doubt existed as to the quality of marked calves and the effects of the scheme, the Dairy Board, in 1936, instituted an enquiry to assess the results of the work.

Data were produced for the seasons 1929-30 to 1935-36 inclusive which indicated that there was a considerable margin of production in favour of the marked stock as compared with all tested stock (N.Z. Dairy Board,1937a). This was to be expected in comparing a selected with an unselected group.

Table XIV shows an analysis of the marked stock in 358 herds. In this comparison each age group of the marked stock showed a clear margin of superiority over the

corresponding unmarked group, but since herd differences were ignored, and it is likely that in the higher producing herds there was a greater proportion of marked calves, the results were not convincing.

TABLE XIV. Analysis of production records of 358 herds containing marked stock (1934-35).

	Marked Stock			Unmarked Stock			Difference
Age	No.	Fat	Days	No.	Fat	Days	lbs. fat
2 Yr. Olds	1,140	234	276	2,474	213	267	21
3 " "	907	272	278	2,379	247	271	26
Mature	1,762	314	282	11,417	291	-	23

N. Z. Dairy Board (1937a).

In Table XV however, the production of marked heifers was compared with that of their dams in the same herd (1933-34 season). When allowance was made for age differences there was evidence that the production of the marked heifers was lower than that of their dams when the average production of the dams was above the 300 pounds level.

TABLE XV. Analysis of comparison of production of marked heifers with dams in the same herd. (1933-34 season)

	Production of Dam	Heifer		Dam	
		No.	lbs. fat	No.	lbs. fat
2-year old heifers	Below 300 lbs. fat	96	257	96	254
	300-400 lbs. fat	208	267	208	349
	Above 400 lbs. fat	99	301	99	440
	Average	403	273	403	349
3-year old heifers	Below 300 lbs. fat	63	293	63	265
	300-400 lbs. fat	132	310	132	349
	Above 400 lbs. fat	65	324	65	439
	Average	260	309	260	351

N. Z. Dairy Board (1937a).

Whilst the numbers involved were rather small and the sample of herds well above average in production, there was evidence that the Certified Bulls in use were incapable of maintaining

production at the higher levels and that selection based on single records was unsatisfactory. Further evidence was produced in the preliminary work on Sire Survey (Ward,1936) that the breeding worth of many registered purebred bulls was far from satisfactory.

It became apparent, therefore, that whilst marked stock were, on the average, superior to the inelegible animals in the same herds, regression of the daughters' productions to the breed mean was responsible for disappointing progress, particularly in the case of dams with a single high record. Since the elegibility of the dam and the sire to beget marked calves depended on single records of production only, the basis of selection was not sufficiently accurate to permit worthwhile improvements. In addition, the numbers of calves marked were, at no stage, sufficient to play a major part in providing herd replacements in recorded herds, let alone the Dominion herd as a whole.

Nevertheless, it should not be thought that the Calf Marking Scheme was a total failure. On the contrary, it was a considerable factor in herd improvement, particularly as an educational movement. It drew the attention of farmers to herd recording, and hastened the more widespread use, firstly of registered pedigree bulls, and later registered bulls with butterfat backing. It encouraged some farmers to feed their cows better and to milk them a little longer each season in order to have them qualify as the dams of Marked Calves or Certified Bulls. It drew attention to the menace of the cull cow as a replacement animal and was a factor in making possible the policy of "cull cow drives" and the elimination of these animals by slaughter ("N.Z. Dairy Exporter",1928). Finally, the scheme prepared the way for the large-scale identification of calves made necessary by the extension of Sire Survey work, and calves identified in conjunction with the Marked Calf Scheme formed the basis of the first sire surveys.

CHAPTER IX

PRODUCTION REGISTERS

During the 1930's there was, amongst those interested in herd recording, a growing recognition of the ineffectiveness of dam selection on the basis of single lactation records. The low repeatability of single records is now more generally appreciated and provides one reason why selection on this basis was so disappointing. During the 1930's a trend toward the use of lifetime averages in selection was commenced as a measure likely to give a better estimate of a cow's breeding worth and an indication of her ability to produce economically over a long period. In 1939 the N. Z. Dairy Board adopted the principle of compiling a Lifetime Merit Register as one which emphasised the importance of continuous recording and provided a useful aid to the selection of stock.

1. The Lifetime Merit Register (1939)

On the recommendation of the Herd Recording Council, the N. Z. Dairy Board authorized the publication of the first Lifetime Merit Register (L. M. R.) in 1939. The Register was commenced on 1st July, 1939, and entry was governed by the following rules:-

1. Qualifying standard for entry in the Register shall be 2,500 lbs. butterfat.
2. Group records only will be recognized.
3. There shall be no correction for age and no restriction on the age at commencement of record (Herd Recording Council, 1939a).

Provision was made to permit entry of any cow which qualified prior to the opening of the Register provided the cow was individually identifiable at the time of application for entry.

The Register was at first limited to cows with "Group" records because these were the only records over which Dairy Board had control, and it was contended that lifetime production figures compiled under Group Herd Test conditions

gave a better indication of a cow's worth under commercial dairying conditions than did C.O.R. and O.H.T. records (ibid). In 1940, however, (Herd Recording Council, 1940c) entry was granted to cows with Certificate of Record and Government Official Herd Test records. This proved to be an important step forward, because a large proportion (60 per cent) of the industry's bulls were registered purebreds (N.Z. Dairy Board, 1943) and the compilation of a comprehensive lifetime merit register of pedigree cows has enabled discerning breeders and buyers to select their bulls from L.M.R. cows, a policy supported by the herd improvement authorities.

It became apparent, however, that certain cows whose annual production was too low to permit them to qualify as dams of marked calves (see p.147), could still, by great longevity, gain entry to the Lifetime Merit Register. To remedy this weakness a clause was added making it necessary for a cow to qualify "in not more than eight lactations." (Herd Recording Council, 1941c). This was limited further in 1944 when the time limit for production of the required 2,500 lbs. of butterfat was made "not more then eight successive years" (Herd Recording Council, 1944). More recently it has been suggested that the standard should be raised further by limiting the period to seven years (Herd Recording Council, 1950a). This followed an investigation which appeared to indicate that the male progeny of L.M.R. cows were not improving production as much as the sons of Intermediate Merit Register cows. The suggestion has been deferred pending further investigation (Herd Recording Council, 1950b).

Elite Lifetime Merit Register (1944).

The Elite Lifetime Merit Register was introduced in 1944 "for cows that have produced at least 4,000 lbs. of butterfat in not more than ten successive years" (Herd Recording Council 1944). Elite entries in the Register were denoted by capital letters.

Intermediate Merit Register (1944).

In order to provide a Register which would enable entries to be made of consistently high-producing cows which were not old enough to have qualified for entry in the Lifetime Merit Register, the Dairy Board approved the opening of an Intermediate Merit Register (I.M.R.), with the following rules in 1944:-

1. To qualify for entry in the Register a cow tested under Certificate of Record, Government Official Herd Test, and/or Group Herd Test must have produced in three successive lactations during a period of three successive years a total of at least 1,200 lbs. of butterfat, such total to be produced before the animal reaches the age of seven years (increased to 7 years 364 days in 1945). Such total shall, however, be reduced to 1,150 lbs. of butterfat where the cow commences the first qualifying lactation at an age of less than 2 years 183 days.
2. To qualify, a cow must have produced in each lactation at least 350 lbs. of butterfat, except in the case of a lactation commencing before the age of 2 years 183 days, the minimum standard for which shall be 300 lbs. of butterfat (Herd Recording Council,1944).

In 1951 the qualifying standard was reduced to 325 lbs. of butterfat in the case of lactations commencing before the age of 3 years 183 days, and 300 lbs. of butterfat for lactations commencing before the age of 2 years 183 days (Herd Recording Council,1951b).

Qualifying records for the Intermediate Register were based on the first 305 days of each lactation and it was necessary for owners to make application for entry of eligible cows in the Register (Herd Recording Council,1944).

2. Publication of Merit Registers.

The first four issues of the Lifetime Merit Register (1940, 1940-41, 1941-42, 1942-43) were published in the Annual Reports of the N.Z. Dairy Board. The list of pedigree cows was published separately, in alphabetical order, and in addition all pedigree and grade entries were listed according to herds. The Registers show the name of the testing member, the full name of the cow, herd book number (if registered), breed, total production (total milk, average

test and total fat), age at commencement and completion of the record. Since 1944 the name of the sire has also been given.

Each issue until that for the 1945-46 season incorporated all previous issues, new entries being made, previous ones brought up to date and completed records indicated by the words "final figures". More recently only supplementary registers have been issued, for cows currently in production, with an index to merit cows which have completed their records.

Since 1944 a special publication, the "Sire Survey and Merit Register" has been issued annually. This contains all details of the Intermediate and Lifetime Merit Registers. In the 6th Edition (1948-49 season) information was presented in the following sections:-

1. Complete register of merit pedigree cows, by breeds, giving name of cow, name of sire, herd-book number and reference to the edition of the L.M.R. or I.M.R. in which productiondetails last appeared. Elite entries appear in capitals.
2. Lifetime merit cows still in production, by breeds. Also grade cows but only those sired by pedigree bulls and officially identified are eligible.
3. Intermediate merit cows still in production, by breeds. Details of the three qualifying lactations are given.

3. The Value of Merit Registers.

It is the function of the Sire Survey Scheme to provide information concerning the production of the daughters of individual sires. In a similar way, on the female side, the purpose of the various Merit Registers is to make available a list of high producers of sound constitution, from which suitable dams of herd sires can be selected. By availing themselves of the information collected in the Sire

Survey and Merit Register, farmers can greatly reduce the uncertainty involved in selecting herd sires. It has been shown (Ward et al,1949) that selection of bulls from Merit Sires and out of Lifetime Merit cows has given the most satisfactory results, and that on the average, when the quality of the sire is not considered, the sons of Lifetime Merit cows have higher daughter averages than the sons of cows with single records over 600 lbs. of butterfat.

While publication of the names of cows qualifying for entry in the various Merit Registers gives prominence primarily to individual animals, a study of the complete Register provides information concerning various studs and various strains. It is the opinion of those responsible for compilation of the Merit Register that "concentration on those strains which have given proof of ability to produce consistently at a high butterfat level and to transmit desirable dairy qualities is a policy designed to effect an improvement in the general quality of the Dominion's dairy herd" (Ward and Lawry,1949).

To draw attention to studs with a minimum proportion of cows qualified for entry into the Merit Registers, the 7th Edition of the Sire Survey and Merit Register (1951) incorporated a "Merit Stud" section in which was listed "pedigree herds under Group Herd Test which have a minimum of six cows entered in the Merit Registers, representing at least forty per cent of the mature pedigree cows in the herd."

The present method of compilation of Merit Registers suffers from one serious weakness; cows must exceed an arbitrary qualifying figure regardless of the environment in which their records were compiled. A cow in a poor environment may greatly exceed the herd average and not qualify, while on the other hand a cow producing below her herd average in a good environment will qualify. There is no evidence to suggest that, as regards production, cows in different herds differ greatly in genotype. In New Zealand there is so much

buying and selling of sires that, with some exceptions there is probably little between-herds variation in breeding worth. The policy of using the actual record of a cow as an index of breeding worth, without any reference to the contemporary herd average has been criticised by Shrode and Lush (1947) on the grounds that it " ... assumes that general environmental differences between herds do not exist." In effect then, the present Merit Registers attribute all the between herd differences to heredity. There is a need for some modification of the existing system which will take cognizance of the considerable environmental differences known to exist between herds.. The N. Z. Dairy Board do attempt to overcome this deficiency by encouraging prospective buyers to visit the farm of the vendor in an attempt to assess the environment. Though this advice does meet, to some extent, the criticisms of the present scheme, it is far from satisfactory. Farmers' estimates of the environment are likely to be inaccurate especially when based on a single visit at a time when conditions may be far from typical.

