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Research in Dairying—A Survey

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Changes in Milk Production in Great Britain during the Past Half-century

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Organization of the industry at the beginning of the century

The producers of milk and dairy produce at the beginning of the century and up to the twenties could be grouped into a series of zones. This was necessitated by the comparatively primitive methods of handling and transporting milk, and also to a considerable extent by the consumers' prejudice against milk that had been cooled and delayed for more than a few hours in its progress from the cow to the breakfast table.

Cows were kept in many towns and large cities, so that milk could be delivered quickly, and be handed to the consumers fresh and warm from the byre. Often the only land attached to the 'town dairy' was an exercise yard, or paddock, so that no pasturage or arable crops were available, and all food had to be bought. This necessitated a steady supply of purchased hay, straw and roots, as well as more concentrated feeding-stuffs, and also a ready market at all times of the year for the manure. Thus, the system survived longest in the towns where, within easy carting distance, there was land well suited for arable cultivation, with farms ready to sell farm crops and to buy back manure.

The system also required the constant renewal of the cow population because breeding or rearing of stock was rarely attempted. Newly calved cows of a dual-purpose type were bought and milked as long as they continued to give a satisfactory yield. They were fed heavily, and by the time the yield of milk had dropped to about 1 gal./day, they were sold for slaughter as fat cows and replaced by new purchases. I need not say anything about the objections on the part of the health authorities to the keeping

of cows in the middle of densely populated town areas. From an agricultural point of view, the system was extremely wasteful because of the slaughter of many of the best dual-purpose cows of the country when they had barely reached their most productive period, and could have been kept for at least 2 or 3 years longer to breed calves of a similarly high class.

On the outskirts of the towns were farms which not only kept cows, but also had a certain area of land for both grass and arable crops. They, therefore, grew hay, straw and roots required by the herd, and thus their main purchases were concentrated foods such as the by-products of the oil-crushing, milling and brewing industries. Their land was, however, too limited in area and too valuable to be used for the rearing of stock, so that they also depended on the purchase of cows, though they might take a calf or two from some of the best and youngest cows. Their milk too was delivered as quickly as possible to the consumers, usually twice a day in summer, though possibly only once a day in winter. The necessity for milking at what now seem to be unearthly hours in the morning—3 or 4 a.m.—in order to get the morning's milk to the customer in time for breakfast partly accounted for the distaste which most farmers had for what they termed 'cow keeping'.

At a greater distance were farmers dependent on railways for the delivery of their milk into the towns. In the absence of proper cooling on the farms and of refrigerated vans for railway transport, it was impossible to avoid considerable wastage by souring during the hot summer months. Consequently many such farmers sold milk only in winter, and during the summer months made cheese. Apart from other considerations, the wholesale price of summer milk was often very unattractive.

At a still greater distance from a liquid milk market, cheese-making dominated the policy in areas well suited by soil and climate for milk and cheese production, but unsuited by the situation for the sale of liquid milk. The most important of these were: the south-west of Scotland with its Cheddar and Dunlop cheese; the Cheshire region, including considerable areas of North Wales, Staffordshire and Shropshire, as well as Cheshire itself; the Somerset area, which was the original home of the Cheddar cheese, and the north Midlands with Derby and Stilton cheese. Cheese-making under farmhouse conditions is mainly a summer occupation, and milk can be produced most cheaply on grass in summer. Therefore, nearly all the cows calved in early spring, March or April, and were thus ready to take full advantage of the flush of grass in May and June. They dried off in the autumn and were kept cheaply throughout the winter, almost entirely on hay, though some of the cheese-making farmers would sell some milk in winter. These men would thus have to have a proportion of cows calving in the autumn, and would feed their herd on a higher level than the pure cheese-makers.

In many areas unsuited for large-scale arable farming or for the production of milk on a large scale, dairying as a subsidiary industry was of considerable importance because the breeding and rearing of cattle was one of the most important enterprises, especially in marginal or upland areas. As a by-product, butter brought in an income to the farmer's wife, and a substantial proportion of the country's total requirements for butter was supplied by our own farms, and made mainly in the farmhouses.

Changes since the beginning of the century

Production of milk. During the last 50 years this zonal arrangement has almost disappeared. Now the sale of milk off the farms is almost universal. Even the remote farms have been enabled to sell milk by: (1) cleaner methods on the farm; (2) milk cooling on the farm; (3) motor transport for conveying milk from the farm to the depot or factory; (4) pasteurizing and efficient cooling in depots and factories.

The farmhouse processing of milk has dwindled to insignificant amounts, and manufacture of both cheese and butter is now mainly confined to factories. Tables 1 and 2 indicate some of these changes during the recent war period. These are still more striking if one puts them against the background of 1900 or 1908.

