FOOD TABLES.

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L. "Food Tables" Presented by –

FOOD TABLES,

BY

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PREFACE.

The following tables represent the result of an attempt to simplify (with special reference to Indian requirements) the construction of dietaries, the valuation of foods, and the calculation of food problems generally.

To solve such problems by the aid of treatises on dietetics involves much labour and research. It is as an endeavour to reduce this that the tables which follow must be regarded.

As pointed out in the explanation of the tables, the calculations must be taken as approximate only. It is therefore essential to avoid too rigid an adherence to estimates deduced from them. Despite this, I trust that the tables may prove of some use to those engaged in dealing practically with matters involving the calculation of food problems.

With the tables I republish a memorandum on the subject of the probable food requirements of Natives of India while at labour, light-labour, and rest, and also a memorandum on the dynamic value of the task exacted from labourers on Famine Relief Works in the Bombay Presidency.

I. B. LYON.

Bombay, October 1877.

INTRODUCTION.

Of the three parts into which the present collection of Food Tables is divided, Part I. deals with the construction of Dietaries ; Part II. with the valuation of Food Materials generally, and specially with the valuation of Indian food grains; Part III. contains two re-published Memoranda on respectively, 1, the Nutritive value of dietaries required by Natives of India while at labour, light-labour, and rest; and 2, the Dynamic value of the task exacted from Native labourers on Famine Relief Works.

From want of some definite system, such as Part I. may be regarded as a first attempt to supply, the construction of a dietary has hitherto been a matter involving the expenditure of a considerable amount of time and labour. My endeavour has been to reduce this by condensing the data required into a series of tables systematically arranged, so that, by their aid and attention to a few simple rules, any one may in a very few minutes construct a dietary of any required nutritive value. The system on which the tables of Part I. are constructed may be shortly defined as one of replacement, and may be regarded as a further development of that involved in the Table of Food Equivalents published by me in 1874. It will be found sufficiently explained in the directions given for the employment of TABLES 1 to 4.

In the estimation of the comparative value of food materials—the subject dealt with in Part II.—a difficulty has always existed, arising from the fact that no single food material (milk excepted) is by itself a perfect food. In other words, no single food material contains organic principles of the three classes required in food (Carbohydrates, Albuminates, and Fats*) in the proportion in which in a well constructed dietary they ought to exist. Hence, as a certain quantity of each of these three classes of principles must be contained in the daily food of man, it be-

* See page 18.

comes a matter of considerable difficulty to form a true estimate of the nutritive value of any single food material as considered by itself. For example, if we for safety's sake estimate the value of a food material from the quantity of those principles it contains in least proportion relatively to the quantity required in a day's food (*e.g.*, a cereal by the quantity of Albuminates* present), we under-estimate its value when employed in combination with other food materials. On the other hand, if we estimate the value of a food material by the quantity of those principles it contains in greatest proportion relatively to the amount required, we over-estimate its value if employed by itself. No tables, therefore, for the valuation of food materials can be looked on as complete unless they take notice of the value of food materials when combined together as well as when uncombined. Tables which deal with the value of food materials uncombined are to be found in all works on dietetics. Part II., however, contains in addition tables for the

* See page 18.

estimation of the value of food materials when combined with one another.

The special portion of Part II. attempts to show in tabular form the comparative values of a given weight and the quantity required per head per diem of various cereals when unmixed and when mixed with pulse. The range of feeding power of equal weights of various cereals and mixtures of cereals with pulse is so great, that it cannot but constitute a very important factor in dealing with questions of Famine relief in India. The tables referred to have, therefore, been constructed with the object of showing at a glance the relative feeding power of the several cereals and of mixtures of cereals with pulse.

The two re-published Memoranda forming Part III. deal with a question which has of late been under discussion—viz., the food requirements of Natives of India while at labour and at rest. This question, it is obvious, is the basis upon which an Indian Famine wage must depend. Its definite settlement is, therefore—even now when the Famine of 1877 is approaching an end—

a matter of much importance. In regard to it two main questions may be considered to present themselves. *First*, are the average food requirements of bodies of individuals proportionate to their average weight, as well as to the work they are called upon to perform ? *Second*, having agreed upon the nutritive value of the dietary required by a body of individuals under certain conditions as regards work, &c., and knowing that in India the food materials of this dietary must be almost wholly cereals and pulse, are we to base the calculation of our Famine wage upon the sum required to purchase a sufficiency of the least nutritive cereal—viz., rice—or upon the sum required to purchase a sufficiency of such more nutritive food materials as are available for the supply of the individuals to be fed ? Without going again into the discussion of the first of these two questions, I content myself here by pointing out that the weight of theory and experience is unquestionably in favour of the proposition that food requirements *are* proportionate to average weight and work. The second question is to the full as important as the first. A consideration of the points brought out in TABLES 14 and 15 of Part II. will show that the difference between two estimates founded the one on the sum required to purchase a sufficiency of the least nutritive cereal, and the other on the sum required to purchase a sufficiency of such more nutritive food materials as are available, is even greater than the difference between two estimates: the one based on the non-admissibility of reduction of food in proportion to average weight and work, the other on the contrary supposition. Undoubtedly, according to the view we take of the two questions referred to, our estimate of a Famine wage will vary, a by no means exaggerated representation of the variation being 2 to 1; *i.e.*, according to the view we take of these two questions, we may estimate the required Famine wage at a certain sum or at half that sum, a difference sufficiently great to show the necessity for very careful consideration of the matter.*

* The extreme range is 100 to 38, or between $2\frac{1}{2}$ to 1 and 3 to 1.

PART I.

TABLES FOR CONSTRUCTION AND VALUATION OF DIETARIES.

The following six tables are intended to facilitate the construction and valuation of dietaries ; they may be described as follows :—

1. A Table for the conversion of grains Carbon into ounces Cereal or Pulse.

2. A Table showing the quantity in ounces of various food grains required to yield any number of grains of Nitrogen from 10 to 300.

3. A Table showing the quantity in ounces of various food materials other than food grains required to yield any number of grains of Nitrogen from 10 to 300.

4. A Table showing the number of ounces Cereal or Pulse equal in Carbon yielding power to the quantities of food materials shown in Table 3.

5. A Table showing the number of grains of Nitrogen in any given number of ounces of food material from 1 to 9.

6. A Table showing the number of grains of Carbon in any given number of ounces of food material from 1 to 9.

TABLE No. 1.

CARBON TABLE showing the number of ounces of Cereal or Pulse required to yield any given number of Grains of Carbon from 100 *to* 6,000.

Carbon.	Cereal or Pulse.	Carbon.	Cereal or Pulse.	Carbon.	Cereal or Pulse.	Carbon.	Cereal or Pulse.
Grains.	Ounces.	Grains.	Ounces.	Grains.	Ounces.	Grains.	Ounces.
100	·6	1600	9·4	3100	18·3	4600	27·0
200	1·2	1700	10·0	3200	18·8	4700	27·6
300	1·8	1800	10·6	3300	19·4	4800	28·2
400	2·4	1900	11·2	3400	20·0	4900	28·8
500	3·0	2000	11·8	3500	20·6	5000	29·4
600	3·5	2100	12·4	3600	21·2	5100	30·0
700	4·1	2200	12·9	3700	21·8	5200	30·6
800	4·7	2300	13·5	3800	22·4	5300	31·2
900	5·3	2400	14·1	3900	23·0	5400	31·8
1000	5·9	2500	14·7	4000	23·5	5500	32·4
1100	6·5	2600	15·3	4100	24·1	5600	33·0
1200	7·1	2700	15·9	4200	24·7	5700	33·6
1300	7·7	2800	16·5	4300	25·3	5800	34·1
1400	8·2	2900	17·1	4400	25·9	5900	34·7
1500	8·8	3000	17·7	4500	26·5	6000	35·3

½ oz. Fat (Ghee, Oil, &c.)	yields as much Carbon as	1 oz.	Cereal or Pulse.
1 oz. Sugar	do.	1 oz.	do.
2½ oz. Lean Meat	do.	1 oz.	do.
1¾ oz. Fat Meat	do.	1 oz.	do.
1¼ to 1½ oz. Bread	do.	1 oz.	do.
2 to 2¼ oz. Fish	do.	1 oz.	do.
5½ oz. Milk	do.	1 oz.	do.
1 oz. Cheese	do.	1 oz.	do.
1 oz. Biscuit	do.	1 oz.	do.
3½ oz. Potatoes	do.	1 oz.	do.
9½ oz. Carrots	do.	1 oz.	do.
1¼ English Eggs	do.	1 oz.	do.
2 Bombay Eggs	do.	1 oz.	do.

TABLE No. 2.

NITROGEN EQUIVALENTS of Food Grains showing the quantity (in ounces) of each Food Grain required to yield any given number of Grains of Nitrogen from 10 *to* 300.

Nitrogen.	Pulse.	Wheat.	Oatmeal	Bajri.	Maize.	Millet.	Jowari.	Barley.	Rice.	Nitrogen.
Grs.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Grs.
10	·56	1·1	1·2	1·5	1·5	1·6	1·7	1·8	2	10
20	1·1	2·2	2·3	2·9	2·9	3·1	3·4	3·5	4	20
30	1·7	3·3	3·5	4·3	4·3	4·7	5·0	5·2	6	30
40	2·3	4·4	4·6	5·7	5·8	6·3	6·7	7·0	8	40
50	2·8	5·4	5·8	7·1	7·2	7·8	8·4	8·7	10	50
60	3·4	6·5	6·9	8·6	8·7	9·4	10·0	10·4	12	60
70	3·9	7·6	8·1	10·0	10·1	10·9	11·7	12·1	14	70
80	4·5	8·7	9·2	11·4	11·6	12·5	13·4	13·8	16	80
90	5·0	9·8	10·4	12·8	13·0	14·1	15·0	15·5	18	90
100	5·6	10·9	11·5	14·2	14·4	15·6	16·8	17·3	20	100
110	6·2	11·9	12·7	15·7	15·9	17·2	18·4	19·0	22	110
120	6·7	13·0	13·8	17·1	17·3	18·8	20·1	20·7	24	120
130	7·3	14·1	15·0	18·6	18·8	20·3	21·8	22·3	26	130
140	7·8	15·2	16·1	20·0	20·2	21·9	23·5	24·0	28	140
150	8·4	16·3	17·3	21·4	21·7	23·5	25·1	25·8	30	150
160	9·0	17·4	18·4	22·9	23·1	25·0	26·8	27·5	32	160
170	9·5	18·5	19·6	24·3	24·5	26·6	28·5	29·3	34	170
180	10·1	19·5	20·7	25·7	26·0	28·1	30·2	31·0	36	180
190	10·6	20·6	21·9	27·1	27·4	29·7	31·8	32·8	38	190
200	11·2	21·7	23·0	28·6	28·9	31·3	33·5	34·5	40	200
210	11·8	22·8	24·2	30·0	30·3	32·8	35·2	36·3	42	210
220	12·3	23·9	25·3	31·4	31·8	34·4	36·9	38·0	44	220
230	12·9	25·0	26·5	32·8	33·2	36·0	38·5	39·7	46	230
240	13·5	26·0	27·6	34·3	34·7	37·5	40·2	41·4	48	240
250	14·0	27·1	28·8	35·7	36·1	39·1	41·9	43·2	50	250
260	14·6	28·2	29·9	37·1	37·5	40·6	43·6	44·9	52	260
270	15·1	29·3	31·1	38·6	39·0	42·2	45·2	46·6	54	270
280	15·7	30·4	32·2	40·0	40·4	43·8	46·9	48·3	56	280
290	16·3	31·5	33·4	41·5	41·9	45·4	48·6	50·0	58	290
300	16·8	32·6	34·5	42·9	43·3	46·9	50·3	51·7	60	300

TABLE

NITROGEN EQUIVALENTS of Food Materials other than Food to yield any given number of

Nitrogen.	Meat uncooked & without Bone.		Fish.		Eggs.*		Milk.
	From Lean M.	To Fat M.	From Mackerel.	To Eel & Sole.	From (English).	To (Bombay).	
Grains.	Ounces.	Ounces.	Ounces.	Ounces.	No.	No.	Ounces.
10	·7	1·1	·6	1·2	·6	·9	3·7
20	1·4	2·1	1·2	2·3	1·3	1·8	7·3
30	2·1	3·2	1·8	3·5	1·9	2·7	11·0
40	2·8	4·2	2·5	4·6	2·5	3·6	14·6
50	3·5	5·2	3·1	5·7	3·1	4·5	18·2
60	4·2	6·3	3·7	6·9	3·7	5·4	21·9
70	4·9	7·3	4·3	8·0	4·4	6·3	25·5
80	5·6	8·4	4·9	9·1	5·0	7·2	29·1
90	6·3	9·4	5·5	10·3	5·6	8·1	32·8
100	7·0	10·4	6·1	11·4	6·2	9·0	36·4
110	7·7	11·5	6·7	12·6	6·8	9·9	40·0
120	8·5	12·5	7·3	13·7	7·5	10·8	43·7
130	9·2	13·6	7·9	14·9	8·0	11·7	47·3
140	9·9	14·6	8·6	16·0	8·7	12·6	51·0
150	10·6	15·6	9·2	17·1	9·3	13·5	54·6
160	11·3	16·7	9·8	18·3	9·9	14·4	58·2
170	12·0	17·8	10·4	19·4	10·6	15·3	61·9
180	12·7	18·9	11·0	20·6	11·2	16·1	65·5
190	13·4	19·9	11·6	21·7	11·8	17·0	69·1
200	14·1	21·1	12·2	22·9	12·4	17·9	72·8
210	14·8	22·1	12·8	24·1	13·0	18·9	76·4
220	15·4	23·1	13·4	25·2	13·6	19·8	80·0
230	16·1	24·1	14·0	26·3	14·3	20·7	83·7
240	17·0	25·1	14·6	27·4	15·0	21·6	87·4
250	17·7	26·1	15·2	28·6	15·6	22·5	91·0
260	18·4	27·2	15·8	29·8	16·2	23·4	94·6
270	19·1	28·2	16·5	30·9	16·8	24·3	98·3
280	19·8	29·2	17·2	32·0	17·4	25·2	102·0
290	20·5	30·2	17·8	33·1	18·0	26·1	105·6
300	21·2	31·2	18·4	34·2	18·6	27·0	109·2

* Eggs by number ; all other materials by weight.

No. 3.

Grains showing the quantity in ounces of each Food Material required Grains of Nitrogen from 10 *to* 300.