Nevertheless the N. Z. Dairy Board's production registers are serving a useful purpose in directing attention to a sound basis of selection of herd sires, and the Herd Recording Council's advocacy of lifetime production records as an aid to selection has attracted increasing attention. The Herd Improvement Associations, through their annual Sire Procuration Catalogues, issued to " ... encourage herd imppove - ment through breeding by giving information concerning bulls of a standard to warrant the attention of the discriminating buyer" (Wellington Hawkes Bay H. I. A. ,1951), have stressed the value of Merit Registers in sire selection. Also, the classifications "Elite L. M. R. ", "L. M. R. " and "I. M. R. " are now widely used in the sale-ring, and auctioneering firms have shown their awareness of the publicity value of these qualifications by printing full details of the qualifyihg standards in their sale catalogues. For example, the Jersey National

Sales catalogue has regularly quoted this information since 1946 (Wright, Stephenson, 1946). Such publicity must be considered valuable in obtaining the more widespread adoption of sounder methods of sire selection, based not on single records, but on a series of production figures.

CHAPTER X

SIRE SURVEY

The progeny test, variously known when applied to bulls as sire survey, bull-testing or bull-indexing, has been defined by Lush (1945) as a means of " ... estimating the individual's heredity by studying its offspring."

The principle of using butterfat production records for this purpose has been applied for many years . Lush (ibid) stated that in the United States Department of Agriculture Yearbook of 1894 the proving of bulls and the continued use of sires of proved excellence were urged. In Denmark " ... organised progeny testing by means of testing records has been carried out ... for several decades" (Ward 1946a), and Larsen (1935) stated that progeny testing was commenced in that country in 1900. In the United States, much was written on the subject of progeny testing dairy bulls before Goodale, in 1927, introduced the Mount Hope Index (Prentice, 1942). This practical index, the outcome of extensive statistical research, gave impetus to the work of bull-indexing in America.

In New Zealand, the genesis of progeny testing was more recent. Prior to 1920, Certificate of Record Bulls and Champion Butterfat Bulls were classified on the performance of their daughters, but these bulls could not be accepted as adequately progeny-tested since only single records of a selected sample of their daughters were considered in making the awards.

About 1930, however, frequent references began to appear in the agricultural press to the need for progeny testing sires. "The Land of Efficiency" (1927) stated that "the records of at least five daughters of a bull should be compared with their dams' records in proving sires." The "Dairyfarmer" (1932) reviewed the Danish Progeny Performance

Test then in operation and commented upon the growing demand in New Zealand for bulls with butterfat backing. Soon afterwards the "N. Z. Dairy Exporter" (1934a) stated that there was " ... no doubt that the adoption of a system of determining on uniform and reliable lines the breeding value or index of bulls could give great assistance in the constructive breeding of dairy herds."

Prior to 1930 the officially recommended methods of herd improvement by breeding were:

1. The use of herd recording as a guide in the culling of low producers (Hume 1931c).
2. Support of the Marked Calf Scheme to increase the supply of replacements from superior dams (ibid).
3. The widespread use of registered purebred bulls.

This policy appeared sound until the evidence accumulated through continuous recording indicated that many purebred sires were lowering production in the herds they headed (see p. 25). In these herds dam selection was ineffectual in maintaining or improving production levels and a demand arose for more information concerning the breeding worth of herd sires. At first, a single record of a bull's dam was accepted as a likely index of a bull's worth, but following the publicity given to the overseas work quoted above (p. 164) increased attention was paid to the possibility of using the progeny test as an aid to bull selection in New Zealand.

1. The Need for Sire Survey

(a) The Relative Importance of Sire and Dam.

With unimportant exceptions, sire and dam play an equal part in the breeding of an individual animal. However, important practical implications lie in the fact that whereas a bull can be assessed by progeny test for his ability to transmit productive characters, the cow rarely has sufficient offspring to enable such a test to be conducted. In the case of the cow, therefore, reliance has to be placed on her own production records as an indication of her breeding worth.

Genetically, the best cow is not always as good, nor the worst cow as poor as their production records would indicate (Ward,1945). Thus when cows in one herd are mated to the same bull, an average of only 15 to 20 per cent of the difference in production levels between dams is transmitted to their daughters (Ward and Campbell,1940). Improvement by selection of replacement stock on the basis of the records of the dams was therefore rather slow, particularly when single records were used as the estimate of breeding worth.

Prior to about 1925 the individual merit of sires had been largely neglected, though it had long been realised that "the bull is half the herd" ("N.Z. Dairy Exporter",1935). Ward (1945a) postulated that about fifteen heifer calves would be sired by the average bull annually, and with a working lifetime of three to four years, approximately fifty heifer calves would be available from the average bull as compared with two or three from the average cow with an expected herd life of five to six years. "Therefore the bull is about twenty times more important than the average cow in determining the quality of future generations of dairy stock" (ibid). It is apparent, therefore, that if by progeny testing reliable estimates of bulls' breeding values could be obtained, the subsequent effect on the national herd would be considerable.

(b) The Findings of Preliminary Investigations.

When the New Zealand Dairy Board assumed control of Herd Recording in 1936, it authorised an investigation into the effect on production of sires then in use. The results, the more important of which are summarised below, were presented in a report to the Herd Recording Council in September, 1936 (Ward,1936).

Table XVI shows an analysis of the production of pedigree and grade stock recorded by the N.Z. Co-operative Herd Testing Association during the seasons 1932-33 to 1935-36 inclusive.

TABLE XVI. Analysis of production of pedigree and grade stock during seasons 1932-33 to 1935-36 inclusive (N. Z. Co-op. Herd Testing Association figures only).

	Two Years			Three Years			Mature			Total		
	No.	Fat	Dys	No.	Fat	Dys	No.	Fat	Dys	No.	Fat	Dys
Pedigree	4418	222	263	3820	249	267	13278	280	269	21516	263	268
Grade	74992	207	259	70548	237	263	264621	275	267	410161	256	265

This evidence that such a narrow margin of production existed in favour of the pedigree stock must have come as a rude shock to those with implicit faith in the superiority of the pedigrees

In Table XVII is presented an analysis of grade and pedigree stock in those herds in which some pedigree cows were tested in the Waikato during 1935-36.

TABLE XVII. Within-herds comparison of pedigree and grade stock, 1935-36 (N. Z. Co-operative Herd Testing Association only).

	Number of Cows	Lbs. fat	Days
Pedigree Stock	5,463	271	271
Grade Stock	18,350	279	268

The slight margin of production shown in favour of grade animals when kept under the same conditions as the pedigree stock was alarming, but since no analysis of the age composition of the two groups of cattle was given, conclusions other than the most tentative would be dangerous.

The above tables may be criticised on the grounds that they were based on data obtained from the Waikato where herd recording had been strongly established for many years. The sample might therefore include, in general, well-established herds which in many cases would really comprise unregistered purebreds. They would not, therefore, be typical of New Zealand grade herds at that time. Further the data were for pedigrees under Group Herd Test only, and it could be argued that these cows were in herds in which the owner was endeavouring to replace his grade cattle by pedigrees and in consequence practising little selection amongst the registered animals.

Such cows, it could be claimed, would be inferior to the average of the country's pedigree stock. Whilst it is probable that there is some basis for these objections, no direct comparison between all pedigrees and all grades was possible because of the small number of the former under Official test, the possibility of selecting cows to be recorded, and the differences in feeding conditions in pedigree and grade herds. Nothing was known of the productive ability of unrecorded purebred herds, but the average production of unrecorded grade cows was known to be approximately twenty pounds below that of recorded grades (N. Z. Dairy Board, 1937), and it was a fairly safe assumption that per cow production would be higher in recorded than in unrecorded pedigree herds.

Nevertheless, Ward (1936) commented that if these tables were indicative of the average producing ability of the pedigree stock, then the average ability of pedigree bulls could not be placed very much (if any) higher. Since a survey of herds recorded by the N. Z. Co-operative Herd Testing Association in the 1936-37 season showed that 70 per cent of herds were headed by pedigree bulls and 80 per cent of the herds were using replacement stock sired by such bulls (Herd Recording Council, 1937b), evidence indicating an unsatisfactory level of production in the registered purebred stock had serious implications.

Additional pertinent information was made available from a series of daughter-dam comparisons made "within herds" and "within seasons" involving 633 pairs in 1933-34 and 996 pairs in 1934-35 (Ward, 1936). In this sample of "Group" tested herds, daughters from dams producing below the general average improved on their dams; this improvement declined and reached zero as the dams' production reached the general average and as the production of the dams increased above the general average so did the production of the daughters fail by an increasing extent to maintain that standard. The daughters were all "marked" stock, in herds

above the Dominion average and it would be expected that greater care would be taken in selecting sires in such herds. The failure of these sires to further increase production was disturbing.

Finally, an analysis of herd averages of sixty herds which had been recorded for eight consecutive seasons showed that although cows in the lower levels of production had been eliminated, herd averages of the higher producing herds had regressed towards the mean of all herds in the sample (Ward, 1936). This indicated that despite recording and dam selection, the herd sires had been unable to maintain production at the higher levels.

With this evidence before it, the Herd Recording Council instructed the Supervisor of Herd Recording and the Technical Officer to proceed with the drafting of a Sire Survey Scheme.

When it is remembered that progeny-testing commenced in Denmark about 1900 (Larsen, 1935), and that the importance of the sire had been appreciated to some degree in New Zealand for several decades (see Singleton, 1915) it is pertinent to ask why a system for progeny testing sires was so long delayed in this country. Two suggestions were advanced by the "N. Z. Dairy Exporter" (1935):

1. Few herds were continuously recorded, so the necessary data for a general survey were not available.
2. The fact that at least three years must elapse before production records of a bull's progeny were available was a deterrent.

However, these were more in the nature of handicaps to a scheme, once introduced, than factors explaining its delayed introduction.

The outstanding fact seems to be that the widespread adoption of herd recording was a much later development in New Zealand than in Denmark. Prior to 1930 untried pedigree bulls were in general able to raise production in

the average grade herd, and while registration remained the chief criterion for bull selection, and registered bulls gave satisfactory results, there was little awareness of, and little interest in, overseas progeny test work. It was not until the late 1920's that complaints about the quality of purebred bulls became evident, and to counter this, breeders commenced to make bulls available with butterfat backing, usually in the form of a single lactation record of the sire's dam. Finally, when evidence began to accumulate indicating that dam selection on the basis of single records and sire selection on pedigree or single records of the dam were giving unsatisfactory results, some consideration was given to progeny testing. Hume (1951) stated, however, that the development of progeny testing was delayed for some time because the Herd Recording Movement lacked personnel with the necessary technical knowledge to attack the problems of evolving a Sire Survey Scheme until, in 1934, the necessary investigation was commenced by Mr. A.H. Ward, then Secretary of the New Zealand Co-operative Herd Testing Association.

The early investigations and subsequent development of Sire Survey were then hampered by the lack of a general calf identification scheme, for although calf marking had been in operation since 1925, it did not provide for the identification of all calves in the herd, which was an essential requirement for Sire Survey.

2. The Technique of Sire Survey

(a) The Preliminary Investigations.

Efforts to evolve a progeny test system which would be practicable under New Zealand conditions were commenced by Ward in 1934, and quickly received the support of the Dominion Group Herd Testing Federation. The greatest initial handicap was the lack of general identification of heifer calves, and at the outset only "marked" calves and registered purebred calves were included in the investigations. Trials

were carried out using various bull indices and age correction factors, and a number of private surveys were issued in graph form (Ward, 1951). The "N. Z. Dairy Exporter" (1935) reported that in the course of these investigations, the following general principles and techniques were tentatively adopted:- From testing members with complete herd records for a number of years a full list of the mates and daughters of individual sires was obtained. All normal lactations between 200 and 320 days duration were corrected to maturity equivalent by means of conversion factors (two-year-old record plus one third and three-year-old record plus one sixth appear to have been most commonly used), and averaged to obtain the effective average production for each daughter and dam. A graph showing the individual productions both of daughters and their dams was plotted. The principle was recognized that all records should be made available and any comparison between the production of daughters and dams should include the whole of such pairs available. It was stated (ibid) that "unfavourable comparisons of daughter-dam production are of equal importance with highly favourable comparisons." It was considered necessary to have at least ten daughter-dam pairs and a minimum of two effective lactations per animal before any conclusive evidence could be obtained as to the value of the bull (ibid). Candy (1936) reported that the investigations showed the immediate need for widespread continuous recording and the permanent identification of all heifer calves reared if a successful proven bull scheme was to be introduced.

