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Table of Contents

SCIENCE

Rothamsted experiments... 103
Sheep... 103
Apples as food for stock, Prof. Shutt
on... 101

THE DAIRY

Stilton-cheese, W. R. Gilbert on... 104
Cheddar-cheese... 105
Butter-making... 106
Cooperative butter-making... 106
A lesson for Dairymen... 107
Do your cows pay their board?... 107
Milk and butter at the Dairy show 108
Devonshire cream... 110
Canadian butter... 110
Ties not wanted for cows... 110
Canadian "Creameries Conventions" 110
Canadian export of butter... 110

THE FARM

Ottawa Expt.-farm, Mr. Gigault, on
the... 111
Cultivation of mangels... 112

NOTES BY THE WAY:

To our readers... 113
English food imports... 113
New-Zealand's crops... 113
Water in turnips... 113
Shires and Clydesdales... 113
Wheat-crop of the U. S... 113
Carrots as a diuretic... 113
Soil analysis... 113
Draining... 113
Devonshire butter... 114
When to cut grain crops... 114
Woolly taste in mutton... 114
Green manuring... 114
Lime and potash... 114
Lucerne again... 114

THE GRAZIER AND BREEDER.

Crosses... 114
On feeding milk-cows... 115
The cow-stables... 115

THE HOUSEHOLD:

Christmas... 117
Guest-chambers... 117
Mulled claret... 117
Games for children... 116
"Under the Mistletoe"... 116
"Jack Horner"... 116
Christmas, Geo. Moore on... 116

Farmers Syndicate of the P. Q.
London markets... 117

Agriculture in Gaspé, Moore on... 117
Cleaning out ditches, etc. Bouthillier
on... 117

THE POULTRY YARD:

General topics, A. G. Gilbert on... 118

THE GARDEN AND ORCHARD.

The Chrysanthemum show, Mont
real... 119
Ginseng, Craig on... 119

Science.

ROTHAMSTED EXPERIMENTS.

(Continued)

The experiments with sheep.

It has been pointed out that, compared with pigs, there is with ruminants a much smaller amount of increase obtained, in proportion both to their weight within a given time and to a given amount of food passed through the body, and that there is also a much larger amount of necessarily effete matter in their food; and that, therefore, the result of calculations of feeding experiments with them in regard to the question of the sources in the food of the fat stored up in the body are less conclusive. It will, nevertheless, be of interest to adduce some direct experimental evidence on the point.

Some time after the discussion at Hamburg, in 1876, two sets of experiments made at Rothamsted with sheep, in which the concentrated foods were barley or malt, and in which, therefore the amount and proportion of nitrogenous substance consumed were low, were selected for calculation.

The first series comprised five pens with four or five sheep in each. The experiments had been made in the spring of 1879, and extended over a final fattening period of ten weeks. In each pen barley or malt was given in fixed quantity per head per day, and in each pen, also, mangels were given in addition ad libitum.

The second series also comprised five pens, but with twelve sheep in each. The experiments were made in the winter of 1883-84, and they extended over a final fattening period of twenty weeks. The animals were at an earlier stage of progress at the commencement, and not quite so mature at the conclusion, as those of the other series. In each pen barley or malt was given in fixed quantity per head, in each clover chaff also in fixed quantity, and in each roots were given ad libitum, Swedish turnips during the first sixteen weeks, and a mixture of one-fourth swedes and three-fourths mangels during the last four weeks of the twenty.

The results of these two series of experiments with sheep, calculated to show their bearing on the question of the sources of the fat stored up by the animals, are given in Table 72:

It will be seen that the form of the table is, so far as the facts will allow, the same as has been adopted in the case of the various experiments with pigs. A general description of the food of each series is given over the columns relating to the series, and at the head of each separate column is given a description of the limited food supplied to each pen.

The results are calculated for 100 increase in live weight. Referring to the upper division of the table, there are first shown the amounts of nitrogenous substance (digestible) in the fixed food, the amounts in the increase, and the

TABLE 72.—Sources of the fat of the animal body. Experiments at Rothamsted with sheep (Assumed that 100 digestible nitrogenous substance in food may yield 51.4 fat.)