Cheese.	Biscuit.	Wheaten Bread. From (Bombay.)	Wheaten Bread. To (English).	Vegetables. From Potatoes.	Vegetables. To Carrots.	Nitrogen .
Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Grains.
·4	·5	1·2	1·8	10	25	10
·9	·9	2·4	3·6	20	50	20
1·3	1·4	3·6	5·4	30	75	30
1·7	1·8	4·8	7·2	40	100	40
2·2	2·2	5·9	9·0	50	125	50
2·6	2·7	7·1	10·8	60	150	60
3·0	3·1	8·3	12·6	70	175	70
3·5	3·6	9·5	14·4	80	200	80
3·9	4·0	10·7	16·2	90	225	90
4·4	4·4	11·9	18·0	100	250	100
4·8	4·9	13·0	19·8	110	275	110
5·2	5·3	14·2	21·6	120	300	120
5·7	5·7	15·4	23·4	130	325	130
6·1	6·2	16·6	25·2	140	350	140
6·5	6·6	17·8	27·0	150	375	150
7·0	7·1	19·0	28·8	160	400	160
7·4	7·5	20·2	30·6	170	425	170
7·8	8·0	21·4	32·4	180	450	180
8·3	8·4	22·5	34·2	190	475	190
8·7	8·8	23·7	36·0	200	500	200
9·2	9·3	24·8	37·8	210	525	210
9·6	9·8	26·0	39·6	220	550	220
10·0	10·2	27·2	41·4	230	575	230
10·4	10·6	28·4	43·2	240	600	240
10·9	11·0	29·6	45·0	250	625	250
11·4	11·4	30·8	46·8	260	650	260
11·8	11·9	32·0	48·6	270	675	270
12·2	12·4	33·2	50·4	280	700	280
12·6	12·8	34·4	52·2	290	725	290
13·0	13·2	35·6	54·0	300	750	300

TABLE

CARBON REPLACEMENT TABLE for Food Materials other than
as much Carbon as the quantities of Food

Nitrogen.	Meat uncooked & without Bone.		Fish.		Eggs.		Milk.
	From Lean M.	To Fat M.	From Mackerel.	To Eel & Sole.	From (English).	To (Bombay).	
Grains.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.
10	·3	·7	·3	·6	·5	·5	·7
20	·5	1·2	·6	1·1	1·0	1·0	1·3
30	·8	1·9	·9	1·7	1·4	1·5	2·0
40	1·1	2·4	1·2	2·2	1·9	2·0	2·7
50	1·3	3·0	1·4	2·7	2·3	2·5	3·3
60	1·6	3·7	1·7	3·3	2·8	3·0	4·0
70	1·9	4·2	2·0	3·8	3·2	3·5	4·6
80	2·1	4·9	2·3	4·3	3·7	4·0	5·3
90	2·4	5·5	2·6	4·9	4·2	4·5	6·0
100	2·7	6·0	2·8	5·4	4·7	5·0	6·6
110	2·9	6·7	3·1	6·0	5·2	5·5	7·3
120	3·2	7·2	3·4	6·5	5·6	6·0	8·0
130	3·4	7·9	3·7	7·1	6·1	6·5	8·6
140	3·7	8·5	4·0	7·6	6·6	7·0	9·3
150	4·0	9·0	4·2	8·1	7·0	7·5	10·0
160	4·2	9·7	4·5	8·6	7·5	8·0	10·6
170	4·5	10·3	4·8	9·2	8·0	8·5	11·2
180	4·8	11·0	5·1	9·8	8·5	9·0	11·9
190	5·0	11·5	5·4	10·3	9·0	9·5	12·6
200	5·3	12·2	5·7	10·8	9·4	10·0	13·2
210	5·5	12·8	6·0	11·3	9·9	10·5	13·8
220	5·8	13·4	6·2	11·9	10·4	11·0	14·5
230	6·1	14·0	6·5	12·4	10·8	11·5	15·2
240	6·3	14·5	6·8	13·0	11·3	12·0	15·8
250	6·6	15·1	7·1	13·5	11·8	12·5	16·5
260	6·9	15·7	7·4	14·0	12·2	13·0	17·2
270	7·1	16·3	7·7	14·5	12·6	13·5	17·8
280	7·4	16·9	8·0	15·0	13·1	14·0	18·5
290	7·7	17·5	8·3	15·5	13·6	14·5	19·2
300	7·9	18·0	8·6	16·1	14·1	15·0	19·8

No. 4.

Grain showing the quantity in ounces of Cereal or Pulse containing Material shown in the same position in Table 3.

Cheese.	Biscuit.	Wheaten Bread. From (Bombay).	Wheaten Bread. To (English).	Vegetables. From Potatoes.	Vegetables. To Carrots.	Nitrogen.
Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Grains.
·4	·6	1·0	1·3	2·9	2·7	10
·8	1·0	2·0	2·5	5·8	5·3	20
1·2	1·5	3·0	3·8	8·7	8·0	30
1·6	2·0	4·0	5·1	11·6	10·6	40
2·1	2·5	4·9	6·3	14·4	13·3	50
2·5	2·9	5·9	7·6	17·3	16·0	60
2·9	3·4	6·9	8·8	20·2	18·5	70
3·3	3·8	7·8	10·1	23·1	21·2	80
3·7	4·3	8·8	11·4	26·0	24·0	90
4·2	4·8	9·8	12·6	28·8	26·5	100
4·6	5·3	10·7	13·9	31·7	29·1	110
5·0	5·7	11·7	15·1	34·6	31·8	120
5·4	6·2	12·7	16·4	37·5	34·4	130
5·8	6·7	13·7	17·7	40·4	37·0	140
6·3	7·1	14·7	18·9	43·3	39·8	150
6·7	7·5	15·7	20·2	46·1	42·4	160
7·1	8·0	16·7	21·4	49·0	45·0	170
7·5	8·5	17·7	22·7	51·9	47·7	180
7·9	9·0	18·6	24·0	54·8	50·3	190
8·3	9·5	19·5	25·2	57·7	53·0	200
8·7	9·9	20·4	26·5	60·5	55·6	210
9·1	10·4	21·4	27·7	63·4	58·3	220
9·5	10·8	22·4	29·0	66·3	60·1	230
10·0	11·3	23·4	30·3	69·2	63·5	240
10·4	11·7	24·4	31·5	72·1	66·2	250
10·8	12·2	25·4	32·8	74·0	68·8	260
11·2	12·7	26·4	34·0	77·8	71·5	270
11·6	13·2	27·4	35·3	80·7	74·1	280
12·0	13·7	28·4	36·6	83·6	76·8	290
12·4	14·2	29·4	37·8	86·5	79·5	300

TABLE

For FACILITATING VALUATION OF DIETARIES showing the
of Food Materials

NITROGEN IN

Ounces......	1	2
Pulse...	17·86	35·72
Wheat	9·22	18·44
Oatmeal	8·70	17·40
Bajri (Penicillaria Spicata)	7·00	14·00
Maize	6·93	13·86
Millet (Panicum Miliaceum)	6·40	12·80
Jowari (Sorghum Vulgare)	5·97	11·94
Barley	5·81	11·62
Rice...	5·07	10·14
Meat (Lean meat uncooked without bone) ...	14·22	28·44
Meat (Fat meat uncooked without bone)	9·60	19·20
Bread (Bombay wheaten)	8·44	16·88
Bread (English wheaten)	5·55	11·10
Fish (Mackerel)	16·40	32·80
Fish (Eel and Sole)	8·75	17·50
Milk...	2·75	5·50
Cheese	23·00	46·00
Potatoes	1·00	2·00
Carrots	·40	·80
Eggs English (number)*	16·14	32·28
Eggs Bombay (number)*	11·16	22·32
Biscuit	22·70	45·40
Fat and Sugar ... ... nil	...	...

* Eggs by number ; all other articles by weight.

No. 5.

amount in Grains of Nitrogen in any given number of ounces from 1 *to* 9.

GRAINS.

3	4	5	6	7	8	9	
53·58	71·44	89·30	107·16	125·02	142·88	160·74	Pulse.
27·66	36·88	46·10	55·32	64·54	73·76	82·98	Wheat.
26·10	34·80	43·50	52·20	60·90	69·60	78·30	Oatmeal.
21·00	28·00	35·00	42·00	49·00	56·00	63·00	Bajri.
20·79	27·72	34·65	41·58	48·51	55·44	62·37	Maize.
19·20	25·60	32·00	38·40	44·80	51·20	57·60	Millet.
17·91	23·88	29·85	35·82	41·79	47·76	53·73	Jowari.
17·43	23·24	29·05	34·86	40·67	46·48	52·29	Barley.
15·21	20·28	25·35	30·42	35·49	40·56	45·63	Rice.
42·66	56·88	71·10	85·32	99·44	113·76	127·98	Meat.
28·80	38·40	48·00	57·60	67·20	76·80	86·40	Meat.
25·32	33·76	42·20	50·64	59·08	67·52	75·96	Bread.
16·65	22·20	27·75	33·30	38·85	44·40	49·95	Bread.
49·20	65·60	82·00	98·40	114·80	131·20	147·60	Fish.
26·25	35·00	43·75	52·50	61·25	70·00	78·75	Fish.
8·25	11·00	13·75	16·50	19·25	22·00	24·75	Milk.
69·00	92·00	115·00	138·00	161·00	184·00	207·00	Cheese.
3·00	4·00	5·00	6·00	7·00	8·00	9·00	Potatoes
1·20	1·60	2·00	2·40	2·80	3·20	3·60	Carrots.
48·42	64·56	80·70	96·84	112·98	129·12	145·26	Eggs.
33·48	44·64	55·80	66·96	78·12	89·28	100·44	Eggs.
68·10	90·80	113·50	136·20	158·90	181·60	204·30	Biscuit.
...	...	...	...	...	...	...	

TABLE No. 6.

For FACILITATING VALUATION OF DIETARIES showing the amount in Grains of Carbon in any given number of ounces of Food Material from 1 *to* 9.

CARBON IN GRAINS.

Ounces......	1	2	3	4	5	6	7	8	9
Cereals and Pulses	170	340	510	680	850	1020	1190	1360	1530
Uncooked Meat without bone from	64	128	192	256	320	384	448	512	576
Do. do. to	98·3	197	295	393	492	590	688	786	885
Bread wheaten from	140	280	420	560	700	840	980	1120	1260
Do. to	119	238	357	476	595	714	833	952	1071
Fish	80	160	240	320	400	480	560	640	720
Milk	30·8	61	92	123	154	185	216	246	277
Cheese...	162	324	486	648	810	972	1134	1296	1458
Potatoes	49	98	147	196	245	294	343	392	441
Carrots	18	36	54	72	90	108	126	144	162
Fat	345·6	691	1037	1383	1728	2074	2419	2765	3111
Sugar	187	374	561	748	935	1122	1309	1496	1683
Eggs from English (number)*	128·7	257	386	515	644	772	901	1030	1158
Do. to Bombay (number)*...	85·8	172	257	343	429	515	600	686	772
Biscuit	183	366	549	732	915	1098	1281	1464	1647

* Eggs by number ; all other articles by weight.

Explanation of the method of using the foregoing Tables in the Construction and Valuation of Dietaries.

TABLE 1.—This table shows approximately the number of ounces cereal or pulse required to yield any given number of grains of Carbon from 100 to 6,000. At the foot of the table is a statement showing approximately the number of ounces of various food materials other than food grains, equal in Carbon yielding power to one ounce of cereal or pulse.

In constructing a dietary by the aid of these tables, the first step is to convert by TABLE 1 the number of grains of Carbon the dietary is to contain into ounces of cereal or pulse, and from the quantity thus obtained to deduct one ounce for each half ounce of fat, and one ounce for each ounce of sugar we intend to insert into the dietary. Thus suppose a dietary is to contain 4,000 grains of Carbon, opposite 4,000 in the table stands 23·5 ounces, and suppose that it is intended to give in the dietary one ounce of fat and one-fifth of an ounce of sugar, 2·2 must be deducted, reducing the total to 21·3 ounces.

TABLE 2 shows the quantity in ounces of various food grains yielding any given number of grains of Nitrogen from 10 to 300. The figures in the first and last columns of this table represent grains of Nitrogen, the figures in the remaining columns quantities in ounces of the food grains heading the columns, required to yield the quantities of Nitrogen shown in the same horizontal line in the first and last columns.

Unless a dietary is to contain one or more of the food materials mentioned in the next two tables, all that remains to be done, after employing TABLE 1 in the manner just described, is to search the columns of TABLE 2 for two or more quantities which will together make up the total number of ounces found by TABLE 1, and at the same time yield the amount of Nitrogen required.

Thus, suppose a dietary is to contain 4,200 grains of Carbon and 200 grains of Nitrogen, and suppose, also, that one ounce of fat (ghee, oil, or butter) is to be given,—by TABLE 1 it is found that 24·7 — 2·0 (for the added fat) is the number of ounces of cereal and pulse required; and by TABLE 2 that this total of 22·7 ounces will contain 200 grains of Nitrogen if made up of—

1. Rice 16 oz., Pulse 6·7 ounces.
2. Pulse 5·6 oz., Jowari 17·1 oz.
3. Pulse 3·9 oz., Bajri 18·8 oz.
4. Pulse 3·4 oz., Wheat 10·9 oz., Rice 8·4 oz.
5. Pulse 4·5 oz., Bajri 14·2 oz., Rice 4·0 oz., &c. &c.

In constructing a dietary by the aid of these two tables, the following precautions should be observed :—

1. When two or more numbers of ounces taken from TABLE 2 yield the required amount of Nitrogen, but fall short of the total number of ounces of cereal and pulse shown by TABLE 1 to be required for the Carbon, the total number of ounces required by TABLE 1 may be made up by increasing the quantity of any of the food grains employed. Least disturbance of the strength of the dietary is however obtained by taking those quantities which contain the required Nitrogen and at the same time are nearest below the total ounces required for the Carbon, and increasing the quantity of the least Nitrogenous grain* sufficiently to make up the total ounces required.

2. A certain quantity of fat should be added to any dietary which is to be composed of cereals and pulse. About half an ounce of fat (ghee, oil, or butter) per 100 grains of Nitrogen is a suitable quantity, a certain amount of common salt should also be added, and it is advisable to add a small amount of condiments.

3. The quantity of pulse should be kept within reasonable limits, say under 4 to 5 ounces, hence of the examples just given, Nos. 3, 4, and 5, are to be preferred to Nos. 1 and 2.

* Farthest to the right in TABLE 2.

Tables 3 and 4 are to be employed when a dietary is to contain one or more of the food materials mentioned therein.

Table 3 corresponds to Table 2; it contains in its first and last columns figures representing quantities (in grains of Nitrogen). In the remaining columns are quantities (in ounces) of various food materials, other than cereals or pulse yielding the number of grains of Nitrogen shown in the same horizontal line in the first and last columns of the table.

Table 4 is rendered necessary by the fact that the food materials, to which it and Table 3 refer, contain amounts of Carbon per ounce differing from the amounts contained in cereals and pulse. It shows the number of ounces of cereal and pulse equal in Carbon yielding power to the quantities of different food materials occupying the same relative position in the columns of Table 3. Hence by Table 3 we can ascertain the amount of certain food materials required to yield a given number of grains of Nitrogen, and by Table 4 the number of ounces of cereal or pulse corresponding in Carbon yielding power thereto; for example, by Table 3 we find that 8·4 ounces of fat meat is the quantity standing opposite 80 grains of Nitrogen in the fat meat column, and that therefore 8·4 ounces of fat meat contain 80 grains of Nitrogen. In Table 4 occupying the same relative position is the number 4·9, signifying that 8·4 ounces of fat meat, yielding 80 grains of Nitrogen, contain only as much Carbon as 4·9 ounces of cereal or pulse.

Hence when a dietary is to consist of the food materials mentioned in Tables 3 and 4, or to contain such food materials in addition to cereals or pulse, the steps of construction become as follows:

1. Convert as before the quantity of Carbon required into ounces cereal and pulse by Table 1, and as before deduct 1 ounce for each half ounce of fat and one ounce for each ounce of sugar it is proposed to insert into the dietary.

2. Search the columns of Tables 2 and 4 for two or more quantities which will together make up the total number of ounces ascertained from Table 1 as required for the Carbon, and at the same time yield the required amount of Nitrogen.

3. Replace the figures obtained from Table 4 by those occupying the same relative position in Table 3.

Example.—Construction of a dietary containing, say, 4,600 grains of Carbon and 240 grains of Nitrogen—half an ounce of fat and three-tenths of an ounce of sugar to be given.

1. By Table 1.—4,600 equals 27·0 ounces, deduct (for added fat and sugar) 1·3 oz. = 25·7 oz.

2. By Tables 2 and 4.—25·7 oz. with 240 grains of Nitrogen may be made up in several

ways, *e.g.*: Suppose we take from TABLE 2 Rice 8 oz.=40 grains Nitrogen, we have 25·7 — 8·0=17·7 oz. with 240 — 40=200 grains of Nitrogen to be made up from TABLE 4.

3. Referring to TABLE 4 it is found that 17·7 oz. with 200 grains of Nitrogen may be made up by taking

10 grains Nitrogen	from Potatoes.........	= 2·9 oz.
50 ,,	from English Bread.	= 6·3 ,,
140 ,,	from Fat Meat	= 8·5 ,,
200 grains Nitrogen = cereal and pulse, or its equivalent in Carbon yielding power	....	17·7 oz.

4. Replacing the figures derived from TABLE 4 by those occupying corresponding positions in TABLE 3, it is found that 10 oz. potatoes, 9 oz. English bread, and 14·6 oz. fat meat are the quantities required, hence our dietary containing 4,600 grains of Carbon and 240 grains of Nitrogen becomes in ounces

Rice	8
Potatoes	10
English Bread	9
Fat Meat	14·6
Fat	·5
Sugar	·3

With certain modifications the same precautions should be adopted in constructing dietaries with the aid of TABLES 3 and 4 as were directed to be observed when constructing dietaries from the figures given in TABLES 1 and 2; these modifications are :—

1. That the quantity of certain food materials other than pulse, cheese for example, must, as in the case of pulse, be kept within reasonable limits.