When the Dairy Board assumed control of Herd Recording in 1936, Mr. Ward was appointed Technical Officer and was instructed to continue his investigations. In June, 1937, the Herd Recording Council accepted a draft copy of a proposed Sire Survey Scheme, and recommended to the Dairy Board that a Dominion-wide survey of sires should be instituted:

"(a) To provide a service for all testing members whereby the general effect of the sire in the herd may be

ascertained ....

"(b) To obtain much needed data on the inheritance of milk and butterfat producing qualities ....

"(c) To survey the economic aspect of present breeding trends in the Dominion and to suggest a basis for policy in future breeding practices." (N.Z. Dairy Board, 1937).

(b) The Technique of the Dairy Board Scheme 1937.

The general conditions covering the survey were as follows:-

Application for Sire Survey. - All requests for sire surveys must be made at the commencement of the season's testing, on the official form provided, and members must undertake to supply all the particulars required. Except in the case of a one-sire herd, the sire must be segregated from the herd and complete particulars of all service dates should be recorded on the shed sheets. The sire survey service is being made available free in order that an investigation may be conducted into all phases of the inheritance of milk and butterfat-producing qualities - for that reason members must co-operate by supplying all the information required. Information supplied in connection with any particular survey will be treated with the utmost confidence. Surveys will be divided into two classes:

(a) "Official" Surveys - These will include all surveys carried out in compliance with the following requirements -

(1) All daughters shall have been individually identified by tattoo as calves (except registered purebred Friesians) and nominated on the form provided before the commencement of their first test.

(2) The sire shall be individually identifiable at the commencement of the survey.

(3) The herd must have been under test during the two previous seasons.

(4) The number of daughters in the survey must be at least ten.

Surveys will be divided into three stages - preliminary, intermediate and final - and will be issued (provided the number of "daughter" lactations is sufficient) at the end of the first, second and third years of the survey respectively.

(b) "Private" Surveys for members' information only will include all surveys which can reasonably be carried out but which do not qualify for inclusion in the "official" class.

Surveys will only be carried out for sires at present in use in the herd.

Surveys are automatically discontinued if the herd is withdrawn from testing.

All daughters in milk in the applicant's herd must be included in every survey; details of daughters under test in other herds should also be supplied (N.Z. Dairy Board, 1937).

Only the first 320 days of any lactation were used in assessing

lactation yield, and the average production for any animal in the survey was taken as the average of all her available Group Herd Test records with the exception of the following:-

(i) Records subnormal due to abortion.
(ii) Records subnormal due to age (over 10 years).
(iii) Records subnormal due to sickness, disease etc., and where previous or succeeding lactation records confirm the subnormal nature of the record.
(iv) Any other records which are obviously subnormal due to conditions not natural to that herd or cow (N. Z. Dairy Board, 1941).

No charge was made for the service and no attempt was made to classify bulls by single indices of production, surveys being issued in graph form together with a detailed list of the average production of each daughter and dam.

The requirements for the three stages of the survey were defined as follows:-

(i) A 'Preliminary' survey is issued on the basis of the first lactation of all daughters in milk, with a minimum of ten.
(ii) An 'Intermediate' survey is issued when two lactations have been completed by at least eight daughters.
(iii) A 'Final' survey is issued when three lactations have been completed by at least six daughters (N. Z. Dairy Board, 1941).

A scheme for the identification of heifer calves was introduced, in which the recording officer tattooed all calves kept for rearing, recording the details of breeding and identification in triplicate on a Calf Allocation Sheet. Copies were then lodged with the Herd Recording Department, the Herd Improvement Association office and the farmer, to be completed two years later when the heifers entered the herd. The scheme was voluntary but in any one herd all calves had to be tattooed.

It was stressed at the outset that the Sire Survey Scheme should be essentially investigational in character and as complete information as possible should be obtained from the industry. For that reason "no discrimination should be made between data from registered and unregistered sires" (N. Z. Dairy Board, 1937). This policy met with considerable opposition from pedigree breeders who claimed that the surveying

of grade bulls would encourage their use. A majority of the members of the Herd Recording Council (1937), however, held the opinion that since Sire Survey was to be a service to recording farmers, no distinction could be made between those using grade and pedigree bulls, although it was suggested that only grade bulls then in use be surveyed. Eventually (N. Z. Dairy Board, 1941) the "official" service was confined to registered purebred sires, although a "private" survey could still be obtained for a grade sire.

Corrections for Age: When sire surveys were first introduced, dam-daughter comparisons were considered to provide the most informative data. This system entailed comparing records made by animals of different ages, and there was a need for conversion factors to adjust records to a uniform age basis. For this reason the subject was investigated by Ward and Campbell (1938) with a view to obtaining a set of conversion factors which, under New Zealand conditions, would be accurate without being unduly complicated.

From an analysis of the records of 702 cows of predominantly Jersey type, tested for at least six consecutive years under "normal and average" New Zealand herd conditions, they found that the results pointed quite definitely to the relationship between immature and mature cows being in the nature of a regression. They were unable to find any evidence supporting the theory that increase in production operates as a percentage addition from early age to maturity. A problem was encountered in deciding what should be regarded as the correct maturity equivalent, and for the purposes of daughter-dam comparisons for Sire Survey work, Ward and Campbell assumed that "in most cases the average production of the four lactations at four, five, six and seven years of age would constitute a reasonable interpretation of the maturity equivalent." For this reason the only correctionfactors used in sire survey work in New Zealand have been those converting two and three-year old records of daughters to a maturity basis.

Under the original technique of survey where, generally, not more than three records of a daughter were compared with the lifetime record of her dam, it was considered advisable to use a conversion factor which took into account the fact that the averages of the daughters were more likely to be affected by fluctuations in climatic and herd conditions than the lifetime averages of the dams. In other words, the factor corrected for imperfect repeatability of records as well as for age. Lush (1945a) pointed out that such a factor should not be called an "age" correction factor, but since it gave the probable future production of a cow it was the correct factor for its intended purpose. Relative to their records the lower producing daughters were given a bigger correction than daughters in the higher production levels, the assumption being that adverse environmental conditions had been a factor contributing towards the lower record of one daughter, whereas the high producing daughter's record had been made under more favourable environmental conditions (Ward et al,1947). This interpretation was based on an analysis by Ward and Campbell (1938) of the lifetime records of approximately 1,500 cows. The cows were classified according to their production records at two years of age and the actual increase from two years to maturity was obtained for all levels of two-year-old production. The results of this analysis indicated that on the average the low-producing two-year-olds increase to maturity by a greater actual amount than the higher producing two-year-olds. On the basis of this work, the following conversion factors were introduced:-

3/4 of the two-year-old record + 150 lb. fat = maturity equivalent (lb. fat).

7/10 of the three-year-old record + 140 lb. fat = maturity equivalent (lb. fat).

These corrections were employed for Jerseys, Ayrshires and Shorthorns. A similar equation but one resulting in a higher correction was used for Friesians (Ward et al,1947).

(c) Changes in Technique.

When the Sire Survey Scheme was formulated in 1937 it was fully expected that progressive changes in the technique would be made as they became necessary. Ten years later Ward et al (1947) replying to comment on the frequent changes in method wrote: "It is essential that the technique of sire survey, dealing as it does with individual bulls and providing information for the individual breeder and herd owner, should continue to be investigated and the technique improved in accordance with the conclusions drawn from such investigations. The fundamental principles established at the outset of sire survey work have been consistently maintained; the changes that have been made are refinements necessary to give effect more fully to those principles."

The chief changes which have been made are as follows:-

1. In 1943 the length of lactations considered for sire surveys was altered from between 100 and 320 days to between 100 and 305 days (N.Z. Dairy Board,1943).
2. In the 1945-46 season the daughter-dam comparison was made a "within season" comparison, the "all-daughter" average being given also (N.Z. Dairy Board,1946).
3. From the 1949-50 season the surveys were issued in the form of a daughter-mature cow comparison on a "within season" basis, the "all-daughter" average remaining a constant feature.

The reduction of lactation length from 320 to 305 days was made on the recommendation of a sub-committee of the Herd Recording Council which was appointed in 1943 to review critically the progress of the Sire Survey Scheme. This sub-committee criticised 365-day recording as being unsuited to New Zealand's seasonal dairying and suggested that the first 305 days of lactations be made the basis of all herd recording work (N.Z. Dairy Board,1943).

The change to a "within season" daughter-dam

comparison was made necessary by the fact that originally no allowance was made for daughters and dams making their records in different seasons, and consequently some surveys were apt to be misleading unless details of seasonal conditions were available when interpreting the survey. Thus Ward (1946) stated that "toward the end of the 1945-46 season it became obvious that the daughter-dam comparison based on all normal lactations of daughters and dams would penalise a number of sires with daughters whose first records were being made in the 1945-46 season under drought conditions." The change to a "within season" comparison meant that the daughter's production would be compared with that of her dam in the same season, and records for a daughter whose dam had no comparable record, whilst being included in the average for all daughters, would be excluded from the daughter-dam comparison. This, in turn meant a considerable reduction in the number of daughter-dam pairs available for comparison, and "in approximately 20 per cent of the surveys less than five daughter-dam pairs were now available for comparison," (Ward,1946) five being the smallest number of pairs on which a reasonably reliable comparison could be based (Ward,1947a). However, Ward (ibid) maintained that in most cases the disadvantage of small numbers was more than offset by the increased reliability of a "within season" comparison, and whilst this may have been true, there was a strong possibility that a survey would be unduly biassed by a single high or low production figure. Furthermore, it was possible to have more than one daughter of a single dam in the survey and if that dam was much above or below average she could exert undue influence on the result.

The daughter-dam comparison method had the further disadvantage that the dams were a selected sample, being, on the average, eighteen pounds of butterfat in excess of the average for normal mature cows in the same herd (Ward and Lawry,1948). Since the daughters of a bull replace other cows as well as their own dams (some cows having more than one

daughter), this consideration was important in interpreting a bull's value.

The change in Sire Survey technique (in 1945-46) to a "within season" daughter-dam comparison made it necessary to reconsider the basis for correcting immature records, since the change automatically took seasonal variation in herd environment into account. Also, because the number of records used in the comparison was the same for both daughters and dams, any correction for imperfect repeatability made on the daughters' records would also have to be applied to the dams' records. It was emphasised by Ward et al (1947) that the correction factor was not meant to forecast the actual production at maturity of individual daughters, but to arrive at an average maturity figure for all daughters of a particular sire, comparable with the records of their dams in the same season, the latter being actual mature records.

Extensive analyses comparing the results of groups of two-year-old cows on different levels of production with the production of mature cows under similar conditions indicated that where environmental conditions are reasonably stable there is no significant difference in the increase to maturity for low-producing, as compared with high-producing cows (Ward et al, 1947). They concluded, therefore, that a constant addition can be used for converting two and three-year-old records to maturity. This conflicted with the earlier work of Ward and Campbell (1938) based on an analysis of the lifetime records of 1,500 cows (see p.175). As the dams' records which were used in the comparison were made in the age-range from four to nine years inclusive, the average of the lactations in that period was used as the basis for maturity (previously an age range of four to seven years inclusive had been used).

