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UNIVERSITY OF BRISTOL.


DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

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# WINTER FEEDING FOR MILK PRODUCTION

(An Economic Study)

BY

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# WINTER FEEDING FOR MILK PRODUCTION.

## An Economic Study

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# I N T R O D U C T I O N

This report is based upon the data collected from records for 133 herds during the winter period, October 1934 to March 1935. It is confined to a study of winter feeding costs and endeavours to establish general principles which are valid for any winter.

The data for quantities and values of concentrates, hay, straw, roots and green crops has been obtained from weekly records kept by the farmer and posted to this department. The quantity of milk sold wholesale has been obtained from the monthly statements issued by the Milk Marketing Board, whilst the quantity of milk sold or utilised in other ways has been obtained from the farmers' weekly records.

An estimate of the cost of winter grazing has been made in the following manner, Particulars of grassland costs, cultivating, manuring, hedge-cutting etc., have been collected on monthly records kept by the farmer. The total grassland cost has been calculated from this material, together with information on rent, from which has been deducted an allocation for farm house, buildings and cottages.

The total grassland cost has been divided into two parts, for grazed pastures and mown meadows, according to the acreage grazed or mown. The total grazing cost is then found by adding to the cost allocated to pastures, one-third of the aftermath of the hay crop.

The total grazing cost has been divided between the dairy herd and other stock, and between the summer and winter periods.

The division between the dairy herd and other stock has been made with the aid of data for numbers of different classes of livestock grazed, also collected on the monthly grassland records. All stock have been reduced to cow-units, and the total grazing cost divided in proportion.

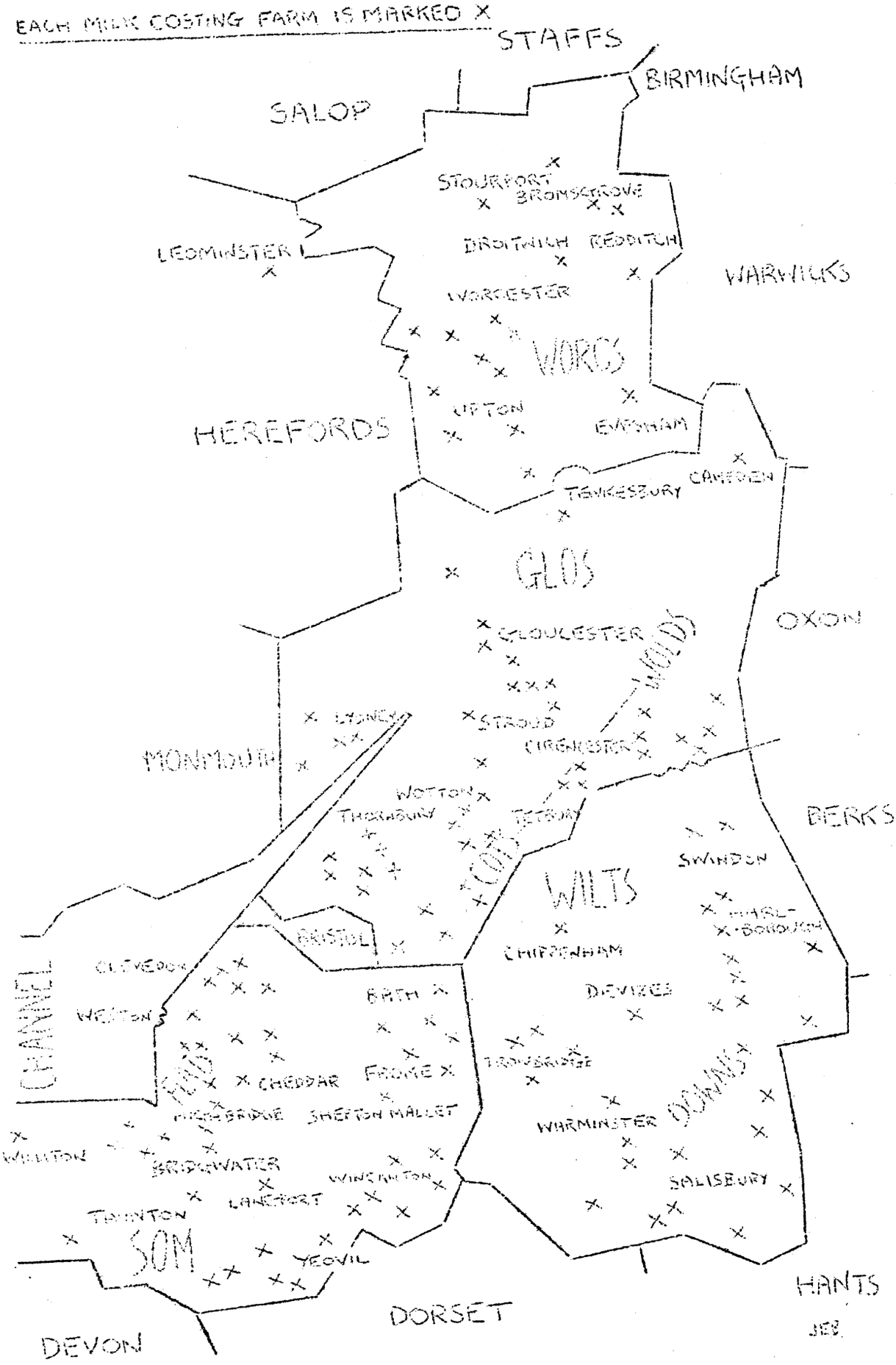
In order to divide the grazing cost between the summer and winter periods, several items of information were observed. The weekly records reveal the periods for which the cows were in day and night, or out only in the day; a circular letter invited farmers to express their own opinion; and an idea of the importance of grazing was gleaned from the gradual increase or decrease of the hay ration.

It must be remembered that cost figures include winter grazing, but quantity figures do not.

With the exception of one, the herds are situated in the counties of Worcestershire, Gloucestershire, Somerset and Wiltshire. The exception is a Herefordshire herd situated in the north-eastern part of the county, and in classification has been included with the Worcestershire herds.

# MAP OF AREA

EACH MILK COSTING FARM IS MARKED X

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## 1. FIGURES IN THE AGGREGATE

The first section of this bulletin is devoted to a study of the aggregate statistics for 133 herds for the winter six months.

The total quantity of milk produced is 1,340,239 gallons, giving an average per herd of 10,077 gallons. The yield per cow-in-herd works out at 1.51 gallons, whilst the yield per cow-in-milk is 1.97 gallons. Assuming that cows are milked twice a day, this means that a fraction under 1 gallon is obtained every time a cow is milked.

The average size of the herd is 38 cows, of which only 29 are in milk.

The total cost of food provided for all herds, amounts to £41,301. This sum includes an amount estimated for the cost of winter grazing, whilst other home-produced foods such as oats, hay, mangolds and kale are charged at a price calculated in proportion to their feeding value when compared with the market values of barley, maize, groundnut cake and cotton cake.

Daily food cost per cow, on this basis, works out at 11.20d., averaged over all cows, in milk and dry, whilst the food cost of milk works out at 7.40d., per gallon.

The total weight of foods fed, excluding winter grazing, amounts to 248,316 cwts, being made up as follows:-

TABLE 1.

| Food | Total Quantity | Quantity per Cow-per-Day |
|---|---|---|
| Concentrates | 51,866 cwts. | 6.56 lbs. |
| Hay and Straw | 100,060 cwts. | 12.65 lbs. |
| Succulents | 96,390 cwts | 12.19 lbs. |
| Total | 248,316 cwts. | 31.40 lbs. |

Since the average yield of milk is 1.51 gallons per cow per day, and since about 3½ lbs. of concentrates are recommended per gallon, the amount of concentrates fed should be approximately 5.6 lbs. per day. The actual figure of 6.56 lbs. is, therefore, rather high, though an allowance must be made for the feeding of concentrates to dry cows in preparation for milk production.

The hay ration of 12.65 lbs. per day is very low considering the average yield. The figure usually recommended is about 20 lbs., and the balance is not to be accounted for by the feeding of roots and greens, which can be substituted at the rate of not less than 4 lbs. for 1 lb. of hay. The deficiency in the hay ration may be made up partly by the feeding of concentrates as part of the maintenance ration.

The total weight of concentrates fed is divisible into manufactured cakes and dairy nuts, and into separate concentrated products which are mixed on the farm. Manufactured cakes account for 55% of the concentrates, and farm-mixed concentrates for 45%. Thus, on an average, a cow is fed with 3.61 lbs. of manufactured concentrates and 2.95 lbs. of farm-mixed concentrates, per day.

Farm-mixed concentrates were fed to a total amount of 23,315 cwts. This quantity can be further subdivided:-

TABLE 2

| Concentrate | Total Quantity | Percentage |
|---|---|---|
| Oil cakes | 7,715 cwts. | 33 % |
| Maize Products | 5,889 cwts. | 25 % |
| Bran & Wheat Products | 3,127 cwts. | 14 % |
| Other Products | 6,584 cwts. | 28 % |
| Total | 23,315 cwts. | 100 % |

Thus oil cakes account for one-third of the purchases of farm-mixed concentrates, and maize products for one quarter.

Another classification shows the relative importance of the many products that the market has to offer to the milk producer:-

TABLE 3

| Concentrate | Total Quantity | Percentage |
|---|---|---|
| Flaked Maize | 3,789 cwts. | 16 % |
| Groundnut Cake | 3,339 cwts. | 14 % |
| Dried Beet Pulp | 2,736 cwts. | 12 % |
| Cotton Cake | 2,598 cwts. | 11 % |
| Crushed Oats | 2,139 cwts. | 9 % |
| Bran | 2,010 cwts. | 9 % |
| Maize meal & cubes | 1,679 cwts. | 7 % |
| Palm Kernel & Coconut | 1,298 cwts. | 6 % |
| Wheat | 747 cwts. | 3 % |
| Ricemeal | 740 cwts. | 3 % |
| Others | 2,240 cwts. | 10 % |
| Total | 23,315 cwts. | 100 % |

The high position of dried beet pulp, higher than cotton cake, oats, or bran, is an interesting commentary on the importance of the sugar beet industry to milk producers. Amongst the miscellaneous foodstuffs, the most important are soya bean cake, maize gluten, middlings, dried brewers' grains, beans, barley meal and linseed cake.

Of the total weight of hay and straw fed, only 12,234 cwts. are allocated to straw, accounting for 1.55 lbs. per cow per day. This reduces the hay ration to 11.10 lbs. per cow per day. The whole of the straw cannot be regarded as strictly for feeding.

The succulent feeds are analysed as follows:-

TABLE 4

| Fodder | Total Quantity | Quantity per cow per day | Percentage |
|---|---|---|---|
| | cwts. | lbs. | % |
| Mangolds | 39,825 | 5.04 | 41 |
| Turnips & Swedes | 8,241 | 1.04 | 9 |
| Kale | 34,875 | 4.41 | 36 |
| Cabbage | 7,015 | 0.89 | 7 |
| Beet Tops | 3,285 | 0.42 | 3 |
| Wet Grains | 2,550 | 0.32 | 3 |
| Apple Pomace | 599 | 0.07 | 1 |
| Total | 96,390 | 12.19 | 100 |

Mangolds and kale together account for over three quarters of the succulent foods. Included with wet grains is a small quantity of green maize.

The above classes of foodstuffs, concentrates, hay and succulents are not comparable from class to class, owing to the different purposes to which foods are put, and to the different food values which they possess. Reduction to a starch equivalent basis gives the best method for comparison, but before this is done, a useful purpose is served by giving the total bulk of dry matter contained in the foodstuffs. Some foods contain more water in their composition than others, and this is eliminated in the calculation of dry matter. It does not follow, however, that the dry matter is wholly digestible since some foods are more fibrous than others.

TABLE 5

| Food | Total Quantity of Dry Matter | Dry Matter fed per-cow-per-day |
|---|---|---|
| | cwts. | lbs. |
| Concentrates | 45,188 | 5.72 |
| Hay and Straw | 85,788 | 10.83 |
| Succulents | 12,996 | 1.65 |
| Total | 143,972 | 18.20 |

Here, the succulent foods occupy a much less prominent position, providing less than one-tenth of the dry matter fed. The figure of 18.20 lbs. of dry matter fed per-cow per-day is surprisingly low, especially as the general impression to be obtained from farmers is one of over-feeding rather than under-feeding. The appetite of an 11 cwt. cow is given by the agricultural chemist as 25 lbs. of dry matter, thus revealing a very wide discrepancy. If winter grazing is to account for the difference, then it must provide for no less than 27% of the entire winter sustenance of the herds. A dry matter bulk of 18.20 lbs. is only sufficient to satisfy the appetite of a 6½ cwt. animal!

In addition to the provision of sufficient bulk to satisfy the appetite, feeding must supply enough energy to maintain the animal's body alive and in healthy condition (maintenance ration) and enough to provide, in the case of dairy cows, for the production of milk (production ration). In order to make these calculations, the "starch equivalent" of each food is used. The "starch equivalent" is the proportion of the food which can be regarded both as digestible and available for maintenance or production. The chemical constitutents of the foodstuffs, protein, starch, fibre and oil are all reduced to their value as starch. Thus, the starch equivalent of decorticated groundnut cake is known to be 73%. This means that in every 100 lbs. of decorticated groundnut cake, there is the equivalent of 73 lbs. of starch available for the maintenance of the cow or for the production of milk. The total amount of starch equivalent provided is given in the following table:-

TABLE 6

| Food | Total Quantity of Starch Equivalent | Starch Equivalent fed per cow per day |
|---|---|---|
| | cwts. | lbs. |
| Concentrates | 35,656 | 4.51 |
| Hay and Straw | 31,531 | 3.99 |
| Succulents | 7,395 | 0.93 |
| Total | 74,582 | 9.43 |

The relative importance of hay has now been reduced since, whilst providing bulk, it does not possess the same food value as concentrates.

In all 885,852 "cow days" have been required to provide the milk costed. On the assumptions that the average weight of the cow is 11 cwts. and that 7 lbs. per day of starch equivalent are required to maintain this weight, then the total maintenance requirement of all the cows of the 133 herds is 55,366 cwts. of starch equivalent.

Further, on the assumption that each gallon of milk produced requires 2.25 lbs. of starch equivalent, the total production requirement of 1,340,239 gallons amounts to 26,924 cwts. of starch equivalent. The aggregate balance for 133 herds is, therefore:-

TABLE 7

| | Total Quantity of Starch Equivalent | Starch Equivalent per-cow-per-day |
|---|---|---|
| | cwts. | lbs. |
| Maintenance Requirement | 55,366 | 7.00 |
| Production Requirement | 26,924 | 3.40 |
| Total Requirement | 82,290 | 10.40 |
| Actually Fed | 74,582 | 9.43 |
| Deficiency | 7,708 | 0.97 |

The deficiency amounts to 9.4% of the total requirement If winter grazing is to be regarded as providing the deficiency, it must account for 27% of the dry matter bulk consumed and 9.4% of the total food value in terms of starch, as well as provide nearly 1 lb. of starch equivalent per cow per day. Should this be the case, then, in order to supply a maintenance ration of 7.00 lbs. per day and a production ration of 3.40 lbs. per day, grazing, hay and succulents together provide 5.89 lbs. and concentrates 4.51 lbs. Thus 1.11 lbs. of concentrates are fed as part of the maintenance ration. A fraction under a quarter of the concentrates fed is not required for milk production. However, a proportion of this surplus is required for feeding to dry cows, so that the surplus will not be as great as it appears here. Furthermore, in assuming that 2.25 lbs. of starch equivalent are required per gallon of milk, a minimum figure is chosen in order to minimise the starch deficiency obtained.