	Fixed food: Barley or malt mangels ad libitum.					Fixed food: Barley or malt, and clover chaff; roots (swedes and mangels) ad libitum.				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
	Barley.	Malt and malt dust.	Barley, steeped.	Malt and malt dust, steeped.	Malt and malt dust, extra quantity.	Barley and clover chaff.	Malt and clover chaff.	Barley and clover chaff.	Malt and clover chaff.	Barley two-thirds, malt one-third, and clover chaff.
<i>Per 100 increase in live weight.</i>										
Nitrogenous substance:										
In fixed food (digestible).....	25	23.3	19.9	25	27.9	52.4	51.1	55.8	55.9	58.7
In increase.....	6.5	6.5	6.5	6.5	6.5	7.5	7.5	7.5	7.5	7.5
Available for fat formation.....	18.5	16.8	13.4	18.5	21.4	44.9	43.6	48.3	48.4	51.1
Fat:										
In increase.....	74	74	74	74	74	69	69	69	69	69
In total food (digestible).....	10.3	8.8	9.6	10.3	10.2	13.1	12.9	13	13.3	13.8
Newly formed.....	63.7	65.2	64.4	63.7	63.8	55.9	56.1	56	55.7	55.2
Derivable from nitrogenous substance.....	9.5	8.6	6.9	9.5	11	13.1	22.4	24.8	24.9	26.3
From other sources.....	54.2	56.6	57.5	54.2	52.8	32.8	33.7	31.2	30.8	28.9
<i>Fat derivable from the nitrogenous substance of the roots according to the percentage of it capable of fat formation.</i>										
Fat from nitrogenous substance of roots:										
If 50 per cent capable of fat formation.....	22.2	20.8	21.4	26.6	23.3	14.1	14	14	14.2	14.8
If 60 per cent capable of fat formation.....	26.6	25	29.3	31.9	28	16.9	16.8	16.9	17	17.8
If 70 per cent capable of fat formation.....	31.1	29.1	34.1	37.2	32.6	19.7	19.6	19.7	19.9	20.7
If 80 per cent capable of fat formation.....	35.5	33.3	39	42.6	37.3	22.6	22.4	22.5	22.7	23.7
If 90 per cent capable of fat formation.....	40	37.4	43.9	47.9	41.9	25.4	25.2	25.3	25.6	26.6
If 100 per cent capable of fat formation.....	44.4	41.6	48.8	53.2	46.6	28.2	28	28.1	28.4	29.6

difference—the amounts available for fat formation. Next are given the amounts of fat in the increase, in the total food (digestible), and the difference—the newly-formed fat; the amounts derivable from the available nitrogenous substance in the fixed food and the difference—the amount required to be produced from other sources. Then, in the lower division of the table are given, for each pen, the amounts of fat derivable from the nitrogenous substance of the roots, on the alternative assumptions that 50, 60, 70, 80, 90 per cent, or the whole, of that which they contain will be digestible and available for fat formation.

It should be further explained that 80 per cent of the nitrogenous substance of barley or of malt is reckoned as digestible and available for the purposes of the system. Wolff's estimates were, in 1874, 80 per cent; in 1888, 77.3 per cent; and in 1890, 77 per cent. In malt dust 80 per cent is assumed to be digestible, against Wolff's estimate of 80 per cent in 1874 and 82 per cent in 1888 and 1890. In clover chaff two-thirds or 66.7 per cent of the nitrogenous substance is reckoned as digestible, against a range in Wolff's tables, according to quality, from 51.4 to 69.9 per cent. In the case of Swedish turnips and mangels Wolff assumes the whole of the nitrogenous substance to be digestible and available, drawing no distinction in this respect between the amounts existing as albuminoids, as amides or other nitrogenous compounds. To this point I shall have to refer in more detail presently.

Then, as to the fat of the foods: the percentage of it reckoned as digestible is that given in Wolff's tables of 1874. In the case of barley he then reckoned only 65 per cent of the total to be digestible, but more recently he has supposed the whole of it to be so. For clover chaff his figures are the same at all three periods, as they are also for mangels.

Let us now turn to the calculated results as given in the table, and first to those relating to the first series of five pens, in which the fixed food was either barley or malt, and the ad libitum food consisted of mangels only. As already said, the period of experiment comprised only the last ten weeks of fattening. Hence, it commenced at a somewhat advanced stage of progress, and the animals were, at the conclusion, probably fully as fat as, if not fatter than the sheep which had been analyzed as "fat." Taking into account the weight and condition of the animals at the beginning and at the end the percentages of carcass and of inside fat in the live weight, it is calculated that the increase over this short finishing period, would contain 74 per cent of fat and only 6.5 per cent of nitrogenous substance.

On these assumptions, the figures show that after deducting the estimated amount of nitrogenous substance in 100 of increase from the amount supplied in the fixed food, there remained in the different cases, 18.5, 16.8, 13.4, 18.5, and 21.4 parts of nitrogenous substance available from the fixed foods for the formation of fat.