The correction factors adopted to convert immature records to their probable maturity equivalent were as follows:-

Breed	Correction applied to 2-year-old record	Correction applied to 3-year-old record
Ayrshire	80 lb. fat	40 lb. fat
Friesian	90 " "	45 " "
Jersey	70 " "	35 " "
Shorthorn	80 " "	40 " "

(Ward and Lawry,1949)

These figures were based on:

1. An analysis of the production records of approximately 22,000 pedigree cows tested in the 1937-38 and 1938-39 seasons according to the age of the cow.
2. A comparison of the average of two-year-old and three-year-old cows with the average of mature cows in the same herd in the same season, 1,330 pedigree and grade herds being included (ibid).

For breeds other than the Jersey difficulty was experienced in obtaining sufficiently large samples from which to obtain reliable estimates.

A check was carried out on the factors after they had been in use one season by grouping the records of daughters appearing in all Intermediate and Final Surveys issued in 1947 in two year, three year and mature (four to nine years) age classes. A total of 708 surveys was included but of these 516 were for Jersey bulls. The check justified the factors used for Jerseys, but results for the other breeds, based on much smaller numbers, did not reveal the same consistency (Ward et al,1947).

Since present methods of herd recording in New Zealand give but an approximation of individual lactation yields (Campbell,1946), it is not essential that correction factors should be highly accurate. It is important, however, that they be consistent, since even small differences between breeds will tend to bias the results of surveys when breed comparisons are made.

The "within-season" daughter-dam comparison was replaced, in the 1949-50 season by a "within-season"

daughter-mature cow comparison. In compiling this survey, the daughter average is calculated, as in the past, from all lactations for daughters in milk 100 days or more, with the exception of lactations between 100 and 200 days which are obviously abnormal or which are ruled abnormal following appeal by the member. Records are corrected to maturity and limited to 305 days. The mature cow average is based on normal records of cows four to nine years of age inclusive, and in milk 100 days or more but excluding the daughters of the bull under survey.

It will be noticed that in the calculation of the daughter average, all lactations receive equal weighting. Theoretically, each daughter should weight the survey equally regardless of her number of lactations but in practice it is found that much work is saved and little error introduced if the daughter average is taken as the average of all lactations. In any instance where the survey is obviously biassed by this method the individual daughter averages are used (Castle, 1951).

In publishing the results, the Herd Recording Council (1950) decided that if a daughter-mature cow comparison were given in full it would be tantamount to publishing the herd average, a figure which is regarded as confidential. Consequently published results show:

1. The corrected all-daughter average.
2. Results of the daughter-mature cow comparison in a form which shows the margin by which the bull's daughters exceed or fail to reach "expectancy" ("N. Z. Dairy Exporter", 1950).

"Expectancy" is defined as the average production of the daughters of all bulls surveyed in herds where the mature cow average is the same as in the herd in which the bull under consideration has been surveyed (ibid). Expectancy tables have been in use since 1943 as an aid to the interpretation of sire surveys and, prior to 1950, when surveys were issued as a daughter-dam comparison, Expectancy tables were published

annually. With the introduction of the daughter-mature cow comparison in 1950, however, the new Expectancy table was not published because it would enable farmers to calculate confidential herd averages (ibid,1950) (see also p.189).

(d) Summary.

The present mechanism of Sire Survey may, therefore, be summarised as follows:-

(1) Identification:

(a) The whole herd is recorded.

(b) In co-operating herds all calves reared are identified and those not coming into milk must be accounted for.

(c) Except in one-sire herds the sires must be segregated from the herds and complete records kept of all service dates.

(2) Application:

(a) Surveys are now (since 1950) automatic, surveys being made and published without application.

(3) Eligibility:

This determines whether a survey will be "Official" or "Unofficial" (private).

To qualify for an official survey:

(a) Identification must be provided as above.

(b) The sire must be a registered purebred animal.

(c) There must be at least ten daughters.

An "Unofficial" survey may be provided if one or more of the above conditions are not fulfilled.

(4) Compilation:

The survey is in the form of a daughter-mature cow comparison on a within season basis.

"Official" Surveys are compiled in Preliminary, Intermediate and Final stages.

If between six and ten daughters are available a "Preparatory" survey may be made for the owner's information only.

(5) Publication:

See next section.

3. The Publication and Classification of Surveys

(a) Publication.

During the first years of the Sire Survey Scheme, surveys of individual bulls were not published, the service being chiefly aimed at providing information to the farmer on his own herd sires. In any case, few Final surveys were completed until three years after the commencement of the Scheme. However, since one of the main phases of sire survey work was "to provide information on which strains of our pedigree cattle are providing sires of good and outstanding merit" (Ward, 1941a) it was essential that results be published as soon as the technique of survey was proved satisfactory and a reasonable volume of information was available.

Accordingly, in 1941 the first list of Official Proven Sires was published in the Annual Report of the N. Z. Dairy Board (1941). It contained 71 Final, 29 Intermediate and 42 Preliminary Surveys. The basis for qualification as an Official Proven Sire was as follows:-

> All those bulls 50 per cent of whose daughters under Official Survey have produced an average of at least 350 lb. fat. Also certain bulls 50 per cent of whose daughters have produced between 340 and 350 lb. fat where the average increase in production as compared with their dams has been sufficient to qualify a bull as having a reproducing ability of approximately 350 lb. fat (Ward, 1941a).

Further lists of Official Proven Sires were published in the N. Z. Dairy Board Annual Reports for 1941-42 and 1942-43.

In 1943 the Herd Recording Council's sub-committee which was set up to review sire survey work, recommended that all surveys should be published irrespective of their results (N. Z. Dairy Board, 1943). The use of the term "Official Proven Sire" was then discontinued and bulls which reached the standard previously required for that title became known as

"Merit" sires (N. Z. Dairy Board, 1943). Such bulls were eligible to sire "Merit" calves (see p. 151).

An important innovation was the publication, in 1945, of the first Sire Survey and Merit Register, giving details of all surveys issued up to the end of December, 1944. Subsequent volumes have been published annually, summaries only being contained in the Dairy Board Annual Reports. The surveys of "Merit Sires" have been printed in distinctive type.

(b) Classification of Surveys.

The qualifying standard for "Merit sires", of 350 lb. fat for 50 per cent of the daughters, had the disadvantage that it made little allowance for the degree of improvement or otherwise of daughters over their dams. "For example a sire mated to dams averaging 414 lb. fat leaving daughters averaging 351 lb. fat qualified as a 'Merit Sire'; whilst a sire mated to dams averaging 309 lb. fat, leaving daughters averaging 347 lb. fat did not reach the qualifying standard" (Ward, 1946a). In 1946, therefore, the standard was altered on the basis of the assumption "that 40 per cent of the difference in production between daughters and dams can be attributed to the influence of the sire, so that for a sire whose daughters average less than their dams, 40 per cent of the difference between daughters and dams is deducted from the daughters' average, and only if the corrected figure is still over 350 lb. butterfat does the sire qualify as a "Merit Sire". Similarly, for sires whose daughters average more than their dams, only if the daughters' average plus 40 per cent of the difference between the average of daughters and their dams amounts to 350 lb. of fat, or better, does the sire qualify as a "Merit Sire" (Ward, 1946a). Classification was to be based on Final surveys only (N. Z. Dairy Board, 1946). The standard was no longer based on the average of 50 per cent of the daughters.

However it was later (1947-48 season) decided to classify bulls as Merit Sires on Preliminary and Intermediate as well as Final surveys. An examination of a large number of surveys showed that if 350 lb. fat was the minimum "Merit" requirement in Final surveys, then the levels which bulls on Preliminary and Intermediate survey should reach to be classed as "Merit" were 380 and 370 lb. butterfat respectively. It was estimated that 95 per cent of bulls classified as Merit Sires on this basis for Preliminary and Intermediate surveys would achieve "Merit" status on Final survey (Herd Recording Council,1948a). In the 1947-48 and 1948-49 seasons, therefore, a bull qualified as a Merit Sire if the corrected average of all daughters (plus or minus 40 per cent of the difference between daughters and dams) was 380 pounds, 370 pounds and 350 pounds of butterfat for Preliminary, Intermediate and Final surveys respectively (Sire Survey and Merit Register,1949).

In the 1949-50 season, a further change was made. The butterfat standards remained the same and a bull qualified as a Merit Sire:

(a) If the average of all daughters of the sire reached the qualifying standard and is equal to or above the 'Expected' average for his daughters.
or
(b) If the average of all daughters of the sire is below the qualifying standard but is above the 'Expected' average ('Expectancy') of his daughters he will qualify as 'Merit' if his daughters average plus forty per cent of the difference between the daughter average and the 'Expected' average reaches the qualifying standard (Sire Survey&Merit Register, 1951).

4. Discussion of the Existing System of Sire Survey

Perhaps the outstanding feature of Sire Survey to the average New Zealand farmer is the difficulty and frequently the impracticability of having a bull surveyed. With natural mating predominant, the average herd size of approximately fifty-five cows in recorded herds is insufficient to permit the rapid survey of sires when ten daughters are

required. Farmers naturally wish to exploit an old and tried bull to the maximum, and in herds of average size there is little scope for doing this and saving sufficient progeny from a young bull to give an early survey simultaneously. This fact is well demonstrated by Table XVIII which shows that of 461 sires first surveyed in 1945 only 8 per cent were five-year-old animals and 55 per cent of these surveys were preparatory only (see p. 181). Of 367 sires for which further information was available only 41 per cent were still in use in the herds in which they were surveyed and 40 per cent were already dead.

TABLE XVIII. Analysis showing age in 1945 and history of sires surveyed for the first time in 1945.

Sire's age in Spring 1945	Stage of Survey			Total all stages		Sire's age in 1945	Sire's history where available				Details not available
	Prep.	Int.	Final	No.	%		Still in use	Sold for dairying	Dead	Total	
5 yrs.	28	8	-	36	7.8	5 yrs.	22	4	3	29	6
6 "	84	40	-	124	26.9	6 "	53	15	25	93	31
7 "	76	45	7	128	27.7	7 "	41	23	42	106	22
8 "	38	29	15	82	17.8	8 "	18	13	33	64	18
9 "	11	17	6	34	7.4	9 "	4	7	19	30	4
10 "	10	13	5	28	6.1	10 "	6	5	11	22	6
Over 10	4	16	9	29	6.3	Over 10	6	3	14	23	7
Total	251	168	42	461	100	Total	150	70	147	367	94
%	55	36	9	100		%	41	19	40	100	

N. Z. Dairy Board Unpublished Data.

The position is further elucidated by Table XIX which shows an analysis of the average number of daughters entering herds each year for 781 sires under survey. Only 19 per cent of the sires surveyed had ten or more daughters entering a herd following their first mating season and 58 per cent following their first two mating seasons. These findings raise the question as to whether the widespread progeny testing of sires under New Zealand conditions can yield sufficiently valuable information to compensate the majority of farmers

for the extra expense and inconvenience involved in retaining sires until they are adequately surveyed.

TABLE XIX. Average number of daughters coming into the herd each year for 781 sires under survey.

No. of Daughters	1st Crop		1st & 2nd Crop		1st 2nd & 3rd Crop		1st 2nd 3rd & 4th Crop	
	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %	No.	Cumulative %
1	75	10						
2	84	20	8					
3	68	29	12	3	1			
4	90	41	20	6	2			
5	58	48	20	10	3			
6	91	60	47	17	9	4	2	
7	68	68	39	24	7	5		
8	65	77	57	33	10	8	4	
9	37	81	56	42	31	14		
10	38	86	53	50	19	19	2	3
11	42	92	34	56	20	24	5	
12	22	94	38	62	28	31	5	8
13	7	95	43	69	21	36	10	12
14	11	97	37	75	28	42	8	15
15	9	98	29	79	19	47	14	21
16	4)		20	83	20	51	12	27
17	2)		20	86	21	56	11	31
18	5)	100	23	90	23	62	5	33
19	1)		13	92	22	67	10	38
20	2)		14	94	17	71	10	42
21-25	2)		26	98	77	89	55	66
26-29			10)		24	95	37	82
30 & Over			2)	100	22	100	43	100
Totals	781		621		424		233	

- N. Z. Dairy Board Unpublished Data.