It must also be remembered that the digestion of concentrates for the purpose of making milk liberates a quantity of heat which helps to maintain the body temperature of the cow, and to this extent a portion of the maintenance ration will not be required. Some portion of the total starch deficiency may be accounted for in this way.

In a later section of this bulletin it is shown that, for many herds, the actual starch fed is in excess of requirements. A moment's reflection will make it clear that for every cwt. of starch equivalent that is fed as surplus over requirements, an extra cwt. of deficiency must be found for some other herd. The figure of 7,708 cwts. found above is the net minimum deficiency, based on the assumption that for no herd, and, indeed, for no individual cow, does a surplus over requirements exist. The figure of 9.4% which may be the contribution to be accounted for by winter grazing, must, therefore, be regarded as a minimum.

In the foregoing analsysis, all the chemical constitutents of the foodstuffs are reduced to their food value as starch. Not only is it necessary to provide a sufficient quantity of starch equivalent, but the distribution of constitutents amongst carbohydrates, oils and protein must be considered. More especially, the total food energy must contain a sufficient proportion of protein, since this latter is not only essential to the formation of lean meat and muscle tissue, but is an essential ingredient in milk formation. The percentage of digestible protein, known as the "protein equivalent", must, therefore, be tabulated:-

TABLE 8

| Food | Total Quantity of Protein | Protein fed per-cow-per-day |
|---|---|---|
| | cwts. | lbs. |
| Concentrates | 8,552 | 1.08 |
| Hay and Straw | 3,559 | 0.45 |
| Succulents | 916 | 0.12 |
| Total | 13,027 | 1.65 |

It is known that an 11 cwt. cow requires 0.75 lbs. of digestible protein for maintenance purposes so that the protein maintenance requirement for the 133 herds amounts to 5734 cwts. Allowing 0.6 lbs. of digestible protein for every gallon of milk produced, the protein production requirement for these herds amounts to 7180 cwts.

The aggregate balance for 133 herds is, therefore,:-

TABLE 9

| | Total Quantity of Protein | Protein Equivalent per-cow-per-day |
|---|---|---|
| | cwts. | lbs. |
| Maintenance Requirement | 5,734 | 0.725 |
| Production Requirement | 7,180 | 0.908 |
| Total Requirement | 12,914 | 1.633 |
| Actually Fed | 13,027 | 1.647 |
| Surplus | 113 | 0.014 |

Whilst dry matter and starch equivalent both reveal deficiencies, protein reveals a surplus. The needs of the cow, both for maintenance and production purposes, are satisified by the quantities of foods recorded as fed. There is no dependence on winter grazing for protein requirement. It must again be noted, however, that no allowance is made in these calculations for the feeding of protein to dry cows in preparation for milk production, over and above what is required to maintain their weight. This consideration may be sufficient to convert the surplus, which is less than 1% of requirements, into a small deficit.

The protein in winter grazing is substantially less than is to be found during the growing season of early summer, but none the less, it is in excess of the protein in hay. These figures suggest that grazing forms a not inconsiderable part of the feeding, especially in the autumn months. The value of the protein, however, appears to be overlooked. The production requirement for an average yield of 1.51 gallons is 0.908 lbs. of protein. The amount of protein fed in concentrate form is 1.08 lbs., a slight surplus.

The total foodcost of £41,301 can be analysed as follows:-

TABLE 10

| Foodstuff | Total Cost | Percentage |
|---|---|---|
| | £ | % |
| Concentrates | 18,235 | 44 |
| Hay and Straw | 16,086 | 39 |
| Succulents | 3,579 | 9 |
| Grazing | 3,401 | 8 |

Table 7 shows the weight of starch equivalent fed to be 74,582 cwts. Since this does not include winter grazing, the total cost of this quantity of starch is £37,900. Thus the cost of 1 lb. of starch equivalent averages 1.09d.

No useful purpose is served by comparing the cost of starch in the form of concentrates, hay and succulents respectively, since the hay and succulents have been charged

at a price which makes their cost per lb. starch equivalent approximately equal to that of concentrates. However, useful comparisons can be made between the cost of starch in dairy cake and its cost in farm-mixed concentrates; and also between the estimated cost of starch in winter grazing and its cost in concentrates.

The total cost of concentrates is £18,235; of this. £10,877 is the cost of factory-mixed cake containing 19,986 cwts. of starch equivalent. The cost of 1 lb. of factory-mixed starch is, therefore, 1.17d., whilst the cost of 1 lb. of farm-mixed starch is 1.01d. A production ration for 1.51 gallons, the average yield, should contain 3.40 lbs. of starch equivalent. In manufactured cake the cost is 3.43d. The saving amounts to 0.36d. per gallon of milk produced. Dairy cake has been assigned a starch equivalent of 70%; if its starch equivalent were 81%, it would cost exactly the same. Although it can be argued that the starch equivalent of cake is higher than 70%, it certainly is not as high as 81%. The cost of mixing must be deducted from the advantage of 0.36d. per gallon, but the margin will probably still be in excess of $\frac{1}{4}$d. a gallon.

The sum of £3,401 is the estimated cost of winter grazing. The starch deficiency of Table 7, which may be attributed to winter grazing, amounts to 7,708 cwts. A figure of 0.95d. per lb. starch equivalent in grazing is thus obtained. This is undoubtedly too high, and is explained by the fact that the above figure for starch deficiency is the net amount, assuming that not a single cow is consuming in excess of requirements. In a later section of this report, a much better estimate of the cost of starch equivalent in winter grazing will be made.

A list of the figures used for calculating the dry matter, starch and protein equivalents of the various foodstuffs will be found in Appendix I.

## 2. VARIATION FROM FARM TO FARM

The degree of variation from farm to farm is very considerable. This fact is certainly no new discovery, for agricultural production has always been regarded as subject to variation in the most diverse manner. This is seen, not only in the cost of production, but in yield, size of herd, quantities of foods fed, and distribution of foods between different classes, as concentrates and hay, to mention only a few of the sources of variation.

In Appendices 2 and 3, to be found at the end of this report, data is given for the individual herds costed.

Appendix 2 arranges the farms in order of food cost per gallon, beginning with the lowest food cost, and ending with the highest. The locality of the farm is given, and both the positions of the farms and the positions of the principal towns are to be found upon the map in the front of this report. Appendix 2 gives, in addition, the following individual detail:-

(a) The average number of cows in the herd and the number in milk. Summer dairies can be distinguished by the low proportion of the number in milk during the winter.

(b) The gallons per day per cow, both as averages for the entire herd, and as averages over the cows in milk only.

(c) Food cost per cow per day, and per gallon. These figures include charges for winter grazing.

In Appendix 3, the farms are arranged in the same order, namely, in order of food cost per gallon. Cross reference to the material of Appendix 2 is thus rendered easy. The table is devoted to giving individual detail for the quantities of foodstuffs fed, as folows:-

(a) The weight of food fed per cow per day, divided into concentrates, hay, and succulents. The hay includes a certain amount of straw. These divisions are identical with those used in section 1 of this report.

(b) The weight of concentrates fed per gallon.

(c) The dry matter content fed per cow per day, of the concentrates, hay, and succulents added together. This figure gives the average dry-matter-bulk appetite, but it does not include any allowance for grazing.

(d) The total weight of starch equivalent fed per cow per day; the total requirement of starch equivalent: and the surplus "fed over required" or the deficiency "required over fed". The figures are calculated as for Tables 6 and 7 in section 1 of this report. Certain modifications are made for herds other than shorthorns. The figures given in section 1 for maintenance and production requirements are the basic figures for shorthorn cows. The following figures are used for cows of various breed.

TABLE 11. REQUIREMENTS

| Breed | Maintenance Starch Equivalent per Cow per Day | Production Starch Equivalent Per Gallon |
|---|---|---|
| Lincoln Red | 7 lbs. | 2¼ lbs. |
| Friesian | 7 lbs. | 2¼ lbs. |
| Shorthorn | 7 lbs. | 2¼ lbs. |
| Red Poll | 6½ lbs. | 2¼ lbs. |
| Guernsey | 5¾ lbs. | 2¾ lbs. |
| Jersey | 5 lbs. | 2¾ lbs. |

In the tables that follow, a summary of the variation from farm to farm is given. Not only are these tables useful in presenting to the eye a ready picture of the variation in the different factors, but each individual farmer can assess his own position. Thus a farmer whose yield per cow-in-herd is 1.80 gallons will know from Table 12, that his is one of 24 farms having a yield between 1¾ and 2 gallons, whilst 18 farms have yields of 2 gallons or more, and 91 farms have yields below 1¾ gallons. The position of the farm can be read in this way, for any of the factors given.

TABLE 12. VARIATION IN SIZE OF HERD.

| Number of Cows-in-Herd | Number of Herds | Number of Cows-in-Milk | Number of Herds |
|---|---|---|---|
| less than 10 | 4 | less than 10 | 11 |
| 10 - 19 | 21 | 10 - 19 | 39 |
| 20 - 29 | 33 | 20 - 29 | 30 |
| 30 - 39 | 24 | 30 - 39 | 25 |
| 40 - 49 | 18 | 40 - 49 | 14 |
| 50 - 59 | 14 | 50 - 59 | 9 |
| 60 - 69 | 8 | 60 - 69 | 0 |
| 70 - 79 | 4 | 70 - 79 | 3 |
| 80 or more | 7 | 80 or more | 2 |

TABLE 13. VARIATION IN YIELD

| Gallons per Day per Cow-in-Herd | Number of Herds | Gallons per Day per Cow-in-Milk | Number of Herds |
|---|---|---|---|
| over 3 | 1 | over 3 | 2 |
| $2\frac{3}{4}$ - 3 | 0 | $2\frac{3}{4}$ - 3 | 5 |
| $2\frac{1}{2}$ - $2\frac{3}{4}$ | 0 | $2\frac{1}{2}$ - $2\frac{3}{4}$ | 10 |
| $2\frac{1}{4}$ - $2\frac{1}{2}$ | 4 | $2\frac{1}{4}$ - $2\frac{1}{2}$ | 23 |
| 2 - $2\frac{1}{4}$ | 13 | 2 - $2\frac{1}{4}$ | 28 |
| $1\frac{3}{4}$ - 2 | 24 | $1\frac{3}{4}$ - 2 | 29 |
| $1\frac{1}{2}$ - $1\frac{3}{4}$ | 32 | $1\frac{1}{2}$ - $1\frac{3}{4}$ | 29 |
| $1\frac{1}{4}$ - $1\frac{1}{2}$ | 36 | $1\frac{1}{4}$ - $1\frac{1}{2}$ | 6 |
| 1 - $1\frac{1}{4}$ | 18 | 1 - $1\frac{1}{4}$ | 1 |
| less than 1 | 5 | less than 1 | 0 |

TABLE 14. VARIATION IN COSTS.

| Foodcost per Cow per Day | Number of Herds | Foodcost Per Gallon | Number of Herds |
|---|---|---|---|
| under 8d. | 12 | | |
| 8d. - 9d. | 16 | 4d. - 5d. | 8 |
| 9d. - 10d. | 6 | 5d. - 6d. | 14 |
| 10d. - 11d. | 15 | 6d. - 7d. | 23 |
| 11d. - 1/-. | 14 | 7d. - 8d. | 31 |
| 1/-. - 1/1. | 20 | 8d. - 9d. | 27 |
| 1/1. - 1/2. | 16 | 9d. - 10d. | 17 |
| 1/2. - 1/3. | 10 | 10d. - 11d. | 7 |
| 1/3. - 1/4. | 14 | 11d. - 1/-. | 6 |
| over 1/4d. | 10 | | |

TABLE 15. VARIATION IN CONCENTRATES FED

| Concentrates fed per Cow-per-Day | Number of Herds | Concentrates fed per Gallon | Number of Herds |
|---|---|---|---|
| under 2 lbs. | 2 | under 2 lbs. | 5 |
| 2 - 3 lbs. | 8 | 2 - 3 lbs. | 12 |
| 3 - 4 lbs. | 6 | 3 - 4 lbs. | 37 |
| 4 - 5 lbs. | 14 | 4 - 5 lbs. | 31 |
| 5 - 6 lbs. | 19 | 5 - 6 lbs. | 31 |
| 6 - 7 lbs. | 22 | 6 - 7 lbs. | 10 |
| 7 - 8 lbs. | 16 | 7 - 8 lbs. | 4 |
| 8 - 9 lbs. | 8 | 8 - 9 lbs. | 2 |
| 9 - 10 lbs. | 20 | 9 - 10 lbs. | 1 |
| 10 - 11 lbs. | 9 | | |
| 11 lbs. or over | 9 | | |

TABLE 16. VARIATION IN FODDERS FED

| Hay and Straw fed per Cow-per-Day | Number of Herds | Succulents fed per Cow-per-Day | Number of Herds |
|---|---|---|---|
| 4 - 6 lbs. | 4 | 0 - 4 lbs. | 57 |
| 6 - 8 lbs. | 8 | 4 - 8 lbs. | 8 |
| 8 - 10 lbs. | 19 | 8 - 12 lbs. | 10 |
| 10 - 12 lbs. | 28 | 12 - 16 lbs. | 8 |
| 12 - 14 lbs. | 31 | 16 - 20 lbs. | 20 |
| 14 - 16 lbs. | 15 | 20 - 24 lbs. | 10 |
| 16 - 18 lbs. | 11 | 24 - 28 lbs. | 7 |
| 18 - 20 lbs. | 11 | 28 - 32 lbs. | 4 |
| 20 lbs. and over | 6 | 32 - 36 lbs. | 2 |
| | | 36 - 40 lbs. | 2 |
| | | 40 lbs. and over | 5 |

TABLE 17. VARIATION IN DRY MATTER AND STARCH

(Excluding Winter Grazing)

| Dry Matter fed per Cow-per-Day | Number of Herds | Starch Equivalent per Cow-per-Day | Number of Herds |
|---|---|---|---|
| under 12 lbs. | 6 | under 6 lbs. | 7 |
| 12 - 14 lbs. | 13 | 6 - 7 lbs. | 15 |
| 14 - 16 lbs. | 20 | 7 - 8 lbs. | 13 |
| 16 - 18 lbs. | 20 | 8 - 9 lbs. | 17 |
| 18 - 20 lbs. | 22 | 9 - 10 lbs. | 18 |
| 20 - 22 lbs. | 19 | 10 - 11 lbs. | 10 |
| 22 - 24 lbs. | 15 | 11 - 12 lbs. | 21 |
| 24 - 26 lbs. | 9 | 12 - 13 lbs. | 17 |
| 26 - 28 lbs. | 5 | 13 - 14 lbs. | 9 |
| 28 lbs. and over | 4 | 14 lbs. and over | 6 |

TABLE 18. VARIATION IN STARCH DEFICIENCIES AND SURPLUSES

( Excluding Winter Grazing)

| Deficiency or Surplus<br>Starch Equivalent per Cow-per-Day | | Number of Herds |
|---|---|---|
| Deficiency | 4 lbs. or more | 7 |
| | 3 - 4 lbs. | 16 |
| | 2 - 3 lbs. | 18 |
| | 1 - 2 lbs. | 22 |
| | less than 1 lb. | 17 |
| Surplus | less than 1 lb. | 16 |
| | 1 - 2 lbs. | 23 |
| | 2 - 3 lbs. | 7 |
| | 3 lbs. or more | 7 |

The foregoing tables reveal the exceptionally large degree of variation that is to be met with in dairy farming. In yield, size of herd, costs, and quantities of different kinds of foodstuffs, the picture is the same. Some herds average more than 3 gallons daily per cow, others do not achieve 1 gallon; food cost per gallon of milk ranges from 4d. to 1/-; food cost per cow ranges from 5d. to over 1/8d. per day; the weight of concentrates fed per gallon of milk varies from nil to over 9 lbs.; the daily hay ration varies from 5 lbs. to 31 lbs.; roots and green crops are not fed at all on some 50 farms, yet one farm shows an average of almost 50 lbs. per day.

