The Food and Feeding of Mine Native Labourers

by

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The following paper was read at a meeting of the Transvaal Mine Medical Officers' Association, on the 17th July, 1941.

This paper is in effect a report upon our investigations into the food and feeding of the Native labourers on a certain group of our mines, and an attempt to introduce a standard plan for controlling the diet and the costs thereof. But it is also presented in the hope that greater attention will be focused on diet, which is as important a factor in the health and happiness of the mine Native labourer as it is in the happiness of human beings at large.

It might well be asked at once: "Why attempt such standardization? Why interfere with a department of compound life which appears to be functioning smoothly and well? There is a Government minimum ration scale, below which no mine would dare to feed. Indeed, it is generally recognized that practically all mines give considerably more in certain items of foodstuffs than the scale demands, and, in addition, issue foodstuffs which do not appear on the scale at all for the sake of variation and better health. There is no evidence of gross malnutrition or of an undue number of deficiency diseases in the labour force of the mines." The answer is that such an immense advance in the science of dietetics has been made in the last few years, and there is such a growing certainty of the influence of correct feeding on health and efficiency, that it surely seems worth while applying that knowledge towards improving both the health and efficiency of the Native labourers, who are such an important cog in the mining industry's machine. Such a consideration is becoming increasingly important. As secondary industries develop and as more and more Native labour is required in those spheres, there will be, to some extent, a shortage of labour. The strain of such a shortage would be eased to a large degree by a comprehensive Government scheme to combat ill-health in the territories—a discussion which is not in the province of this paper—but in the meantime, it behoves us to conserve the health of the labour we get. In the forefront of methods for conservation is correct feeding. It is also common knowledge among us that there are considerable variations on the mines in the quantity and quality of food issued, and in the methods of preparation and cooking. An investigation into the reasons for such variations on our own mines, it was thought, would be enlightening. I would like to express my thanks and appreciation to the Resident Director of the New Consolidated Gold Fields, Limited, for his permission to disclose certain facts and figures which might have remained dark secrets in our own domestic archives, but without which the whole force and purpose of this paper would have been lost.

The plan we have evolved was—and is—never intended to be an unwarranted incursion by medical officers into the domain of compound management, which has for years past been genuinely interested and enthusiastic about the feeding of Natives. But when it is realized that the Mining Industry spends some £2,500,000 to

£3,000,000 per year on food for the labourers, and that the health of the force depends largely upon that food, then it is reasonable to say that the mine medical officers should take it upon themselves to provide the Industry with an assurance that the money is being wisely spent. By virtue of their training, the medical officers should be able—and should be called upon—to advise on and control the dietetic side of compound feeding; and immediately and automatically the economics of the subject will be thrust upon them. This they will quickly discover if they embark upon our plan or a similar one. If they set out to improve the diet, costs may be considerably increased, but there can be no real doubt that the improved health and the greater contentment of the labourers and the increased popularity of their mines will effect economies in other directions which will more than compensate.

Location of the Investigations.

The investigations started in June, 1938, on five mines of our group which were close together geographically and which were all in different stages of development. One was an old mine long established. Another had just begun to produce and the others were in various stages of shaft sinking and development. There were therefore completely different working conditions on all mines and Native labour was consequently sufficiently differentiated racially to show whether standard methods of feeding could be introduced to please all types. (The total force was between 15,000 and 16,000 including about 1,000 tropical Natives.)

Quantities and Costs.

The first investigations concerned factors affecting costs in compound feeding:—

(1) It was primarily necessary to know what types and quantities of foodstuffs were being used in our compounds, since our ordinary inspections revealed obvious differences. Indeed, there was something of an attitude between compounds of complete water-tight compartmenting. One compound appeared to know nothing of what another was doing in the way of feeding. Many analyses were made of the monthly returns of the consumption of foodstuffs on eleven different mines of our Group, in which are included the five mines which were the subject of our investigations. Table "A" is a typical example of these analyses. All showed that the variations were considerable and are only attributable to the difference in ideas of feeding held by the officials responsible.