From the point of view of technique the existing system has two serious weaknesses and a number of relatively minor ones. The greatest weakness lies in the difficulty of assessing the environmental conditions under which a bull is proven. There is a paucity of information on the effect of surveying the same sire under different conditions. The translation of results from one set of conditions to another is full of uncertainty. Some information on this problem is being obtained from artificially bred daughters of the same bull in different herds (Ward, Castle and Lawry, 1950), but perhaps more precise information concerning the importance of environment could

be obtained by the more extensive use of identical twins.

In view of the great variation in regional and even local environments, some injustice arises from the enforcement of a Dominion-wide standard for Merit Sires. Thus, it is easier for a bull to reach "Merit" standard in Taranaki where the recorded per cow production average is nearly 300 pounds of butterfat, than in Northland where, due chiefly to the less favourable environment, the average per cow production is about fifty pounds lower. Despite constant advice to the contrary, the term "Merit Sire" has come to be accepted by many farmers as an infallible measure of superior breeding worth, and a vigorous educational programme on survey interpretation has been, and still is, necessary. In actual fact, many good bulls, used in herds of poor average production cannot qualify, whilst at the higher levels of production, bulls as good as, or better than average, used in herds with a mature-cow average above 380 pounds of butterfat have reasonable chances of qualifying as Merit Sires. The same sire, used in two herds on different planes of production may qualify as Merit Sire on a survey of his daughters in the high producing herd, but fail to qualify when surveyed in the low producing herd. This is a distinct weakness of the classification, and it emphasises that in the interpretation of sire surveys it is essential to study the amount by which the daughter averages exceed or are below "Expectancy".

It appears that farmers prefer to have some hallmark placed on superior animals, but at present the possibility of misinterpretation of the "Merit" classification reduces its value. The prospects of increasing its validity by imposing regional standards must be discarded because of the considerable variability within districts and because of the need for simplicity and uniformity in the Sire Survey System. An alternative which has much to recommend it is to abandon the present requirements for a Merit Sire and replace them with a Merit Sire classification which pays more

attention to the amount by which the daughter average of the sire is above or below "Expectancy".

The second major weakness of the existing Sire Survey Scheme is that surveys are based, in general, on unauthenticated Group Herd Test records. For the commercial farmer, interested only in his own butterfat production, this may be of little importance, but where, as with pedigree breeders, the results of the survey of a bull may determine to a large extent the market value of his progeny, the incentive for falsification of records is considerable. In addition, identification of calves depends entirely on the farmers' integrity and apart from deliberate falsification there is a distinct possibility of calves being incorrectly identified, especially where they are not temporarily marked at birth with a mark which will persist until they are tattooed. Also, Stewart (1951) has drawn attention to the likelihood of mistaken paternity where two bulls are run with heifers at intervals separated by but a few days.

While criticisms of the Sire Survey System on the grounds of unauthenticated records and variable environments are valid, they are to some extent academic, for so frequently the ideal is not practicable. Large scale Sire Survey in New Zealand must, of necessity, be based on the existing recording system which has been proved practical and economical, and while natural mating predominates the need to survey large numbers of bulls will continue. In these circumstances sires will have to be surveyed under diverse conditions. If artificial insemination achieves widespread use consideration should be given to the introduction of a scheme such as operates in Denmark for the proving of a small number of selected sires under uniform conditions (Ward, 1946a). This may be a development of the future in New Zealand, but meanwhile, the present system, modified if necessary, should continue to operate and should have beneficial effects.

A number of relatively minor factors of which the present use of the Expectancy table is most important, are worthy of comment. The Expectancy table is compiled each season by plotting "daughter average" against "mature cow average" for all the surveys completed in that season. Each survey is treated as a unit, and with the number of surveys at present being completed annually (see Table XX, p.193) there is ample data at the middle and lower levels of production on which to plot the relationship between "daughter average" and "mature cow average", a relationship which appears to be linear. For surveys in which the "daughter average" and/or "mature cow average" exceed about 400 pounds of butterfat, however, there is insufficient data to give an accurate "plot" and "expectancy" is calculated by straight line extrapolation (Castle,1951). More information is required on the validity of such a procedure. More data is also required on the manner in which "expectancy" varies from season to season, for this variation may cause apparent anomalies at different stages of a survey. Further, as more data is accumulated, separate "expectancy" values for different breeds may prove to be necessary. Thus, present indications are that "expectancy" for Friesians is slightly higher than for the other breeds (N.Z. Dairy Board,1951). If breed differences do exist, then slight anomalies will occur when sires are surveyed on the results of cross-bred daughters. At present, in such cases, the breed of the sire determines the correction factor to be used, this being another source of slight error. Also, consideration may have to be given to heterosis in cross-bred animals, although as yet the occurrence of this phenomenon in dairy cattle has not been conclusively demonstrated (Robertson,1949).

Herd improvement authorities in New Zealand have attached considerable importance to the relationship between butterfat test and butterfat production within a breed, as an adjunct to the use of sire surveys in bull selection. From

an analysis of 1204 sire surveys Ward (1944) showed that within a breed (Jersey) high butterfat test of the milk was closely associated with high butterfat production. Consequently, considerable publicity has been given to the study of butterfat test as an aid in selecting dairy stock, on the grounds that " ... a far greater number of herds or bulls will be found in the high butterfat production groups if the average fat percentage for cows in those herds or daughters of those bulls is above average" (Ward,1945).

The attention devoted to butterfat test as an aid to selection appears to be out of proportion to its importance. A degree of association between high test and high production is indisputable, but high test is not an end in itself; it is only a guide to where high levels of production may be found. Where high production has been achieved, then butterfat test is of secondary importance.

The present method of issuing surveys as a daughter-mature cow comparison is a considerable improvement on previous techniques. However, with the existing form of publication of the daughter-mature cow comparison (see p.180), the interpretation of surveys by intending purchasers has been made more difficult, for neither the mature cow average nor the Expectancy table from which the latter average could be obtained, is published. The average farmer can gain little information concerning the level of production of herds where surveys are conducted unless he uses Expectancy tables compiled and published in previous seasons (for daughter-dam rather than daughter-mature cow comparisons), and these may merely lead him into error.

It has been the policy of the Herd Recording Department to recommend that intending purchasers of dairy stock should visit the farm on which the stock were reared or on which their records were made, and attempt to assess the environmental conditions under which the records were compiled. The principle is sound but is limited in its practicability.

The assessment of environmental conditions under which records were made, after the records have been completed, from a visit to the farm is extremely difficult. The appraisal of environment in the light of month by month variation in feeding conditions requires considerable skill.

One of the main objects in visiting the farm must be to study the available production records, particularly the mature cow average which provides a measure of the environment. From a study of the records, discussion with the breeder, and an inspection of the stock and the farm, a buyer may be able to make a sound choice. However, farmers are physically restricted in the number of farms they can visit, and more information is required to indicate those studs which might most profitably be inspected. The Herd Improvement Associations' Sire Procuration Catalogues (see p.162) and the N.Z. Dairy Board's Merit Stud list (see p.161) meet this need in part.

A simple and most effective method of identifying likely sources of cattle of high dairy merit would be to publish mature cow averages. This information is now treated as confidential, on the grounds that its publication would penalise breeders farming under unfavourable environmental conditions, and would encourage undesirable competitive practices. The treatment of herd averages as confidential information is, to some extent, a relic of the days when many farmers had to be persuaded to test. Now that recording is more widely practiced, and some Herd Improvement Associations have waiting-lists for admission of new members (Candy,1949), a change of policy should be considered. The likely gains from a more positive approach to the use of herd records, which would include publication of herd averages, would seem to outweigh the disadvantages of such a change. The practice would not be without precedent for in Denmark a herd summary for every herd under test is published annually in the annual reports of the Association of Milk Recording Societies (Milk

Marketing Board, 1946). Also, in the publication of sire surveys in New Zealand information on the average length of lactation of the sire's daughters would serve as an indicator of persistency and seasonal conditions. At present no allowance is made for length of lactation, and the sires of late calving animals are penalised.

In New Zealand, then, where environment varies so widely, farmers must be educated to interpret production records in the light of existing environmental conditions. Where incomplete information is published, their efforts to select stock by enlightened methods may be hampered. In assisting farmers in the interpretation of herd recording data, the N.Z. Dairy Board's consulting officers, now increased to nine in number, (Herd Recording Council, 1951b) will play an important part.

Despite the shortcomings of the existing Sire Survey Scheme, the "educated" farmer can, if he takes the trouble, derive much information from a study of surveys published in their present concise form. In the past, farmers' understanding of Sire Survey has been retarded by the frequent changes in survey technique. However, it appears now that a technique which is reasonably sound has been evolved, and if such proves to be the case farmers will have the opportunity to become more familiar with it, and their task of interpretation will be made easier. That in turn will mean that more advantageous use will be made of survey information.

5. The Application of Sire Survey Results

Sire Survey, introduced in 1937, was retarded in its early stages by farmer apathy, lack of calf identification and the check imposed on all recording services by World War II. Nevertheless, considerable progress has been made. Prior to 1943 the publication of surveys was optional, and the first lists of proven sires, issued in the 1940-41 season comprised only sires reaching a certain minimum

standard. In 1943 when surveys were compulsorily published for the first time, results of approximately 600 official surveys were made public (N. Z. Dairy Board, 1943). Ward (1943) stated that by the end of the 1942-43 season 1,395 "Official" and "Private" surveys had been issued. In 1945 the first edition of the Sire Survey and Merit Register was issued which contained, in consolidated form, results of surveys previously published and those issued between the end of the 1942-43 season and December, 1944. In the seven editions of this booklet so far issued, details of 3,784 official surveys, including approximately 2,770 Final surveys have been published. Table XX shows the available statistics on the number of surveys completed.

TABLE XX. Summary of Sire Surveys issued and published (approximate figures only).

Year	Bulls surveyed (pedigree and grade)		Surveys published (official)	
	New surveys	Total surveys (cumulative)	Individual editions	Cumulative total
1937-38	100	100		
1938-39	110	210		
1939-40	220	430		
1940-41	290	720		
1941-42	360	1080		
1942-43	320	1400	600	600
1943-44	470	1870		
To Dec. 31st 1944		1870	827	827
1944-1945			1141	1148
1945-46			361	1509
1946-47			1212	2017
1947-48			1246	2579
1948-49			1289	3014
1949-50			1722	3784

- N. Z. Dairy Board, (1948); Sire Survey and Merit Register, (1951).

The Sire Survey Scheme had not long been in operation when it became apparent that surveyed sires did not, on the average, increase production in the herds in which they were proved. In February, 1943 the Herd Recording Council set up a sub-committee " ... to make a critical review of the sire survey work carried out ... and to prepare

a plan to put into effect in the dairy industry the steps necessary to attain the goal indicated as appropriate from sire surveys" (N. Z. Dairy Board, 1943). The report of this sub-committee has been reviewed elsewhere (see p. 46). The 1,078 surveys then completed indicated that only one in three of the bulls surveyed had improved production and Table XXI condensed from Ward (1942) further illustrates that most of the bulls improving production were used in "below average" herds.

TABLE XXI. Results of Surveys issued to 31-10-42.

Average production of mates of each sire (pounds fat)	Number of Surveys	Results of Surveys		
		Bulls improving per cent	Bulls maintaining per cent	Bulls lowering per cent
400 and over	88	6	20	74
340 - 359	203	24	37	39
Below 300	151	73	18	9
Total for all Surveys	1078	32	31	37

The sub-committee concluded that this situation had arisen " ... because the grade herds in which these bulls have been used approximate the same level of production as the pedigree stock from which the herd sires are drawn." However, Hamilton (1944) pointed out that the sample of sires examined was a highly selected one since sire survey could only be conducted in herds where complete records of production and matings were available, and the owners of such herds were likely to have exercised more than ordinary care in the selection of their herd sires. However, these better-than-average sires were mated to better-than-average cows (mature average 343 lbs. of butterfat) and Hamilton (ibid) concluded that if all bulls in the industry could be placed under survey the proportion of sires improving, maintaining, or lowering production would probably be substantially similar to that of the selected sample under discussion. While there is some truth in Hamilton's interpretation of the situation, the

results shown in Table XXI probably exaggerated the seriousness of the position. It seems likely that the widely practised methods of sire selection had not enabled breeders to select sires of registered bulls with the same degree of accuracy possible in the selection of dams and that the sample of bulls included in the early sire surveys may not have been as highly selected as the cows to which they were mated. Consequently, under survey they showed poor results.