Table 1. *Production of milk in the United Kingdom**

	Average, 1936–9	1940–1	1943–4	1945–6
Cows and heifers in milk (thousands)	3283	3418	3576	3534
Average gross yield (gal./cow)	542	470	479	506†
	Gal. × 10^6			
Gross production	1781	1608	1712	1789
Total available for human consumption	1563	1446	1580	1654
Total consumed as liquid	1002	1137	1339	1432

* Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1949).

† Edwards (1950) estimated that in 1948–9 the average yield of the 2,800,000 cows in England and Wales was 600 gal.

Table 2. *Utilization of milk in the United Kingdom**

	Average, 1936–9	1940–1	1943–4	1945–6
Gross production (gal. × 10^6)	1781	1608	1712	1789
Total available for human consumption (gal. × 10^6)	1563	1446	1580	1654
Total consumed as liquid milk (gal. × 10^6)	1002	1137	1339	1432
Total made into cheese on farms (gal. × 10^6)	34	15	6	5
Total made into butter on farms (gal. × 10^6)	151	79	49	50
Total made into cream on farms (gal. × 10^6)	18	5	—	—
Manufactured off farms (gal. × 10^6)	358	210	186	167
Butter produced (tons × 10^3)	46	26	18	17
Cheese (tons × 10^3)	44	33	21	25

* Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1949).

Value of agricultural output. Table 3 summarizes the chief changes in the values of agricultural output during the last 40 years. Milk and dairy produce in 1908 provided 20 % of the British farm income. Now the proportion out of a greatly increased total is over 30 %.

Stock. The following points are brought out in Table 4: (*a*) The steady increase in the numbers of cattle, even in the prewar period. (*b*) Cows and heifers in milk or in calf have increased to a proportionately greater extent than the total cattle population. In 1894, they constituted 38·8 % of the total cattle population, in 1939, 44·5 %, and in 1946, 46·8 %. This in turn reflects the tendency towards milk production.

Table 3. *Changes in percentage value of different items of agricultural output in Great Britain in the last 40 years*

	1908*	1938†	1945†
All farm crops	30	16	23
Fruit, flowers, vegetables and nursery stock	5·5	14	20·5
Total livestock and produce	64·5	70	56·5
Dairy produce	20	26	31
Poultry and eggs	3·5	10	6·7
Other livestock and produce	41	34	18·8
Total value (£'s sterling × 10^6)	151	265	546

* Board of Agriculture (1912).

† Compiled from statistics of the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland (see, for example, Department of Agriculture for Scotland (1948, 1950); Ministry of Agriculture and Fisheries (1941); Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1948)).

Table 4. *Numbers of stock in Great Britain*

(Thousands)

	1894*	1939†	1946†	Loss or gain 1939–1946 (%)
Total cattle and calves	6,346	8,119	8,716	+ 7·3
Cows and heifers in calf or in milk	2,460	3,615	4,066	+12·5
Total sheep and lambs	25,800	25,993	19,718	−24·1
Breeding ewes	—	19,572	8,018	−24·2
Total pigs	2,390	3,767	1,643	−56·4
Total poultry	—	64,137	47,276	−26·3
Agricultural horses	1,000	649	519	−20·0

* Board of Agriculture (1895).

† Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1950).

Table 5 is an attempt to indicate changes that have taken place in the relative numerical importance of a few of our British breeds. The first column gives the estimate prepared on the returns of a census made in 1908. Obviously, it can only be taken as a rough guide because, for instance, little or no account is taken of cross-breds. Such a census has not been made since, but for recent years the numbers of bulls licensed afford a means of making a rough comparison. The figures should be taken with a good deal of reserve as a means of assessing the numbers of the different breeds, because the bulls of some breeds are used more for crossing than others. Still there can be no doubt that they do afford a reasonably true picture of the general changes. The chief of these are: (1) Increased importance of Friesians and Ayrshires. (2) Substantial reduction in the beef breeds. (3) Reduced importance of the dual-purpose breeds, though these, owing to the dominant position occupied by the Shorthorns*, still account for nearly half the bulls licensed in the country. Edwards (1950) estimated that in England and Wales in 1948–9 the cow population (2,800,000) included 34 % Shorthorns, 32 % Friesian, 11 % Ayrshire, 9 % Channel Islands, 14 % all others.

* All Shorthorns are grouped together, but, even if beef Shorthorns could be excluded, the percentages would not be greatly altered, e.g. all the Shorthorn bulls licensed in Scotland in 1945–6 do not amount to more than 1½ % of the total number of bulls licensed in Great Britain.