2. That in the addition of fat we must be influenced by the amount of fat already existing in the food materials employed, it of course being unadvisable to add fat to a dietary when the food materials of which the dietary is composed contain already a sufficient quantity of fat.

As a guide on this point we may take it as a general rule that the quantity of fat in a dietary should not greatly exceed ·7 oz. for every 100 grains of Nitrogen or fall short of ·5 oz. per 100 grains of Nitrogen the dietary contains. The following table shows approximately the quantity in ounces of fat contained per 100 grains of Nitrogen in different food materials. From this table it may be readily ascertained when the quantity of fat in a dietary is or is not within the required limits. It is of course understood that when the quantity of fat present in a dietary is below ·5 oz. per 100 grains of Nitrogen, more fat must be added, and when on the other hand it is much above ·7 oz. per 100 grains of Nitrogen, fat or a food material containing it must be withdrawn and be replaced by a food material containing less fat.

Ounces of Fat per 100 *grains Nitrogen in various Food Materials.*

Cereals and Pulse about	...	·10
Lean Meat	,, ...	·25
Fat Meat	,, ...	2·00
Fish from	,, ...	·06
To (Eel)	,, ...	·57
Cheese	...	1·07
Eggs	...	1·29
Biscuit	...	·06
Milk	...	1·09
Bread	...	·16

Examining, for example, by the aid of this table the dietary we have just constructed, we find that as fat meat contains 2 oz. of fat for every 100 grains of Nitrogen, the amount of fat present in 14·6 oz. of fat meat (the quantity which yields 140 grains of Nitrogen) is 2·8 oz. The total quantity of fat required in a dietary containing 240 grains of Nitrogen, is 240 × ·7 or 1·68 oz. Hence, as the fat meat contained in the dietary in itself provides more than this amount of fat, no additional fat is required, and the dietary in question would be improved by the withdrawal of the ½ oz. of added fat, and its replacement by an equivalent quantity (twice its weight, or 1 oz.) of any cereal.

This limit for the fat—viz., ·5 to ·7 oz. per 100 grains of Nitrogen, is founded on the following considerations :

The organic (*i.e.*, the non-mineral) principles contained in foods belong to one of the three following classes, all of which ought to be represented in certain proportions in any well constructed dietary :

1. Principles which, like albumen, contain Nitrogen as well as Carbon called albuminates.

2. Principles which contain Carbon but no Nitrogen, and which are oily in character, called fats.

3. Principles which, like the fats, contain Carbon but no Nitrogen, but which are not oily in character, starch and sugars for example, called carbohydrates.

In any well constructed dietary the proportion of fat ought not to be much below one-third of the quantity of albuminates present, or greatly above one-half of the quantity of albuminates.

When the quantity of fat in a dietary equals ·5 oz. per 100 grains of Nitrogen, the quantity of fat present is about one-third of that of the albuminates; when, on the other hand, it amounts to ·7 oz. per 100 grains of Nitrogen, the quantity of fat present is about one-half of that of the albuminates.

When the amount of fat contained in a dietary is near the limits above laid down, and when at the same time the quantity of Carbon present is not below 16 times the amount of Nitrogen contained in the dietary, the quantity of carbohydrates present is sufficient.

The following table shows the proportion the fats, albuminates, and carbohydrates bear to one another in dietaries in which the amount of fat present is ·7 oz. per 100 grains of Nitrogen, and in which the proportion of Carbon to Nitrogen is 16 to 1, or 18 to 1, or 20 to 1 :—

Carbon.	Nitrogen.	Fat.	Albuminates.	Carbohydrates.
16	1	1	2	7·37
18	1	1	2	8·81
20	1	1	2	10·26

As suggesting the amount of Nitrogen and

Carbon, the daily diet of male adults of average weight should contain under different conditions as regards work, it may be stated—

1. On the authority of Parkes, Letheby, and others, that a male European adult of average weight (150 lbs.) requires when at rest from 190 to 210 grains of Nitrogen and from 4,000 to 4,200 grains of Carbon per diem.

2. On the authority of Moleschott, Parkes, Pavy, and others, that the same individuals at moderate work require 290 to 315 grains of Nitrogen and about 4,500 to 5,500 grains of Carbon per diem. The diet of English convicts at hard labour contains Nitrogen 281 grains, carbon 5,140 grains.

3. On the authority of Playfair and others, that the same individuals engaged in very laborious work require about 350 to 390 grains of Nitrogen and 5,500 to 6,500 grains of Carbon per diem.

It will be observed that these quantities equal per lb. of body weight per diem. .

1. For rest, $1\frac{1}{3}$ to $1\frac{1}{2}$ grains of Nitrogen with $26\frac{2}{3}$ to 28 grains of Carbon, equal to about 20 times as much Carbon as Nitrogen.

2. For moderate work, about 2 grains of Nitrogen with 30 to 36 grains of Carbon, equal to about 16 to 18 times as much Carbon as Nitrogen.

3. For very laborious work, $2\frac{1}{3}$ to $2\frac{2}{3}$ grains of Nitrogen with 36 to 44 grains of Carbon, equal to about 16 times as much Carbon as Nitrogen.

And in regard to what constitutes moderate work and very laborious work, it may be stated, on the authority of Dr. Parkes, that 500 foot tons is an extremely hard day's work, and 300 foot tons an average day's work for a healthy strong adult (European), from which it may be inferred that moderate work is something less than 2 foot tons per lb. of body weight per diem, and very laborious work about 3 foot tons per lb. of body weight per diem.

Tables 5 and 6 are intended to facilitate the valuation of dietaries, saving the necessity for multiplication. Thus Table 5 shows the quantity in grains of Nitrogen in any given number of ounces of a food material from 1 to 9, and of course by moving the decimal point to the right, the quantity of Nitrogen in any larger number of ounces may readily be calculated. For example, let it be required to find the amount of Nitrogen in, say, 24 ounces jowari: under 2 opposite jowari is the number 11·94, this of course is equal to 119·4 grains Nitrogen in 20 ounces jowari: under 4 in the same line is 23·88, hence in 24 oz. jowari

$$\begin{array}{r} 119{\cdot}4 \\ 23{\cdot}88 \\ \hline 143{\cdot}28 \end{array} \text{ grains Nitrogen.}$$

TABLE 6 gives the same information as regards Carbon that TABLE 5 gives in respect to Nitrogen.

It must be always recollected that the numbers given are approximate only, for materials of fair quality. In the case of minimum dietaries therefore it is safer to add a small percentage to the quantities calculated from the tables as an allowance for possible inferiority of quality and error. (See pages 52 and 77.)

PART II.

TABLES FOR VALUATION OF FOOD MATERIALS.— SPECIAL TABLES FOR VALUATION OF CEREALS AND PULSE.

TABLES 7, 8, 9, and 10 are intended to show approximately the relative value of various food materials and mixtures of food materials as sources of Carbon and Nitrogen. For sake of convenience in these tables the values are expressed in what may be called Nitrogen and Carbon equivalents; one equivalent of Nitrogen being taken as equal to 100 grains of Nitrogen, and one equivalent of Carbon to 1,800 grains of carbon—thus

TABLE 7 shows the weight (in lbs. and fractions of a lb. and in ounces and fractions of an ounce) of each food material required to yield, respectively, 1 equivalent of Nitrogen (100 grains) and 1 equivalent of Carbon (1,800 grains).

TABLE 8 has three columns of figures: the first column shows the number of Nitrogen equivalents (100 grains of Nitrogen each) contained in 100 lbs. of each food material. The second column the number of Carbon equivalents (1,800 grains of Carbon each) contained in 100 lbs. of each food material. The third column shows the number by which the Carbon equivalents in 100 lbs. of each food material fall short of or exceed the Nitrogen equivalents in 100 lbs. of the same food material.

TABLE 8, it will be observed, divides food materials into two classes: 1, a class where the number of Nitrogen equivalents in any given weight of food material exceed in number the Carbon equivalents; and 2, a class where the Carbon equivalents in any given weight of food material exceed in number the Nitrogen equivalents; for sake of distinction, class 1 may be called Nitrogenous foods, and class 2, Carbonaceous foods.

TABLE 9 shows the proportion in which any given Carbonaceous food must be mixed with any given Nitrogenous food, in order that the mixture shall contain an equal number of Nitrogen and Carbon equivalents, *i.e.*, Nitrogen to Carbon in the proportion of 1 to 18. The proportion is shown in percentages of Carbonaceous foods required; for example, in this table opposite jowari in the pulse column will be found the number 70·8 signifying that when jowari and pulse are mixed together in the proportion of 70·8 lbs. of jowari to 29·2 lbs. of pulse, the mixture contains Nitrogen and Carbon in the proportion of 1 to 18.

TABLE 10 gives approximately the values of the various mixtures shown in TABLE 7. The values are expressed in equivalents of Nitrogen and Carbon per 100 lbs. of the mixture. For example, opposite each cereal in the pulse column of this table is the number 151, signifying that 151 times 100 grains of Nitrogen with 18 times as much Carbon is contained in 100 lbs. of cereal and pulse mixed in the proportions shown in TABLE 9.

These four tables therefore show—

TABLE 7.—What weight of each food material is required for 100 grains of Nitrogen or 1,800 grains of Carbon.

TABLE 8.—How many times 100 lbs. of each food material contains 100 grains of Nitrogen or 1,800 grains of Carbon.

TABLE 9.—The proportion in which any two food materials must be mixed, so that just 18 times as much Carbon as Nitrogen may be contained in the mixture.

TABLE 10.—The number of times 100 grains of Nitrogen with 18 times as much Carbon is contained in 100 lbs. of two food materials mixed in the proportion shown in TABLE 9.

TABLE No. 7.

NITROGEN and CARBON EQUIVALENTS of Food Materials compared for Nitrogen 100 grains, Carbon 1800 grains.

	Nitrogen Equivalents.		Carbon Equivalents.	
	Pounds containing 100 grains of Nitrogen.	Ounces containing 100 grains of Nitrogen.	Ounces containing 1800 grains of Carbon.	Pounds containing 1800 grains of Carbon.
	lbs.	oz.	oz.	lbs.
Cheese...	·2750	4·4	11·1	·6937
Biscuit	·2750	4·4	9·8	·6143
Pulse	·3500	5·6	10·6	·66175
Mackerel	·3812	6·1	22·5	1·4062
Lean Meat uncooked without bone .	·4725	7·0	28·1	1·7578
Wheaten Bread (Bombay) ...	·7437	11·9	12·9	·8035
Fat Meat uncooked without bono ...	·6500	10·4	18·3	1·1440
Eel and Sole	·7125	11·4	22·5	1·4063
Eggs* (by weight)	·7750	12·4	28·0	1·7500
Milk	2·2750	36·4	58·5	3·6525
Wheat...	·6812	10·9	10·6	·66175
Oatmeal	·7187	11·5	10·6	·66175
Bajri (Penicillaria Spicata) ...	·8750	14·2	10·6	·66175
Maize	·9000	14·4	10·6	·66175
Millet (Panicum Miliaceum) ...	·9750	15·6	10·6	·66175
Jowari (Sorghum Vulgare) ...	1·0500	16·8	10·6	·66175
Barley...	1·0812	17·3	10·6	·66175
Rice	1·2500	20·0	10·6	·66175
Wheaten Bread (English) ...	1·1250	18·0	15·1	·9454
Carrots	15·625	250·0	100·0	6·2500
Potatoes	6·250	100·0	36·7	2·2937
Sugar	...	...	9·6	·6025
Fat	...	...	5·2	·3230

* English Eggs about 2 oz. each or 8 to 1 lb.; Bombay Eggs about 1¼ oz. each or 12 to 1 lb.

TABLE NO. 8.

EQUIVALENTS of CARBON and NITROGEN in 100 *lbs. Food Materials.*
1 *Equivalent Nitrogen* = 100 *grains,* 1 *Equivalent Carbon* = 1800 *grains.*

	Nitrogen Equivalents in 100 lbs.	Carbon Equivalents in 100 lbs.	Excess or deficiency of Carbon Equivts.
Cheese	368·00	144·00	—224·00
Biscuit	363·20	162·66	—200·54
Pulse	285·76	151·11	—134·65
Mackerel	262·40	71·11	—191·29
Lean Meat uncooked without bone ...	227·52	56·89	—170·63
Wheaten Bread (Bombay)	135·04	124·44	— 10·60
Fat Meat uncooked without bone ...	153·60	87·38	— 66·22
Eel and Sole	140·00	71·11	— 68·89
Eggs* (by weight)	129·12	57·20	— 71·92
Milk	44·00	27·38	— 16·62
Wheat	147·52	151·11	+ 3·59
Oatmeal	139·20	151·11	+ 11·91
Bajri (Penicillaria Spicata)	112·00	151·11	+ 39·11
Maize	110·88	151·11	+ 40·23
Millet (Panicum Miliaceum)	102·40	151·11	+ 48·71
Jowari (Sorghum Vulgare)	95·52	151·11	+ 55·59
Barley	92·96	151·11	+ 58·15
Rice	81·12	151·11	+ 69·99
Wheaten Bread (English)	88·80	105·78	+ 16·98
Carrots	6·40	16·00	+ 9·60
Potatoes	16·00	43·55	+ 27·25
Sugar	...	166·22	+166·22
Fat	...	307·20	+307·20

* English Eggs about 2 oz. each or 8 to 1 lb.; Bombay Eggs about 1⅓ oz. each or 12 to 1 lb.

TABLE No. 9.

PROPORTIONS in which Food Materials must be mixed in order that the proportion of Carbon to Nitrogen in the mixture shall equal 18 *Carbon to* 1 *Nitrogen. Proportions stated in percentages of Carbonaceous Foods, i.e., in per centages of the Foods named in the first column. The figures of the Table deducted from* 100·00 *give the quantities of Nitrogenous Foods required.*

NITROGENOUS FOODS.

Carbonaceous Foods.	Cheese.	Biscuit.	Pulse.	Fish.		Meat uncooked & without bone.		Wheaten Bread (Bombay).	Eggs.*	Milk.
				From Mackerel.	To Eel & Sole.	From Lean M.	To Fat M.			
	Per cent.	Per cent.	Per ct.	Per cent.	Per cent.	Per ct.	Per ct.	Per cent.	Per ct.	Per ct.
Wheat	98·4	98·2	97·4	98·1	95·0	97·9	94·8	74·6	95·2	82·2
Oatmeal	95·0	94·4	91·9	94·1	85·2	93·5	84·7	47·1	85·8	58·2
Bajri (Penicillaria Spicata) ...	85·1	83·7	77·5	83·0	63·8	81·4	62·9	21·3	64·8	29·8
Maize	84·8	83·3	77·0	82·6	63·1	80·9	62·2	20·8	64·1	29·2
Millet (Panicum Miliaceum)...	82·1	80·4	73·4	79·7	58·6	77·8	57·6	17·9	59·6	25·4
Jowari (Sorghum Vulgare) ...	80·1	78·3	70·8	77·5	55·3	75·4	54·4	16·0	56·4	23·0
Barley	79·4	77·5	69·8	76·7	54·2	74·6	53·2	14·2	55·3	22·2
Rice	76·2	74·1	65·8	73·2	49·6	70·9	48·6	13·2	50·7	19·2
Wheaten Bread (English) ...	93·0	92·2	88·8	91·8	80·2	90·9	79·6	38·4	80·9	49·4
Carrots	95·9	95·4	93·3	95·2	87·7	94·7	87·3	51·0	88·2	63·4
Potatoes	89·0	87·9	83·0	87·4	71·4	86·1	70·6	28·0	72·3	37·6
Sugar	58·9	54·7	44·7	53·5	29·3	50·6	28·5	6·0	30·2	9·1

* English Eggs about 2 oz. each or 8 to 1 lb.; Bombay Eggs about 1⅓ oz. each or 12 to 1 lb.

TABLE No. 10.

APPROXIMATE VALUE of 100 *lbs. of any two Food Materials mixed in the proportion shown in Table* 7.
Value stated in number of Nitrogen-Carbon equivalents each equal to 100 *grains of Nitrogen* + 1800 *grains of Carbon.*

NITROGENOUS FOODS.