The recommendations of the 1943 sub-committee were aimed at achieving a rapid improvement in pedigree herds through the use, by artificial insemination (A.I.) if necessary, of bulls of proven worth. It was stated that a similar though slower improvement could be achieved by the same methods in grade herds. Recommendations for the publication of all official surveys, and a vigorous education and publicity campaign to secure more general support for Sire Survey and the more advantageous use of proven bulls were quickly implemented. However, the improvement of cattle by breeding is a slow process and since only about eight years have elapsed since this policy was formulated it is too soon to expect marked results. Nevertheless, with the rapid post-war increase in recorded cow numbers and the widespread adoption of calf identification the number of sires qualifying for official surveys has increased greatly. Surveys are now compiled for any sire which is eligible and, in addition, in the 1949-50 season a number of surveys were completed on the basis of C.O.R. and O.H.T. records made in herds where all cows were tested. It is apparent that the Sire Survey movement is gaining momentum, for in 1949-50 over 1700 official surveys including 700 at the Final stage were issued (Sire Survey and Merit Register, 1951). This represented an increase of over 400 on the previous season. This number is considerable, but evidence indicates (Table XVIII, p.185) that a large proportion of sires are dead before their surveys are completed. On the basis of 400,000 cows

under test and forty cows per bull, 10,000 sires are required each season in recorded herds. If the herd life of the average sire is taken as four years (N. Z. Dairy Board, 1940), 2500 new sires are required each season. During the 1949-50 season about 600 bulls were surveyed for the first time and of these about one in every five would be expected to reach "Merit" standard (Sire Survey and Merit Register, 1951). It is apparent, therefore, that at present less than 25 per cent of the sires in use in recorded herds have been surveyed and that few Merit Sires are available to commercial farmers.

The necessity of keeping a bull until he is at least seven years old in order to obtain a Final survey, presents a major difficulty on small farms where the carrying of an extra bull, with sparing use, represents considerable expense and inconvenience. It may be suggested that surveys should be taken only to the preliminary stage and that bulls be selected on this basis alone. This would permit more bulls to be proven and thus, theoretically, more superior sires would be found. In practice however, under New zealand conditions, the Preliminary Survey is an uncertain index of a bull's breeding worth and there would be a grave risk of errors in selection on this basis; of the "good" sires being culled with the "bad". Further it is only by compiling accurate surveys of sires and lifetime records of cows that the necessary information can be accumulated to permit reliable pedigree selection of young sires. An important phase of herd improvement work is to educate the farmer to select accurately a herd sire on the basis of its pedigree of production so that the sire's own survey becomes a confirmatory test of his breeding worth and is chiefly of use as a guide to the assessment of his progeny. Not until there is a considerable reduction in the variability of the pedigree stock, however, can such a degree of certainty be achieved.

The paucity of superior proven sires, has led to the investigation of methods of making more advantageous use of the few Merit Sires which are available. Since the registered purebred herds are the source of over 70 per cent of the industry's sires (Ward and Lawry,1948), and only registered purebred bulls are eligible for official surveys (N.Z. Dairy Board,1941) it is apparent that any improvement must stem from the pedigree herds. In general, pedigree breeders have not adopted the principles of the Dairy Board's Herd Improvement Plan as readily as was hoped and most of the pedigree sires have been proved and used in grade herds. With herd-books closed to all but the progeny of registered stock, and official policy in the past against the use of grade bulls, the sons of Merit Sires from grade cows have been largely lost to the Industry, and this despite the fact that the Dominion's pedigree herd was insufficiently large to allow for an adequare selection rate amongst bull calves. Thus, in the period 1946-50 one bull was registered for every two heifers, due largely to the fact that in the Jersey breed, which accounted for four-fifths of all registrations, the ratio of heifers to bulls registered was only 1.8 (Stewart, 1951a).

Nevertheless concentration on the pedigree section of the industry, which possessed the necessary organisation to provide registered sires to the commercial farmers, appeared to offer the best prospects of achieving an improvement in the standard of herd sires.

It has been recognized for many years that artificial insemination (A.I.) offered a valuable method of exploiting superior sires. The "N.Z. Dairy Exporter" (1935) stated: "we think that the development of the proved bull scheme supplemented by A.I. marks the commencement of a new era for the Herd Testing Movement." Investigations into the technique of A.I. have been in progress in New Zealand for more than fifteen years (see Candy,1936) and in 1943 the

Dairy Board financed the establishment of an investigational A.I. centre at Ruakura Animal Research Station (N.Z. Dairy Board, 1945). It was not until 1950, however, that techniques and field practice suitable for New Zealand conditions were developed to the stage where A.I. could be applied commercially.

Ward (1946a) stated that the chief reason for the popularity of A.I. overseas was an economic one. With small farms and expensive stock the cost of keeping a bull was high, and a big saving could be made by the use of A.I.. In New Zealand, however, herds were larger and the cost of keeping a bull relatively small. Further, seasonal dairying in New Zealand reduced the insemination period to about two months and made the cost of A.I. relatively high. To the New Zealand farmer, therefore, A.I. was not so attractive, especially since conception rates were frequently below those obtained by natural mating (Filmer, 1951). To the average farmer, practically the only incentive to adopt A.I. would lie in the quality of the sires from which the semen was obtained as, for example, if the semen of Merit Sires was available. However, from the viewpoint of the Herd Improvement authorities the technique offered the possibility of multiplying many times the use of the semen of superior proven sires.

Early official policy was based on two main points:

1. That only high class proven sires be used for A.I. (Herd Recording Council, 1943).
2. That " ... the primary objective be the insemination of pedigree cows " (Herd Recording Council, 1947).

This was a sound policy since the number of "high class" proven sires was quite inadequate to cover more than a very small proportion of the national herd. Subsequent results have indicated that Merit Sires with daughter averages exceeding 400 pounds of butterfat, used in herds having a

mature average of approximately 330 pounds leave daughters producing about thirty pounds above this latter average (N.Z. Dairy Board,1950). It is obvious then, that such sires can effect a worthwhile improvement in herds considerably above average quality. If, by A.I., a wide coverage of pedigree herds could be achieved with such bulls, there would be a big increase in the available number of sons of outstanding Merit Sires out of L.M.R. and I.M.R. cows. Young bulls with such breeding were shown by Hard et al (1949) to be capable, on the average, of producing daughters whose records averaged between eleven and eighteen pounds of butterfat above "expectancy" (see p.180). When used and proved in grade herds these sires would, in general, increase production and the best of them would be returned to A.I. centres for use in the pedigree herds which would become, in effect, a superior "nucleus" section of the dairy cattle population. Such a scheme would offer the prospect of making good use of the Industry's best sires.

In practice, however, the implementation of such a scheme has not been possible due to the virtual impossibility of obtaining a sufficient number of Merit Sires of the required standard. Final policy on the exploitation of A.I. has not been determined but meanwhile the Dairy Board is embarking on a scheme to identify and make available more sires of the necessary standard for A.I. The available "Merit Sires of A.I. standard" are being used in pedigree herds, but in addition, approximately ten yearling bulls chosen on pedigree are being used by A.I. in grade herds in Northland, Auckland, Taranaki and the Manawatu. It is expected that some of these sires, surveyed in grade herds, will reach a sufficiently high standard to qualify them for later use in pedigree herds (Standing Advisory Committee,1951). A new group of young sires will probably be used in this manner each season, gradually augumenting the supply of superior Merit Sires. The scheme is in its infancy however,

as, in reality, is the whole Sire Survey Scheme. With more sires being surveyed each year, the number of outstanding Merit Sires becoming available should gradually increase, and with increasing numbers, an improvement in the standard of the "top" sires may be expected. With the large number of sires to be surveyed, progress will be retarded by the need to keep daughters of sires which prove to be of poor quality, but it is reasonable to expect that the cumulative influence of the use of an increasing number of Merit Sires and sons of "Merit Sires of A.I. standard" in grade herds will lead to a steady increase in production in future years.

PART FOUR

SUMMARY AND CONCLUSIONS

CHAPTER XI

SUMMARY AND CONCLUSIONS

1. SUMMARY

Investigations of herd-testing methods were commenced in New Zealand in 1896 (p. 4), but systematic herd recording was not introduced until 1909, fifteen years later than in Denmark. From the outset emphasis was placed on lactation records; tests of short duration, widely publicised in America were not important in New Zealand (p. 54). The Association System, introduced in 1909 (p. 6), provided inexpensive records for commercial farmers and was numerically the most important system until 1924.

In 1912 the Dairy Division introduced the Certificate of Record system, a 365-day test for selected registered purebred cows (p. 56). It was hoped that the authentication of high individual records would draw attention to the specialised dairy breeds, for it was felt that rapid improvement could be achieved by the widespread use of registered purebred bulls (p. 57). Few cows were recorded annually, and the system, being expensive, required a heavy Government subsidy (p. 68). Persistent criticism of the 365-day test period preceded the introduction, in 1930, of a 305-day C. O. R. division, which was, however, poorly supported for some years (p. 64).

In response to the need for an inexpensive herd test for pedigree cows, the Dairy Division inaugurated the Official Herd Test in 1927. A 305-day test, the O. H. T. was not made compulsory for all cows in the herd (p. 65). The number of breeders supporting this test remained small until after World War II, many breeders preferring to record their herds under Group Herd Test (p. 66).

The Association System, the popularity of which

was limited due to the inconvenience of weighing [illegible] sampling, the additional equipment required to re[illegible] machine-milked cows, and the inadequate authentication of records (p.10) was quickly superseded by the Group Herd Test which was introduced during the 1922-23 season (p.12). The Group System, in which a testing officer visited each of a group of about twenty-seven herds monthly, gained rapidly in popularity, 100,000 cows being recorded during 1924-25 and 212,000 during 1928-29 (p.11). In each area a Herd Testing Association with a Management Committee elected jointly by testing farmers and dairy companies co-ordinated the work of a number of groups. Testing fees levied by each Association were usually graded according to herd size (p.15). A system of marking heifer calves with satisfactory butterfat backing, introduced in the Waikato in 1925, was later adopted by other Associations and proved a useful adjunct to herd recording (Ch. VIII).

In 1926 a Dominion Group Herd Testing Federation was formed and all existing Associations affiliated to this national organisation (p.18). The Federation obtained a Government subsidy for herd recording in 1927 and Government assistance has been granted in each subsequent year (p.26). In 1929 a Herd Testing Central Executive was appointed by the Government to determine the policy of the Group Herd Testing movement, the implementation of this policy being in the hands of the Dominion Group Herd Testing Federation (p.20). The Central Executive appointed a Federation Supervisor of herd testing to co-ordinate all "Group" and "Association" (own sample) herd recording activities (p.21). A set of uniform rules, binding on all Associations affiliated to the Federation was introduced in 1931, but the Federation lacked adequate statutory authority to enforce its rules, and complete uniformity could not be achieved (p.24).

The herd testing movement encouraged the use

of registered purebred sires, and, until the late "twenties" such sires, on the average, appeared to be increasing production. However, the purebred population was increasing rapidly (p. 81), selection was lenient, and by about 1930 evidence accumulated through continuous recording indicated that in many herds registered purebred bulls were lowering production (p. 25). An increasing number of farmers then demanded butterfat backing for their herd sires, though for some years a single high record of the sire's dam was considered adequate (p. 25).