TABLE "A."

ANALYSIS OF FOOD CONSUMED IN ONE MONTH PER 100 NATIVES OF STRENGTH ON 10 DIFFERENT MINES.

Mine Name.		Mine "A."	Mine "B"	Mine "C"	Mine "D."	Mine "E."	Mine "F."	Mine "G."	Mine "H."	Mine "I."	Mine "J."
ARTICLE OF DIET	Unit Used.										
Mealie Meal No. 4	Bags	26	18 } 24	23	23	25	23	28	20 } 20·16	22	36
,, ,, No. 1	,,	0	6 }	0	0	0	0	0	·16 }	0	0
Boer Meal	,,	½	½	0	0	0	0	0	0	0	0
Mealies Yellow	,,	½	0	0	0	0	0	2·7	0	2/3	1/40
Samp	lbs.	53	931	648	873	788	700	0	1,040	213	428
Rice	,,	123	130	108	35	114	90	15	8	6	125
Bread	,,	1,158	1,164	1,014	504	1,142	1,026	1,286	946	883	1,021
Beans, Kidney	,,	0	273	0	0	0	0	0	300	100	450
,, Kaffir	,,	0	0	263	279	322	190	363	0	210	0
,, Sugar	,,	67	0	0	0	0	0	0	300	150	275
Peas	,,	34	0	0	0	0	0	0	0	0	0
Meat Beef	,,	1,745	1,549	1,732	1,575	1,700	1,460	1,262	1,000	1,555	1,940
Offal	,,	0	381	240	209	267	324	74	100	304	562
Bones	,,	345	357	201	155	145	150	0	60	0	0
TOTAL MEAT	,,	2,090	2,287	2,173	1,939	2,212	1,934	1,336	1,160	1,859	2,502
Mutton	,,	0	4	0	0	0	0	0	0	0	46
Fat	,,	0	15	48	48	57	45	33	30	23	80
Monkey Nuts	,,	170	69	0	0	0	0	111	144	100	0
Black Pudding	,,	0	29	0	0	0	0	0	0	0	0
Fish	,,	0	72	0	0	0	0	0	170	20	0
Curry Powder	,,	7	3	2	1·6	4·5	1·8	0	1	3·8	4·4
Pepper	,,	6/8	3·5	1·9	2/3	2·1	1	0	1	0	2·6
Cocoa	,,	7	4·7	1·6	0	4·7	3·5	0	0	0	6·2
Coffee	,,	13	37	16	14	16	5·5	7	26	16	45
Tea	,,	0	3	1·5	0	0	0	0	0	0	6
Vegetables	,,	726	920	1,082	1,170	870	960	855	740	9070	2,717
Sugar, No. 2 Government	,,	285	396	410	285	322	281	60	250	187	575
Salt	,,	81	118	105	100	110	90	60	100	109	150
Malt	,,	923	368	140	250	280	113	117	290	383	833
Soya Bean Flour	,,	81	30	103	102	70	106	83	14	0	100

As a corollary of the variations shown in Table "A" a profound difference in the cost of foodstuffs might be expected. Table "B" shows the monthly cost of foodstuffs consumed per 1,000 of average strength in the first three months of 1939 for six of our producing mines. It is interesting to note the costs of Mines "C" and "E" which were already attempting the standardized control.

TABLE "B."

COMPARISON OF COSTS OF FOODSTUFFS CONSUMED PER 1,000 OF STRENGTH ON SIX PRODUCING MINES IN THE FIRST THREE MONTHS OF 1939.

Month.	"A."	"B."	MINES. "C."	MINES. "D."	"E."	"F."	Difference of:
January	£611	£624	£583	£518	£583	£543	£106 per 1000 between highest and lowest
February	£595	£564	£533	£500	£544	£518	£ 95 " " " "
March	£609	£596	£572	£466	£557	£530	£143 " " " "

Comparison of Costs between Mines.