Carbonaceous Foods.	Cheese.	Biscuit.	Pulse.	Fish.		Meat uncooked & without Bone.		Wheaten Bread (Bombay).	Eggs.	Milk.
				From Mackerel.	To Eel & Sole.	From Lean M.	To Fat M.			
Wheat	151	151	151	149	147	149	147	144	146	129
Oatmeal	150	151	151	146	139	144	141	137	137	99
Bajri (Penicillaria Spicata) ...	150	153	151	137	122	133	127	130	118	64
Maize	150	153	151	137	121	133	127	130	117	63
Millet (Panicum Miliaceum)...	150	153	151	134	117	130	124	129	113	58
Jowari (Sorghum Vulgare) ...	149	153	151	133	115	127	122	129	110	55
Barley	149	153	151	132	114	127	121	129	109	54
Rice	149	154	151	129	110	123	118	128	104	51
Wheaten Bread (English) ...	137	108	110	102	98	101	102	117	96	66
Carrots	21	22	25	18	22	18	25	69	20	20
Potatoes	54	57	61	47	51	45	56	101	47	33
Sugar	151	164	157	122	99	112	109	127	90	40

From the figures given in these four tables we may—subject to certain conditions—deduce the feeding power of any food material or mixture of food materials included in the tables. These conditions are, so to speak, a consequence of the need there exists for observing the precautions laid down at pages 13 and 17, and may in general terms be stated as follows :—

1. That from considerations connected with digestibility, &c., the quantity of certain food materials given per head must be kept within certain limits ; for example, in the case of pulse the quantity given should be kept below 4 to 5 oz. per head per diem.

2. That no food material or mixture of food materials which contains little fat can be employed without the addition of fat, and that all dietaries should provide for the addition of a certain amount of salt and condiments.

3. That as Tables 7 to 10 provide only for 18 times as much Carbon as Nitrogen, where more Carbon is required, our estimates must be altered so as to provide for it. The addition, however, per 100 grains of Nitrogen of either ·6 oz. of fat or 1·2 oz. of any cereal will raise the Carbon from 18 times as much as the Nitrogen to the proportion of 20 times as much as the Nitrogen, and each successive addition of ·6 oz. fat or 1·2 oz. cereal per 100 grains of Nitrogen

will produce a rise in the proportion of Carbon to the same extent.

4. As the tables are based on the average composition of food materials of good quality, it is desirable, especially in the case of minimum dietaries, to add to our estimates of quantities required a percentage allowance to meet possible inferiority of quality and error.

Subject to these four conditions the feeding power of any of the mixtures included in TABLES 9 and 10 may be arrived at in a very simple way. For example, suppose from the considerations put forward (page 20), the individuals to be fed are to be provided for at the rate of 200 grains of Nitrogen with a suitable proportion of Carbon per head per diem; then the figures of TABLE 10, divided by 2, give the number of individuals that 100 lbs. of each of the mixtures will provide for this rate for one day. Again, suppose the rate to be 150 grains of Nitrogen per head per diem, 2/3ds of the figures of TABLE 10 must be taken, and so on.

Subject, also, to the four conditions stated, so far as the feeding power of any food material considered by itself is capable of estimation, the figures of TABLE 8 may be employed for the purpose in the same way as the figures of TABLE 10 may be employed in estimating the feeding power of mixtures. It is evident, however, that for this purpose it is only safe to employ the lower of the two figures which stand, in the first two columns of the table, opposite to the name of the food material. It must be recollected, also, that food must contain carbohydrates (see page 18) as well as albuminates and fat; no food material, therefore, which is deficient in carbohydrates, meat for example, can be used by itself, just as no food material, a cereal or pulse, for example, which contains little fat can be used (see condition 2) without an admixture of fat.

One or two examples will serve to show what information may be derived from these tables.

Suppose the question to be the estimation of the feeding power of a single unmixed food material, this—so far as we are able to form such an estimate—may be ascertained from TABLE 8, in the following way:

When the food material is one of those placed below the horizontal line running across the middle of TABLE 8, a Carbonaceous food in fact (see page 23), employ the figures in the first or Nitrogen column of the table, adding, in accordance with condition 2, ·6 oz. of fat per 100 grains of Nitrogen. For example, the feeding power of wheat may be ascertained and compared with that of bajri as follows:

100 lbs. of wheat will supply 73·76 individuals (½ 147·52) with 200 grains of Nitrogen per head,

or 98·34 individuals (⅔ds of 147·52) with 150 grains of Nitrogen per head.

100 lbs. of bajri will supply 56 individuals (½ 112) with 200 grains of Nitrogen per head, or 74⅔ (⅔ds of 112) with 150 grains of Nitrogen per head.

Quantity of fat to be added—in the case of wheat 147·52 × ·6 = 88½ oz.; in the case of bajri 112 × ·6 = 67·2 oz.*

Proportion of Carbon supplied not under 18 times, or with the addition of fat, not under 20 times the amount of Nitrogen.

When the food material is one of those placed above the horizontal line in TABLE 8, a Nitrogenous food in fact (see page 23), its feeding power—except in the case of pulse and cheese barred by condition 1—may be ascertained by employing the figures of the second or Carbon column of the table. Here, however, it must be recollected that certain of these food materials (meat, fish, and eggs) are deficient in Carbohydrates, and that this deficiency constitutes an objection (see page 18) to their employment *per se*. With this reservation we have, for example—

100 lbs. of fat meat will supply 43·69 (½ 87·38) individuals with 200 grains of Nitrogen, or 58·25 (⅔ds of 87·38) individuals with 150 grains of Nitrogen, and not less than 18 times as much Carbon per head, &c. &c.

* See also pages 43 and 44.

In the case of this and other Nitrogenous foods, when estimates are formed as in the example given, the Carbon will amount to *not less* than 18 times the Nitrogen estimated for, but at the same time there will obviously be an excess of Nitrogen over and above the quantity required. From what was stated (page 20), it is evident, however, that it is consistent with safety in some cases to be content with 16 times as much Carbon as Nitrogen. In such a case, the figures given in the second column of TABLE 8 must be raised 12½* per cent., *i.e.*, in proportion of 16 to 18. Raised in this way we have—

183·00	instead of	162·66	for Biscuit
80·00	instead of	71·11	for Fish
64·00	instead of	56·89	for Lean Meat
135·04	instead of	124·44	for Wheaten Bread (Bombay)
98·31	instead of	87·38	for Fat Meat
64·35	instead of	57·20	for Eggs
30·80	instead of	27·38	for Milk

and our amended estimate becomes—

100 lbs. of fat meat will supply 49·15 (½ 98·31) individuals with 200 grains of Nitrogen, or 65·54 (⅔ds of 98·31) individuals with 150 grains of Nitrogen and not less than 16 times as much Carbon per head.

It here also may be pointed out, that in the case of Nitrogenous foods the figures of the last column of TABLE 8 multiplied by ·67 give the quantity in lbs. of any cereal which, if added to the 100 lbs. of Nitrogenous food, will raise the feeding power of the mixture to the figure shown in the first

* But not above the figures of the first column.

column. For example, in the case of fat meat the figure in the last column 66·22 × ·67 gives 44·37, hence by adding to 100 lbs. of fat meat 44·37 lbs. of any cereal, we have a mixture sufficing for the supply of 76·8 (½ 153·6) individuals with 200 grains of Nitrogen per head, or 102·4 (⅔ds of 153·6) individuals with 150 grains of Nitrogen per head and 18 times as much Carbon as Nitrogen. In such a case the data given at page 18 will guide us as to whether an addition of fat is required or not.

When the question is the feeding power of a mixture of two food materials, TABLE 9 shows the proportion in which they must be mixed in order that just 18 times as much Carbon as Nitrogen may be contained in the mixture, and TABLE 10 the feeding power of 100 lbs. of food materials mixed in the proportions shown in TABLE 9. For example, on reference to TABLES 9 and 10 we find that in TABLE 10 opposite each cereal and pulse mixture is the number 151, hence—

(1.) 97·4 lbs. wheat + 2·6 lbs of pulse (see TABLE 9) will supply ½ 151 or 75·5 individuals with 200 grains of Nitrogen per head, or 2/3rds of 151, say 100 individuals with 150 grains of Nitrogen per head; as before, in accordance with condition 2, 151 × ·6 = 90½ oz. of fat must be added.

(2.) 77·5 lbs. of bajri + 22·5 lbs. of pulse (see TABLE 9) will supply the same number of individuals at the same rate, if as above 90½ oz. of fat be added.

(3.) In the case of rice and pulse, for the supply of the same number of individuals at the same rate, the quantities required would be (see Table 9) 65·8 lbs. of rice + 34·2 lbs. of pulse + 90½ oz. of fat. This mixture would, however, give more than 5 oz. of pulse per head, and is therefore inadmissible under condition 1. (See page 30.)

When, as in the case of rice and pulse—see above (3),—the mixture shown in Tables 9 and 10 would give a quantity of pulse (*or cheese*) greater than is admissible under condition 1, the alternative may be adopted of combining one of the other mixtures of Tables 9 and 10 with it, so as to bring the percentage of pulse (*or cheese*) within the required limits. For example, suppose we combine together the mixture of wheat and pulse contained in Tables 9 and 10, and the mixture of rice and pulse contained in the same tables, we have 97·4 lbs. of wheat + 65·8 lbs. of rice + 2·6 + 34·2 = 36·8 lbs. of pulse. This mixture contains 18·4 per cent. of pulse and becomes admissible under condition 1, and with the addition of 90½ oz. fat per 100 lbs., its feeding power per 100 lbs. is the same as that of the other cereal and pulse mixtures of Tables 9 and 10.

In all estimates derived from Tables 9 and 10 the proportion of Carbon is 18 times, or with the addition of either ·6 oz. of fat or 1·2 oz. of any cereal per 100 grains of Nitrogen, 20 times the quantity of Nitrogen estimated for.

In order that it may be readily ascertained when a mixture of cereal and pulse is barred by condition 1, the table (No. 11) given below may be employed. This table shows the greatest percentage of pulse admissible under condition 1 in any mixture of cereal and pulse :—

TABLE 11.

		Pulse limited to 4 oz. per head.	Pulse limited to 5 oz. per head.
		Greatest percen	tage admissible.
Grains Nitrogen allowed ...	150	25·0	31·4
" " " ...	160	23·5	29·4
" " " ...	170	22·1	27·8
" " " ...	180	21·0	26·3
" " " ...	190	19·4	24·6
" " " ...	200	18·8	23·5
" " " ...	210	17·9	22·3
" " " ...	220	17·1	21·2
" " " ...	230	16·3	20·3
" " " ...	240	15·7	19·5
" " " ...	250	15·0	18·7

Table 11 reads as follows. If individuals are to be allowed per head 150 grains of Nitrogen, any mixture of cereal and pulse which contains over 25 per cent. of pulse is barred if the quantity of pulse per head is to be limited to 4 oz., and no mixture containing more than 31·4 per cent. of pulse is admissible, inasmuch as if this percentage is exceeded the quantity of pulse per head becomes more than 5 oz. Similarly when the allowance of Nitrogen is 200 grains per head, the percentage of pulse must be kept under 18·8 or 23·5 per cent. according as to whether it is intended to limit the quantity of pulse given to 4 oz. or 5 oz. per head.

The next four tables, 12 to 16, complete the series of cereal and pulse tables, and provide for cases where the cereal to be given, if mixed with pulse in the proportion shown in Table 9, would form a mixture containing a greater percentage of pulse than is admissible according to Table 11; thus—

Table 12 shows the number of ounces of cereal which must be added to 4 oz. of pulse in order to provide a given number of grains of Nitrogen.

Table 13 shows the percentage of cereal contained in mixtures of cereal and pulse mixed in the proportions indicated in Table 12.

Table 14 shows the number of rations in 100 lbs. of (1) unmixed cereals; (2) cereal and pulse mixtures of Tables 12 and 13; (3) cereal and pulse mixtures of Table 9.

Table 15 shows the weight in ounces of each ration of (1) unmixed cereals; (2) cereal and pulse mixtures of Tables 12 and 13; (3) cereal and pulse mixtures of Table 9.

To all the mixtures included in these three tables, about ½ an ounce of fat per 100 grains of

Nitrogen ought to be added, and salt and condiments (see condition 2, page 29), and remarks on last line of Table 15 (pages 43 and 44).

Oatmeal and wheat are not included in Tables 12 and 13, as when these cereals are employed less than 4 oz. of pulse per head is required. Table 9 shows the proportion in which pulse should be mixed with these two cereals, and the last line of Tables 14 and 15 respectively the number of rations in 100 lbs. of the mixture, and the weight in ounces of each ration.

TABLE No. 12.

OUNCES CEREAL required in addition to 4 oz. Pulse for any given number grains Nitrogen from 150 to 250.

Grains Nitrogen...	140	150	160	170	180	190	200	210	220	230	240	250
	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.
Rice	13¾	15½	17½	19½	21½	23½	25½	27½	29½	31½	33½	35½
Barley	12	13½	15¼	17	18¾	20½	22¼	24	25½	27¼	29	30¾
Jowari (Sorghum Vulgare)...	11½	13¼	15	16½	18¼	20	21½	23¼	25	26½	28¼	30
Millet (Panicum Miliaceum).	11	12¼	14	15½	17	18½	20¼	21¾	23¼	25	26½	28
Maize	11	12	13	14¼	15¾	17¼	18½	20	21½	23	24½	26
Bajri (Penicillaria Spicata)..	11	12	13	14	15½	17	18⅓	19¾	21¼	22⅔	24	25⅓

TABLE No. 13.

PERCENTAGE CEREAL in Mixtures of Table 12.

Grains Nitrogen...	140	150	160	170	180	190	200	210	220	230	240	250
Rice	78	79·5	81·4	83·0	84·3	85·5	86·3	87·3	88·1	88¾	89⅓	89·9
Barley	75	77·1	79·2	80·9	82·4	83·7	84¾	85·7	86·4	87·2	87·9	88·5
Jowari (Sorghum Vulgare)...	74·2	76·8	78·9	80·5	82·0	83⅓	84·1	85·3	86·2	86·8	87·3	88·2
Millet (Panicum Miliaceum...	73⅓	75·4	77·7	79·5	80·9	82·2	83·5	86·9	85·3	86·2	86·8	87·5
Maize	73⅓	75	76·3	78·1	79¾	81·2	82·2	83·3	84·3	85·2	85·9	86⅔
Bajri (Penicillaria Spicata)...	73⅓	75	76·3	77·8	79·5	80·9	82·1	83·1	84·1	85·0	85·7	86·5

TABLE No. 14.

Number of Rations in 100 lbs. (1) *of each Cereal ;* (2) *of the Cereal and Pulse Mixtures of Tables* 12 *and* 13 *;* (3) *of the Cereal and Pulse Mixtures of Table* 9.

	Grains Nitrogen ...	140	150	160	170	180	190	200	210	220	230	240	250
Cereals alone.	Rice	57·9	54·0	50·7	47·7	45·0	42·7	40·5	38·6	36·8	35·2	33·8	32·4
	Barley	66·6	61·9	58·1	54·6	51·6	48·9	46·4	44·2	42·2	40·4	38·7	37·1
	Jowari	68·2	63·6	59·7	56·1	53·0	50·2	47·7	45·4	43·4	41·5	39·8	38·2
	Millet	73·1	68·2	64·0	60·2	56·8	53·8	51·2	48·7	46·5	44·5	42·6	40·9
	Maize	79·2	73·9	69·3	65·2	61·6	58·3	55·4	52·8	50·4	48·2	46·2	44·3
	Bajri	80·0	74·6	70·0	65·8	62·2	58·9	56·0	53·3	50·9	48·7	46⅔	44·8
	Oatmeal	99·3	92·8	87·0	81·8	77·3	73·2	69·6	66·2	63·2	60·5	58·0	55·6
	Wheat	105·2	98·3	92·2	86·7	81·9	77·6	73·7	70·2	67·0	64·1	61·4	59·0
Cereals + 4 oz. Pulse per head.	Rice and Pulse ...	90	82	74·4	68	62·7	58	54·2	50·7	47·7	45	42⅔	40·5
	Barley do. ...	100	91·4	83·1	76·2	70⅓	65·3	60·9	57·1	54·2	51·1	48·4	46·0
	Jowari do. ...	103	92¾	84·2	78·0	71·9	66⅔	62·7	58·7	55·1	52·4	49·6	47·0
	Millet do. ...	106⅔	98·4	88·8	82	76·2	71·1	65·9	62·1	58·7	55·1	52·4	50·0
	Maize do. ...	106⅔	100	94·1	87·6	81·0	75¼	71·1	66⅔	62·7	59¼	56·1	53⅓
	Bajri do. ...	106⅔	100	94·1	88·8	82·0	76·2	71·6	67⅓	63⅓	60	57·1	54·2
Cereal and Pulse Mixtures of Tables 9 and 10...	...	107·8	100	93·7	88·2	83⅓	78·9	75·5	71·4	68·1	65·2	62·5	60·0

TABLE No. 15.