Before the advantages and disadvantages of all these many different methods of winter food management are discussed, it is of interest to find out which of these factors are subject to the greatest variation, and which to the least. It has been stated, for instance, that the average yield per cow-in-herd is 1.51 gallons per day. Only two herds, however, are to be found with a yield of 1.51 gallons; the other 131 herds have yields either higher or lower. The average amount by which individual yields vary from the average yield of 1.51 gallons can be calculated, and expressed as a percentage of the average yield. Similarly for any other factor of management it is possible to calculate, not only the average, but the average amount of variation, and this average variation can be expressed as a percentage of the average. The following table presents such material.

TABLE 19. DEGREES OF VARIATION

| Factor of Management | Average | Average Variation | Average Variation as Percentage of Average |
|---|---|---|---|
| Size of Herd: all cows | 38 cows | 16 cows | 42 % |
| Size of Herd: Cows-in-Milk | 29 cows | 12 cows | 41 % |
| Yield per Day per Cow-in-Herd | 1.51 g. | 0.35 g. | 23 % |
| Yield per Day per Cow-in-Milk | 1.97 g. | 0.38 g. | 19 % |
| Food Cost per Cow per Day | 11.20 d. | 3.52 d. | 31 % |
| Food Cost per Gallon | 7.40 d. | 1.89 d. | 26 % |
| Concentrates per Cow per Day | 6.56 lbs. | 2.35 lbs. | 36 % |
| Hay and Straw per Cow per Day | 12.65 lbs. | 1.41 lbs. | 11 % |
| Succulents per Cow per Day | 12.19 lbs. | 9.85 lbs. | 81 % |
| Concentrates per Gallon | 4.34 lbs. | 0.88 lbs. | 20 % |
| Dry Matter per Cow per Day | 18.20 lbs. | 4.99 lbs. | 27 % |
| Starch per Cow per Day | 9.43 lbs. | 2.38 lbs. | 25 % |

Whilst the average size of the herd is 38 cows, the average variation of individual herds from this figure is 16 cows more or less, a variation equal to 42% of the average itself. The variation of yield is less than the variation in the size of the herd. The variation in the number of cows in milk is a small fraction less.

The variation of yield is less than the variation in the the size of the herd. Variation of yield per cow-in-herd is rather larger than variation in yield per cow-in-milk. The existence of a number of summer milk producers is responsible for exceptionally low yields per cow-in-herd; these exceptional cases are not revealed in a classification by yield per cow-in-milk.

Food cost per cow is more subject to variation than food cost per gallon. A certain number of high food costs per cow are occasioned by high yields, and in these cases the food cost per gallon is not exceptional.

Variation in the quantity of succulents fed per cow is very much more marked than the variation in the quantity of concentrates fed. A large proportion of herds receive no succulents, yet the variation in concentrates fed is none the less very marked, certainly more marked than the variation in the hay ration. Since concentrates are fed for milk production, and hay primarily for maintenance, the comparison reflects the variation in yield on the one hand, and the much more rigid maintenance requirement on the other hand. Even so, the variation in concentrates fed per cow is greater than the variation in yield, supporting the conclusion already noted, that in many cases the feeding of concentrates is excessive.

Some part of the variation in concentrates fed per cow reflects, however, the requirements of higher yield, so that the variation of concentrates fed per gallon is less than that of concentrates fed per cow.

## 3. SOME FACTORS OF MANAGEMENT

This section of the report is devoted to an examination of the effect upon the food cost per gallon of a number of management factors. If the data collected were complete, it would be possible to give an account of the reasons for variation with a high degree of accuracy. Some relevant data, however, are absent, such as the characteristics of the soil and the feeding value of the hay. Although this examination is, therefore, necessarily incomplete, some important causes of variation in the food cost per gallon can be revealed.

Food cost per gallon is equal to food cost per cow divided by yield per cow, and can be reduced either by an increase of yield in relation to a given cost per cow, or by a reduction of the cost per cow in relation to a given yield.

If an increase in yield is accompanied by an increase in the cost per cow of exactly the same proportion, then the cost per gallon is not altered. For example, consider a yield of 1.5 gallons obtained with a food cost of 12d. per cow. Food cost per gallon is then 8d. Suppose that both yield and food cost per cow are increased by one-third. Yield is then 2 gallons, and food cost per cow 16d., whilst food cost per gallon is 8d., exactly the same as before. If, however, yield rises by a proportion which is greater than the proportion in which food cost per cow rises, then food cost per gallon will fall.

Again, if food cost per cow and yield are each lower by the same proportion, then food cost per gallon is unaltered. Yet if yield is lowered by a lesser proportion than food cost per cow is lowered, then food cost per gallon will fall.

A farmer cannot, of course, change his yield level with the ease that this argument suggests, but the same principle operates when different herds are compared. Herd A has a lower food cost per gallon compared with herd B for one of two reasons. If herd A has a higher food cost per cow than herd B, then the yield of herd A is proportionally still higher, or if herd A has a lower food cost per cow than herd B, then the yield of herd a is not reduced in the same proportion as food cost per cow.

In farming practice, rather more emphasis has been placed upon the method of increasing yield than upon the method of reducing food cost per cow. This emphasis is easily explained. An important part of the food cost is for the maintenance of the cow's weight. This part remains approximately the same for all levels of yield. High yield

has the effect of spreading the maintenance cost over a greater quantity of milk, thus reducing the cost per gallon. Maintenance costs have the characteristics of overhead charges; the greater the turnover, the less their burden.

It has been shown in Table 7, that for the herds costed, maintenance requirements are more than double production requirements. This being so, the advantage of spreading maintenance costs over higher yield should be particularly marked. The following table shows the advantage, in theory, of higher yields. It is based upon the assumptions, used in section 1 of this report, that the maintenance cost of the average cow is 7 lbs., of starch equivalent, whilst the production requirement is $2\frac{1}{4}$ lbs. of starch equivalent per gallon of milk.

TABLE 20. THEORETICAL ADVANTAGE OF HIGHER YIELDS

| Yield Gallons | Maintenance Requirement lbs. Starch | Production Requirement lbs. Starch | Total Starch Requirement | lbs. Starch Required per Gallon |
|---|---|---|---|---|
| 1 | 7.00 | 2.25 | 9.25 | 9.25 |
| $1\frac{1}{4}$ | 7.00 | 2.81 | 9.81 | 7.85 |
| $1\frac{1}{2}$ | 7.00 | 3.38 | 10.38 | 6.92 |
| $1\frac{3}{4}$ | 7.00 | 3.94 | 10.94 | 6.25 |
| 2 | 7.00 | 4.50 | 11.50 | 5.75 |
| $2\frac{1}{4}$ | 7.00 | 5.06 | 12.06 | 5.36 |
| $2\frac{1}{2}$ | 7.00 | 5.63 | 12.63 | 5.06 |
| $2\frac{3}{4}$ | 7.00 | 6.19 | 13.19 | 4.80 |
| 3 | 7.00 | 6.75 | 13.75 | 4.59 |

Since the cost of starch equivalent is roughly 1d. per lb., the fall in starch requirement as shown in the last column should also provide an approximate measure of the fall in pence of food cost per gallon as yield increases.

The data for 133 herds can now be arranged in yield groups. The following table shows the advantage, in practice, of higher yields:-

TABLE 21. ANALYSIS BY YIELD GROUPS

| Yield Per Cow-In-Herd Gallons | Number of Herds | Average Yield Gallons | Daily Food Cost per Cow | Food Cost per Gallon |
|---|---|---|---|---|
| Below 1¼ | 23 | 1.05 | 9.23 d. | 8.76 d. |
| 1¼ - 1½ | 36 | 1.39 | 10.50 d. | 7.62 d. |
| 1½ - 1¾ | 32 | 1.62 | 11.66 d. | 7.21 d. |
| 1¾ - 2 | 24 | 1.86 | 12.67 d. | 6.83 d. |
| 2 & over | 18 | 2.22 | 14.49 d. | 6.53 d. |

As yield increases, food cost per cow increases, but food cost per cow does not increase as rapidly as yield, so that a fall in the cost per gallon is shown. Between the two extreme yield groups, a margin of 2.23 d. per gallon is found, a considerable advantage in favour of higher yields.

The advantage in practice remains somewhat less than the advantage in theory:-

TABLE 22. HIGH YIELDS IN THEORY AND PRACTICE

| Yield Gallons | IN THEORY | | IN PRACTICE | |
|---|---|---|---|---|
| | Starch per Gallon | % Fall | Food Cost per Gallon | % Fall |
| Below 1¼ | 8.92 lbs. | - | 8.76 d. | - |
| 1¼ - 1½ | 7.28 lbs. | 18 % | 7.62 d. | 13 % |
| 1½ - 1¾ | 6.57 lbs. | 10 % | 7.21 d. | 5 % |
| 1¾ - 2 | 6.01 lbs. | 9 % | 6.83 d. | 5 % |
| 2 & over | 5.40 lbs. | 10 % | 6.53 d. | 4 % |

A glance at the columns showing the reduction in theoretical starch requirement and the reduction in food cost per gallon as yield increases, shows that the reduction in food cost is less than the reduction in starch requirement. Thus, comparing the yield group "1¼ - 1½ gallons" with the group "below 1¼" gallons, there is a fall in starch requirement of 18%, but the fall in food cost per gallon amounts to 13%. Similarly in all cases, the fall in food cost is less than the fall in starch requirement.

This margin between theory and practice can be expressed in another way. Higher yield requires an increase in the cost per cow, on account of the increase in the cost of the production ration. In practice, this increase is heavier than is expected, thus offsetting in part, the advantage of higher yield. It is not, however, so heavy that it completely offsets the advantage of higher yield.

The next table analyses the change in food cost per gallon for successive groups arranged according to food cost per cow.

TABLE 23. ANALYSIS BY FOOD-COST-PER-COW GROUPS

| Food Cost per Cow per Day | Number of Herds | Average Yield Gallons | Average Food Cost per Cow | Food Cost per Gallon |
|---|---|---|---|---|
| under 9d. | 28 | 1.27 | 7.73d. | 6.09d. |
| 9d. - 11d. | 21 | 1.47 | 10.13d. | 6.88d. |
| 11d.- 1/1d. | 34 | 1.60 | 11.94d. | 7.46d. |
| 1/1d.-1/3d. | 26 | 1.61 | 13.76d. | 8.57d. |
| 1/3d.& over | 24 | 1.88 | 16.17d. | 8.63d. |

If increasing food cost per cow is a reflection of the increased production ration for higher yield, and if higher yield leads to a reduced food cost per gallon, then it should follow that increased food cost per cow should also be related to a reduced food cost per gallon. However logical this argument may sound, the data of Table 22 contradict it, for, as food cost per cow increases, food cost per gallon also increases.

Thus it must be concluded that increased food cost per cow per day is not a reflection, in the first place, of the needs of higher yield.

In table 23, the margin between the two extreme groups is 2.54d. per gallon, a margin which is wider than that of Table 21, where a margin of 2,23d. was found. In Table 21, it was found that 18 herds with yields of 2 gallons or more, produced at an average winter food cost of 6.53d. per gallon. From Table 23 we now learn that the 28 herds with a food cost per cow per day of below 9d., produce at an average winter food cost of 6.09d. per gallon. It would appear, therefore, that a low food cost per cow per day reduces the cost per gallon more effectively than a high yield!

At least it can be said that a considerable number of low-cost-per-gallon farms are low, not because they have high yields and are able to spread their maintenance costs, but because they have very low costs with low yields. It is a case of reducing the cost per cow more rapidly than the yield!

Appendix 2 shows that, of the ten herds with lowest food costs per gallon, six possess a low cost per gallon primarily because their cost per cow is low (M.31, M.30, M.91, M.65, M.68 and M.79), whilst four possess a low cost per gallon primarily because their yield is high (S.43, M.94, M.50 and S.40). Of the next ten, five show a low cost per cow (S.84, M.89, M.118, W.311 and M.76), whilst five show a high yield (S.198, M.131, M.6, M.60 and W.307).

Two points, then, require emphasis. Firstly, the data for 133 herds show that a low cost per cow is a slightly more important contributor to a low cost per gallon, than is a high yield. Secondly, that in considering the advantage of high yield in spreading the burden of maintenance cost, some factor is at work to offset the theoretical advantage in part.

Clearly, then, it is necessary to find out the nature of this factor which is offsetting the theoretical advantage of higher yield.

As a rule, in feeding for higher yield, it is necessary to curtail somewhat the feeding of bulky foodstuffs, in order to allow of a higher consumption of concentrated foodstuffs. It has been assumed, so far, that there is no additional cost attaching to this process of substitution. If, in order to allow for a higher milk-producing capacity, a portion of a more cheaply produced feed must be eliminated and an additional portion of a more expensive feed must be included, then there is brought into play a factor which will operate, at least in part against the advantage of higher yield.

Since foodstuffs such as hay, mangolds, and kale have been priced at an amount which makes them possess approximately the same cost per lb. starch equivalent, the "substitution cost" cannot be found in the case of replacing these foodstuffs in part by cake or other concentrates. In practice, of course, the principle of substitution cost will have an effect here, but the the costings scheme, as at present organised, is not in a position to reveal its importance.

In the following table, the herds have been classified in three groups according to the starch deficiency or surplus as calculated for Appendix 3.

TABLE 24. STARCH DEFICIENCY AND SURPLUS

| Starch Deficiency or Surplus per Cow per Day | Number of Herds | Yield Gallons | Food Cost per Cow per Day | Food Cost per Gallon |
|---|---|---|---|---|
| Deficiency | | | | |
| 2 lbs. or more | 41 | 1.37 | 8.39d. | 6.13d. |
| Under 2 lbs. | 39 | 1.60 | 11.53d. | 7.21d. |
| Surplus. | 53 | 1.60 | 14.14d. | 8.82d. |

Thus the 41 herds which reveal a starch deficiency of 2 lbs. or more, produce at an average winter food cost of 6.13d. per gallon. In comparing the amount of starch equivalent actually fed with the amount required, no allowance is made for winter grazing, which can be regarded as the source of the deficiency. The 41 farms with deficiencies of 2 lbs. of starch equivalent per cow per day, are most likely to be the 41 farms depending most upon winter grazing.

We now have:-
18 herds with yield of 2 gallons or more : food cost 6.53d. per gallon.
28 herds with food cost per cow under 9d. per day : food cost 6.09d. per gallon.
41 herds with starch deficiency of 2 lbs. or more per cow per day : food cost 6.13d. per gallon.

Since these 41 herds also posses a yield of 1.37 gallons, distinctly below the average of 1.5 gallons, there can be no doubt regarding the importance of winter grazing in reducing the winter food cost per gallon. At the same time, the tendency for yields to be low on farms with more ample winter grazing, is the principal explanation of low-yield herds amongst the low-cost-per-gallon farms. A study of the data for low-cost-per-gallon farms as given in Appendices 2 and 3, shows that the examples of low yields are particularly associated with high starch deficiencies. Tables 25 and 26 collect together the essential data.