(2) *Comparison of Feeding Costs.*—It is always necessary and desirable to have a reliable comparison between mines of feeding costs. In this group, the cost of food per shift fed was the comparative figure universally used, and is obtained by dividing the total costs of foodstuffs per month by the number of feeding shifts as returned by the compound for the period. A study of Table "C," however, shows that in computing the feeding shifts, compounds do not appear to have a uniform method. It might be thought—or hoped—that the total feeding shifts (returns by the compound) per month would bear some fairly constant relation to the total feeding shifts that might be expected for the average strength, i.e., product obtained by multiplying the average strength by the number of days in the month. The table shows the wide differences on all mines, which may be accounted for by the inclusion of an uncertain number of feeding shifts by some mines to allow for the feeding of visiting Natives, Natives remaining longer in the compound after discharge, etc., and their exclusion by others. Whatever the reason, it appears that the traditional figure of the cost per feeding shift is quite valueless as a means of comparison of costs between mines. It is even doubtful whether it is of any use on any one particular mine as an index of costs (*vide* difference column of mine E in Table "C.") In some ways it is as fallacious as that well-known figure the cost per patient per day in hospital as a means of comparison of costs between hospitals. Such cost may show remarkable fluctuations if the total costs remain steady but the patient days vary disproportionately. We are, nowadays, only interested in the cost of foodstuffs consumed per Native per month or per day as a means of comparison between mines, obtained by dividing the total cost of foodstuffs by the average strength per month or per day.

Waste Food.

In all compounds, waste of food was apparent. On certain days, chosen at random, weighing of waste food was carried out, and, as an example, I may cite the case of one compound of 4,000 Natives. Here the waste food of one day weighed 1½ tons (exclusive of bones). Assuming (and the assumption was made by actually weighing the food issued to various Natives) that the average Native can eat six to eight pounds of cooked food per day, the waste was enough to feed roughly another 400 Natives, i.e., 1/10th of the total strength. There is small wonder that the waste contractors went on their way rejoicing to feed the little pigs! Waste food indicates that either too much of particular items is being issued, or that the food is being badly cooked. In any case, both points were deemed worthy of investigation.

The Contracting for and Buying of Foodstuffs.

It can well be imagined how difficult—and certainly how expensive—the buying of foodstuffs can be if each individual mine insists on different quantities and qualities of foodstuffs. The acceptance by all mines of standard qualities and quantities eases the difficulties of the buying department and definitely results in economic buying.

Having now arrived at a clear conception of the variations in the quantities, qualities and costs of foodstuffs supplied in our compounds, it was suggested that some form of weekly return of foods consumed daily would not only indicate variations in cost but would also provide an idea of the daily diet of the Natives.

TABLE "C."

RELATION BETWEEN FEEDING SHIFTS PER MONTH RETURNED BY COMPOUND ("A") AND THE FEEDING SHIFTS FOR THE AVERAGE STRENGTH OBTAINED BY MULTIPLYING THE AVERAGE STRENGTH BY THE DAYS IN THE MONTH ("B").