*Showing the number of ounces of unmixed Cereals and various Mixtures of Cereals and Pulse required to supply **various** quantities of Nitrogen from* 140 *to* 250 *grains with* NOT LESS *than* 18 *times as much Carbon as Nitrogen.*

	Grains Nitrogen...	140	150	160	170	180	190	200	210	220	230	240	250
Ounces unmixed Cereal (see Tables 2 & 14).	Rice	28	30	32	34	36	38	40	42	44	46	48	50
	Barley	24	25·8	27·5	29·3	31·0	32·8	34·5	36·3	38·0	39·7	41·4	43·2
	Jowari	23·5	25·1	26·8	28·5	30·2	31·8	33·5	35·2	36·9	38·5	40·2	41·9
	Millet	21·9	23·5	25·0	26·6	28·1	29·7	31·3	32·8	34·4	36 0	37·5	39·1
	Maize	20·2	21·7	23·1	24·5	26·0	27·4	28·9	30·3	31·8	33·2	34·7	36·1
	Bajri	20·0	21·4	22·9	24·3	25·7	27·1	28·6	30·0	31·4	32·8	34·3	35·7
	Oatmeal	16·1	17·3	18·4	19·6	20·7	21·9	23·0	24·2	25·3	26·5	27·6	28·8
	Wheat	15·2	16·3	17·4	18·5	19·5	20·6	21·7	22·8	23·9	25·0	26·0	27·1
Ounces Grain including Pulse 4 oz. (see Tables 12 & 13).	Rice and Pulse ...	17¾	19½	21½	23½	25½	27½	29½	31½	33½	35½	37½	39½
	Barley do. ...	16	17½	19¼	21	22¾	24½	26¼	28	29½	31¼	33	34¾
	Jowari do. ...	15½	17¼	19	20½	22¼	24	25½	27¼	29	30½	32¼	34
	Millet do. ...	15	16¼	18	19½	21	22½	24¼	25¾	27¼	29	30½	32
	Maize do. ...	15	16	17	18¼	19¾	21¼	22½	24	25½	27	28½	30
	Bajri do. ...	15	16	17	18·1	19½	21	22⅓	23¾	25¼	26⅔	28	29½
Cereal and Pulse Mixtures of Tables 9 and 10 ...		14·8	16·0	17·0	18·1	19·1	20·2	21·2	22·3	23·3	24·3	25·4	26·5

One or two examples will suffice to show the use of TABLES 12 to 15.

By TABLE 12 we find that with 4 oz. of pulse, 15½ oz. of rice, or 13¼ oz. of jowari or 12 oz. bajri, must be given if the allowance of Nitrogen is to be not less than 150 grains. Similarly if the allowance of Nitrogen is to be not less than 200 grains with the same quantity—viz., 4 oz. of pulse, we must give per head 25½ oz. of rice, or 21½ oz. of jowari, or 18⅓ oz. bajri, &c. &c.

By TABLE 13 we find that if according to TABLE 12 we give 4 oz. pulse and 21½ oz. of jowari containing together 200 grains of Nitrogen, 100 lbs. of such a mixture will contain 84·1 lbs. of jowari, &c.

By TABLE 14 we find that 100 lbs. of jowari and pulse mixed in the proportions shown in the corresponding position in TABLES 12 and 13 will provide for 92¾ individuals at the rate of 150 grs. of Nitrogen per head, or 62·7 individuals at the rate of 200 grains of Nitrogen per head, &c. &c. Also, that if jowari unmixed with pulse is employed, the number of individuals supplied at the same rates by 100 lbs. will be respectively 63·6 and 47·7, &c.; and also, that if 100 lbs. of a mixture or combination of mixtures of cereal and pulse derived from ABLE 9 is used, the number of individuals supplied at the same rates will be respectively 100 and 75·5, &c. &c.

TABLE 15 corresponds to TABLE 14, and shows the weight in ounces of each ration into which, according to TABLE 14, 100 lbs. of food material would have to be divided. Thus, in order to secure, say, 200 grains of Nitrogen per head, we find by TABLE 14 that 100 lbs. of jowari can only be divided among 47·7 individuals, and by TABLE 15 that each individual would at this rate receive 33·5 ounces. Again, if jowari and 4 oz. of pulse per head be given, we find by TABLE 13 that for 200 grains of Nitrogen the percentage of jowari in the mixture would have to be 84·1; by TABLE 14 that 100 lbs. of such a mixture would provide 200 grains of Nitrogen per head for 62·7 individuals, and by TABLE 15 that the grain ration per individual would weigh inclusive of the pulse 25½ ounces. Again, if a cereal and pulse mixture or combination of cereal and pulse mixtures derived from TABLE 9 is used, we find by TABLE 9 the proportions for such mixture by TABLE 14 that 100 lbs. of such a mixture would provide 75·5 individuals with 200 grains of Nitrogen per head; and by TABLE 15 that the weight of each ration would be 21·2 oz., &c. &c.

The last line of TABLE 15, it must be remarked, shows the least quantity of cereal and pulse that can be given when 18 times or—with the addition of ·6 oz. fat per 100 grains of Nitrogen—20 times as much Carbon as Nitrogen is required. In every case where the quantity to be given per head is greater than the quantity shown in the last line of TABLE 15, the quantity of Carbon provided is (unavoidably) greater than 18 times the Nitrogen. Hence, when it is desired that the Carbon shall not be less than 20 times the Nitrogen, it is absolutely necessary in the case of estimates based on the last line of TABLE 15 either that the full quantity of fat should be given, or, if not given, that whatever amount *less* than the full quantity (of ·6 oz. per 100 grains of Nitrogen) is supplied, should be replaced by double its weight of a cereal. On the other hand, in cases where the weight of grain given per head is in excess of that shown in the same column in the last line of TABLE 15, less than the full quantity of fat may be given, provided that the excess weight of grain is double the quantity of fat not supplied. From what, however, was stated (page 18) it will be seen that it is not advisable in the case of cereal and pulse dietaries to give less than ·3 to ·4 oz. of fat per 100 grains of Nitrogen.

Example by the last line of TABLE 15, we find that for 200 grains of Nitrogen the least quantity of cereal and pulse that may be given is 21·2 oz.; this, however, only provides 18 times as much Carbon as Nitrogen—viz., 3,600 grains. For 20 times as much Carbon as Nitrogen = 4,000 grains, 1·2 oz. of fat must be added, or if, say, only ½ this quantity, *i.e.*, ·6 oz. of fat is given, 1·2 oz. more cereal must be supplied, raising the total quantity of cereal and pulse to 22·4 oz. In the case, however, say, of unmixed bajri, as the quantity required per head for 200 grains of Nitrogen is 28·6 oz., the withdrawal of ½ the fat need not be compensated by the addition of cereal, the amount of cereal already in excess being 28·6 — 21·2 = 7·4 oz., or much greater than 1·2 oz., *i.e.*, double the weight of the unsupplied fat. In the case of unmixed wheat, the quantity in excess is only 21·7 — 21·2 = ·5 oz. Here, therefore, only ·25 oz. of fat may be withdrawn without replacement by cereal—any greater quantity withdrawn than this requires to be compensated for by the addition of double its weight of any cereal.

It must not be forgotten that all these estimates are subject to the general conditions previously laid down in speaking of estimates of feeding power derivable from TABLES 7 to 10.

It may also be pointed out, that in estimating the feeding power of mixtures of cereals and pulse from the tables of Part II., it is advisable to calculate on the supposition that 4 oz. of pulse per head is the greatest admissible quantity. By doing this, room is always allowed for the compensation of possible Nitrogen error, by the substitution per head of an extra ounce of pulse for one ounce cereal.

Referring now specially to the results brought out in TABLES 14 and 15, it will be seen that the feeding power of a given weight of cereal, or mixed cereal and pulse, varies very greatly, the extreme range being from 54 to 100. In other words, if not less than a certain weight of rice (the least nutritious of the cereals) is required to feed 54 individuals, the same weight of other cereals or of mixtures of other cereals with pulse may fairly be estimated to range in feeding power from sufficient for the supply of 55 individuals, to sufficient for the supply of 100 individuals according to the cereal employed, and to the proportion in which pulse is mixed with it. It is true, of course, that this represents the extreme theoretical range, and that in practice it may be found that the gain obtainable is not so great as this. Still, as these figures represent a possible gain in feeding power of 85 per cent., there is every reason to suppose that difference in feeding power is a very important factor indeed in cases where largo bodies of individuals have to be fed almost wholly on cereals and pulse.

This difference is so enormous, and involves such important practical considerations, that it may be as well to point out the data upon which the estimate just given of its numerical value depends. These may be stated as follows :—

1. The amount of Nitrogen in a dietary must not be less than a certain quantity.

2. With this lowest admissible quantity of

Nitrogen it will suffice if the dietary provides for 20 times as much Carbon as Nitrogen.

3. All dietaries consisting solely of cereals or cereals and pulse must have fat added to them, a fair proportion being ·6 oz. per 100 grains of Nitrogen contained in the dietary (·6 oz. of fat contains 200 grains of Carbon).

4. The quantity of Nitrogen in rice is not greater than 5·07 grains per oz.

5. Without exceeding limits of digestibility, a mixture of cereals and pulse may be made which shall contain 9·44* grains of Nitrogen with 18 times as much Carbon, or—if ·6 oz. of fat be added per 100 grains of Nitrogen—20 times as much Carbon as Nitrogen per oz.

Simple proportion now gives the result thus: 9·44 : 5·07 : : 100 : 54, *i.e.*, as the quantity of Nitrogen in the most advantageous mixture of cereal and pulse is to the quantity of Nitrogen in rice so is 100 to 54.

Turning now to the special application of this difference in feeding power, it seems to me unquestionable that in the conduct of famine relief operations in India the greatest economy of transport and the greatest economy of money are only to be obtained when the fullest possible advantage is taken of this difference. It follows,

* 9·44 = 170 (the grains carbon per oz. in cereals and pulse) ÷ 18.

therefore, that in the conduct of relief operations, wherever other considerations render it possible, the measures we adopt should be framed with reference thereto. Thus, for example :—

1. Other things being equal, when the relief granted is to suffice for subsistence only, it is preferable to grant it in food rather than in money, so that the most nutritious diet procurable for a given cost may be secured to the recipients of relief.

2. Where the relief granted takes the form of payment for a task of work, and is therefore on a higher scale than that granted for mere subsistence, it might, in cases where the tendency of the recipients is to purchase the less nutritious cereals, become a question for consideration whether it would not be practicable and advisable to endeavour to secure them a more nutritious dietary for their wage by some such measures as the following :—

(*a*) by paying a small fraction of the wage as a ration of cooked pulse ; or

(*b*) by offering to grind, free of charge, the more nutritious cereals, such as bajri and wheat, so as to offer, as it were, a premium to the labourers to purchase such cereals in place of the less nutritious ones.

The last table of Part II., TABLE 16, gives certain useful factors : thus it contains—1, Parke's factors for the valuation of dietaries; and 2, Frankland's factors for dynamic value; from these the other factors given in the table are derived. It will be noticed that these derived factors facilitate the calculation of the dynamic value of the mixtures of food materials shown in TABLES 9 and 10; thus, for example, the number of grains Nitrogen contained in one of these mixtures, fat not having been added, multiplied by 13·8 gives approximately the dynamic value in foot tons of the mixture, or, if fat is added in the proportion of ·6 oz. per 100 grains of Nitrogen, the factor becomes 15·9 instead of 13·8.

TABLE No. 16.

VARIOUS FACTORS.

Parke's Factors for valuation of food :—

1 oz. dry Albuminate	=	Nitrogen 69 grs.,	Carbon	233 grs.
1 ,, ,, Fat	=	nil,	,,	345·6 ,,
1 ,, ,, Carbohydrate (except Lactin)			,,	194·2 ,,

Frankland's Factors for Dynamic value :—

1 ounce dry Albuminate	=	Foot tons	165·20
1 ,, ,, Fat	=	,,	351·56
1 ,, ,, Starch	=	,,	151·66

From the above Factors it follows :—

Grs. Nitrogen × ·0145 = ounces Albuminates.

Grs. Nitrogen × 3·377 = Carbon of Albuminates.

Grs. Carbon — Carbon of Albuminates and Fat × ·00515=oz. Carbohydrates.

Also,—

Grs. Nitrogen × 2·394 = Foot tons for Albuminates.

Grs. Carbon—Carbon of Albuminates and Fat × ·781 =Foot tons for Carbohydrates.

Also where Carbon is to Nitrogen as 18 to 1, dynamic value may be approximately ascertained in foot tons,

1. When this proportion is exclusive of Carbon in fat by multiplying grains Nitrogen by 13·8 adding 351·56 for each ounce of fat.

2. When this proportion includes Carbon of fat by multiplying grains Nitrogen by 13·8 adding 81·65 for each ounce of fat.

3. When fat ·6 oz. is added for each 100 grains of Nitrogen, multiply grains Nitrogen by 15·9.

ADDITIONAL NOTES TO PARTS I. AND II.

Food ought not to be given in too concentrated a form. Thus in dietaries which consist almost wholly of cereals and pulse, some portion of the daily allowance should be given in the form of soup, gruel, &c., so that bulk and dilution may be secured.

It has already been several times pointed out that estimates derived from these tables must be considered as approximate only, and that, especially in the case of minimum dietaries, it is advisable to make a percentage allowance for possible inferiority of quality and error. Taking all circumstances into consideration, an increase of 10 per cent.* on the quantities shown in the tables would be an outside allowance. Of course, so great an allowance as this will only be required in extreme cases.

Some of the food grains included in the tables are also known under other names, thus :—

Jowari is also called Cholum and Joar.

Bajri is also called Cumboo.

Millet includes Cheena, Sawi, and Varagoo.

With Millet may be classed Natchni, which is also known as Nagli, Ragi, and Murwa (Eleusine Corocana).

* See also part III. (page 77).

PART III.

Memorandum on the question of the probable least quantities of food required to maintain Natives of India in health and strength while at Labour, Light Labour, and Rest.

(*Published in Gazette of India of* 19*th May*, 1877.)

During the year 1876, 534 Native prisoners (all on hard labour) were discharged from the Bombay House of Correction. Their average weight on admission was 105 lbs. = 7 stone 7 lbs. On discharge they were found to have gained in weight on an average 1 lb. 10¼ oz. each. Their daily diet, while in Jail, is shown at (*a*) Table I., its value in Nitrogen and Carbon, calculated by the factors given in Table II., is, as shown (Table III. *a*), Nitrogen 201·6 grains, Carbon 4,011 grains daily.

These quantities of Nitrogen and Carbon are very much less than the quantities laid down by authorities as requisite for a European of average weight in moderate work. Thus many authorities estimate the quantities required by a European, of average weight in moderate work, at about Nitrogen 300 grains, Carbon 4,850 grains daily (see Table IV., 1 and 2). Letheby, taking a mean calculated from the researches of various physiologists, estimates the quantities required by a European male adult of average weight on ordinary labour as Nitrogen 307 grains, Carbon 5,688 grains (Table IV., 3). The hard labour diet of English convicts contains Nitrogen 281 grains, Carbon 5,140 grains per diem (see Table IV., 10).

The experience of the Bombay House of Correction that Native prisoners at hard labour gain weight on a diet containing less Nitrogen and Carbon than the quantities laid down by authorities as requisite for European adults of average weight in moderate work, is confirmed by the experience of the Jails of the Hyderabad Assigned Districts. The hard labour diet of these Jails is shown in Table I. (*b*), and its value, Nitrogen 230·5 grains, Carbon 4,600 at Table III. (*b*). On this diet the lowest, except the Bombay House of Correction diet, of the hard labour diets of the Indian Jails, the prisoners are found to be "very healthy." Again the new scale for all Indian Jails proposed by the Jail Conference recently assembled at Calcutta (Table I. (*c*)), values (see Table III. (*c*)) Nitrogen 213·2 grains, Carbon 4,454 grains.