TABLE 25. HIGH YIELD AND LOW COST

| Farm Position and Number | Yield Gallons | Food Cost per Cow per Day | Starch Deficiency per Cow per Day |
|---|---|---|---|
| 5 S.43 | 1.89 | 8.98d. | 3.46 lbs. |
| 6 M.94 | 3.09 | 15.50d. | 2.69 lbs. |
| 7 M.50 | 2.08 | 10.36d. | 2.77 lbs. |
| 8 S.40 | 2.30 | 11.43d. | 1.01 lbs. |
| 12 S.198 | 2.30 | 12.32d. | 0.54 lbs. |
| 13 M.131 | 2.35 | 12.82d. | 0.69 lbs. |
| 16 M.6 | 2.04 | 11.59d. | 0.93 lbs. |
| 17 M.60 | 2.48 | 14.19d. | 0.95 lbs. |
| 20 W.307 | 2.19 | 12.82d. | 1.87 lbs. |

TABLE 26. LOW YIELD AND LOW COST FARMS

| Farm Position and Number | Yield Gallons | Food Cost per Cow per Day | Starch Deficiency per Cow per Day |
|---|---|---|---|
| 1 M.31 | 1.68 | 6.94d. | 4.35 lbs. |
| 2 M.30 | 1.75 | 7.39d. | 3.47 lbs. |
| 3 M.91 | 1.27 | 5.75d. | 6.27 lbs. |
| 4 M.65 | 1.33 | 6.19d. | 4.47 lbs. |
| 9 M.68 | 1.52 | 7.65d. | 3.56 lbs. |
| 10 M.79 | 1.53 | 8.00d. | 3.78 lbs. |
| 11 S.84 | 1.43 | 7.59d. | 4.43 lbs. |
| 14 M.89 | 1.38 | 7.57d. | 4.44 lbs. |
| 15 M.118 | 1.24 | 7.05d. | 4.96 lbs. |
| 18 W.311 | 1.61 | 9.31d. | 2.07 lbs. |
| 19 M.76 | 1.47 | 8.60d. | 3.20 lbs. |

The above tables, between them, include the 20 lowest-food-cost-per-gallon herds, divided into two groups. What a contrast between the groups! The general picture of Table 25 is one of high yields, high costs per cow, and small deficiencies. The general picture of Table 26 is one of lower yields, low costs per cow, and large deficiencies.

These are the two ways of keeping down the food cost per gallon: high yields, which spread the burden of maintenance, and large starch deficiencies made good by winter grazing. Farms S.43, M.31, and M.30 appear to derive their advantage from both sources, for the existence of a high starch deficiency is combined with a yield which is moderately high.

A more complete account of the total starch deficiency can now be given. In Table 7, the "balance sheet" was constructed for the 133 herds added together. Tables 27, 28 and 29 provide similar information for groups arranged according to the amount of starch deficiency or surplus. The maintenance requirement is, again, 7 lbs. of starch equivalent per cow per day, and the production requirement $2\frac{1}{4}$ lbs. per gallon. The amounts "actually fed" refer only to rationed foods and do not include winter grazing.

TABLE 27. DEFICIENCY 2 LBS. PER COW PER DAY, OR MORE

| | Total Quantity of Starch Equivalent | Starch Equivalent per Cow per Day |
|---|---|---|
| | cwts. | lbs. |
| Maintenance Requirement | 21,028 | 7.00 |
| Production Requirement | 9,247 | 3.08 |
| Total Requirement | 30,275 | 10.08 |
| Actually Fed | 20,688 | 6.88 |
| Deficiency | 9,587 | 3.20 |

TABLE 28. DEFICIENCY UNDER 2 LBS. PER COW PER DAY

| | Total Quantity of Starch Equivalent | Starch Equivalent per Cow per Day |
|---|---|---|
| | cwts. | lbs. |
| Maintenance Requirement | 16,254 | 7.00 |
| Production Requirement | 8,362 | 3.60 |
| Total Requirement | 24,616 | 10.60 |
| Actually Fed | 22,306 | 9.60 |
| Deficiency | 2,310 | 1.00 |

TABLE 29. STARCH SURPLUS GROUP

| | Total Quantity of Starch Equivalent | Starch Equivalent per Cow per Day |
|---|---|---|
| | cwts. | lbs. |
| Maintenance Requirement | 18,084 | 7.00 |
| Production Requirement | 9,315 | 3.60 |
| Total Requirement | 27,399 | 10.60 |
| Actually Fed | 31,588 | 12.23 |
| Surplus | 4,189 | 1.63 |

Tables 27 and 28 give a total deficiency of 11,897 cwts. of Starch Equivalent (on 80 herds), whilst Table 29 gives a total surplus of 4,189 cwts. (on 53 herds). The deficiency of 7,708 cwts., given in Table 7 is equal to the difference between the total deficiency here, of 11,897 cwts., and the total surplus of 4,189 cwts.

Where the starch deficiency is in excess of 2 lbs., it would appear that winter grazing accounts for almost one-third of the total starch requirement.

At the end of Section 1, an estimate was given of 0.95d. as the cost of 1 lb. of starch equivalent in the form of winter grazing. An indication was also given that this figure is too high. From Tables 27 and 28, it is seen that a starch deficiency total is obtained of 11,897 cwts. This figure is higher than before because it has not been offset by the surpluses of 53 herds. On the 80 herds for which deficiencies appear, the total cost of winter grazing amounts to £2,408, and consequently a better estimate can now be given of the cost of 1 lb. of starch equivalent in the form of winter grazing.

This new estimate is 0.43d. per lb. starch equivalent. This must be compared with a cost of 1.09d. per lb. for starch in concentrate form. Since the herds with deficiencies depend to quite a considerable extent upon winter grazing, the importance of grazing, as a contributor to lower cost, is further emphasized.

For the 41 herds with deficiencies in excess of 2 lbs. of starch equivalent per cow per day, the cost of 9,587 cwts. starch is £1,261. For these farms, the cost of starch equivalent in the form of winter grazing is as low, on the average, as 0.28d. per lb.

If, therefore, the advantage of high yields is offset by the existence of a large group of winter-grazing farms having low yields and low costs, the advantage of high yield should become more apparent within groups of similar deficiencies or surpluses. In Table 24, three groups arranged according to deficiency and surplus were set out. The importance of yield within each of these three groups is given in the following table:-

TABLE 30. EFFECT OF YIELD WITHIN GROUPS

| Deficiency or Surplus per Cow per Day | Yield Group | Number of Herds | Average Yield Gallons | Average Food Cost per Gallon |
|---|---|---|---|---|
| Deficiency 2 lbs. or more. | Low | 28 | 1.18 | 6.79d. |
| | High | 13 | 1.73 | 5.26d. |
| Deficiency under 2 lbs. | Low | 16 | 1.33 | 7.97d. |
| | High | 23 | 1.85 | 6.69d. |
| Surplus | Low | 17 | 1.30 | 10.16d. |
| | High | 36 | 1.83 | 8.11d. |

Within each group there is a fall in the average food cost per gallon from the low-yield herds to the high-yield herds. The average yield for all herds, of 1.51 gallons per cow per day, has been taken as the dividing line between low yields and high.

For the group of large deficiencies, the high yield herds save 1.53d. per gallon; for the group of small deficiencies, the high yield herds save 1.28d. per gallon, whilst for the group of surpluses, the high yield herds save 2.05d. per gallon.

In Table 22, it was shown that the percentage reduction in cost as yield increases, is not so great as the percentage reduction in theoretical starch requirement per gallon. The following table shows very clearly why this was the case.

TABLE 31. ADVANTAGE OF YIELD IN THEORY AND PRACTICE

| Deficiency or Surplus per Cow per Day | Starch Requirement per Gallon | % Fall | Food Cost per Gallon | % Fall |
|---|---|---|---|---|
| Deficiency 2 lbs. or more. | | | | |
| Low Yield | 8.19 lbs. | | 6.79d. | |
| High Yield | 6.29 lbs. | 23 % | 5.26d. | 23 % |
| Deficiency under 2 lbs. | | | | |
| Low Yield | 7.46 lbs. | | 7.97d. | |
| High Yield | 6.03 lbs. | 19 % | 6.69d. | 16 % |
| Surplus | | | | |
| Low Yield | 7.63 lbs. | | 10.16d. | |
| High Yield | 6.07 lbs. | 20 % | 8.11d. | 20 % |

Here, the relationship between theory and practice is particularly close. It can be stated, therefore, that the discrepancy between theory and practice as revealed in Table 22, is attributable to the starch deficiency or surplus, i.e., in general, to the presence of winter grazing.

A further point requires special emphasis. Whilst the 41 farms with large deficiencies show an average food cost per gallon of 6.13d. (Table 24), the 13 of these which also maintain yields in excess of average, show an average food cost per gallon of 5.26d.

The last tables of this section show how the proportions of foodstuffs other than grazing change as yield increases.

TABLE 32. CHANGES IN FOODS AS YIELD INCREASES

| Yield per Cow-in-Herd Gallons | FED PER COW PER DAY | | | Concentrates per Gallon |
|---|---|---|---|---|
| | Concentrates | Hay & Straw | Succulents | |
| | lbs. | lbs. | lbs. | lbs. |
| Below 1¼ | 4.49 | 12.76 | 6.85 | 4.26 |
| 1¼ - 1½ | 5.83 | 12.50 | 9.38 | 4.23 |
| 1½ - 1¾ | 7.13 | 12.52 | 14.15 | 4.41 |
| 1¾ - 2 | 7.84 | 13.58 | 19.02 | 4.23 |
| 2 & over | 10.39 | 11.38 | 16.88 | 4.68 |

A rise in yield is associated with marked rise in concentrates fed per cow. The change in concentrates per gallon is irregular, with some tendency to rise with yield. Since ¾ lbs. of concentrates per gallon will satisfy production requirements, concentrates are fed as part of the maintenance ration throughout the entire range of yield.

The daily ration of hay and straw is also somewhat irregular, there being no clear indication that the ration falls with yield. The daily ration of succulents rises rapidly with yield, with the exception of the highest-yield group. This is a surprising feature of the table. In the next section of the bulletin, it will be seen that upon the Wiltshire downs, a high winter yield is obtained in an area in which arable land is prevalent and in which a high proportion of roots and kale are fed. Thus the increase of succulents here may be occasioned in part by this accidental association. Again, since low winter yields are found where winter grazing is of importance, there are grounds for supposing that low yield is partly associated with a grassland area.

The existence of winter grazing may also be a reason for the relatively steady appearance of the hay ration in the above table. In Table 33, the starch deficiency is given for each yield group. If it is assumed that this deficiency is accounted for by grazing, it is possible to estimate what the hay ration would have been, had there been no grazing.

TABLE 33. CHANGE OF HAY AND GRAZING WITH YIELD

| Yield Group Gallons | Starch Deficiency per Cow per Day | Hay Equivalent of Deficiency | Total Hay and Grass Ration in Terms of Hay |
|---|---|---|---|
| | lbs. | lbs. | lbs. |
| Below 1¼ | 1.71 | 5.14 | 17.90 |
| 1¼ - 1½ | 1.38 | 4.16 | 16.66 |
| 1½ - 1¾ | 0.89 | 2.68 | 15.20 |
| 1¾ - 2 | 0.03 | 0.08 | 13.66 |
| 2 & over | Surplus | - | 11.38 |

The hay equivalent of winter grazing has been found by dividing the starch deficiency of each group by the starch equivalent of hay; to this is added the hay ration as shown in Table 32. A definite fall in the hay and grass ration is found. The fall may be somewhat exaggerated since a certain quantity of grazing is wasted, and this will occur principally in those groups where the starch deficiency is low or non-existent.

## 4. VARIATION IN COSTS FROM AREA TO AREA

A classification of farms by area is a difficult task owing to the lack of precise data. The influence of soil and farm position on both yield and food cost per cow is, however, of very great importance. The problems analysed in Section 3 of this report show the importance of both yield and food cost per cow upon the food cost per gallon. These elements are not, however, absolutely under the control of the farmer. The position of his farm and the nature of his soil and grass determine much for the farmer, although he may bring his skill to bear upon the problem of improving his grassland. It still remains true, however, that many farmers find themselves favoured with advantages that the others do not possess, whilst, on the other hand, many farmers, even though they apply themselves to improving their grassland, have an uphill task before them.

We have seen that low food costs per gallon are derived in part from high yields, in part from low cost per cow attributable to a supply of winter grazing. The supply of winter grazing is in the main determined by the locality in which the farm is situated, position and soil both being of importance. Again, if high yields are maintained in an area of relatively poor summer grazing, the summer cost of cake may well place the farm in a disadvantageous position, although winter milk may be produced at a relatively low cost.

An examination of variations from area to area must, therefore, be made in order to assess the amount of variation which can roughly be regarded as beyond the control of the farmer.

There are two areas which can be readily distinguished as possessing characteristics of their own: the Wiltshire Downs and the Cotswold Hills. Of the two, the Wiltshire Downs can be more easily differentiated. Wiltshire farms are, as a rule, either downland or not downland.. Some farms on the boundary of the downland area are both downland and vale, whilst others, as in the Wylye valley, also possess both downland and valley pastures. It has not been difficult, however, to divide the Wiltshire herds into two distinct groups.

The downland group consists of the following farms:- W.35, M.30, M.31, and M.76 in the Marlborough Down area, and W.6, W.16, M.39, W.47, M.56, M.60, M.84, M.85, M.86, M.130, M.131 and M.139 in the Salisbury Plain area. A study can be made of these farms as a group.

The Cotswold Hills are more difficult to distinguish. The limestone wolds themselves, and the plateaux where arable farming is prevalent, are clearly defined, but both to the west and to the east, difficulties arise. Many deep valleys work their way through the western escarpment in the Stroud and Wotton-under-Edge districts. In the neighbourhood of the latter town is a belt of high land which nevertheless stands below the

escarpment. The opinion of farmers in this region is that their farms are vale farms. Indeed, they have little in common with those upon the wolds, being grass and more productive. They are, therefore, classified as vale farms.

In the Stroud district, the valleys are entirely surrounded by Cotswold hills, and are little more than Cotswold slopes in many cases. The farms here are classified as Cotswold farms.

On the eastern parts of the Cotswold hills, it is difficult to demark the boundary as the country slopes gently downward from Cirencester towards Swindon, and from Badminton towards Chippenham. The county boundary of Gloucestershire and Wiltshire has been adopted, as this serves reasonably well to divide the Cotswolds from the Vale of Swindon. To the south, the Cotswold hills extend into Somerset, and Bath has been taken to mark the border. Thus one Somerset farm, M.138, being in Somerset to the north of Bath, is included in the Cotswold group.

The following are the Cotswold farms:-
Stroud district:- M.37, M.52, M.61 and M.71.
Chipping Campden:- M.15.
Cirencester district (Eastern):- M.3, M.4, M.11, M.12, M.20, and M.58.
Tetbury district (Southern):- 6C1a, 6C1b, M.65, M.68, M.78, M.116, M.118 and M.138.

The Wiltshire Downs and the Cotswolds are the two principal hill regions, and a useful contrast can be made in considering these areas together. Table 34 gives the essential data for these two areas.