Month.	Mine "A."				Mine "B."				Mine "C."				Mine "D."				Mine "E."			
	Average Strength	"A"	"B"	Difference between "A" and "B"	Average Strength	"A"	"B"	Difference between "A" and "B"	Average Strength	"A"	"B"	Difference between "A" and "B"	Average Strength	"A"	"B"	Difference between "A" and "B"	Average Strength	"A"	"B"	Difference between "A" and "B"
1938																				
January	6,737	208,340	208,847	*507*	7,852	245,828	243,412	2,416	7,335	221,392	227,385	*5,993*	4,233	131,222	131,223	*1*	4,887	163,023	151,497	11,526
February	7,083	197,463	198,324	*861*	8,215	231,532	230,020	1,512	7,367	200,180	206,276	*6,096*	4,499	122,092	125,972	*3,880*	5,485	153,793	153,580	213
March ..	7,288	224,891	225,928	*1,037*	8,335	259,088	258,385	703	7,922	238,328	245,582	*7,254*	4,827	150,004	149,637	367	5,926	192,154	183,706	8,448
April ..	7,380	220,298	221,400	*1,102*	8,564	258,246	256,920	1,326	7,758	226,800	232,740	*5,940*	4,994	149,626	149,820	*194*	6,502	192,590	195,060	*2,470*
May ..	7,600	234,221	235,600	*1,379*	8,767	272,018	271,777	241	7,668	231,777	237,708	*5,931*	5,153	153,863	159,743	*5,880*	6,150	188,854	190,650	*1,796*
June ..	7,778	232,120	233,340	*1,220*	8,771	263,473	263,130	343	7,538	220,522	226,140	*5,618*	5,217	156,042	156,510	*468*	5,707	171,362	171,210	152
July ..	7,876	241,476	244,156	*2,680*	8,588	266,694	266,228	466	7,459	225,346	231,229	*5,883*	5,147	158,330	159,557	*1,227*	5,935	190,107	183,985	6,122
August ..	7,752	237,866	240,312	*2,446*	8,521	265,533	264,151	1,382	7,520	227,062	233,120	*6,058*	5,164	160,108	160,084	24	6,116	188,577	189,596	*1,019*
Sept. ..	7,895	234,830	236,850	*2,020*	8,469	255,691	254,070	1,621	7,272	213,164	218,160	*4,996*	5,240	156,358	157,200	*842*	5,942	181,242	178,260	2,982
October	7,760	238,160	240,560	*2,400*	8,208	255,028	254,448	580	7,144	216,995	221,464	*4,469*	5,129	157,623	158,999	*1,376*	6,296	196,924	195,176	1,748
November	7,599	224,961	227,970	*3,009*	8,113	245,251	243,390	1,861	7,101	208,561	213,030	*4,469*	4,974	148,203	149,220	*1,017*	6,107	181,525	183,210	*1,685*
December	7,286	221,329	225,866	*4,537*	8,151	254,357	252,681	1,676	7,378	223,879	228,718	*4,839*	4,903	151,202	151,993	*791*	5,471	171,026	169,601	1,425

* Figures in italics are minus figures.

HOW THE STANDARDIZED PLAN WAS INTRODUCED AND DEVELOPED.

The Food Control Chart.

In July, 1938, a chart was devised to show the daily issues with a weekly summary of costs and quantities. It has since been modified to its present form (Appendix I). A few preliminary experiments were done to determine the cooked weights of fixed quantities of certain foodstuffs like beans, samp, mealie meal, and how much of the foods an average Native could eat per day. With this knowledge, and using the Government minimum ration scale, standard daily quantities per 100 Natives were laid down as a guide to the amounts required. At the same time an endeavour was made to provide a better balance in the diet by increasing the meat, fat and vegetable ration well above the minimum laid down, with the hope that the carbohydrate would be automatically reduced by the increased satiety value of the additions.

A set scale of rations (Appendix II) was agreed upon for indunas, clerks, Police, etc., by the compound managers, so that the rationed Natives of one mine would be no better or no worse off than those of another.

Variety in the diet was recommended as relief for monotony and the completed charts at the end of each week indicated at a glance to the controlling officer what daily variations had been introduced.

The information gained from the charts was discussed critically and constructively at a series of monthly meetings, at which the managers and the compound managers of the five mines were present. I would here like to pay tribute to the great enthusiasm and interest of all these officials. What success has attended this venture in reorganizing the diet and its control is due almost entirely to their efforts.