During the economic depression of 1930-34 vigorous propaganda and a Government subsidy helped to prevent a decline in the number of cows recorded, but a rapid increase in the Dominion dairy cow population led to a decline in the rate of improvement in per cow production (p. 28).

In 1934, as a result of evidence given by Dominion Group Herd Testing Federation representatives, the Dairy Industry Commission recommended that a Herd Testing Council be set up to administer all herd recording systems. The Breed Societies, however, asked that the "official" systems remain under the jurisdiction of the Dairy Division, and as a result no change was made (p. 30). In 1935, however, following further efforts by the herd-testing Federation to strengthen the administration of group herd testing, the Executive Commission of Agriculture vested control of the Group movement in the N. Z. Dairy Board (p. 31).

Under the terms of the Herd Testing Regulations, 1936, the New Zealand Dairy Board assumed control of Group Herd Testing and was adequately endowed with statutory authority and finance. A Herd Recording Council of the N. Z. Dairy Board was set up to administer herd recording (p. 33). Continued unsuccessful efforts were made to eliminate duplication by the various testing systems (p. 37). Further, there was considerable agitation by farmers'

organisations for the expansion of herd recording activities which resulted in the Herd Improvement Plan of 1939 (p. 39). This Plan aimed at increasing the efficiency of production of milk and butterfat and emphasised the need for co-operation between the N. Z. Dairy Board and the Breed Societies " ... to provide an improvement in the standard of herd sires." Evidence had accumulated from several sources (p. 166) which indicated that many pedigree bulls were lowering production in the herds in which they were used. A Sire Survey Scheme, introduced in 1937 (p. 35) was restricted to bulls in herds recorded under Group Herd Test. Many of the most influential breeders supported the "official" systems which permitted selective testing, and for this reason bulls could not be satisfactorily surveyed in their herds. The Breed Societies refused to prevent registration of transfer of bulls lacking butterfat backing until 1941 when the Friesian Association introduced such a scheme (p. 43).

As part of the Herd Improvement Plan (1939) the twenty-eight existing Herd Testing Associations were organised into six Herd Improvement Associations to give increased efficiency (p. 41).

The investigational programme, commenced in 1937 was expanded, a Technical Committee being set up to " ... determine the data to be collected, form of collection, and methods of analysis" (p. 44). A vigorous campaign was instituted " ... for the dissemination of information among dairy farmers on present methods of scientific breeding and herd management", six Consulting Officers being appointed to assist with this work (p. 44). Later, these officers played an important role in obtaining information on dairy-farming problems and practices (p. 97).

Results of the N. Z. Dairy Board's investigational work, published in the Dairy Board's Annual Reports, have not been discussed in detail in this thesis. However, an attempt has been made to systematize the types of survey

conducted according to method of collection of data, under the following headings:-

I. Information collected directly from farmers.

II. Information collected through testing officers.

III. Information collected through consulting officers (p. 94).

Further, the comparative merits of the various survey techniques employed by the N. Z. Dairy Board have been discussed (Ch. VI) and surveys completed or now in progress have been considered from the point of view of method of collection and analysis, and value of the information obtained (Ch. VII).

In 1943 a sub-committee of the Herd Recording Council reviewed the Sire Survey Scheme and prepared a plan by which it was hoped to make the best use of information collected through sire surveys (p. 47). An analysis of the factors involved in improvement of per cow production from 1920 to 1943 demonstrated the ineffectiveness of dam selection and drew attention to the unsatisfactory standard of a large proportion of the bulls then surveyed (p. 46). It was concluded that recorded grade herds approximated the same level of production as the bull-breeding herds (p. 47). To achieve an improvement in the genetic worth of the national herd, recommendations were made for: the recording of all pedigree cows with selective registration on the basis of performance, continuous testing of a high proportion of grade herds, identification of heifer calves, the surveying of a large number of bulls, the publication of all surveys and the widespread use, by artificial insemination if necessary, of the best proven sires (p. 48).

There was considerable disruption of Group herd recording services during World War II, leading to a sharp decline in the number of cows recorded and some curtailment of investigational work (p. 46). From the 1942-43 season

onwards, however, numbers increased rapidly until in the 1949-50 season 424,000 cows, representing over 23 per cent of all cows in milk, were recorded (p.50). This number included 41,000 pedigree cows under Group Herd Test (p.77). During the first ten years of the Herd Improvement Plan there was an increase of thirteen pounds of butterfat in the average per cow production of all cows in milk, due probably to a combination of improved environment and better stock (p.52).

The Government recording systems underwent considerable expansion from 1939 onwards, when the 305-day C.O.R. and the O.H.T. systems, in particular, increased greatly in popularity (p.67). In 1946 the "all cow" rule was introduced for the O.H.T. system but existing conditions prevented its enforcement (p.68). In the post-war period increasing difficulty was experienced in meeting the demand for "official" recording services.

The Sire Survey Scheme, introduced in 1937 has increased rapidly in importance. Prior to the 1945-46 season the survey was in the form of a daughter-dam comparison (p.176); this was changed in 1946 to a daughter-dam comparison "within seasons" (p.177); and since the 1949-50 season surveys have been issued as a daughter-mature cow comparison (p.179). The technique has been progressively improved, and the number of bulls surveyed annually has increased steadily (p.193). The soundness of the existing technique (p.184), and the application of sire survey results in New Zealand (p.192), have been discussed at some length. Plans are now being evolved by the N.Z. Dairy Board for the exploitation of superior proven sires by artificial insemination (p.199). The N.Z. Dairy Board has, through its Lifetime Merit Register (p.157) and Intermediate Merit Register (p.159) endeavoured to encourage selection on a sound basis by giving prominence to those

cows which have demonstrated their ability to produce at a creditable level over a period of years. In addition, efforts have been made through the Merit Stud list (p.161) to draw attention to studs having a high proportion of I.M.R. and L.M.R. cows.

Recently, because of high costs and the inability of the Dairy Division to provide an adequate service, the Certificate of Record and Government Official Herd Test systems have been abandoned, and the N.Z. Dairy Board has accepted control of all herd recording (p.86). The Herd Recording Council has introduced an Official Pedigree Test to provide authenticated production records for registered animals, and has set up a Pedigree Testing Committee to advise the Council on matters relating to the recording of pedigree cows (p.36). A large proportion of the national pedigree herd is now recorded (p.82) and the existing organisation of herd recording offers a sound basis for future work in herd improvement.

2. CONCLUSIONS

The Herd Recording Council's sub-committee (1943) indicated that during the period 1920-43 the improvement in per cow production was due chiefly to (1) change in breed composition and (2) improved environmental conditions (p.46). The herd recording movement exerted a strong influence on both these factors. As regards the former, herd recording drew attention to the superiority of registered stock of the specialised dairy breeds over grade and dual purpose animals so far as fat production was concerned (p.47); in respect of the improved environmental conditions, for many years herd recording authorities have vigorously advocated better farming methods (p.27) and more recently have sought information, through an investigational programme, to give a factual basis to their extension work (p.44).

It is yet too early to assess the effects of

the Herd Improvement Plan (1939). The improvement in the Dominion per cow average of thirteen pounds of butterfat during the period 1939-49 was due probably, to a combination of genetic and environmental factors (p.52). The Sire Survey Scheme has been pursued with considerable vigour and the investigational programme has yielded much information of immediate value to the industry as well as the vital statistics essential in the planning of a herd improvement programme (p.142). However, Hamilton's (1944) statement that "an improvement of 25 per cent to 30 per cent in the average production per cow is not an impossible objective for the dairy industry in New Zealand in the ten years after the war ..." has little prospect of realisation. The rate of increase in per cow production, which was virtually stationary in 1943, has not shown any sharp upward trend, though a slow improvement has been evident (p.51). Since the 1942-43 season the number of cows recorded has increased rapidly, exceeding 23 per cent of all cows in milk during 1949-50 (p.50). In addition, a large proportion of all pedigree cows is now recorded (p.82). This increase has occurred under favourable economic conditions, and it is difficult to forecast future trends, especially should a recession of dairy produce prices occur. Since at present practically the whole structure of herd improvement through breeding - production records, merit registers, calf identification, sire survey - is dependent on herd recording, the importance of continued recording in the majority of pedigree herds and a large sample of grade herds cannot be over-emphasised.

In most New Zealand herds the production level is still such that rapid increases in production can be achieved through improved management, particularly as regards nutrition (p.52). However, according to Mitchell (p.129) and Jensen et al (1942) a level of nutrition may soon be

reached at which diminishing returns from each increment of feed will demand, for economical production, an improvement in genotype. Studies of efficiency of production under free grazing conditions which may be expected to follow the current intake studies being conducted by Wallace (p.130) are likely to be of the utmost importance to the New Zealand dairy industry.

With the existing division of the dairy cattle population into registered and unregistered stock, the rate of improvement through breeding depends on the margin of superiority of the pedigrees over the grades. If the registered stock are not, on the average, superior to the unregistered, there is no justification, from the point of view of butterfat production, for regarding them as a suitable nucleus herd for the production of bulls for use in commercial herds. Bearing this in mind, it appears that, in New Zealand, where the margin of superiority of the pedigrees over the grades is apparently very narrow (p.83), the breeders have not fulfilled their responsibility to the industry. Complete lack of recording in some herds, selective, or sporadic recording with selection on single records in many others (p.77), concentration on type at the expense of production (p.75), failure to enforce production standards as a requirement for registration and transfer (p.36), and failure to open herd books to superior high grades at times when the pedigree population was too small to permit adequate selection (p.197) have been important contributing factors to the slow rate of improvement of the registered stock. The Breed Societies have, in general, failed to give progressive leadership to the breeders and the industry as a whole. Individual breeders may perhaps be exonerated because while they could sell their stock profitably on the basis of type and single records they saw no need for continuous recording. More far-sighted policy might have been expected from the Breed Societies however,

but with occasional exceptions (p. 43; 49) they have been reluctant to adopt recent herd improvement measures. A rapid change of policy by the Breed Societies is required, involving the encouragement of continuous recording under normal herd conditions, the surveying of bulls, avoidance of undue emphasis on type, and the exploitation by artificial insemination of superior proven sires in pedigree herds. This latter may involve, for a time at least, a disregard of bloodlines and line-breeding, but in general, would probably involve no great departure from existing policies. In the past however, the conservatism of the breeders has been such that the rapid acceptance of the above changes cannot readily be foreseen. Nevertheless in recent years there has been a marked trend away from selective recording (p. 82) and with the acceptance by many breeders of the Official Pedigree Test (p. 87) involving the testing of all cows in the herd, the more general adoption by breeders of the principles of the Herd Improvement Plan may be anticipated.

Breeders and commercial farmers who have co-operated fully with the N. Z. Dairy Board by practising continuous recording and the methods of selection recommended have not experienced unmixed success. A sire survey system based on a minimum of ten daughters of a bull, makes extremely difficult the proving of sires in small or average-sized herds (p. 185), and in all but the largest herds it is necessary during one season to mate a young bull to a large proportion of the herd in order to obtain sufficient daughters for a survey. This involves making sparing use of the senior herd sire in that season, and should the young bull prove to be of low breeding worth, might seriously depress the production level of the herd. This is not an argument against progeny testing - it merely emphasises the great care necessary in selecting a young sire on pedigree, and stresses the necessity of breeders

and herd recording authorities making available all information which might assist a buyer to select an unproven bull more accurately (p.190).

Because the number of recorded herds large enough to practise progeny testing is limited, there are insufficient proven sires in New Zealand for recorded herds alone (p.196). Very few Merit Sires are available (p.196). Little or nothing is known concerning the breeding worth of the majority of bulls in New Zealand and a large number of those surveyed have proved mediocre (p.196). Rapid improvement in the national herd may be achieved through the widespread use of the small group of bulls known to possess superior genotype. Now that artificial insemination technique problems have largely been solved (p.198), every effort should be made, through A.I., to achieve the maximum exploitation in the bull-breeding herds, of the industry's best sires. This will demand vigorous administration of the A.I. scheme and the co-operation of the pedigree breeders. In such a scheme, it appears, lies the best prospect for worthwhile improvement in the genetic merit of New Zealand's dairy stock.