Table 5. *Changes in numerical importance of some British breeds of cattle*

Breed	Census of cattle, 1908*		Bulls licensed in Great Britain			
			1937–8†		1945–6†	
	No.	Percentage of total	No.	Percentage of total	No.	Percentage of total
Shorthorn	4,413,000	63·9	25,068	56·1	15,415	38·1
Devon	455,000	6·6	1,091	2.4	682	1·7
Ayrshire	440,000	6·4	5,083	11·4	7,203	17·8
Hereford	385,000	5·6	2,116	4·7	1,742	4·3
Welsh	248,000	3·6	349	0·8	401	1·0
Aberdeen Angus	194,000	2·8	2,530	5·7	1,533	3·8
Lincoln Red	169,000	2·4	1,324	3·0	1,242	3·1
West Highland	100,000	1·4	60	0·1	74	0·2
Channel Islands	101,000	1·5	2,496	5·6	1,850	4·6
Galloway	31,000	0·4	337	0·8	301	0·7
Red Poll	27,000	0·4	569	1·3	474	1·2
Friesian	—	—	2,914	6·5	8,565	21·2
Other breeds and descriptions	342,000	5·0	731	1·6	878	2·2
Total	6,905,000		44,668		40,360	

* Board of Agriculture (1912).

† Compiled from statistics of the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland.

Table 6 gives some indication of the effect that changes in relative numbers of the different breeds may have on the milk supply. Apart from changes in relative numbers of breeds to which I have called attention, the numbers of cows now producing milk

Table 6. *Yields of milk per lactation of cows and heifers of different breeds in England and Wales*

Breed	No. of herds, 1948–9	Average yield, 1946–9* (lb.)
Ayrshire	2601	7374
Friesian	4752	8278
Guernsey	1393	6872
Jersey	1082	6448
Red Poll	425	6861
Shorthorn	5022	6660

* Milk Marketing Board (undated).

for sale have been greatly increased by the fact that many farms previously regarded as unsuitable for milk production have been tempted by the relatively high price of milk to embark on milk selling. Even in eastern counties, from Aberdeen to Norfolk, previously regarded as definitely wedded to arable farming, and where milk selling used to be regarded as hardly a respectable business, many herds of dairy cows have taken the place of fattening bullocks and flocks of sheep. But probably a still greater effect on the milk market has been produced in the western areas which always had cows of one kind or another, but did not think of selling milk. This applies especially to some of the poorer hill districts, where the traditional type of farming was associated with the rearing of store cattle and the keeping of sheep. The yields obtained on such

farms even from dairy breeds are much below those from herds in districts well suited for milk production, and where the business is well understood.

Management. Formerly the great majority of cows calved in spring, and thus by far the greater part of our milk supply was produced in summer. For instance, in 1878 a writer estimated that 76 % of cows in Great Britain calved between January and June; only 24 % between July and December. To a great extent this was arranged deliberately in order that full advantage might be taken of the summer growth of grass, but it was—and still is—also easier to arrange for spring calvings than for autumn calvings. The proportion now calving in autumn is very much higher than the figures I have just quoted. Even since the beginning of the war, the tendency for more autumn calvings has become increasingly obvious. For instance, in Cheshire, a county with a strong tradition for spring calving, because of its old cheese-making practice, the proportion of the annual output of milk in winter is now nearly 50 %. In the same county, the calves born from September to February inclusive, in 1949–50 came to no less than 66 % of the total cow population. It is well known that, other things being equal, cows calving in autumn or midwinter give a greater total yield of milk than cows calving in spring or summer, and this change in the distribution of calvings during the seasons has undoubtedly contributed to the great increase in milk production.

Concentrated foods. An adverse factor is the great reduction in the quantity of concentrated feeding-stuffs available, especially since the beginning of the last war. At that time we were importing as much as 8 million tons of feeding-stuffs. In addition, there were more by-products from the milling industry than now, because the extraction of flour in the milling process was lower. It was possible to use high-yielding cows largely as converters of cheap imported foods into milk. The outbreak of war changed that, and we see the effect in the reduction of milk output during the 1st or 2nd year of the war. Since then, there has been a steady recovery, partly due to increasing efficiency in the growing of arable crops for milk production on the part of farmers who, before the war, had probably never ploughed land at all, but also to improvement in grassland management, and the substitution of new grass for a great deal of the poor old permanent pasture.

Another contributing factor that must be remembered when thinking of increased production from grassland is the fact that the sheep formerly kept for fat lamb production on a great deal of grassland of the country were drastically reduced in numbers at the outbreak of war. Although they have increased again to some extent, the competition of the dairy cow has prevented return to anything like full prewar numbers. The effect of a flock of sheep on milk production can only be fully appreciated by those who have had to try to combine the two kinds of stock.

Although the quantity of concentrated food available is only a fraction of what was formerly fed to dairy cattle, there can be no doubt that far better use is made of the limited quantity available. The system whereby feeding-stuffs are rationed by the Ministry of Food, according to the quantity of milk produced in itself goes far to ensure efficient use. Moreover, apart from this official rationing, which determines the quantity of concentrates given to the whole herd on any particular farm, the great development of milk recording does much to ensure that having got to the farm the

food is distributed to the cows in the herd according to their individual production and needs.