TABLE 34. THE WILTSHIRE DOWNS AND THE COTSWOLD HILLS

| | All Herds | Wiltshire Downs | Cotswold |
|---|---|---|---|
| Number of Herds | 133 | 16 | 20 |
| Gallons per Day per Cow-in-Herd | 1.51 | 1.62 | 1.35 |
| Average Number of Cows per Herd | 38 | 70 | 42 |
| Food Cost per Cow per Day | 11.20 | 10.25d. | 11.11d. |
| Food Cost per Gallon | 7.40d. | 6.33d. | 8.24d. |
| | lbs. | lbs. | lbs. |
| Concentrates per Cow per Day | 6.56 | 6.60 | 6.52 |
| Hay & Straw per Cow per Day | 12.65 | 12.14 | 13.84 |
| Succulents per Cow per Day | 12.19 | 16.94 | 10.20 |
| Concentrates per Gallon | 4.34 | 4.08 | 4.84 |
| Dry Matter per Cow per Day | 18.20 | 18.33 | 19.02 |
| Starch per Cow per Day | 9.43 | 9.15 | 9.60 |
| Starch Deficiency per Cow per Day | 0.97 | 1.49 | 0.43 |

Food cost per gallon is 1.07d. below average on the Wiltshire Downs, and 0.84d. above the average on the Cotswolds. The total margin of 1.91d. is a striking picture of the difference that locality can cause. Compared with the Wiltshire Downland farmer, the Cotswold farmer has an uphill task.

On the Downs, a yield above average is maintained on a very large herd, whilst cost per cow is below average. The cost per cow on the Cotswolds is a fraction below average, but the yield is down heavily, and this is the principal contribution to the high cost per gallon.

The feeding of concentrates per cow is above average on the Downs, and below average on the Cotswolds. The disparity in yield is such that, for the Downs, the quantity of concentrates fed per gallon is below average, and for the Cotswolds is in excess of the recognized normal requirement of 3½ lbs. per gallon, by no less than one and a third lbs. per gallon.

Farm-mixed concentrates account for 45% of all concentrates for all herds, 56% on the Downs, and 43% on the Cotswolds. The most important farm-mixed concentrates are:-

Downs (1) groundnut, (2) flaked maize, (3) undecorticated cotton cake, and (4) crushed oats.

Cotswolds (1) dried beet pulp, (2) flaked maize, (3) decorticated cotton cake, and (4) groundnut.

The feeding of hay and straw is below average on the Wiltshire Downs and above on the Cotswold Hills. The average starch deficiency is above average on the Downs and below average on the Cotswolds. If the starch deficiency is translated into its equivalent as lbs. of hay, as in the last table of Section 3 of this report, it is found that the hay and grass ration expressed as hay is 15.56 lbs. for all herds, 16.61 lbs. on the Downs, and 15.131 lbs. on the Cotswolds. The high downland figure is due to the substitution of concentrates in the maintenance ration.

More straw is fed on the Downs than in any other area. Of the total hay and straw ration of 12.14 lbs., no less than 4.28 lbs, consists of straw. The Cotswold area is the second most important feeder of straw, yet here only 1.76 lbs. of straw are fed on an average per cow per day.

Since both areas are arable areas, a high proportion of succulent foods should be found. This proves to be the case in Wiltshire, but not on the Cotswolds. Mangolds are particularly prominent in feeding on the Downs. Whilst for all herds, rather more mangolds are fed than kale, on the Downs, the weight of mangolds fed is more than double the weight of kale fed. No less than 9.69 lbs. of mangolds are fed, on an average, per cow per day.

In the Cotswold area, only 1.83 lbs. of mangolds are fed per cow per day. No other area reveals a lower figure. Kale is the main constitutent of the succulent ration being fed to the amount of 4.35 lbs.

It is not, however, possible to attribute the difference in cost levels to the feeding of mangolds and kale, for these have been priced, not costed. The low Wiltshire Down cost is to be attributed to the high average yield and to the considerable starch deficiency.

Since the type of agricultural area is largely responsible for the variation in the size of the herd, it is advisable to study the variation in the size of the herd which is associated with variation in costs only within different agricultural areas. The majority of large herds are found either on the Downs or on the Cotswolds, and an examination of costs on both larger and smaller herds can be made for each area.

TABLE 35. SIZE GROUPS ON THE DOWNS AND COTSWOLDS

| | WILTSHIRE DOWNS | | COTSWOLD HILLS | |
|---|---|---|---|---|
| | 60 Cows or more | Under 60 Cows | 40 Cows or more | Under 40 Cows |
| Number of Herds | 9 | 7 | 10 | 10 |
| Average Number of Cows | 93 | 42 | 61 | 25 |
| Gallons per Cow per Day | 1.54 | 1.83 | 1.30 | 1.46 |
| Food Cost per Cow per Day | 9.19d. | 13.16d. | 10.50d. | 12.45d. |
| Food Cost per Gallon | 5.96d. | 7.21d. | 8.08d. | 8.56d. |
| Per Cow per Day | lbs. | lbs. | lbs. | lbs. |
| Starch Requirement | 10.47 | 11.26 | 9.92 | 10.29 |
| Starch Fed | 8.20 | 11.11 | 9.07 | 10.95 |
| Starch Deficiency | 2.27 | - | 0.85 | - |
| Starch Surplus | - | 0.15 | - | 0.66 |

The low cost per gallon on the Wiltshire Downs is seen to be due to the very low cost on those herds which consist of 60 cows or more. Those herds of less than 60 cows cannot be regarded as small herds, yet the average food cost per gallon is 7.21d., compared with 5.96d. for the very large herds. This is due to the high food cost per cow of 13.16d. per day, and this, in turn is a reflection of the small starch surplus. It appears, therefore, that the

considerable proportion of winter grazing which has been detected on the 16 Wiltshire Down farms belongs entirely to the 9 herds having 60 cows or more.

The size of the samples here is very small, and emphasis cannot be laid upon these conclusions. A note of warning must, however, be made, since it is not possible to regard the low winter food cost on Wiltshire Downland herds as typical of the general position on Downland farms as a whole. Whilst in other districts, the sample of farms can probably be regarded as representative of the entire district, this may well not be the case for the Wiltshire Downs. However, a very low food cost per gallon is to be expected on very large Wiltshire herds, when an average yield is maintained and a reasonable amount of winter grazing is available.

In the Cotswold area, the dividing line between larger and smaller herds has been taken at 40 cows. The group of larger herds averages 61 cows, and the group of smaller herds averages 25 cows. As in Wiltshire, the advantage lies with the larger herds, but the difference is not so marked. The food cost of 8.08d. per gallon for the larger herds is still above the average of all herds, and the average of 8.56d. for the group of smaller herds is unusually high. Again, the high cost per cow is the source of the high cost per gallon, and, yet again, this is in turn attributable to the existence of a starch surplus. In all probability, the size of the herd has been increased to that point which bears hard upon the supply of summer grass available, so that autumn grass is insufficient.

Similar data for vale types of farming are next considered, omitting for the moment, Somerset, which will require a treatment of its own. The vale areas now under discussion are:-

(1) The Wiltshire Vales.

(2) The Gloucestershire Vale.

(3) The Worcestershire Vale.

The streams which rise on the eastern slopes of the Cotswold Hills form two river systems, those of the Thames and the Bristol Avon. The River Thames is formed in the Cirencester district, and flows through Cricklade in the northern part of Wiltshire. The vale of Swindon is, therefore, to be regarded as part of the Upper Thames Valley.

The Avon flows through the north-western part of Wiltshire: Malmesbury, Chippenham, Melksham, Bradford. Thus the vale lands of the Trowbridge district are part of the Avon Valley. Continuous with this area is the Vale of Pewsey, which is drained by streams which form another River Avon flowing across Salisbury Plain to the south coast.

The Gloucestershire Vale lies on either side of the River Severn. The valley is wider to the east, extending to the foot of the Cotswold Hills, and including the Vale of Berkeley. One farm included is situated in the Forest of Dean.

The Worcestershire Vale is drained by the Severn and its tributaries, the Teme from the west, and the "Warwickshire" Avon from the east. A number of farms are situated at a somewhat higher altitude, on the slopes of the Lickey Hills and the Ridgeway, in the north of the county.

The following table throws into relief, the characteristics of these vale districts.

TABLE 36. THE VALE DISTRICTS

| | Wiltshire | Gloucester | Worcester |
|---|---|---|---|
| Number of Herds | 13 | 24 | 18 |
| Gallons per Day per Cow-in-Herd | 1.53 | 1.65 | 1.56 |
| Average Number of Cows | 41 | 26 | 28 |
| Food Cost per Cow per Day | 11.20d. | 12.80d. | 12.50d. |
| Food Cost per Gallon | 7.33d. | 7.77d. | 8.01d. |
| | lbs. | lbs. | lbs. |
| Concentrates per Cow per Day | 6.14 | 7.18 | 8.27 |
| Hay & Straw per Cow per Day | 13.41 | 13.77 | 12.12 |
| Succulents per Cow per Day | 12.55 | 11.90 | 10.37 |
| Concentrates per Gallon | 4.01 | 4.35 | 5.30 |
| Dry Matter per Cow per Day | 18.52 | 19.63 | 19.26 |
| Starch per Cow per Day | 9.39 | 10.54 | 10.57 |
| Starch Deficiency per Cow per Day | 1.05 | 0.17 | - |
| Starch Surplus per Cow per Day | - | - | 0.06 |

Food cost per gallon is lowest in Wiltshire, and highest in Worcestershire. Compared with Wiltshire, Gloucestershire has a higher yield, but a proportionally still higher food cost per cow. Compared with Gloucestershire, Worcestershire has a rather lower yield, but a food cost per cow which is almost as high. Food cost per gallon is nowhere as low as upon the Wiltshire Downs, and nowhere as high as upon the Cotswolds.

Between the three groups, there are marked distinctions in the feeding of concentrates, both per cow and per gallon. The quantity of concentrates fed per gallon is unusually high in Worcestershire, being 5.30 lbs. as compared with the recognised standard of 3½ lbs. The feeding of concentrates in the Wiltshire Vale is below the

average for all herds, and much nearer the standard quantity. In all cases, manufactured cakes and nuts account, for more than half of the total quantity of concentrates, and in Gloucestershire for more than two-thirds.

Of the farm-mixed concentrates, the following are the most important, in order:-

Wiltshire Vale (1) flaked maize, (2) ricemeal, (3) groundnut and (4) bran.

Gloucestershire Vale (1) maizemeal, (2) ricemeal, (3) groundnut and (4) palm kernel.

Worcestershire (1) dried beet pulp, (2) palm kernel, (3) maizemeal and (4) bran.

The variation in the feeding of hay and straw is very slight, being lowest per cow in Worcestershire. If the starch deficiency is translated, as before, into its equivalent as lbs. of hay, it is found that the hay and grass ration expressed as hay is 16.56 lbs. in Wiltshire, 14.28 lbs. in Gloucestershire, and 12.12 lbs. in Worcestershire where concentrates are fed as part of the maintenance ration.

The feeding of straw is not so marked as it is on the Wiltshire Downs and on the Cotswolds. In the Wiltshire Vale, of the hay and straw ration of 13.41 lbs. per cow per day, 1.39 lbs. consists of straw; in Worcestershire 0.78 lbs. out of 12.12 lbs; and in Gloucestershire, only 0.13 lbs. out of 13.77 lbs.

The ration of succulents is slightly above the average in the Wiltshire Vale, and below in Gloucestershire and Worcestershire. Kale is by far the most important crop fed on Wiltshire Vale farms, being fed to a greater extent, 8.14 lbs. per cow, than in any other area. On the other hand, fewer mangolds are fed than in any other area except the Cotswolds.

In the Gloucestershire Vale, both mangolds and kale are fed, the former rather more heavily than the latter. Only in the Wiltshire Vales is kale fed more heavily than in the Gloucestershire Vale.

In Worcestershire roughly one half of the succulents fed consists of mangolds, one quarter of kale, and one quarter of beet tops. It is of interest to note that whilst dried beet pulp is the most important concentrate fed in Worcestershire, this is the only area in which the feeding of beet tops is of any importance.

The examination of costs according to size group is made for the three groups of vale herds added together. The table following divides the herds into two groups, those of 30 cows or more, and those of under 30 cows.

TABLE 37. SIZE GROUPS IN VALE FARMING

| | 30 Cows or more | Under 30 Cows |
|---|---|---|
| Number of Herds | 21 | 34 |
| Gallons per Cow per Day | 1.49 | 1.73 |
| Food Cost per Cow per Day | 11.46d. | 13.41d. |
| Food Cost per Gallon | 7.69d. | 7.73d. |
| Per Cow per Day | lbs. | lbs. |
| Starch Requirement | 10.35 | 10.90 |
| Starch Fed | 9.84 | 10.75 |
| Starch Deficiency | 0.51 | 0.15 |

The smaller herds, of under 30 cows, maintain a higher yield at an additional cost per cow. The difference in the food cost per gallon is so small that it must be ignored. The higher yield on the smaller herds does not provide a material advantage in a lower cost per gallon because the starch deficiency, and hence the amount of winter grazing is less.

This reduced starch deficiency on smaller herds recalls the same situation amongst the hill farms of the Wiltshire Downs and the Cotswolds. Again this may be due to the tendency of those with smaller herds to raise their number to a maximum point in relation to the amount of summer grazing. In consequence, a reduced amount of winter grazing per cow offsets the advantage of higher winter yield.

Lastly, a study must be made of Somerset. Whilst most counties are subject to great variations in soil type, Somerset is subject to extreme variation. A classification of farms by agricultural area is thus rendered especially difficult. One area, however, can be easily distinguished: the flats.

Bordering upon the coast of the Bristol channel are localities which are either subject to serious flooding during the winter months, or would be were it not for the extensive drainage schemes which have covered the localities with their typical "rhynes" and banks of willow trees. Flooding has deposited a rich alluvial soil making the

grassland particularly productive. The area can be defined as that drained by the Rivers Axe, Brue and Parett, together with the district between Clevedon and Yatton, and Weston-Super-Mare. Highbridge and Bridgwater are the centres of the most important block of flats. Inland, the area stretches to Glastonbury and Langport, whilst the coastal belt west of Bridgwater is also included on the coast side of the Bridgwater - Kilve road.

The productive character of the grassland has given rise to two systems of dairy farming. These cannot always be distinguished, but a rough demarcation is possible. Some farms make the best possible use of the summer grazing by maximising their spring calvings, concentrating milk production in the summer months, and supplying the seaside towns of Clevedon, Weston-Super-mare and Burnham-on-Sea, with milk and cream. The winter yield of milk is, consequently, low.

Other farms make the best possible use of the winter grazing, often with very high yields. Some outstanding examples of herds which base a high yield upon ample winter grazing are to be found in this district of Somerset. As a rule it is the large herds which maximise the production of summer milk, and the small herds which maintain a high output of winter milk. Much information would be lost if the two groups were merged together, and although the samples are small, an interesting contrast is provided.

TABLE 38. SIZE GROUPS ON THE SOMERSET FLATS

| | 30 Cows or More | Under 30 Cows |
|---|---|---|
| Number of Herds | 8 | 7 |
| Gallons per Day per Cow-in-Herd | 1.22 | 1.82 |
| Average Number of Cows | 50 | 17 |
| Food Cost per Cow per Day | 9.64d. | 11.10d. |
| Food Cost per Gallon | 7.87d. | 6.10d. |
| | lbs. | lbs. |
| Concentrates per Cow per Day | 5.38 | 6.00 |
| Hay and Straw per Cow per Day | 10.74 | 12.02 |
| Succulents per Cow per Day | 2.43 | 4.08 |
| Concentrates per Gallon | 4.40 | 3.30 |
| Dry Matter per Cow per Day | 14.26 | 16.01 |
| Starch per Cow per Day | 7.49 | 8.55 |
| Starch Deficiency per Cow per Day | 2.27 | 2.54 |

The 8 herds with 30 cows or more are:- M.7, M.22, M.91, M.96, M.100, M.103, M.112, and M.117. The 7 herds with under 30 cows are:- M.6, M.94, M.108, M.111, M.119, S.84 and S.198.