Considering together the experience of the Bombay House of Correction and the experience of the Hyderabad Assigned District Jails, and considering also this proposal of the Jail Conference which, it may be presumed, is founded on the experience of officers well qualified to judge of the requirements of Native prisoners, there seems to be no doubt but that hard labour prisoners in Indian Jails require a diet containing less Carbon and Nitrogen than the amounts laid down by authorities as required by Europeans of average weight in moderate work. There thus appears to be a difference between Indian experience and European authorities.

If, however, the weight of Natives of India as compared with Europeans is taken into account, this apparent difference practically disappears, for taking the Bombay House of Correction diet, shown by experience to suffice for labouring prisoners averaging 105 lbs. in weight and raising its value in the proportion of 105 to 150, the quantities become Nitrogen 288 grains, Carbon 5,730 grains, quantities not greatly different from—1, Letheby's estimate for ordinary labour (Table IV., 3), viz., Nitrogen 307 grains, Carbon 5,688 grains, and 2, the value of the hard labour diet of English convicts (Table IV., 10), viz., Nitrogen 281 grains, Carbon 5,140 grains. The proportion 105 to 150 is employed, because, while the average weight of the prisoners discharged from the Bombay House of Correction in 1876 was on admission 105 lbs., the average weight of a European male adult is given by most authorities as 150 lbs.

There certainly appears to be no theoretical objection to the proposition that the quantity of food required by adults is proportionate to their weight; provided, of course, always that the quantity of work expected from them is likewise proportioned to their weight. In order, however, to place the three diet scales I now propose (see Tables V. to IX.) as much as possible on the basis of experience, I take as the foundation of the scales the experience of the Bombay House of Correction, viz., that Native prisoners, averaging 105 lbs. in weight, did well at Jail labour on a daily diet containing Nitrogen 201·6 grains, Carbon 4,011 grains. From this I derive the three proposed scales as follows :—

1. *Scale No.* 1.—The labour scale ;—is simply the Bombay House of Correction scale, raised and lowered proportionally to the weight of the individuals to be fed.

2. *Scale No.* 2.—The light labour scale ;—is Scale No. 1, reduced in the same proportion that the light labour diet of English convicts (Table IV., 12) is lower than English convict hard labour diet (Table IV., 10).

3. *Scale No.* 3.—The bare sustenance scale ;—is Scale No. 1, reduced in the same proportion that a mean between Edwin Smith's and Letheby's estimates for bare sustenance (Table IV., 16 and 17,) is lower than English convict hard labour diet (Table IV., 10).

On these three scales the quantities of Nitrogen and Carbon required daily by men averaging 105 lbs. in weight is in grains (Table V.) :—

	Nitrogen.	Carbon.
On Scale No. 1, Labour	201·6	4,011
On Scale No. 2, Light labour ...	173·6	3,528
On Scale No. 3, Bare sustenance ...	136·7	3,195

These quantities are represented respectively by the following weights in ounces (*a*) of jowari and pulse—(*b*) of bajri and pulse, *plus* in each case, half an ounce of fat :—

	Jowari.	Pulse.	Total.
(*a*)—Scale 1, Table VII., Columns 3 and 6	16·98	5·62	22·60
„ 2 „ VIII. „ „ ...	15·08	4·68	19·76
„ 3 „ IX. „ „ ...	15·23	2·56	17·79
	Bajri.	Pulse.	Total.
(*b*)—Scale 1, Table VII., Columns 3 and 9	18·60	4·00	22·60
„ 2 „ VIII. „ „ ...	16·50	3·26	19·76
„ 3 „ IX. „ „ ...	16·67	1·12	17·79

TABLE No. I.

Daily Allowance (exclusive of Salt and Condiments of certain Indian Jails).

(*a*)—*Bombay House of Correction—(for Labouring Prisoners).*

	Ounces.
Rice	8·0
Wheat	4·57
Bajri	3·43
Dhall	5·0
Vegetables	8·0
Fat	·5

On this diet 534 Native prisoners, all on hard labour, discharged during 1876, gained in weight on an average 1 lb. $10\frac{1}{4}$ oz. each. The average weight of the prisoners on admission was 7 stone 7 lbs. Of the 534 discharged during the year—

295 gained in weight on an average .. 4 lbs. 3 oz. each.
102 lost in weight on an average .. 3 lbs. 8 oz. each.
137 neither gained nor lost weight.

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Of these prisoners—

130 had been under 3 months in Jail.
89 had been over 3 and under 6 months in Jail.
127 had been over 6 and under 12 months in Jail.
71 had been over 12 and under 24 months in Jail.
27 had been over 2 years in Jail.

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The non-labour diet of the Common Jail, Bombay, is the same as the above less daily—

Wheat or Bajri	2 oz.
Dhall	1 oz.
Vegetables	2 oz.

Other Dietaries.

(*b*) Jails, Hyderabad Assigned Districts, labouring prisoners.

(*c*) New proposed scale for all Indian Jails do.

(*d*) Jails, Hyderabad Assigned Districts, non-labouring prisoners.

(*e*) Oudh Jails non-labouring prisoners.

Daily, exclusive of Salt and Condiments.	Cereals.	Pulses.	Vegetables.	Fatty Matter.
	Ounces.	Ounces.	Ounces.	Grains.
(*b*) Hyderabad Assigned Districts (labour)	20·7	4·8	3·4	192
(*c*) New Scale (labour) ...	20·0	4·0	6·0	218·75
(*d*) Hyderabad Assigned Districts (non-labour)... ...	16·3	4·5	3·4	144
(*e*) Oudh (non-labour) ...	17·5	1·5	5·5	90

Dr. Cruickshank, Inspector General of Prisons, Bombay, in forwarding the above scales, writes : " Please look at the diet scales of the Hyderabad Assigned Districts where the prisoners are very healthy."

TABLE No. II.

Factors employed in estimating the value of the various Dietaries, and in the construction of Tables VII., VIII., and IX.

(1)	Rice, Nitrogen, grains per oz.		... ...	5·07
(2)	Barley do.	(E. Smith)	...	5·81
(3)	Jowari do.	(Parkes)	...	5·97
(4)	Common Millet do.	(Parkes)	...	6·40
(5)	Maize do.	(mean)	...	6·93
(6)	Bajri do.	(Parkes)	...	7·00
(7)	Oatmeal do.	(Letheby)	...	8·70
(8)	Wheat do.	(mean)	...	9·22
(9)	Pulse do.	(mean)	...	17·86
(10)	Succulent vegetables, do.	(mean)	...	·70
(11)	Average Carbon of cereals and pulse, grains per oz.		... ...	170·0
(12)	Do. do. of succulent vegetables, grains per oz.		... ...	33·5
(13)	Carbon of fat, grains per oz.	(Parkes)	...	345·6

(*See* also Appendix.)

TABLE No. III.

Value in Nitrogen and Carbon of the Indian Dietaries enumerated in Table 1.

	Nitrogen Grains daily.	Carbon Grains daily.
(*a*) Bombay House of Correction (labour)	201·6	4,011
(*b*) Hyderabad Assigned District Jails (labour)	230·5	4,600
(*c*) New proposed Scale for all Indian Jails (labour)	213·2	4,454
(*d*) Bombay Common Jail (non-labour)	165·8	3,434
(*e*) Hyderabad Assigned District Jails (non-labour)	194·9	3,764
(*f*) Oudh Jails (non-labour) ...	151·2	3,485

The above values raised 3-7ths or in the proportion of 105 to 150.

(*a*) Bombay House of Correction (labour)	288	5,730
(*b*) Hyderabad Assigned District Jails (labour)	329	6,571
(*c*) New proposed Scale for Indian Jails (labour)	305	6,363
(*d*) Bombay Common Jail (non-labour)	237	4,906
(*e*) Hyderabad Assigned District Jails (non-labour)	278	5,377
(*f*) Oudh Jails (non-labour) ...	216	4,979

TABLE No. IV.

Daily Nitrogen and Carbon of European Dietaries.

	Nitrogen Grains daily.	Carbon Grains daily.
1.—Standard Diet (Moleschott) ...	316·5	4,862
2.— Do. (Parkes, Pavy, Church) ...	300	4,850
3.—Mean for ordinary labour (Letheby)	307	5,688
4.—Hard working labourers (Playfair)	389	6,086
5.—Active labourers do. ...	373	4,473
6.—Active labourers, Royal Engineers (Playfair)	350	6,504
7.—Moderate exercise (Playfair) ...	291	5,094
8.—English Soldier, Home Service (Playfair)	293	5,164
9.— Do. do. (Parkes).	266	4,718
English Government Convict Establishments.		
10.—(*a*) Hard labour ...	281	5,140
11.—(*b*) Industrial employment	256	4,766
12.—(*c*) Light labour ...	242	4,520
13.—Mean of English, Scotch, Welsh, and Irish farm labourers (E. Smith)	300	6,478
14—English farm labourers, lowest of the four (E. Smith)	228	5,810
15.—Low-fed operatives average (E. Smith)	214	4,881
16.—Bare sustenance diet (E. Smith).	200	4,300
17.— Do. (Letheby)..	181	3,888
18.— Do. (Playfair)..	161	3,103

Notes to Table IV.

1. For a male European adult of average height and

weight (5 feet 6 inches to 5 feet 10 inches and 140 to 160 lbs.) in moderate work.

2. Average weight (154 lbs., Church) and moderate work.

3. Mean calculated from researches of various physiologists for adult males.

5. Soldiers during war.

6. Calculated from amount of food consumed by 495 men of the Royal Engineers at work at Chatham.

7. Mean of English, French, Austrian, and Prussian soldiers during peace.

16. Average representing the daily diet of an adult man during periods of idleness.

17. Mean calculated from researches of various physiologists, representing the amount required by an adult man during idleness.

18. Mean of—diet of needle-women in London, certain prison dietaries, common dietary for convalescents, Edinburgh Infirmary, average diet during cotton famine of 1862 in Lancashire.

The three diet scales now given (see Tables V. to IX.) are calculated as follows :—

Diet Scale No. 1.—This is the Bombay House of Correction diet ([*a*] Tables I. and III.) raised and lowered in proportion to weight. The average weight of the prisoners on admission into the House of Correction being 105 lbs., Nitrogen 201·6 grains, Carbon 4,011 grains (the value in Nitrogen and Carbon of the House of Correction diet) is placed opposite the weight 105 lbs. For every 5 lbs. in weight over or under 105 lbs. $\frac{1}{21}$ of these quantities of Nitrogen or Carbon is added or deducted as the case may be. It will be observed that at weight 150 lbs. the quantities of Nitrogen and Carbon become respectively 288 and 5,730 grains. At 150 lbs., therefore, the Nitrogen is very slightly above the Nitrogen of the English convict hard labour diet (Table IV., 10), viz., 281 grains ; the Carbon, however, is considerably higher than the Carbon of the English convict hard labour diet, viz., 5,730, as compared with 5,140 grains, or 11·47 per cent. higher. Letheby's mean estimate for ordinary labour (Table IV., 3), viz., Nitrogen 307 grains, Carbon 5,688 grains, comes as regards Carbon very near diet Scale No. 1 at weight 150 lbs. The quantity of Nitrogen in Letheby's estimate, however, is higher, viz., 307, as compared with 288 grains.

Diet Scale No. 2.—This is (diet Scale No. 1) lowered in the same proportion as English convict light labour diet (Table IV., 12) is lower than English convict hard labour diet, *i.e.*, as 281 is to 242 for the Nitrogen and as 5,140 is to 4,520 for the Carbon. Lowered in this proportion, the quantities become—

At 105 lbs.,	Nitrogen	173·6 grains,	Carbon	3,528	grains.
At 150 lbs.,	,,	248·0 ,,	,,	5,039	,,

At 105 lbs., therefore, diet Scale No. 2 is very similar in value to the non-labour diet of the Common Jail, Bombay (Table III. [*d*]) and somewhat better than the Oudh Jails non-labour diet (Table III. [*f*] at 150 lbs. diet Scale No. 2 is better than the average diet of low-fed English operatives, as estimated by Edwin

Smith (Table IV., 15), it is of course also better than the light labour diet of English convict establishments in the same proportion that diet Scale No. 1 is better than the hard labour diet of the same establishments.

Diet Scale No. 3.—This is calculated as follows :—Of the three estimates for bare sustenance diet the mean of the two highest (Edwin Smith's and Letheby's Table IV., 16 and 17) is Nitrogen 190·5, Carbon 4,094 grains ; both these estimates are for average adult males. Playfair's estimate (Table IV., 18), which is considerably lower than the other two is excluded as it does not wholly refer to adult males. Raising this mean in the same proportion as diet Scale No. 1 at 150 lbs., exceeds English convict hard labour diet, the figures become Nitrogen 195·3 grains, Carbon 4,564 grains. These quantities placed opposite weight 150 lbs. form the foundation of diet Scale No. 3. For the other weights shown in the table, the quantities are proportionally reduced. Comparing diet Scale No. 3 with Playfair's estimate for bare sustenance (Table IV., 18), it will be seen that the Nitrogen of the scale does not run below Playfair's estimate until after weight 125 lbs. is reached, and, similarly, it is only when the weight runs below 105 lbs. that the amount of Carbon becomes lower than that given in Playfair's estimate.

TABLE No. V.

Showing the quantity of Nitrogen and Carbon required daily on each of three scales, viz. :—

Scale 1.—A labour scale—the Bombay House of Correction diet raised and lowered in proportion to weight.

Scale 2.—A light labour scale.—Scale No. 1 reduced in the same proportion that English convict light labour diet bears to English convict hard labour diet.

Scale 3.—A bare sustenance scale.—Scale No. 1 reduced in same proportion that a mean bare sustenance estimate for Europeans (mean of 16 and 17 Table IV.) bears to English convict hard labour diet.

Weight—lbs.	Scale No. 1 Daily.		Scale No. 2 Daily.		Scale No. 3 Daily.	
	Nitrogen Grains.	Carbon Grains.	Nitrogen Grains.	Carbon Grains.	Nitrogen Grains.	Carbon Grains.
80	153·6	3,056	132·3	2,688	104·2	2,434
85	163·2	3,247	140·5	2,856	110·7	2,586
90	172·8	3,438	148·8	3,024	117·2	2,739
95	182·4	3,629	157·0	3,192	123·7	2,891
100	192·0	3,820	165·3	3,360	130·2	3,043
105	201·6	4,011	173·6	3,528	136·7	3 195
110	211·2	4,202	181·9	3,696	143·2	3,347
115	220·8	4,393	190·2	3,864	149·7	3,499
120	230·4	4,584	198·4	4,032	156·3	3,652
125	240·0	4,775	206·7	4,200	162·8	3,804
130	249·6	4,966	214·9	4,368	169·3	3,956
135	259·2	5,157	223·2	4,536	175·8	4,108
140	268·8	5,348	231·5	4,704	182·3	4,260
145	278·4	5,539	239·8	4,872	188·8	4,412
150	288·0	5,730	248·0	5,039	195·3	4,564

TABLE No. VI.

Showing the total quantities of mixed Cereal and Pulse which, plus half an ounce of fat, are equivalent to the quantities of Nitrogen and Carbon shown in each of the three scales of Table V.

Weight—lbs.	Scale No. 1, Ounces Daily.	Scale No. 2, Ounces Daily.	Scale No. 3, Ounces Daily.
80	16·98	14·81	13·32
85	18·10	15·80	14·21
90	19·23	16·79	15·11
95	20·35	17·78	16·00
100	21·48	18·77	16·90
105	22·60	19·76	17·79
110	23·72	20·74	18·69
115	24·85	21·73	19·58
120	25·97	22·72	20·48
125	27·10	23·70	21·37
130	28·22	24·69	22·27
135	29·35	25·68	23·16
140	30·47	26·66	24·06
145	31·59	27·65	24·95
150	32·71	28·64	25·85

The three tables which now follow, viz., Tables VII., VIII., and IX., show in what proportions each of the eight cereals—rice, barley, jowari, common millet, bajri, maize, oats, and wheat—must respectively be mixed with pulse in order to furnish the quantities of Nitrogen and Carbon shown on each of the three scales of Table V.