Within a very few months it was astonishing to find that all compounds had apparently succeeded in issuing quantities of foodstuffs that were more or less equal in quantity to the amounts set by the standard, and costs were closely comparable. But success had been gained too easily. Our confidence and satisfaction were rudely shaken in more senses than one by a letter from a Natal recruiter to the N.R.C., in which it was said that complaints had been made by returning Zulus that feeding in one of our compounds was hopelessly inadequate in certain items. This compound was apparently running very close to the standards set, judging by the returns. I am ever grateful for that letter. It contained much unwarranted criticism because the writer had no real conception of what we were trying to do—and bitterest pill of all, he even referred to me as Dr. McTosh !—but it also contained the germ of an idea that really put us upon the track of what I consider to be the fundamentally important consideration in compound feeding. He wrote : " Standardized rationing may be an excellent scheme, but one cannot bring about standardization of appetites, tastes and customs of Natives." These are wise and incontestable words as regards appetites in Natives or anybody else. It is impossible to lay down a ration scale, minimum or otherwise, when rations are being issued in the cooked form. The size of appetites varies enormously, and to ensure contentment one must allow hunger to be satisfied by giving as much of all foods as the Native feels he requires, with the exception of meat and beer, which, for obvious reasons, must be rationed. This important principle was adopted. It might be inferred that nonlimitation of most foods would produce an unlimited increase in the costs of feeding, but this is not so. Under the methods of issue now in vogue, the actual quantity of food used is in many instances below the standards set. (See Appendix I which shows the typical weekly return of a compound). A similar result was observed by Scrivener at Nkana who experimented with a system of " mess " feeding in which he actually allowed natives to help themselves to what food they required.

As regards tastes and customs, it behoves us of course, to pay great attention to them while endeavouring at the same time tactfully to overcome those which cause objections to the partaking of foods which we know the Natives ought to eat for the sake of health. It must be remembered that the mine populations are no longer " raw." They are becoming used to the strange ways of mine life and they are extraordinarily amenable even to dietary changes if tactfully and judiciously handled. And no one will deny that particular ingenuity must be employed to ensure that certain protective foods are taken daily, if we desire to conserve the health of our labour force. Therefore when initiating such a scheme as ours, there is no need to be unduly influenced by the knowing ones, who will shake lugubrious heads and prophesy universal riots if new-fangled ideas are introduced. Propaganda and talks on feeding are most valuable in reassuring the Natives and overcoming prejudices which, if allowed to stand, would be most detrimental to their health under the conditions of mine life and

work. A prescribed lecture on food and feeding should be read to all new Natives, defining the importance of the subject in the new surroundings. Leaflets on the same subject should be printed in different languages and be posted up in compound rooms. (Appendix III), is the English original of one form of lecture and leaflet used.

The Need for Proper Observations and Reliable Data.

It was, however, quite obvious, in view of these complaints, that although a standard method could be introduced, there were insidious dangers in the scheme if the standards were too rigidly observed without knowing exactly whether all appetites were satisfied. European observers were specially appointed to carry out studies which occupied practically the whole of five months. They started with observations on the breakfast meal.

Observations on the Breakfast Meal.

The most inconclusive evidence existed or could be obtained as to the number of Natives taking breakfast and what they liked for breakfast. In some of our compounds it was reported that 100 per cent. took stew and porridge; others said that 100 per cent. liked porridge, beans and samp. The questionnaire sent out by the Association of Mine Managers in 1938 (following Dr. Goldsmith's paper) on the subject of breakfast brought forth the same contradictory evidence, although it disclosed the fact that a breakfast of some sort was provided on all mines. Our observations showed that the reported figure of 100 per cent. taking breakfast was slightly exaggerated! It was actually nearer 30 per cent. to 40 per cent. on all mines.

After numerous experiments providing all sorts of breakfast menus—stews, soups, porridge, beans and samp, coffee, bread, sausage, lambalaza—and taking careful count of all Natives coming for the meal, there is no doubt in our minds that lambalaza supplemented by a certain amount of thick porridge, bread, coffee, cocoa or tea, is quite the most acceptable form of breakfast. Physiologically it certainly is a sound plan to provide a good carbohydrate meal before the hard manual labour of the shift, but the provision of lambalaza should not be regarded merely as an addition of so much more carbohydrate to a diet which already has such a great preponderance of that element. I do not think there is any scientific evidence as yet, but there can be no doubt that lambalaza, since it is a fermented grain porridge, contains a certain amount of the Vitamin " B " complex produced by yeasts, and possibly " C." There is conceivably too a greater food value in such fermented cereals, for the proteins fats and carbohydrates normally present in maize may be broken down into much more assimilable forms by fermentation. The " bacterial ennoblement " of food by fermentation or even putrefaction is a point in nutrition that has largely been lost sight of in these days of food refinement and purity. Our forefathers liked their meat somewhat " high," and perhaps there were good physiological reasons for their taste. The tables hereunder indicate, as an example of what was general, the findings in a small compound of Natives. Between the first and last observations, other forms of breakfast were tried, e.g., stew, soup, etc. We have now completely eliminated beans and samp from breakfast menus.