Food cost per gallon is very low on the smaller herds. The table shows clearly the advantage of combining a yield of 1.82 gallons with a starch deficiency of 2.54 lbs. per cow per day. The yield on the larger herds is very low, but it does not result in an excessively high cost per gallon because the starch deficiency, and hence the amount of winter grazing, is considerable.

A further point of interest is the very low feeding of concentrates per gallon on the smaller herds, 3.30 lbs. per gallon. This is less than the recogised quantity, and indicates that autumn grazing is sufficiently plentiful, and of high quality, that the feeding of concentrates is limited.

For the two groups together, the most important farm-mixed concentrates are, in order, (1) maizemeal, (2) groundnut, (3) flaked maize, and (4) crushed oats.

The feeding of both straw and succulents is less than in any other areas. The small quantity of succulents fed consists principally of mangolds. The kale ration is, by itself, smaller than in any other area.

The remaining Somerset farms form a belt which lie in hillier regions. It is difficult to classify them as hill or vale. On the Eastern Mendips, in the Radstock, Shepton Mallet and Frome area, the country is high, yet the farming is not so clearly of a hill type as on the Downs or on the Cotswolds. The country is undulating rather than hilly. To the south, the undulating belt stretches away to Wincanton, and a second belt of lowhills forms the southern border of the country in the neighbourhood of Yeovil, Crewkerne, Chard, Ilminster, Wellington and Minehead.

There are 27 farms in this hilly belt from the Eastern Mendips to the Blackdown and Brendon Hills. In the table following they are classified in two groups, those of 30 cows or more, and those of under 30 cows.

TABLE 39. SIZE GROUPS IN THE SOMERSET HILL BELT

| | 30 Cows or More | Under 30 Cows |
|---|---|---|
| Number of Herds | 17 | 10 |
| Gallons per Day per Cow-in-Herd | 1.47 | 1.57 |
| Average Number of Cows | 40 | 21 |
| Food Cost per Cow per Day | 10.83d. | 12.67d. |
| Food cost per Gallon | 7.34d. | 8.09d. |
| | lbs. | lbs. |
| Concentrates per Cow per Day | 5.75 | 6.74 |
| Hay and Straw per Cow per Day | 11.54 | 13.83 |
| Succulents per Cow per Day | 16.29 | 9.89 |
| Concentrates per Gallon | 3.90 | 4.30 |
| Dry Matter per Cow per Day | 17.16 | 19.03 |
| Starch per Cow per Day | 9.00 | 9.86 |
| Starch Deficiency per Cow per Day | 1.32 | 0.66 |

The larger herds show a lower food cost per gallon, thus revealing the same tendency as upon the Downs and Cotswolds. The advantage of the larger herds can again be traced to the higher starch deficiency.

The principal farm-mixed concentrates fed to the 27 herds in the Somerset hill belt are, in order, (1) flaked maize, (2) groundnut, (3) bran, and (4) dried beet pulp. More flaked maize is fed in this area than in any other.

The quantities of straw and succulents fed are larger than upon the flats, though straw accounts only for 0.47 lbs. out of a total hay and straw ration of 11.63 lbs. per cow per day. The succulents are divided in the ratio of 5 parts mangolds, 4 parts kale, and 2 parts cabbage.

## CONCLUSIONS

It is claimed that the foregoing analysis shows very clearly that two major factors are responsible for the wide variation found in the food cost per gallon from farm to farm. These are yield and starch deficiency or surplus.

Whilst classification by yield reveals a considerable advantage in favour of higher yields, it is not as great as would be expected from a study of theoretical food requirements. Many herds with low food costs per gallon are found to possess a low cost per cow with low yield. These low per-gallon costs are due to large starch deficiencies.

The starch deficiency is calculated by subtracting the starch recorded as fed in the form of concentrates, hay, straw, roots, and green crops, from the total requirement. It is assumed that the deficiency is a measure of the amount of starch equivalent provided by winter grazing.

The fact that the advantage of higher yield is rather less than is expected from theoretical considerations, is wholly explained by those herds with very low food costs per cow and large starch deficiencies. When the influence of yield upon the food cost per gallon is studied for groups of herds possessing similar starch deficiencies or surpluses, it is found that the advantage of higher yield conforms in a very striking manner to the expected theoretical fall.

The assumption that starch deficiency is a measure of the amount of starch equivalent consumed in the form of winter grazing, is clearly open to criticism. The assumption can be regarded only as a first approximation to the truth. In an earlier publication of this department entitled "An Enquiry into Management for Milk Proudction," now out of print, it was shown that winter starch deficiencies were almost entirely accounted for in the months of October and November. This is strong evidence in favour of the assumption made in the present bulletin. A similar subdivision of the winter period 1934-5 has not yet been made. A further bulletin on week-by-week changes in feeding for a twelve-month period will be published in the near future. Such a study will throw considerable light upon the relationship between starch deficiency and grazing.

A second assumption which materially affects the analysis is that which is made for the starch equivalent of hay. The assumed average is 35.3 % starch equivalent and is not likely to be the true average for the total bulk of hay consumed during the winter, whilst variation from farm to farm is likely to be as considerable in this respect as in any other. In the months of January and February, starch deficiencies and surpluses may well measure variations in the feeding value of hay.

A third assumption has been made in the pricing of hay. Again, variations in the cost of production of hay are known to be very considerable from farm to farm, as are the relative proportions of concentrates and hay fed per cow. An effort is now being made to calculate the cost of production of hay on each farm. It will be possible to estimate the importance of this factor in a subsequent publication.

In spite of these limitations, the material of this bulletin advances some distance towards th ultimate destination. The advantage of higher yields is not likely to be seriously affected by any subsequent analysis. Where a plentiful supply of good quality hay produced at low cost is available, low food costs per gallon based upon low yields will again be seen, a phenomenon parallel with that of low food costs per gallon based upon winter grazing. Yet the present bulletin demonstrates that the advantage of high yield persists within the group of herds showing large starch deficiencies.

Although higher yield is favoured, the material collected does not give a solution to the problem of forcing yield. The recommendation given suggests the elimination of poor yielders from the herd, the prevention of severe drops during the period of lactation, and the selection of likely high yielders for transference into the herd.

Substantial variation is found from district to district. The food cost per gallon is not entirely under the control of the farmer; at least the effort required to bring about a reduction in cost varies for different districts.

Yields are usually higher on smaller herds, especially upon the Wiltshire Downs, on the Somerset Flats, and in the vale areas of Gloucestershire. The amount of winter grazing as measured by starch deficiency is greatest on the Somerset Flats and among the very large herds on the Wiltshire Downs. The amount of winter grazing is least amongst the smaller herds except in Somerset, being particularly slight on the Cotswolds and in Worcestershire. Good yields combined with high starch deficiencies are responsible for low food costs of the Somerset Flats. Low yields and starch surpluses (or low deficiencies) are responsible for high food costs on the Cotswolds. The majority of small herds lose the advantage of higher yields through low starch deficiencies, whilst in Worcestershire, and to some extent, in Gloucestershire, the existence of starch surpluses completely offsets the advantage of higher yields.

Starch surpluses are usually accompanied by an unduly heavy feeding of concentrates. The feeding of concentrates per gallon is particularly high in Worcestershire and upon the Cotswolds. It has been shown that mixed concentrates are somewhat less expensive than dairy cake or nuts. Mixed concentrates are fed in high proportion on the Wiltshire Downs, whilst dairy cake and nuts are fed in high proportion in the Gloucestershire Vale.

The individual details given in the appendices show that examples of farms can be found which do not conform to the general picture of the district, as, for instance, low costs on the Cotswolds, or high costs on the Somerset Flats. Close study of yield or starch deficiency will show the reason. Thus low Cotswold costs can be found based upon high starch deficiencies. An examination of these individual exceptions will be found to justify opinion that "exceptions prove the rule."

## APPENDIX I

### Analysis of Foodstuffs - Figures used in this bulletin

| | Dry Matter Percentage | Starch Equivalent Percentage | Protein Percentage |
|---|---|---|---|
| Dairy Cake | 86.0 | 70.0 | 17.0 |
| Groundnut Cake | 89.7 | 73.0 | 41.3 |
| Decorticated Cotton Cake | 90.2 | 68.4 | 34.6 |
| Undecorticated Cotton Cake | 87.9 | 41.6 | 17.3 |
| Palm Kernel and Coconut | 90.0 | 73.0 | 17.0 |
| Flaked Maize | 89.0 | 84.0 | 9.2 |
| Maizemeal | 87.0 | 77.6 | 7.6 |
| Bran | 87.0 | 42.6 | 9.9 |
| Ground Wheat | 86.6 | 71.6 | 9.6 |
| Crushed Oats | 86.7 | 59.5 | 7.6 |
| Ricemeal | 91.1 | 72.3 | 7.0 |
| Dried Beet Pulp | 90.0 | 65.5 | 5.1 |
| Hay | 85.7 | 33.3 | 4.0 |
| Oat Straw | 86.0 | 21.0 | 0.5 |
| Barley Straw | 86.0 | 23.0 | 0.7 |
| Wheat Straw | 86.0 | 13.0 | 0.1 |
| Mangolds | 12.5 | 6.5 | 0.4 |
| Turnips | 8.5 | 4.4 | 0.4 |
| Swedes | 11.5 | 7.3 | 0.7 |
| Kale | 14.3 | 8.9 | 1.3 |
| Cabbage | 11.0 | 6.6 | 0.9 |
| Sugar Beet Tops | 16.2 | 8.6 | 1.2 |
| Brewers' Wet Grains | 32.4 | 18.4 | 5.3 |

## APPENDIX 2. INDIVIDUAL HERD PARTICULARS

### In order of Food Cost per Gallon.

| Position | Farm Number | Locality | Number of cows | | Gallons per day per cow | | Foodcost per cow per day | Foodcost per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | | In Herd | In Milk | In Herd | In Milk | d. | d. |
| 1 | M 31 | Swindon | 99 | 75 | 1.68 | 2.23 | 6.94 | 4.14 |
| 2 | M 30 | Swindon | 94 | 76 | 1.75 | 2.14 | 7.39 | 4.22 |
| 3 | M 91 | Highbridge | 54 | 37 | 1.27 | 1.87 | 5.75 | 4.52 |
| 4 | M 65 | Tetbury | 46 | 39 | 1.33 | 1.57 | 6.19 | 4.66 |
| 5 | S 43 | Ilminster | 44 | 34 | 1.89 | 2.41 | 8.98 | 4.76 |
| 6 | M 94 | Bridgwater | 12 | 10 | 3.09 | 3.71 | 15.50 | 4.98 |
| 7 | M 50 | Marlborough | 20 | 16 | 2.08 | 2.55 | 10.36 | 4.98 |
| 8 | S 40 | Yeovil | 31 | 26 | 2.30 | 2.76 | 11.43 | 4.99 |
| 9 | M 68 | Tetbury | 40 | 31 | 1.52 | 1.98 | 7.65 | 5.02 |
| 10 | M 79 | Frome | 50 | 38 | 1.53 | 2.01 | 8.00 | 5.22 |
| 11 | S 84 | Bridgwater | 27 | 19 | 1.43 | 2.04 | 7.59 | 5.32 |
| 12 | S 198 | Bridgwater | 10 | 7 | 2.30 | 3.09 | 12.32 | 5.37 |
| 13 | M 131 | Warminster | 67 | 59 | 2.35 | 2.60 | 12.82 | 5.52 |
| 14 | M 89 | Wotton-U-E | 11 | 8 | 1.38 | 1.93 | 7.57 | 5.53 |
| 15 | M 118 | Wotton-U-E | 20 | 16 | 1.24 | 1.59 | 7.05 | 5.67 |
| 16 | M 6 | Bridgwater | 7 | 5 | 2.04 | 2.70 | 11.59 | 5.73 |
| 17 | M 60 | Salisbury | 42 | 36 | 2.48 | 2.84 | 14.19 | 5.73 |
| 18 | W 311 | Marlborough | 75 | 58 | 1.61 | 2.06 | 9.31 | 5.79 |
| 19 | M 76 | Swindon | 40 | 33 | 1.47 | 1.70 | 8.60 | 5.85 |
| 20 | W 307 | Trowbridge | 19 | 15 | 2.19 | 2.78 | 12.82 | 5.89 |
| 21 | M 33 | Bristol | 29 | 24 | 1.98 | 2.33 | 11.71 | 5.92 |
| 22 | S 351 | Wincanton | 34 | 24 | 1.68 | 2.34 | 10.02 | 5.95 |
| 23 | M 85 | Salisbury | 77 | 59 | 1.80 | 2.35 | 10.85 | 6.03 |
| 24 | S 2 | Ilminster | 35 | 23 | 1.39 | 2.17 | 8.43 | 6.05 |
| 25 | M 69 | Shepton M. | 39 | 30 | 1.42 | 1.83 | 8.72 | 6.16 |
| 26 | M 113 | Yeovil | 44 | 36 | 1.46 | 1.78 | 9.04 | 6.18 |
| 27 | M 111 | Clevedon | 19 | 14 | 1.61 | 2.18 | 10.14 | 6.32 |
| 28 | M 74 | Bridgwater | 31 | 27 | 1.48 | 1.73 | 9.35 | 6.34 |
| 29 | M 38 | Wotton-U-E | 22 | 17 | 1.41 | 1.84 | 8.97 | 6.34 |
| 30 | M 84 | Salisbury | 51 | 43 | 1.95 | 2.31 | 12.51 | 6.41 |
| 31 | SG 6 | Tewkesbury | 62 | 46 | 1.94 | 2.61 | 12.55 | 6.45 |
| 32 | W 40 | Trowbridge | 72 | 54 | 1.37 | 1.82 | 8.94 | 6.54 |
| 33 | M 81 | Frome | 33 | 30 | 1.65 | 1.83 | 10.85 | 6.59 |
| 34 | M 130 | Warminster | 104 | 76 | 1.70 | 2.32 | 11.17 | 6.59 |
| 35 | M 106 | Redditch | 56 | 43 | 1.96 | 2.54 | 13.01 | 6.64 |
| 36 | M 124 | Swindon | 40 | 31 | 1.16 | 1.52 | 7.79 | 6.74 |
| 37 | W 16 | Salisbury | 146 | 85 | 0.74 | 1.27 | 4.99 | 6.77 |
| 38 | W 322 | Marlborough | 26 | 21 | 1.82 | 2.26 | 12.34 | 6.78 |
| 39 | M 101 | Chippenham | 21 | 14 | 2.17 | 2.22 | 14.88 | 6.85 |
| 40 | M 119 | Clevedon | 23 | 19 | 1.80 | 2.13 | 12.37 | 6.87 |
| 41 | M 4 | Cirencester | 138 | 107 | 1.30 | 1.69 | 8.91 | 6.88 |
| 42 | W 35 | Marlborough | 93 | 74 | 1.40 | 1.77 | 9.66 | 6.89 |
| 43 | M 88 | Frome | 40 | 33 | 1.36 | 1.61 | 9.37 | 6.93 |
| 44 | M 127 | Bristol | 22 | 17 | 1.83 | 2.42 | 12.68 | 6.93 |