Control of disease. Advances in control of disease have undoubtedly contributed very considerably to increased production. Tuberculosis, contagious abortion, milk fever, have within my own experience come largely under control. Mastitis may now almost be put on the same list, and sterility is being seriously attacked. All these diseases formerly took a heavy toll and caused direct loss of cattle, but perhaps even to a greater extent caused loss by reducing the efficiency of the cow as a milk producer. Even now, because of disease or sterility, large numbers of our dairy cows are sold for slaughter before they have passed the period of full efficiency, but the position is better than it was even 30 years ago. On the other hand, some people claim that the breeding and feeding of cows for high production necessarily reduces their ability to resist diseases, or to overcome the effect of minor disturbances. Within limits, which on the average we are not likely to pass, I do not think that there is any evidence to support this view, though it is well known that in some instances cattle that are kept on a low plane of nutrition, amounting to semi-starvation, such as the West Highland cattle in the Hebrides, are remarkable for their longevity.

Breeding. I have left to the last the effect of what we may term improvements in breeding. It is to the credit of the farmers of the south-west of Scotland, led by John Speir, that they were ahead of the rest of Great Britain in the establishment of the milk-recording movement. But though milk recording is the basis of constructive breeding of dairy cattle, it by no means follows that milk recording necessarily results in the rapid raising of production. So far as breeding is concerned, milk recording has mainly been used for (1) the selection of bulls on the performance of their dams and grand dams, (2) the culling of low-yielding cows. Even where it is applied in the most efficient manner by the selection and use of progeny-tested bulls, improvement is far slower than many people suppose. As some of my colleagues have shown in a series of papers, culling of low-producing cows in any herd by itself is only likely to effect very slow improvement indeed. A pedigree herd breeding its own bulls might make progress at a greater rate, but the greatest possibilities lie in artificial insemination units, breeding their own bulls from sires that have been progeny-tested and from a small percentage of the best cows. Such a unit, operating under ideal conditions, might improve the average yield at the rate of about 15 gal./year. This is very much below the expectations of many enthusiasts, but it is greater than the average improvement that has actually been obtained so far at artificial insemination centres. Hitherto, they have only been able to secure a very small proportion of progeny-tested bulls. Without going far into a genetical discussion, in which I should soon be far out of my depth, I may say that the fundamental difficulty about improvement by breeding is the low heritability of milk yield. If two cows in the same herd differ by about 100 gal. milk/year, their daughters are likely to differ by only about $12\frac{1}{2}$ gal.

Of the 100 gal. difference between the two cows, only 25 gal. are due to genetic causes, which can be passed on to the progeny. The remaining 75 gal. difference is due to environmental factors, both during the calf's life, and also in its prenatal existence. Half the calf's genetic make-up comes from its sire, the other half from the dam, and

the 12½ gal. which I have mentioned represents 25 divided by 2. I am confident that taking herds of the same dairy or dual-purpose breeds, there has been improvement in milk yields brought about by the skill of the breeder aided by milk recording, but it is, I think, quite certain that the increase in milk yields that has taken place in perhaps the majority of well-managed herds, during the last 50 or even the last 20 years, has mainly been due to the other causes I have mentioned. I am, nevertheless, hopeful that in the course of the next 50 years, improvements in the selection of breeding stock, especially bulls, and the methods of using them will exert a much greater proportional effect than breeders have been able to secure in the past.

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Culinary Uses of Milk

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A pint of average milk supplies about 340 Cal., 18 g. protein, 680 mg. calcium, 0·6 mg. iron, 600 i.u. vitamin A, 0·2 mg. aneurin, 0·8 mg. riboflavin, 0·48 mg. nicotinic acid, 6 mg. ascorbic acid, and 12 i.u. vitamin D. The proportion this represents of our daily requirement is shown in Fig. 1. A pint of milk would therefore be an excellent addition to our diet for protein, calcium, vitamin A (summer only) and riboflavin. It is, on the other hand, poor in calories, in iron, and in nicotinic acid. The amount of ascorbic acid is variable and depends on the amount of oxidation. Calories, iron and aneurin are easily supplied at the present time by bread. Nicotinic acid is more difficult to obtain in adequate amounts during the present shortage of meat, although fish is a good source, and potatoes are a better source per 100 Cal. than is bread.

Le Gros Clark (1947) showed that the expectation of life is highest if the proportion of calories derived from bread and potatoes is less than 50%. Cuthbertson (1942), in his work on wound healing, showed the value of animal protein, and concluded that the virile races of the world are the animal-protein eaters (Cuthbertson, 1950). We must, therefore, aim at keeping up our animal-protein intake. The lowest minimum adult requirement is 25 g., and the aim of this paper is to show how this value can be maintained by using raw or processed milks.