In Tables VII., VIII., and IX. the first two columns give average weights of persons to be fed, and the third column the total quantity in ounces of mixed cereal and pulse which, *plus* half an ounce of fat, will furnish the necessary Carbon. The remaining eight columns, each headed by the name of a cereal, give the quantities in ounces, of the cereal which must be abstracted from the total quantity shown in column 3 and replaced (in order to furnish the required Nitrogen) by an equal weight of pulse. The examples at the end cf the tables show how they may be employed, all three tables are subject to the general remarks, following the examples.

TABLE No. VII.

Diet Scale No. I.—Labour Scale.

1.—For the weight shown in columns 1, 2, take the quantity (*plus* always half an ounce of fat) of mixed cereal and pulse shown in column 3.

2.—Opposite the quantities shown in column 3, under the name of each cereal, is a number representing the number of ounces of the quantity shown in column 3, which must consist of pulse, the remainder to consist of the cereal heading the column (see Examples).

Weight of Individuals to be Fed.			Ounces of Cereal to be replaced by Ounces of Pulse (average Nitrogen per oz. of Pulse 17·86 grains).							
1	2	3	4	5	6	7	8	9	10	11
Weight in lbs.	Weight in stones and lbs.	Ounces of Cereal and Pulse required + ½ an ounce of fat daily =(C÷170)—1.	Rice—Nitrogen per oz. 5·07 grains.	Barley—Nitrogen per oz. 5·81 grains.	Jowari—Nitrogen per oz. 5·97 grains.	Common Millet—Nitrogen per oz. 6·40 grains.	Maize—Nitrogen per oz. 6·93 grains.	Bajri—Nitrogen per oz. 7·00 grains.	Oatmeal—Nitrogen per oz. 8·70 grains.	Wheat—Nitrogen per oz. 9·22 grains.
80	5·10	16·98	5·28	4·56	4·39	3·92	3·29	3·20	·64	— ·35
85	6·1	18·10	5·59	4·82	4·64	4·13	3·46	3·36	·63	— ·43
90	6·6	19·23	5·89	5·07	4·88	4·34	3·62	3·52	·61	— ·52
95	6·11	20·35	6·20	5·33	5·13	4·55	3·79	3·68	·59	— ·61
100	7·2	21·48	6·50	5·58	5·37	4·76	3·95	3·84	·57	— ·70
105	7·7	22·60	6·[illegible]1	5·84	5·62	4·97	4·12	4·00	·55	— ·79
110	7·12	23·72	7·11	6·09	5·87	5·18	4·28	4·16	·53	— ·88
115	8·3	24·85	7·42	6·34	6·09	5·39	4·45	4·32	·50	— ·96
120	8·8	25·97	7·72	6·60	6·33	5·60	4·62	4·48	·48	— 1·05
125	8·13	27·10	8·03	6·85	6·58	5·81	4·78	4·64	·46	— 1·14
130	9·4	28·22	8·33	7·11	6·82	6·02	4·95	4·80	·44	— 1·22
135	9·9	29·35	8·64	7·36	7·07	6·23	5·11	4·96	·42	— 1·31
140	10·0	30·47	8·94	7·62	7·31	6·44	5·28	5·12	·40	— 1·40
145	10·5	31·59	9·25	7·[illegible]7	7·56	6·65	5·44	5·28	·38	— 1·49
150	10·10	32·71	9·55	8·13	7·80	6·86	5·61	5·44	·37	— 1·57

TABLE No. VIII.

Diet Scale No. II.—Light Labour Scale.

1.—For the weight shown in columns 1, 2, take the quantity (*plus* always half an ounce of fat) of mixed cereal and pulse shown in column 3.

2.—Opposite the quantities shown in column 3, under the name of each cereal is a number representing the number of ounces of the quantity shown in column 3, which must consist of pulse, the remainder to consist of the cereal heading the column.

Weight of Individuals to be Fed.			Ounces of Cereal to be replaced by Ounces of Pulse (average Nitrogen per oz. of Pulse 17·86 grains)							
1	2	3	4	5	6	7	8	9	10	11
Weight in lbs.	Weight in stones and lbs.	Ounces of Cereal and Pulse required + ½ an ounce of fat daily =C÷170—1.	Rice—Nitrogen per oz. 5·07 grains.	Barley—Nitrogen per oz. 5·81 grains.	Jowari—Nitrogen per oz. 5·97 grains.	Common Millet—Nitrogen per oz. 6·40 grains.	Maize—Nitrogen per oz. 6·93 grains.	Bajri—Nitrogen per oz. 7·00 grains.	Oatmeal—Nitrogen per oz. 8·70 grains.	Wheat—Nitrogen per oz. 9·22 grains.
80	5·10	14·81	4·47	3·84	3·69	3·27	2·71	2·63	·37	— ·49
85	6·1	15·80	4·72	4·04	3·88	3·44	2·84	2·75	·33	— ·60
90	6·6	16·79	4·97	4·25	4·08	3·61	2·97	2·88	·30	— ·70
95	6·11	17·78	5·22	4·46	4·28	3·78	3·10	3·00	·26	— ·79
100	7·2	18·77	5·47	4·67	4·48	3·95	3·23	3·13	·23	— ·88
105	7·7	19·76	5·72	4·88	4·68	4·12	3·36	3·26	·19	— ·97
110	7·12	20·74	5·97	5·09	4·88	4·29	3·49	3·38	·16	—1·07
115	8·3	21·73	6·23	5·30	5·08	4·46	3·62	3·51	·12	—1·17
120	8·8	22·72	6·48	5·51	5·28	4·63	3·75	3·63	·09	—1·27
125	8·13	23·70	6·73	5·72	5·48	4·80	3·88	3·75	·05	—1·37
130	9·4	24·69	6·98	5·93	5·68	4·97	4·01	3·88	·02	—1·46
135	9·9	25·68	7·23	6·14	5·88	5·14	4·14	4·00	—·02	—1·56
140	10·0	26·66	7·48	6·35	6·08	5·31	4·27	4·12	—·05	—1·66
145	10·5	27·65	7·73	6·56	6·28	5·48	4·40	4·24	—·08	—1·76
150	10·10	28·64	7·98	6·77	6·48	5·64	4·53	4·37	—·12	—1·86

TABLE No. IX.

Diet Scale No. III.—Bare Sustenance Scale.

1.—For the weight shown in columns 1, 2, take the quantity (*plus* always half an ounce of fat) of mixed cereal and pulse shown in column 3.

2.—Opposite the quantities shown in column 3, under the name of each cereal is a number representing the number of ounces of the quantity shown in column 3, which must consist of pulse, the remainder to consist of the cereal heading the column.

Weight of Individuals to be Fed.			Ounces of Cereal to be replaced by Ounces of Pulse (average Nitrogen per oz. of Pulse 17·86 grains.							
1	2	3	4	5	6	7	8	9	10	11
Weight in lbs.	Weight in stones and lbs.	Ounces of Cereal and Pulse required + ½ an ounce of fat daily = (C + 170)—1.	Rice—Nitrogen per oz. 5·07 grains.	Barley—Nitrogen per oz. 5·81 grains.	Jowari—Nitrogen per oz. 5·97 grains.	Common Millet—Nitrogen per oz. 6·40 grains.	Maize—Nitrogen per oz. 6·93 grains.	Bajri—Nitrogen per oz. 7·00 grains.	Oatmeal—Nitrogen per oz. 8·70 grains.	Wheat—Nitrogen per oz. 9·22 grains.
80	5·10	13·32	2·85	2·23	2·08	1·65	1·09	1·01	— 1·27	— 2·03
85	6·1	14·21	3·01	2·34	2·18	1·71	1·12	1·03	— 1·41	— 2·22
90	6·6	15·11	3·16	2·45	2·28	1·78	1·15	1·05	— 1·55	— 2·42
95	6·11	16·00	3·32	2·56	2·37	1·85	1·17	1·07	— 1·69	— 2·61
100	7·2	16·90	3·47	2·66	2·47	1·92	1·20	1·10	— 1·83	— 2·80
105	7·7	17·79	3·63	2·77	2·56	1·99	1·22	1·12	— 1·97	— 2·99
110	7·12	18·69	3·78	2·88	2·66	2·06	1·25	1·14	— 2·11	— 3·18
115	8·3	19·58	3·94	2·98	2·76	2·13	1·28	1·16	— 2·25	— 3·37
120	8·8	20·48	4·10	3·09	2·86	2·19	1·31	1·19	— 2·39	— 3·56
125	8·13	21·37	4·25	3·20	2·96	2·26	1·34	1·21	— 2·53	— 3·75
130	9·4	22·27	4·41	3·30	3·05	2·33	1·36	1·23	— 2·67	— 3·94
135	9·9	23·16	4·56	3·41	3·15	2·39	1·39	1·26	— 2·81	— 4·13
140	10·0	24·06	4·72	3·52	3·25	2·46	1·42	1·28	— 2·95	— 4·32
145	10·5	24·95	4·87	3·63	3·35	2·53	1·45	1·30	— 3·09	— 4·51
150	10·10	25·85	5·03	3·74	3·45	2·60	1·48	1·32	— 3·23	— 4·70

Examples illustrating the method of employing Tables VII., VIII., and IX.

Average weight of individuals to be fed, say 105 lbs. (=7 stone 7 lbs.), Table V. shows that —for this weight—the amount of Nitrogen and Carbon daily required is in grains—

	Nitrogen.	Carbon.
On Scale 1.—The labour scale............	201·6	4,011
On Scale 2.—Light labour scale	173·6	3,528
On Scale 3.—Bare sustenance scale	136·7	3,195

Table VI. shows that these quantities of Nitrogen and Carbon may be supplied by the following quantities of mixed cereal and pulse, *plus* half an ounce of fat, *e.g.*, ghee or oil, viz. :—

For Scale No. 1	22·60 ounces.
For Scale No. 2	19·76 „
For Scale No. 3	17·79 „

The proportions which the cereal and pulse should bear to one another in the 22·60 ounces required by Scale No. 1 are shown for each of 8 cereal grains in Table VII. Tables VIII. and IX. show similarly the proportions which the cereal and pulse should bear to one another in respectively the 19·76 ounces required on Scale 2 and the 17·79 ounces required on Scale 3.

One or two examples will serve to show how from the tables these proportions can be ascertained. Take, for example, the 22·60 ounces of cereal and pulse required for men averaging

105 lbs. in weight on Scale No. 1. A reference to Table VII. shows, opposite 105 lbs. in the column headed Rice (Column No. 4), the number 6·81, this means that if rice is the cereal given 6·81 ounces out of the 22·60 ounces of mixed cereal and pulse must consist of pulse and the remainder or 15·79 ounces of rice. These quantities, *plus* half an ounce of fat, will supply the amount of Nitrogen and Carbon required. The calculation may be proved by employing the factors given in Table II., thus—

Rice	15·79 × 5·07 =	Nitrogen grains 80·0
Pulse.........	6·81 × 17·86 =	do. 121·6
	22·60 oz. mixed rice and pulse =	201·6

Calculation for Carbon 22·60 × 17º = 3,842 grains
plus for half an ounce fat......... 172 ,,
= Total Carbon grains 4,015

or if instead of rice the cereal employed is bajri, in Column 9, Table VII., under bajri, opposite 105 lbs., is the number 4·00. Hence of the 22·60 ounces of mixed cereal and pulse (Column 3, Table VII.) 4·00 ounces must be pulse of bajri is the cereal used.

Proof.

Bajri.........	18·60 × 7·00 =	Nitrogen grains 130·20
Pulse.........	4·00 × 17·86 =	do. 71·44
	22·60 ounces mixed bajri and pulse =	201·64

Calculation for Carbon as in previous example.

Where as in Column 11, Tables VII., VIII., and IX., and in Column 10, Table IX., and the last portion of Column 10, Table VIII., the figures of the column are preceded by a *minus* sign no pulse need be employed ; the number of ounces of the cereal heading the column shown opposite the weight containing more than the required quantity of Nitrogen,—*e.g.*, the 22·60 oz. required on Scale 1, for men averaging 105 lbs. in weight, contain in the case of wheat 22·60 × 9·22 = 208·37 grains of Nitrogen, a quantity slightly in excess of that (201·6) required by the scale. These *minus* figures come into use when mixed cereals are employed, as will be seen by the following examples :—

1. Men, averaging 120 lbs., require on Scale 1 (see Table V.) Nitrogen 230·4 grains, Carbon 4,584 grains daily. The number of ounces of cereal and pulse necessary (see Table VI.) is 25·97. If the cereals available are rice and bajri in about equal proportions, the calculation becomes—

Rice	... 25·97 — 7·72 (see Table VII., Col. 4)	= 18·25 ÷ 2 =	9·12 oz
Bajri	... 25·97 — 4·48 (see Table VII., Col. 9)	= 21·49 ÷ 2 =	10·75 „
Pulse	... 7·72 + 4·48 = 12·20 ÷ 2	=	6·10 „

Proof.

Rice	... 9·12 × 5·07 =	Nitrogen grains	...	46·24
Bajri	... 10·75 × 7·00 =	do.	...	75·25
Pulse	... 6·10 × 17·86 =	do.	...	108·95
	25·97 oz. mixed cereals and pulse =		...	230·44

Calculation for Carbon 25·97 × 170 = 4,415 grains.
Plus for ½ an oz. fat ... ... 172 „

= Total Carbon... 4,587 „

2. If, however, the cereals to be used are rice and wheat, then the use of the *minus* figures under wheat is shown as follows:—

Rice	... 25·97 — 7·72 (see Table VII., Col. 4)	= 18·25 ÷ 2 = 9·12 oz.
Wheat	... 25·97 + 1·05 (see Table VII., Col. 11)	= 27·02 ÷ 2 = 13·51 „
Pulse	... 7·72 — 1·05	= 6·67 ÷ 2 = 3·34 „

Proof.

Rice ...	9·12 × 5·07 =	Nitrogen grains	... 46·24
Wheat...	13·51 × 9·22 =	do.	... 124·56
Pulse ...	3·34 × 17·86 =	do.	... 59·65
	25·97 oz. mixed cereals and pulse =		... 230·45

Calculation for Carbon as in previous example.

It will be observed that in this last example the *minus* figures of the wheat column are added to the wheat and deducted from the pulse, and are employed in fact in exactly the reverse way to that in which the figures unpreceded by a *minus* sign are employed.

General Remarks applicable to all three Scales.

1. It of course must be understood that the weights for which these scales are calculated are weights of individuals fairly nourished, not weights of individuals reduced by disease or famine below the normal.

2. The Tables VII., VIII., and IX. are based on the supposition that grains fairly clean and fairly free from husk are employed. Should this not be the case a proportionate allowance must be made. Taking all circumstances into consideration it seems to me that (save in very ex-

ceptional cases) an increase of 5 per cent. on the quantities of grain shown in the tables would fairly suffice as compensation for husk.

3. Where a cereal is so deficient in Nitrogen that a large proportion of it requires to be replaced by pulse, it is desirable to mix it with a more Nitrogenous cereal, so that a smaller quantity of pulse may suffice, *e.g.*, rice, especially on Scale 1, and in a less degree on Scale 2 (see Tables VII. and VIII., Column 4), may advantageously be mixed with wheat or bajri.

4. Where a cereal is so rich in Nitrogen that according to the tables little or no pulse is required to be mixed with it, no objection exists to replacing a larger proportion of it by pulse than is by the tables shown to be necessary, provided always that the total quantity of pulse given is kept within reasonable limits, say under 4 to 5 ounces.

5. If on any of the scales the quantity of fat given is raised from $\frac{1}{2}$ an ounce to 1 ounce, a withdrawal of $1\frac{1}{2}$ ounces of cereal and an addition of $\frac{1}{2}$ an ounce of pulse serves to compensate for the change.

Note in regard to the limits of error of the Tables.

It will be observed that the amount of Carbon required regulates the aggregate quantity of cereal and pulse, while the amount of Nitrogen required regulates the proportion which pulse ought to bear to cereal.

In calculating the value of the Bombay House of Correction diet, and in constructing Tables VI. to IX., all cereals and pulses have been assumed to contain 170 grains per ounce of Carbon.