## APPENDIX 2 - CONTINUED

| Position | Farm Number | Locality | Number of cows | | Gallons per day per cow | | Foodcost per cow per day | Foodcost per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | | In Herd | In Milk | In Herd | In Milk | d. | d. |
| 45 | M 110 | Stroud | 13 | 11 | 1.87 | 2.28 | 13.03 | 6.99 |
| 46 | M 51 | Bromsgrove | 13 | 11 | 2.15 | 2.73 | 15.11 | 7.03 |
| 47 | SR 20 | Evesham | 73 | 59 | 1.22 | 1.50 | 8.55 | 7.03 |
| 48 | M 87 | Weston-S-M | 17 | 13 | 1.70 | 2.36 | 11.96 | 7.03 |
| 49 | M 73 | Weston-S-M | 20 | 16 | 1.70 | 2.12 | 12.09 | 7.10 |
| 50 | S 349 | Ilminster | 26 | 19 | 1.73 | 2.40 | 12.28 | 7.10 |
| 51 | M 112 | Weston-S-M | 53 | 36 | 1.02 | 1.52 | 7.31 | 7.14 |
| 52 | M 90 | Bromsgrove | 29 | 25 | 1.85 | 2.18 | 13.22 | 7.14 |
| 53 | M 59 | Gloucester | 20 | 14 | 2.14 | 2.99 | 15.29 | 7.15 |
| 54 | 4 B2 | Thornbury | 39 | 32 | 1.79 | 2.20 | 12.73 | 7.15 |
| 55 | M 135 | Bristol | 35 | 22 | 1.31 | 2.06 | 9.42 | 7.22 |
| 56 | M 42 | Gloucester | 18 | 15 | 1.82 | 2.20 | 13.20 | 7.26 |
| 57 | M 86 | Salisbury | 89 | 70 | 1.52 | 1.92 | 11.03 | 7.26 |
| 58 | M 125 | Williton | 12 | 10 | 1.49 | 1.89 | 10.98 | 7.36 |
| 59 | M 139 | Salisbury | 35 | 29 | 2.14 | 2.56 | 15.73 | 7.36 |
| 60 | M 46 | Worcester | 12 | 10 | 1.66 | 1.93 | 12.35 | 7.43 |
| 61 | M 2 | Lydney | 38 | 33 | 1.18 | 1.37 | 8.74 | 7.44 |
| 62 | M 47 | Wotton-U-E | 24 | 19 | 1.39 | 1.78 | 10.41 | 7.48 |
| 63 | 6 G5 | Worcester | 36 | 28 | 2.01 | 2.58 | 15.16 | 7.53 |
| 64 | M 8 | Thornbury | 13 | 11 | 2.02 | 2.45 | 15.27 | 7.56 |
| 65 | M 133 | Bristol | 25 | 17 | 1.14 | 1.73 | 8.65 | 7.60 |
| 66 | M 71 | Stroud | 40 | 38 | 1.47 | 1.53 | 11.19 | 7.61 |
| 67 | M 7 | Bridgwater | 67 | 53 | 1.49 | 1.87 | 11.32 | 7.62 |
| 68 | M 41 | Wotton-U-E | 16 | 13 | 1.42 | 1.82 | 10.83 | 7.65 |
| 69 | M 116 | Tetbury | 35 | 29 | 1.44 | 1.79 | 11.12 | 7.72 |
| 70 | W 6 | Salisbury | 63 | 46 | 1.94 | 2.64 | 15.08 | 7.75 |
| 71 | M 62 | Devizes | 36 | 28 | 1.03 | 1.35 | 7.99 | 7.76 |
| 72 | M 57 | Worcester | 38 | 28 | 1.35 | 1.87 | 10.62 | 7.85 |
| 73 | M 103 | Weston-S-M | 56 | 39 | 1.38 | 1.97 | 10.85 | 7.88 |
| 74 | M 108 | Clevedon | 21 | 18 | 1.49 | 1.80 | 11.82 | 7.90 |
| 75 | M 14 | Lydney | 11 | 8 | 2.20 | 2.99 | 17.51 | 7.97 |
| 76 | M 11 | Cirencester | 21 | 16 | 1.59 | 2.02 | 12.69 | 7.99 |
| 77 | M 20 | Cirencester | 21 | 19 | 1.51 | 1.68 | 12.14 | 8.01 |
| 78 | M 123 | Trowbridge | 52 | 40 | 1.73 | 2.25 | 13.90 | 8.03 |
| 79 | 6 C1a | Tetbury | 67 | 56 | 1.36 | 1.63 | 10.87 | 8.03 |
| 80 | 4 B3 | Thornbury | 29 | 21 | 1.78 | 2.40 | 14.20 | 8.03 |
| 81 | M 39 | Salisbury | 43 | 33 | 1.52 | 2.01 | 12.29 | 8.07 |
| 82 | M 3 | Cirencester | 60 | 46 | 1.23 | 1.59 | 10.02 | 8.08 |
| 83 | M 18 | Lydney | 25 | 22 | 2.03 | 2.34 | 16.40 | 8.08 |
| 84 | M 134 | Yeovil | 20 | 15 | 1.53 | 2.08 | 12.38 | 8.10 |
| 85 | M 32 | Wincanton | 46 | 38 | 1.63 | 2.00 | 13.20 | 8.11 |
| 86 | M 122 | Droitwich | 43 | 37 | 1.82 | 2.11 | 14.76 | 8.11 |
| 87 | M 37 | Stroud | 6 | 5 | 1.87 | 2.18 | 15.24 | 8.16 |
| 88 | M 35 | Swindon | 49 | 41 | 1.93 | 2.36 | 15.86 | 8.22 |
| 89 | M 23 | Taunton | 26 | 22 | 1.32 | 1.59 | 10.85 | 8.23 |

APPENDIX 2 - CONTINUED

| Position | Farm Number | Locality | Number of cows In Herd | Number of cows In Milk | Gallons per day per cow In Herd | Gallons per day per cow In Milk | Foodcost per cow per day | Foodcost per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | d. | d. |
| 90 | M 15 | Campden | 30 | 25 | 1.54 | 1.87 | 12.77 | 8.27 |
| 91 | SR 13 | Droitwich | 52 | 40 | 1.07 | 1.38 | 8.85 | 8.29 |
| 92 | M 117 | Clevedon | 32 | 23 | 1.73 | 2.40 | 14.30 | 8.29 |
| 93 | M 58 | Cirencester | 38 | 29 | 1.29 | 1.68 | 10.71 | 8.29 |
| 94 | M 140 | Thornbury | 12 | 10 | 1.75 | 2.01 | 14.69 | 8.39 |
| 95 | M 49 | Stourport | 12 | 9 | 1.19 | 1.62 | 10.15 | 8.47 |
| 96 | S 67 | Yeovil | 25 | 21 | 1.60 | 1.86 | 13.70 | 8.53 |
| 97 | M 34 | Worcester | 9 | 8 | 2.21 | 2.29 | 18.92 | 8.54 |
| 98 | M 10 | Gloucester | 11 | 8 | 1.69 | 2.53 | 14.69 | 8.69 |
| 99 | M 82 | Yeovil | 40 | 33 | 1.55 | 1.86 | 13.72 | 8.83 |
| 100 | M 93 | Frome | 32 | 21 | 0.98 | 1.49 | 8.51 | 8.86 |
| 101 | M 102 | Bristol | 27 | 23 | 1.79 | 2.07 | 15.89 | 8.87 |
| 102 | M 56 | Devizes | 53 | 36 | 1.50 | 2.18 | 13.52 | 8.97 |
| 103 | M 64 | Upton-on-S | 20 | 11 | 0.90 | 1.68 | 8.11 | 8.98 |
| 104 | M 55 | Leominster | 23 | 17 | 1.74 | 2.34 | 15.67 | 9.00 |
| 105 | M 75 | Worcester | 24 | 19 | 1.65 | 2.00 | 14.73 | 9.04 |
| 106 | M 100 | Langport | 65 | 37 | 0.98 | 1.63 | 8.55 | 9.06 |
| 107 | M 22 | Cheddar | 38 | 24 | 0.90 | 1.40 | 8.24 | 9.11 |
| 108 | M 78 | Wotton-u-E | 33 | 25 | 1.21 | 1.58 | 11.06 | 9.14 |
| 109 | M 44 | Bromsgrove | 13 | 10 | 1.71 | 2.21 | 15.77 | 9.20 |
| 110 | M 107 | Trowbridge | 55 | 45 | 1.20 | 1.49 | 11.19 | 9.29 |
| 111 | M 48 | Worcester | 19 | 15 | 1.51 | 1.91 | 14.17 | 9.40 |
| 112 | S 49 | Taunton | 48 | 42 | 1.42 | 1.61 | 13.51 | 9.53 |
| 113 | M 5 | Thornbury | 49 | 40 | 1.44 | 1.75 | 13.71 | 9.55 |
| 114 | M 138 | Bath | 41 | 30 | 1.32 | 1.80 | 12.65 | 9.56 |
| 115 | M 109 | Yeovil | 10 | 9 | 1.87 | 2.27 | 18.03 | 9.64 |
| 116 | W 308 | Marlborough | 13 | 11 | 1.41 | 1.66 | 13.69 | 9.74 |
| 117 | M 27 | Salisbury | 53 | 43 | 1.35 | 1.66 | 13.34 | 9.85 |
| 118 | M 97 | Upton-on-S | 7 | 6 | 1.67 | 2.16 | 16.48 | 9.89 |
| 119 | M 105 | Thornbury | 20 | 17 | 1.66 | 1.94 | 16.43 | 9.91 |
| 120 | M 24 | Gloucester | 38 | 22 | 1.36 | 2.39 | 13.57 | 9.96 |
| 121 | 6 G7 | Upton-on-S | 32 | 25 | 1.62 | 2.08 | 16.29 | 10.08 |
| 122 | M 52 | Stroud | 21 | 17 | 2.01 | 2.44 | 20.33 | 10.09 |
| 123 | M 12 | Cirencester | 58 | 51 | 1.31 | 1.50 | 13.42 | 10.18 |
| 124 | M 80 | Bristol | 23 | 17 | 1.79 | 2.42 | 18.39 | 10.24 |
| 125 | M 114 | Bath | 36 | 24 | 1.23 | 1.88 | 12.73 | 10.36 |
| 126 | W 47 | Salisbury | 20 | 18 | 1.85 | 2.06 | 19.48 | 10.54 |
| 127 | M 28 | Cirencester | 27 | 20 | 1.39 | 1.95 | 15.03 | 10.75 |
| 128 | M 17 | Lydney | 25 | 17 | 1.16 | 1.69 | 13.24 | 11.40 |
| 129 | 6 C1b | Tetbury | 62 | 53 | 1.00 | 1.22 | 11.62 | 11.61 |
| 130 | M 61 | Stroud | 56 | 44 | 1.21 | 1.52 | 14.14 | 11.68 |
| 131 | M 96 | Highbridge | 40 | 28 | 1.08 | 1.54 | 12.69 | 11.72 |
| 132 | S 106 | Wincanton | 56 | 33 | 1.01 | 1.72 | 11.86 | 11.74 |
| 133 | M 104 | Bristol | 39 | 27 | 1.31 | 1.87 | 15.58 | 11.87 |

## APPENDIX 3

| Position | Farm Number | Weight fed Per Cow per Day | | | Concentrates fed per Gallon | EXCLUDING WINTER GRAZING | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Weight Fed per Cow per Day | | | |
| | | Concentrates | Hay and Straw | Succulents | | Dry Matter | Starch Fed | Starch Requirements | Surplus + Deficiency- |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 1 | M 31 | 3.25 | 10.21 | 17.63 | 1.94 | 13.54 | 6.43 | 10.78 | -4.35 |
| 2 | M 30 | 3.97 | 9.77 | 24.39 | 2.27 | 14.91 | 7.47 | 10.94 | -3.47 |
| 3 | M 91 | 2.76 | 5.59 | 0.44 | 2.17 | 7.33 | 3.59 | 9.86 | -6.27 |
| 4 | M 65 | 5.21 | 11.01 | - | 3.93 | 14.03 | 5.52 | 9.99 | -4.47 |
| 5 | S 43 | 6.83 | 9.81 | 2.52 | 3.62 | 14.71 | 7.79 | 11.25 | -3.46 |
| 6 | M 94 | 9.65 | 14.31 | - | 3.12 | 20.72 | 11.26 | 13.95 | -2.69 |
| 7 | M 50 | 4.69 | 9.90 | 26.95 | 2.25 | 16.35 | 8.91 | 11.68 | -2.77 |
| 8 | S 40 | 9.27 | 9.15 | 17.06 | 4.04 | 18.37 | 11.19 | 12.20 | -1.01 |
| 9 | M 68 | 8.52 | 7.06 | - | 5.59 | 13.59 | 7.86 | 11.42 | -3.56 |
| 10 | M 79 | 6.66 | 5.99 | - | 4.35 | 10.90 | 6.66 | 10.44 | -3.78 |
| 11 | S 84 | 2.82 | 11.39 | - | 1.98 | 12.19 | 5.79 | 10.22 | -4.43 |
| 12 | S 198 | 9.11 | 8.80 | 18.03 | 3.97 | 17.72 | 11.63 | 12.17 | -0.54 |
| 13 | M 131 | 9.50 | 11.33 | 28.10 | 4.09 | 21.45 | 11.59 | 12.28 | -0.69 |
| 14 | M 89 | 4.31 | 7.97 | 2.78 | 3.14 | 10.90 | 5.66 | 10.10 | -4.44 |
| 15 | M 118 | 2.85 | 8.15 | 1.68 | 2.30 | 9.69 | 4.83 | 9.79 | -4.96 |
| 16 | M 6 | 9.40 | 8.89 | 13.13 | 4.65 | 17.86 | 10.67 | 11.60 | -0.93 |
| 17 | M 60 | 11.42 | 11.63 | - | 4.61 | 19.85 | 11.63 | 12.58 | -0.95 |
| 18 | W 311 | 5.27 | 10.69 | 21.73 | 3.28 | 16.60 | 8.55 | 10.62 | -2.07 |
| 19 | M 76 | 5.49 | 11.70 | - | 3.74 | 14.84 | 7.18 | 10.38 | -3.20 |
| 20 | W 307 | 8.73 | 12.50 | - | 4.01 | 18.32 | 10.06 | 11.93 | -1.87 |
| 21 | M 33 | 7.24 | 12.48 | - | 3.64 | 16.93 | 9.16 | 11.46 | -2.30 |
| 22 | S 351 | 6.35 | 7.10 | 18.10 | 3.77 | 14.03 | 8.28 | 10.78 | -2.50 |
| 23 | M 85 | 7.13 | 11.75 | 18.53 | 3.96 | 18.74 | 9.63 | 11.05 | -1.42 |
| 24 | S 2 | 2.77 | 10.19 | 17.07 | 1.99 | 13.35 | 6.40 | 10.13 | -3.73 |
| 25 | M 69 | 5.19 | 7.84 | 4.92 | 3.67 | 11.77 | 6.52 | 10.20 | -3.68 |
| 26 | M 113 | 4.70 | 10.21 | 18.68 | 3.21 | 15.56 | 8.54 | 10.28 | -1.74 |
| 27 | M 111 | 4.80 | 12.43 | - | 2.99 | 14.71 | 7.48 | 10.62 | -3.14 |
| 28 | M 74 | 4.75 | 11.63 | - | 3.21 | 14.02 | 7.18 | 10.33 | -3.15 |
| 29 | M 38 | 3.44 | 13.28 | - | 2.43 | 14.39 | 6.71 | 10.17 | -3.46 |
| 30 | M 84 | 6.54 | 18.93 | 35.05 | 3.35 | 26.54 | 11.13 | 11.39 | -0.26 |
| 31 | SG 6 | 10.93 | 10.43 | 19.33 | 5.62 | 21.12 | 12.89 | 11.36 | +1.53 |
| 32 | W 40 | 5.20 | 9.94 | - | 3.81 | 12.88 | 6.94 | 10.08 | -3.14 |
| 33 | M 81 | 6.23 | 11.31 | 11.46 | 3.78 | 16.77 | 9.00 | 10.71 | -1.71 |
| 34 | M 130 | 6.71 | 14.08 | 20.17 | 3.96 | 19.62 | 8.51 | 10.82 | -2.31 |
| 35 | M 106 | 7.98 | 16.91 | 16.67 | 4.07 | 23.70 | 12.65 | 11.41 | +1.24 |
| 36 | M 124 | - | 19.66 | - | 0.00 | 16.86 | 6.55 | 9.61 | -3.06 |
| 37 | W 16 | 2.11 | 11.88 | - | 2.86 | 12.08 | 4.59 | 8.66 | -4.07 |
| 38 | W 322 | 10.32 | 9.67 | - | 5.67 | 17.16 | 10.44 | 10.75 | -0.31 |
| 39 | M 101 | 9.36 | 13.90 | 22.29 | 4.31 | 23.08 | 13.13 | 11.88 | +1.25 |
| 40 | M 119 | 5.03 | 14.50 | 9.39 | 2.79 | 17.90 | 8.96 | 11.05 | -2.09 |
| 41 | M 4 | 5.23 | 9.86 | 8.10 | 4.03 | 14.00 | 7.55 | 9.92 | -2.37 |
| 42 | W 35 | 7.56 | 11.19 | 13.34 | 5.40 | 17.90 | 9.18 | 10.15 | -0.97 |
| 43 | M 88 | 4.77 | 7.65 | 17.82 | 3.53 | 12.85 | 6.28 | 10.06 | -3.78 |
| 44 | M 127 | 7.35 | 13.29 | 13.45 | 4.01 | 19.81 | 10.94 | 11.12 | -0.18 |