OBSERVATIONS ON THE BREAKFAST MEAL.

Number of boys at breakfast.	Breakfast consisted of	Dry weight and cost.	Left over.
Average strength 1,037			
Old Diet.	Pots :	Lbs.	Pots.
6 a.m. shift 280	7 Porridge	700 2 0 10	4
Incoming 220	3 Beans	225 0 16 3	1
	3 Samp	225 0 16 3	1
Total ... 500	1 Coffee	6 0 2 6	—
	Sugar	12 0 2 3	—
Total Cost		£3 18 1	
Average strength 1,051			
New Diet.			
6 a.m. shift 825	10 Lambalaza	180 0 10 6	—
Incoming 215	1½ Porridge	180 0 10 6	—
	½ Samp	35 0 2 7	—
Total 1,040	½ Beans	35 0 2 7	—
	3½ Cocoa	3½ 0 2 10	—
	Sugar	100 0 16 6	—
Total Cost		£2 5 6	

One point of technique and organization in the preparation and issue of the breakfast meal should here be stressed. Both lambalaza and the beverage should be adequately sweetened and should be prepared in sufficient time to cool down to a temperature at which they can be rapidly consumed. The average Native is abed to the last minute and is invariably in a hurry when getting his breakfast. If it is too hot to eat, he will either refuse it, throw it away, or store it.

The Midday and Evening Meals.

Here the observations pointed clearly to two facts :—

(*a*) There was a great difference in the preparation and types of foods in different compounds ;

(*b*) Methods of issuing and therefore quantities of issue varied greatly.

As regards (*a*) there is no need to detail in full all our observations. A few examples will suffice. Some mines used beef only. Others mixed beef and offal in the stew. Some curried and thickened the stews, and in others curry was not utilized at all. One had a predilection for kidney beans, others for sugar, and others for kaffir beans. There was no idea of the normal capacities of the pots or troughs, so that haphazard amounts of foodstuffs were put into each with the consequence that one pot might be full of thick meat and vegetable stew while others were singularly devoid of those satisfying attributes. To rectify these shortcomings, and to ensure uniformity of the quality of food in the pots, capacities of cooking pots were measured, and weighed quantities of food were introduced into each, based on the average number of Natives that could be fed from each pot. Standardized instructions (Appendix IV) for preparing and cooking foods were issued.

As regards (*b*), so haphazard and so variable were the amounts of food issued and the utensils used for issuing, that it was a common finding that many Natives coming off shift late at night found that one or another article of food was finished in the kitchens although the waste drums might be full of the missing article. Based on previously mentioned experiments to determine what amount of each cooked foodstuff the average Native could consume, we standardized the size of ladles and utensils (Appendix V), so that the quantity of food issued was almost minimal. But as each Native could have unlimited quantities of all foods except meat either by coming to the kitchen again or signifying his wish for more food at the time of issue, there were no complaints on the score of too little food. It can easily be imagined that in the early days of the introduction of these methods of issue, there was a great demand for second helpings, probably due to a belief in the Natives' mind that they might be missing something. But as they learned that they could always have as much food as they liked, it was surprising to find that all but a very few were satisfied with the initial helping. Every Native now receives all his food no matter at what time he comes off shift.

A direct result has been the elimination of waste to a bare minimum, so much so that waste contractors have now proposed that they be paid, instead of paying, for the removal of waste.

The Need for Careful European Supervision in Compound Kitchens.