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APPENDICES

APPENDIX I

DOMINION SUMMARY OF DAIRY COW POPULATION AND BUTTERFAT PRODUCTION FOR TESTED COWS.

Season	Cows in milk & dry	Cows in milk	Tested cows		
	No. of cows (000's)	No. of cows (000's)	No. of cows tested twice or more[x]	As % of all cows in milk	Av. yield B/fat (lb) cows in milk 100 days or more
1909-10	583		815		
1910-11	634		4,317		
1911-12	656		13,440		
1912-13	678		25,000		
1913-14	701		25,000		
1914-15	725		24,000		
1915-16	750		24,105		
1916-17		684	14,343	2.1	
1917-18		711	26,768	3.8	
1918-19		732	17,000	2.3	
1919-20		783	25,134	3.2	
1920-21		890	35,757	4.0	
1921-22		1,015	45,564	4.5	
1922-23		1,125	84,825	7.5	234
1923-24		1,185	151,214	12.7	213
1924-25		1,196	196,850	16.4	224
1925-26		1,181	169,776	14.4	221
1926-27		1,182	170,150	14.4	240
1927-28		1,243	224,130	18.0	225
1928-29		1,291	259,594	20.1	241
1929-30		1,389	283,731	20.4	254
1930-31		1,500	271,404	18.0	241
1931-32		1,583	259,857	16.4	237
1932-33		1,724	286,054	16.6	256
1933-34		1,816	297,647	16.4	262
1934-35		1,828	265,944	14.5	252
1935-36		1,823	245,355	13.5	258
1936-37		1,805	276,379	15.3	267
1937-38		1,764	271,095	15.4	258
1938-39		1,724	240,209	13.9	230
1939-40		1,719	226,082	13.1	260
1940-41		1,759	296,674	16.9	275
1941-42		1,757	305,715	17.4	256
1942-43		1,715	216,076	12.6	253
1943-44		1,648	223,652	13.6	254
1944-45		1,679	258,808	15.4	279
1945-46		1,662	284,459	17.1	233
1946-47		1,658	318,652*	19.2	260
1947-48		1,714	342,335*	20.0	258
1948-49		1,747	365,440*	20.8	279
1949-50		1,846	424,004*	23.3	273
1950-51			447,270**		

N. Z. Dairy Board, (1950).

** N. Z. Dairy Board Unpublished Data.
* Includes Govt. Official Herd Test.
x Includes G. H. T., A. O. S. T. and Dairy Company systems.

APPENDIX II

NUMBER OF COWS RECORDED BY THE "ASSOCIATION OWN SAMPLE" SYSTEM

Season	Number	Season	Number
1909-10	815	1930-31	25,670
1910-11	4,317	1931-32	21,835
1911-12	13,440	1932-33	23,163
1912-13	25,000	1933-34	20,408
1913-14	25,000	1934-35	15,938
1914-15	24,000	1935-36	11,171
1915-16	24,105	1936-37	12,359
1916-17	14,343	1937-38	14,509
1917-18	26,768	1938-39	11,330
1918-19	17,000	1939-40	11,261
1919-20	25,134	1940-41	9,660
1920-21	35,757	1941-42	7,050
1921-22	45,564	1942-43	5,253
1922-23	67,835	1943-44	4,021
1923-24	96,198	1944-45	4,873
1924-25	87,695	1945-46	5,523
1925-26	59,345	1946-47	4,012
1926-27	56,823	1947-48	4,920
1927-28	56,699	1948-49	4,400
1928-29	45,586	1949-50	6,547
1929-30	40,667		

1909-10 to 1929-30 inclusive, all cows tested; from Philpott (1937) and Singleton (1929b).

1930-31 to 1949-50 inclusive, all cows in milk 100 days or more; from N.Z. Dairy Board Annual Reports.

APPENDIX III

STATISTICS CONCERNING THE RECORDING OF REGISTERED PUREBRED ANIMALS BY THE C.O.R., G.O.H.T. AND G.H.T. SYSTEMS FOR THE PERIOD 1927 TO 1951 INCLUSIVE.

C.O.R.			G.O.H.T.			G.H.T.	
	1st Class Certificates				Breeders using C.O.R. &/or G.O.H.T. systems	Pedigree cows recorded	No. of herds
Year	365-day	305-day	Season	Total cows recorded*			
1928	465		1927-28	1,550	226		
1929	491		1928-29	1,970	272		
1930	643	72	1929-30	1,466	300		
1931	630	107	1930-31	2,236	231		
1932	443	43	1931-32	1,798	160**		
1933	461	46	1932-33	1,692	163**		
1934	536	103	1933-34	2,185	248	10,000	
1935	450	104	1934-35	2,058	228		
1936	490	44	1935-36	1,910	237	12,854	1,053
1937	494	60	1936-37	2,102	250		
1938	497	72	1937-38	2,184	260	14,696	1,097
1939	434	58	1938-39	2,111	238		
1940	431	68	1939-40	2,187	259		
1941	460	90	1940-41	2,797	274		
1942	428	177	1941-42	3,137	311		
1943	355	117	1942-43	2,594	285	17,960	1,133
1944	470	204	1943-44	3,184	330		
1945	484	314	1944-45	4,471	405		
1946	469	346	1945-46	6,129	498		
1947	620	578	1946-47	8,265	597	28,399	1,983
1948	452	585	1947-48	10,178	659	32,580	2,981
1949	315	637	1948-49	13,627	714	34,961	2,251
1950	278	559	1949-50	17,639	753	41,114	2,591
			1950-51	20,594	785		

* Includes small numbers of grades.
** G.O.H.T. only.

Data from: "N.Z. Journal of Agriculture"; N.Z. Department of Agriculture Annual Reports; N.Z. Dairy Board unpublished material; Dairy Division, Department of Agriculture unpublished material; Dr. A. Stewart unpublished material.

APPENDIX IV

FIVE YEARLY AVERAGES OF PRODUCTION FOR HERSEYS AND FRIESIANS GAINING 1ST CLASS 365-DAY CERTIFICATES OF RECORD IN THE PERIOD 1913-50 INCLUSIVE.

Period	Total Certificates All Breeds	Jersey		Friesian	
		Certificates No.	Production lbs.	Certificates No.	Production lbs.
1913	114	66	375	48	397
1914	213	117	413	78	455
1915	180	94	428	71	451
1916-20	263	151	411	72	459
1921-25	752	525	448	126	484
1926-30	521	411	462	92	515
1931-35	504	412	503	70	584
1936-40	469	404	508	52	551
1941-45	439	390	524	42	508
1946-50	427	370	514	46	535

* Minimum standards raised 35 lbs. at the beginning of 1931. From Philpott (1937); Jersey Advanced Registers of Merit; Friesian Production Records; and Dairy Division, Department of Agriculture, unpublished data.

APPENDIX V

AVERAGE NUMBER OF PEDIGREE COWS TESTED PER BREEDER UNDER C.O.R. AND G.O.H.T. DURING THE PERIOD 1941-42 TO 1950-51 INCLUSIVE.

	C.O.R.			G.O.H.T.		
Season	Cows	Breed-ers	Cows per Breeder	Cows	Breed-ers	Cows per Breeder
1941-42	796	311	2.56	3,093	257	12.04
1942-43	668	285	2.34	2,531	240	10.55
1943-44	869	330	2.63	3,134	265	11.83
1944-45	1,075	405	2.65	4,368	347	12.59
1945-46	1,274	498	2.56	6,032	437	13.80
1946-47	1,490	597	2.50	8,113	543	14.94
1947-48	1,454	622	2.34	9,859	601	16.40
1948-49	1,336	620	2.15	13,151	676	19.45
1949-50	1,131	581	1.95	15,294	707	21.63
1950-51	956	466	2.05	17,398	761	22.86

APPENDIX VI

COST OF RECORDING UNDER GROUP HERD TEST IN TERMS OF POUNDS OF BUTTERFAT, ON THE BASIS OF A 40-COW HERD.

Season	Association	Cost per cow (pence)	Average payout per lb. for b/f. supplied to Butter-factories (pence)	Cost in lbs. fat per cow tested
1922-23	Farmers' Union	60 (approx.)	19.5	3.08
1923-24	N.Z. Co-op. H.T.A.	60 (approx.)	18.5	3.24
1924-25	"	57	18.75	3.16
1925-26	"	60	18.61	3.23
1926-27	"	60	15.27	3.93
1927-28	"	48*	17.12	2.80
1928-29	"	49*	18.25	2.69
1929-30	"	57*	16.0	3.56
1930-31	"	63	12.25	5.14
1931-32	"	42*	11.45	3.67
1932-33	"	42*	8.75	4.80
1933-34	"	42*	8.75	4.80
1934-35	Taranaki Co-op. H.T.A.	46*	9.5	4.84
1935-36	"	48*	12.125	3.96
1936-37	"	62	13.558	4.57
1937-38	"	68	14.812	4.59
1938-39	"	68	16.087	4.23
1939-40	Taranaki H.I.A.	66	16.179	4.08
1940-41	"	66	16.106	4.10
1941-42	"	66	16.017	4.12
1942-43	"	66	16.569	3.98
1943-44	"	75	17.597	4.46
1944-45	"	66	19.790	3.34
1945-46	"	88	20.568	4.28
1946-47	"	88	23.691	3.71
1947-48	"	113	26.218	4.31
1948-49	"	123	27.368	4.49
1949-50	"	135	28.720	4.70
1950-51	"	138	30.130**	4.58**

* Subsidized.
** Computed figure.

Data from Hamilton (1944) and Annual Reports of N.Z. Co-op. H.T.A., Taranaki Co-op. H.T.A. and Taranaki Herd Improvement Association.

APPENDIX VII

FINANCIAL ASSISTANCE TO HERD RECORDING AND INVESTIGATIONAL WORK. GROUP HERD TEST AND A.O.S.T. SYSTEMS.

Season	Government £	N. Z. Dairy Board £
1927-28	10,500	
1928-29	10,500	
1929-30	8,500	
1930-31	8,000	
1931-32	7,700	6,000
1932-33	6,000	
1933-34	6,000	
1934-35	5,000	
1935-36	4,000	
1936-37	3,000	230
1937-38	3,000	1,370
1938-39	6,500	3,820
1939-40	15,000	15,000
1940-41	15,000	15,000
1941-42	15,000	15,000
1942-43	10,000	10,000
1943-44	10,000	10,000
1944-45	15,000	15,000
1945-46	15,000	15,000
1946-47	15,000	15,000
1947-48	20,000	20,000
1948-49	20,000	20,000
1949-50	20,000	20,000
1950-51	23,333	23,333

Rounded figures from: N. Z. Dairy Board Annual Reports and Herd Testing Central Executive minutes.

APPENDIX VIII

STATISTICS FOR CALVES IDENTIFIED BY TATTOO BY THREE HERD IMPROVEMENT ASSOCIATIONS.

	Auckland H. I. A.			South Island H. I. A.	Bay of Plenty-East Coast H. I. A.
Season	Calves Tattooed	Members Tattooing Calves	% of Member-ship	Calves Tattooed	Calves Tattooed
1935-36	1,710	147	9		
1936-37	3,952	612	30		
1937-38	3,780	589	33		
1938-39	3,358	478	28		
1939-40	5,736	634	40	327	
1940-41	13,780	997	48	1,186	
1941-42	18,676	1,374	65	2,607	
1942-43	15,780	1,103	78	3,134	
1943-44	14,967	1,083	74	3,562	
1944-45	21,519	1,380	79	4,474	
1945-46	23,442	1,542	80	5,071	
1946-47	24,381	1,773	83	5,349	4,248
1947-48	23,913	1,687	82	5,808	6,552
1948-49	22,592	1,577	71	5,909	8,439
1949-50	27,259	1,952	77	6,401	8,889
1950-51					9,269

- N. Z. Dairy Board unpublished data.

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