APPENDIX 3 - CONTINUED

| Position | Farm Number | Weight fed Per Cow per Day | | | Concentrates fed per Gallon | EXCLUDING WINTER GRAZING | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Weight Fed per Cow per Day | | | |
| | | Concentrates | Hay and Straw | Succulents | | Dry Matter | Starch Fed | Starch Requirements | Surplus + Deficiency - |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 45 | M 110 | 5.91 | 15.53 | - | 3.15 | 18.37 | 9.23 | 11.21 | -1.98 |
| 46 | M 51 | 10.12 | 15.29 | - | 4.68 | 22.41 | 12.22 | 11.84 | +0.38 |
| 47 | SR 20 | 6.67 | 7.39 | - | 5.49 | 12.07 | 6.95 | 9.75 | -2.80 |
| 48 | M 87 | 6.66 | 11.45 | 18.74 | 3.91 | 18.10 | 9.17 | 10.82 | -1.65 |
| 49 | M 73 | 7.27 | 12.67 | - | 4.27 | 17.31 | 8.92 | 10.63 | -1.71 |
| 50 | S 349 | 4.11 | 16.87 | 21.14 | 2.38 | 20.44 | 9.60 | 10.89 | -1.29 |
| 51 | M 112 | 3.76 | 8.43 | - | 3.65 | 10.49 | 5.34 | 9.30 | -3.96 |
| 52 | M 90 | 11.86 | 9.94 | 22.30 | 6.43 | 22.23 | 12.79 | 11.16 | +1.63 |
| 53 | M 59 | 10.22 | 11.36 | - | 5.10 | 19.11 | 11.41 | 11.82 | -0.41 |
| 54 | 4 B2 | 5.68 | 12.63 | 37.10 | 3.19 | 20.91 | 11.36 | 11.02 | +0.34 |
| 55 | M 135 | 5.13 | 11.81 | - | 3.93 | 14.56 | 7.53 | 9.95 | -2.42 |
| 56 | M 42 | 5.25 | 17.38 | - | 2.88 | 19.40 | 9.38 | 11.08 | -1.70 |
| 57 | M 86 | 6.50 | 12.92 | 16.01 | 4.24 | 18.73 | 9.36 | 10.42 | -1.06 |
| 58 | M 125 | 1.96 | 18.66 | - | 1.31 | 17.67 | 7.58 | 10.35 | -2.77 |
| 59 | M 139 | 16.12 | 6.58 | 8.05 | 7.55 | 20.96 | 13.76 | 11.82 | +1.94 |
| 60 | M 46 | 6.05 | 13.78 | - | 3.64 | 17.04 | 8.80 | 10.74 | -1.94 |
| 61 | M 2 | 2.95 | 13.88 | - | 2.49 | 14.39 | 6.66 | 9.66 | -3.00 |
| 62 | M 47 | 6.23 | 10.75 | - | 4.48 | 14.62 | 7.73 | 10.13 | -2.40 |
| 63 | 6 B5 | 9.62 | 12.24 | 24.68 | 4.78 | 22.08 | 12.14 | 11.52 | +0.62 |
| 64 | M 8 | 9.98 | 8.84 | 27.56 | 4.96 | 19.93 | 12.17 | 11.55 | +0.62 |
| 65 | M 133 | 4.32 | 8.15 | 20.57 | 3.79 | 13.48 | 7.35 | 10.57 | -3.22 |
| 66 | M 71 | 7.38 | 12.37 | - | 5.02 | 16.97 | 9.00 | 10.31 | -1.31 |
| 67 | M 7 | 7.19 | 11.23 | - | 4.84 | 15.89 | 8.96 | 10.35 | -1.39 |
| 68 | M 41 | 7.18 | 11.18 | - | 5.08 | 14.86 | 8.40 | 10.19 | -1.79 |
| 69 | M 116 | 5.53 | 13.64 | 20.23 | 3.83 | 19.00 | 9.65 | 10.24 | -0.59 |
| 70 | W 6 | 9.99 | 10.98 | 45.88 | 5.14 | 24.17 | 13.31 | 11.37 | +1.94 |
| 71 | M 62 | 3.71 | 13.42 | 5.78 | 3.62 | 15.48 | 6.67 | 9.32 | -2.65 |
| 72 | M 57 | 7.55 | 9.14 | 7.53 | 5.58 | 17.00 | 9.58 | 10.04 | -0.46 |
| 73 | M 103 | 5.81 | 13.93 | - | 4.21 | 17.00 | 8.68 | 10.11 | -1.43 |
| 74 | M 108 | 7.42 | 11.04 | - | 4.97 | 15.83 | 8.87 | 10.35 | -1.48 |
| 75 | M 14 | 8.90 | 15.38 | 48.56 | 4.05 | 26.74 | 15.38 | 11.95 | +3.43 |
| 76 | M 11 | 10.28 | 11.33 | 7.86 | 6.48 | 19.70 | 10.92 | 10.58 | +0.34 |
| 77 | M 20 | 8.22 | 16.89 | 38.79 | 5.42 | 26.16 | 12.11 | 10.39 | +1.72 |
| 78 | M 123 | 6.83 | 18.26 | - | 3.94 | 21.62 | 10.76 | 10.89 | -0.13 |
| 79 | 6 C1a | 4.40 | 14.85 | 8.99 | 3.24 | 17.76 | 8.83 | 10.06 | -1.23 |
| 80 | 4 B3 | 6.30 | 13.35 | 49.08 | 3.55 | 23.72 | 12.86 | 11.01 | +1.85 |
| 81 | M 39 | 10.42 | 11.95 | 17.16 | 6.85 | 21.83 | 11.00 | 10.42 | +0.58 |
| 82 | M 3 | 5.80 | 12.19 | 7.70 | 4.67 | 16.52 | 8.44 | 9.77 | -1.33 |
| 83 | M 18 | 8.61 | 11.29 | 40.98 | 4.24 | 22.81 | 13.21 | 11.57 | +1.64 |
| 84 | M 134 | 5.13 | 13.51 | 5.05 | 3.36 | 17.20 | 8.85 | 10.44 | -1.59 |
| 85 | M 32 | 7.33 | 12.03 | 19.78 | 4.50 | 19.16 | 10.55 | 10.67 | -0.12 |
| 86 | M 122 | 9.52 | 13.51 | 21.39 | 5.22 | 24.77 | 13.35 | 11.09 | +2.26 |
| 87 | M 37 | 8.09 | 21.15 | - | 4.33 | 25.27 | 12.73 | 11.05 | +1.68 |
| 88 | M 35 | 9.70 | 18.87 | 8.77 | 5.03 | 25.87 | 13.65 | 11.34 | +2.31 |
| 89 | M 23 | 7.86 | 6.74 | - | 5.96 | 12.56 | 7.75 | 9.97 | -2.22 |

## APPENDIX 3 - CONTINUED

| Position | Farm Number | Weight fed Per Cow per Day | | | Concentrates fed per Gallon | EXCLUDING WINTER GRAZING | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Weight Fed per Cow per Day | | | |
| | | Concentrates | Hay and Straw | Succulents | | Dry Matter | Starch Fed | Starch Requirements | Surplus + Deficiency - |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 90 | M 15 | 9.02 | 12.90 | 20.68 | 5.83 | 21.34 | 12.30 | 10.46 | +1.84 |
| 91 | SR13 | 6.19 | 10.91 | - | 5.80 | 14.19 | 7.75 | 9.40 | -1.65 |
| 92 | M 117 | 11.42 | 12.52 | - | 6.63 | 20.54 | 12.15 | 10.89 | +1.26 |
| 93 | M 58 | 7.62 | 14.97 | 15.58 | 5.90 | 21.51 | 9.96 | 9.90 | +0.06 |
| 94 | M 140 | 7.74 | 18.89 | 9.54 | 4.42 | 24.00 | 12.38 | 10.94 | +1.44 |
| 95 | M 49 | 8.57 | 5.02 | 16.26 | 7.19 | 13.85 | 8.20 | 9.68 | -1.48 |
| 96 | S 67 | 12.97 | 8.85 | 7.29 | 8.08 | 20.19 | 12.88 | 10.60 | +2.28 |
| 97 | M 34 | 11.43 | 21.00 | - | 5.16 | 27.93 | 14.76 | 11.97 | +2.79 |
| 98 | M 10 | 9.46 | 14.70 | - | 5.59 | 20.67 | 11.49 | 10.80 | +0.69 |
| 99 | M 82 | 6.31 | 12.03 | 25.29 | 4.06 | 19.35 | 10.29 | 10.48 | -0.19 |
| 100 | M 93 | 2.55 | 12.17 | 18.44 | 2.66 | 14.45 | 6.65 | 9.16 | -2.51 |
| 101 | M 102 | 9.94 | 16.81 | - | 5.56 | 22.94 | 11.94 | 11.03 | +0.91 |
| 102 | M 56 | 5.86 | 18.65 | 26.86 | 3.92 | 24.21 | 11.68 | 10.38 | +1.30 |
| 103 | M 64 | 3.07 | 12.34 | 0.60 | 3.41 | 13.39 | 6.39 | 9.03 | -2.64 |
| 104 | M 55 | 8.47 | 15.06 | 18.05 | 4.86 | 22.44 | 11.27 | 10.91 | +0.36 |
| 105 | M 75 | 9.38 | 13.24 | 17.82 | 5.74 | 21.98 | 12.23 | 11.08 | +1.15 |
| 106 | M 100 | 4.85 | 8.58 | 10.11 | 5.27 | 12.91 | 6.81 | 9.07 | -2.26 |
| 107 | M 22 | 2.90 | 11.72 | 9.96 | 3.20 | 14.36 | 6.74 | 9.03 | -2.29 |
| 108 | M 78 | 4.63 | 17.37 | - | 3.82 | 18.86 | 8.89 | 9.72 | -0.83 |
| 109 | M 44 | 10.55 | 15.82 | 13.41 | 6.14 | 24.90 | 13.23 | 10.85 | +2.38 |
| 110 | M 107 | 6.56 | 14.36 | 6.72 | 5.44 | 18.54 | 9.18 | 9.70 | -0.52 |
| 111 | M 48 | 9.56 | 5.13 | 27.66 | 6.34 | 16.28 | 10.59 | 10.40 | +0.19 |
| 112 | S 49 | 4.31 | 20.78 | 28.57 | 3.04 | 25.13 | 11.75 | 10.19 | +1.56 |
| 113 | M 5 | 6.42 | 18.05 | 16.27 | 4.47 | 23.28 | 11.38 | 10.24 | +1.14 |
| 114 | M 138 | 6.78 | 18.69 | 8.84 | 5.12 | 22.95 | 11.60 | 9.97 | +1.63 |
| 115 | M 109 | 11.34 | 12.31 | - | 6.05 | 20.35 | 11.45 | 10.89 | +0.56 |
| 116 | W 308 | 9.56 | 8.89 | 29.18 | 6.81 | 20.04 | 11.28 | 10.17 | +1.11 |
| 117 | M 27 | 6.89 | 12.54 | 48.23 | 5.09 | 23.62 | 11.99 | 10.04 | +1.95 |
| 118 | M 97 | 10.11 | 16.10 | - | 6.11 | 22.51 | 12.48 | 10.76 | +1.72 |
| 119 | M 105 | 9.92 | 19.88 | - | 5.99 | 25.69 | 14.05 | 10.74 | +3.31 |
| 120 | M 24 | 6.91 | 16.97 | - | 5.07 | 20.50 | 10.50 | 10.06 | +0.44 |
| 121 | 6 G7 | 9.93 | 17.64 | - | 6.15 | 23.68 | 12.83 | 10.64 | +2.19 |
| 122 | M 52 | 16.00 | 12.18 | 15.46 | 7.95 | 29.17 | 17.07 | 11.52 | +5.55 |
| 123 | M 12 | 7.01 | 16.16 | 13.30 | 5.32 | 21.64 | 11.26 | 9.95 | +1.31 |
| 124 | M 80 | 5.86 | 31.42 | 15.57 | 3.26 | 33.80 | 14.86 | 11.02 | +3.84 |
| 125 | M 114 | 10.20 | 14.15 | - | 8.30 | 21.16 | 11.66 | 9.77 | +1.89 |
| 126 | W 47 | 17.12 | 9.86 | 1.89 | 9.25 | 23.53 | 14.62 | 10.84 | +3.78 |
| 127 | M 28 | 9.96 | 25.06 | - | 7.13 | 30.18 | 13.64 | 10.13 | +3.51 |
| 128 | M 17 | 6.76 | 15.23 | 0.97 | 5.82 | 19.02 | 9.90 | 9.61 | +0.29 |
| 129 | 6 Cib | 4.37 | 14.77 | 20.04 | 4.36 | 19.29 | 9.77 | 9.25 | +0.52 |
| 130 | M 61 | 5.73 | 22.38 | 18.00 | 4.74 | 26.13 | 12.67 | 9.72 | +2.95 |
| 131 | M 96 | 5.71 | 16.04 | - | 5.26 | 18.65 | 9.34 | 9.43 | -0.09 |
| 132 | S 106 | 4.19 | 13.37 | 33.49 | 4.15 | 19.58 | 9.89 | 9.25 | +0.64 |
| 133 | M 104 | 6.77 | 19.65 | 31.67 | 5.16 | 28.99 | 13.89 | 9.95 | +3.94 |

## ADVISORY WORK.

The University of Bristol co-operates with the Staffs of the Department of Agricultural Education of the Counties of Gloucester, Hereford, Somerset, Wiltshire and Worcester in providing free advice to farmers, growers and landowners under the Advisory Scheme of the Ministry of Agriculture. Requests for advice should in the first instance, be addressed to the Agricultural Organiser for the county concerned. The Organisers for the five counties in the Western (Bristol) Province are:-

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