The probable limits of error due to this assumption of a uniform Carbon value for all cereals and pulses may be stated as follows:—

It will be observed that the three scales of Tables V. to IX. are comparable (weight for weight) with certain European scales, viz.—

Scale No. 1 with English convict hard labour diet.

Scale No. 2 with English convict light labour diet.

Scale No. 3 with a mean bare sustenance estimate for male European adults.

And that as regards Carbon the three scales of the tables are just 11·5 per cent. richer than the corresponding European scales.

Now suppose that the cereals and pulse supplied to the Bombay House of Correction were exceptionally rich in Carbon and contained 175 instead of 170 grains of Carbon per ounce, then in order to keep up the correspondence of the three scales with the amended value of the Bombay House of Correction diet, the quantities of Carbon shown in

Table V. would have to be raised from 11·5 to 14·4 per cent. above the quantities of Carbon contained in the corresponding European scales.

Taking an extreme case the other way, suppose that in any particular instance the cereals and pulse available for food-supply happen to be so exceptionally poor in Carbon as to contain only 155 instead of 170 grains per ounce,—then the amounts of Carbon yielded by the quantities of cereal and pulse, laid down in the tables for the three scales, would only be 1·9 per cent. higher than the quantities contained in the corresponding European scales.

Hence, even with cereals and pulses exceptionally poor in Carbon, the quantities of cereal and pulse provided by the three scales would still yield 1·9 per cent. more Carbon than is contained in the corresponding European scales ;

Hence also, even with cereals and pulse exceptionally poor in Carbon, an increase of ten per cent. on the quantities laid down in Tables VI. to IX. would raise the Carbon value of the three scales to that shown in Table V. ;

Hence also, even supposing that the cereals and pulse supplied to the Bombay House of Correction were exceptionally rich in Carbon and the cereals and pulse available for food-supply happen to be exceptionally poor in Carbon, an increase of 12½ per cent. on the quantities of cereals and pulse, laid down in Tables VI. to IX., would bring the Carbon value of the three scales into correspondence with the Carbon value of the Bombay House of Correction diet, and would raise the Carbon value of the same scales to 14·4 per cent. above that of the corresponding European dietaries.

The possible Nitrogen error of the scales is more difficult to estimate. An error due to over-estimation of the quantity of Nitrogen in a cereal or pulse would be always, to some extent, met by any increase (as allowance for deficient Carbon, [see above]) of the aggregate quantity of cereal and pulse laid down in Table VI. Any *minus* Nitrogen error not met in this way must be met by increased replacement of pulse for cereal.

I. B. LYON, F.C.S., Surgeon,
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APPENDIX.

Data from which the Factors of Table II. have been derived.

Nitrogen of Cereals—Grains per Ounce.

A—Rice—

Calculated from Letheby	4·34
,, ,, Polson	4·96
,, ,, Poggiale	5·39
Rice supplied to a hospital in Bombay (Lyon)...	5·77

B—Barley—

Calculated from E. Smith	5·81
,, ,, Payen	7·68
,, ,, Fehling and Faisst...	8·14
,, ,, Polson	8·10
,, ,, Poggiale	5·39
,, ,, Mayer	7·85

C—Jowari—

Mean of three samples (Lyon)	7·01
Calculated from Parkes	5·97
,, ,, Church	5·65

D—Common Millet—

Panicum Miliaceum (free from bran) Parkes* ...	6·40

E—Bajri—

Calculated from Parkes (free from bran)	7·00

F—Maize—

Calculated from Letheby	7·66
,, ,, Polson (mean of four)	6·08
,, ,, Poggiale	6·84
,, ,, Mayer	6·62
,, ,, Payen...	7·44

G—Oats—

Oat-meal calculated from Letheby	8·70
Oats calculated from Fehling and Faisst mean ...	7·87
,, ,, ,, Poggiale mean	7·74
,, ,, ,, Mayer mean...	6·49

H—Wheat—

Parkes (wheat-flour)	7·60
Wheat calculated from Peligot	10·09
Wheat-flour ,, ,, Payen	9·98
,, ,, ,, Wanklyn	8·29
Wheat-flour from a hospital in Bombay (Lyon) ...	10·15

* Natchni—Eleusine Corocana (mean of three, Lyon) 6·47.

Nitrogen of Pulses.

Grains per Ounce.

Toor dhall (calculated from Forbes Watson)		... 15·31
Indian Pea	,,	... 17·09
Bhoot	,,	... 26·84
Cooltee	,,	... 16·08
Mussoor	,,	... 17·38
Gram	,, Parkes	... 15·69
Mulmunda (Gray)		... 16·76
Toor dhall from a hospital in Bombay (Lyon)		... 20·56
Ooreed (Lyon)...		... 18·29
Moog ,, ...		... 15·70
Mussoor ,, ...		... 16·28
Muthi ,, ...		... 19·73
Muth ,, ...		... 20·43
Gram ,, ...		... 14·00
Mean of all		... 17·86

Carbon—of Cereals and Pulses.

Grains per Ounce.

Rice—(Parkes)..	...176
,, (Lyon) from a hospital in Bombay...	...179·10
,, ,, mean of 4 samples	...171·09
Barley—calculated from Fehling and Faisst (Cellulose 10—11 per cent.)	...160·5
Barley—calculated from Church	...164·6
Jowari—Mean of 3 (Lyon)	...161·3
Millet—Free from bran (Parkes)	...183·16
,, "Free from husk" (Church) ...	...172·58
Maize—(Parkes)	...176
Oat-meal ,, ...	...172
Wheat-flour ,, ...	...169
,, (Lyon) from a hospital in Bombay	...177·4
Dhall (Toor) ,, ,,	...187·3
Muth ,, ...	...168·87
Gram ,, ...	...169·89
Moog ,, ...	...158·68

Nitrogen and Carbon of Succulent Vegetables.

Grains per Ounce.

Nitrogen—Potatoes (Parkes)	1
Carrots „	·4
Mean Nitrogen	·7
Carbon—Potatoes (Parkes)	49
Carrots „	18
Mean Carbon	33·5

Memorandum as to the Dynamic Value of the task exacted from Labourers on Relief Works.

(Published in Gazette of India of 9th June, 1877.)

Parkes (Manual of Hygiene, p. 389) states :—
" It would, therefore, seem certain that an " amount of work equal to 500 tons lifted one " foot is an extremely hard day's work, which, per- " haps, few men could continue to do. 400 tons " lifted a foot is a hard day's work, and 300 tons " lifted a foot is an average day's work for a " healthy strong adult."

" The Reverend Professor Haughton, M.D., " has shown that walking on a level surface is " equivalent to raising $\frac{1}{20}$ part of the weight " of the body through the distance walked. " * * * The formula is $\frac{(w + w') \times D}{20 \times 2240.}$., where W. is " the weight of the person, W.′ the weight car- " ried, D. the distance walked in feet, 20 the " co-efficient of traction, and 2,240 the number " of pounds in a ton, the result is the number of " tons raised one foot" (Parkes *loc cit*).

Taking 105 lbs. as the weight of a native labourer, and reducing Parkes' estimate of an average day's work in proportion to this weight as compared with 150 lbs. (the weight of an average male European adult), we have as 150 : 105 : : 300 : 210. 210 tons lifted a foot is, therefore, Parkes' estimate of an average day's work, reduced proportionally to weight.

Using Haughton's formula, we find that a man weighing 105 lbs. and carrying 10 lbs., walking on a level, does work equal to lifting 13·51 tons one foot for each mile walked; for (105 × 10) + 5280 ÷ 20 = 30,260 foot-pounds ÷ 2,240 = 13·509 foot tons.

Also 210 ÷ 13·51 = 15·55. Hence, a man weighing 105 lbs. and carrying 10 lbs. in walking on a level 15·55 miles, does work equal to raising 210 tons one foot, *i.e.*, an average day's work of 300 foot-tons reduced proportionally to his weight.

"The basis of the task system upon irrigation "works is that in ordinary times, when the lift "does not exceed 4 feet, and the lead does not "exceed 50 feet, 100 cubic feet of black or red "soil can be excavated and disposed of by one "man, one woman, and one child, and therefore "at the present time 75 cubic feet only is to be "exacted. * * * * I am therefore of opi-"nion that under the existing orders of Govern-"ment the present task set by Colonel Finch is "too high, and should be reduced to 75 cubic feet "for Public Works Department, and to 50 cubic "feet for Civil Agency Works."—(Colonel Merriman, R.E., Chief Engineer for Irrigation, Bombay. No. 1516, dated 5th March 1877, para. 3.)

Estimation of the Dynamic Value of a task of excavating and disposing of 75 cubic feet of black or red soil with a 4 foot lift and 50 feet head, the task demanded on Relief Works under Public Works superintendence from a man, woman, and child.

For the purpose of calculation, the above task may be stated something in the following way :—

1. Excavation and filling baskets, say 3 baskets to a cubic foot.

2. Lifting the baskets on to the heads of the carriers, say 5 feet 6 inches ; say 80 lbs. to the cubic foot ; allow 2 lbs. for weight of basket.

3. Carrying away the earth and returning with the empty baskets.

1. *Excavation and filling baskets.*—A rather low estimate of a day's work for an English labourer employed in excavating earth and filling wheel-barrows is 270 cubic feet. Taking the dynamic value of this to be 350 foot-tons, 75 cubic feet = 97·2 foot-tons.

2. *Lifting the baskets on to the heads of the carriers.*—86 × 75 × $5\frac{1}{2}$ = 35,745 foot-lbs. ÷ 2,240 = 15·84 foot-tons.

3. *Carrying.*—Take for this 75 × 3 = 225 trips. The work of each trip consists of *a*. 105 lbs. (weight of body) + 5 lbs. (for clothes and baskets) + 26·66 lbs. (= 80 ÷ 3 or weight of earth) lift-

ed 4 feet + 50 ÷ 20 (for lead) = total lift $6\frac{1}{2}$ feet = 136·66 lbs. × 6·5 feet = 888·3 foot lbs.; *b.* Return with empty basket 110 × 2·5 = 275 foot-lbs.—Hence 888·3 + 275 × 225 ÷ 2,240 = 116·85 foot-tons.

Hence, supposing the whole task to be done by a man weighing 105 lbs., its dynamic value is 97·2 + 15·84 + 116·85 = say 230 foot-tons. This, however, is the whole task demanded from a man, woman, and child. Taking the man's work at half of this, we have 115 foot-tons as the dynamic value of the day's work of a man weighing 105 lbs. employed on relief-works under Public Works superintendence.

Again, on relief-works under Civil Agency two-thirds only of the above task is required = $153\frac{1}{3}$ foot-tons for the whole task of a man, woman, and child; and taking, as before, half of this to be the proportion done by the man, we have $76\frac{2}{3}$ foot-tons as the dynamic value of the task demanded from men weighing 105 lbs. employed on relief-works under Civil Agency.

Hence, taking 210 foot-tons as an average day's work for a man weighing 105 lbs. (see *ante*), the task of 115 foot-tons demanded from a man (weight assumed as 105 lbs.) on relief-works under Public Works superintendence amounts only to 54·75 per cent. of an average day's work. Similarly, $76\frac{2}{3}$ foot-tons, the task demanded on relief-works under Civil Agency from a man (assumed weight 105 lbs.), amounts only to 36·6 per cent. of 210 foot-tons, *i.e.*, 36·6 per cent. of an average day's work.

Stated in another way :—it has already been shown that a man weighing 105 lbs. and carrying 10 lbs. walking on level ground does work = 13·51 foot-tons for every mile walked. Hence, as 115 ÷ 13·51 = 8·52, and as $76\frac{2}{3}$ ÷ 13·51 = 5·68, the task demanded from a man weighing 105 lbs. on relief-works under Public Works superintendence is just equal to the work which he would do in walking 8·52 miles on level ground carrying 10 lbs. Similarly, the work demanded from a man weighing 105 lbs. on relief-works under Civil Agency is just equivalent to the work which the same man would do in walking 5·68 miles on level ground, carrying 10 lbs.

To show now that natives of India are capable of doing work in proportion to their weight, reckoning 300 foot-tons as an average day's work for a man weighing 150 lbs., I cite the two following instances :—

1. An ordinary day's work for 12 palkee bearers is to carry a palkee down from Matheran to Narel and bring it back from Narel to Matheran with a person inside. The distance from Narel to Matheran is 7 miles ; the height of Matheran above Narel is 2,377 feet. One of the palkees

was found to weigh 195 lbs., and the average weight of the bearers was found to be 117 lbs. as they stood, say 115 lbs. + 2 lbs. for clothes. Taking the up-journey only, and supposing the individual inside the palkee to weigh 125 lbs., the load of each bearer = 195 + 125 ÷ 12 = 26·66 lbs; and 26·66 + 117 = 143·66 lbs., lift 2,377 feet; + for the 7 miles carried 5,280 × 7 ÷ 20 = 1,848 feet; 143·66 × (2,377 + 1,848) ÷ 2,240 = 270·96 foot-tons. The work, therefore, of the up-journey only = 270·96 foot-tons, considerably above 230 foot-tons, *i.e.*, 300 foot-tons reduced in the proportion 150 to 115.

2. The recognized load for a Narel coolie is 40 lbs. This, although brought up to the same height, is carried generally a part of the way by short cuts, reducing the distance walked to about 5 miles. Hence, 117 + 40 = 157 lbs. lifted 2,377 feet + for the 5 miles 5,280 × 5 ÷ 20 = 1,320 feet, and 157 × (2,377 + 1,320) ÷ 2,240 = 259 foot-tons. Taking no account of the walk back unloaded, this is also considerably above 230 foot-tons, *i.e.*, 300 foot-tons, reduced in the proportion 150 to 115.

In the course of a discussion which arose on the preceding memoranda—see *Gazette of India* of July 7 and Sept. 1, 1877—the following additional matter bearing on the subject appeared :—

1.

During 1876 (the year quoted) the rate of sickness and mortality in the Bombay House of Correction was as follows :—

Mortality.—Number of deaths 5, equal to 1·95 per cent. of the average daily number of prisoners.

Sickness.—Daily average sick from all diseases 4·6 per cent.

Total admissions into Hospital during the year for dysentery, diarrhœa, and Anæmia 18.

2.

During the siege of Paris the mobiles employed on severe duties in the trenches during the winter months received a daily diet containing only 12·5 grammes of Nitrogen (= 193 grs.) and 263 grammes Carbon (= 4,060 grains), and preserved generally a good state of health; their average weight was 138¾ lbs. Armand Gautres in citing this experience remarks that the generally accepted bare subsistence ration (0·2 grams. of Nitrogen and 4·202 grammes of Carbon per kilogramme of body weight equal to 1·4 grains Nitrogen and 29½ grains Carbon per lb. of body weight) would appear to be a little too liberal.—(Letter from Dr. Dymock, *Bombay Gazette,* 19th June 1877.)

3.

The Bombay relief kitchen ration during the Famine of 1877 and which, it is stated, proved sufficient, was as follows :—

Excluding special cases such as sick children and suckling mothers which receive special treatment—

A. For a man—

1. Three " breads," each containing 5 ounces of jowari-flour.

2. A pint of ragi gruel, containing 1½ ounces of ragi and salt.

3. Nine fluid ounces of dhall soup.

B. For a woman—

The same as for a man less 1 bread.

The dhall soup contained in 40 gallons 28 lbs. of dhall, 24 lbs. of jowari-flour, and salt and condiments, viz., massala, 4¼ lbs., tamarind 1 lb., turmeric 6 oz., and salt 3 lbs. = in nine fluid ounces to dhall ·63 oz. jowari-flour ·54 oz.

The ration " for a man " equalled, therefore, Nitrogen 113·6 grains, Carbon 3,004 grains, per diem.

4.

The " Dynamic value " in foot-tons of

the three scales proposed in the memorandum, page 65, is as shown in the following Table :—

Body weight in lbs.	Scale 1	Scale 2.	Scale 3.
80	2389	2107	1916
85	2536	2237	2033
90	2683	2367	2150
95	2830	2496	2268
100	2977	2625	2385
105	3124	2754	2502
110	3270	2883	2619
115	3417	3012	2737
120	3564	3141	2854
125	3711	3270	2971
130	3858	3399	3088
135	4004	3528	3206
140	4151	3657	3233
145	4298	3786	3440
150	4445	3915	3557

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