The plan of feeding and control outlined may sound a little complicated, and so it is if it is not intelligently supervised. The kitchen overseer should be thoroughly instructed in his job. He should have some knowledge of food and cooking and sufficient mathematical knowledge to be able to compute the food quantities required and complete the food control sheets. He must conscientiously carry out the general instructions for the preparation of food, and he must be able to organize his kitchen staff that they readily conform to all directions laid down.

Native Cooks.

I think it is obvious that the Native cooks should be a specially selected staff, and specially trained for this work. This involves a consideration that their average rates of pay should be somewhat higher than the average rates of pay for surface labourers, but I think it is worth it if food is to be prepared and issued as our scheme demands. In our early investigations, we found that many cooks had been appointed without any sort of previous experience or training at all. Repeated medical examinations and blood tests should be carried out. Cooks should be taught to keep their bodies, their clothes and their kitchens clean. I suggest that uniforms and head coverings should be issued to, and worn by all Natives who work in the cookhouse and that the washing of hands before handling food should be encouraged by the provision of wash hand basins in the kitchen and meat rooms.

Daily Census of Meals.

There is one point in the organization of cooking and preparation of food which deserves serious attention. It must have struck you that compounds often prepare all the food for the day at the same time, with the consequence that the food for late comers is invariably stewed to a point where it is certainly not as valuable from the nutritional aspect as food cooked for a shorter time. This difficulty can be overcome. A daily progressive census of meals should be made hour by hour for, say, one or two months in each compound. The figures obtained may

be plotted graphically, e.g., if the period of observation is one month, there will be four superimposed graphs for Mondays, four for Tuesdays, and so on. A study of the graphs will show what maximum demand on the kitchen capacity may be expected at any hour on any day, providing, of course, that there is no radical change in the hours of shifts on the mines. In this way the preparation and cooking of food may be regulated to supply the demand each hour. Such regulation is especially necessary in the preparation and cooking of foodstuffs such as meat, vegetables, germinated beans where vitamins are destroyed after long heating.

THE EFFECT OF IMPROVED DIET ON GENERAL HEALTH AND CONTENTMENT OF MINE NATIVE LABOURERS.

When the control chart was devised it will be remembered that an endeavour was made to improve the balance of the diet by giving more meat, fat and vegetables in the daily diet than was usually given. Whole orange juice and soya bean flour were also added. A definite sugar ration was given. It was thought that the results of such improvements might be shown in—

(1) a significant decrease in the sickness morbidity rates,
(2) a decrease in the accident rate, since fit and well-fed labourers might be less prone to accidents than ill-fed and fatigued Natives,
(3) a significant decrease in the total short weights at the periodical weighings, and an all-round increase in the average gain in weight of the Natives,
(4) a substantial increase in the contentment of the Natives which might be indicated by the growing popularity of the mines,
(5) an all-round increase in the physical condition and therefore working efficiency of the Native labourers.

How far our expectations were fulfilled is shown below :—

(1) *Sickness Morbidity Rate.*—Table " D " is a comparison between the sickness morbidity rate per 1,000 for this group of labourers and the same rate for the rest of the Industry's Native labour force.

TABLE " D."

	1938	1939	1940
For the group (all Natives)	257	192	211
For the rest of the Industry	318	314	325

It will be agreed that there has been a significant decrease in 1939 and 1940, the two years in which the improved diet has been fully introduced. I believe the decrease is almost entirely due to the plan of feeding, since any other factors likely to influence the rates have not altered appreciably. Indeed, what alterations have occurred might have been expected to influence the rate unfavourably, because of the extending scope of operations and increasing depths in all the mines. An even more marked improvement is noted in the morbidity rate for " Tropicals."

TABLE " E."

MORBIDITY RATE PER 1,000 PER ANNUM OF TROPICAL NATIVES.

1938	1939	1940
590	376	361

This significant decrease may be due in part to the fact that Tropicals are becoming more acclimatized to their new conditions of working and living, but I am inclined to think that feeding has played its part. The morbidity rate for the group of labourers excluding Tropicals is shown in Table " F " and should be compared with the rate shown in Table " D." It appears that in this group at least, the " Tropicals " did not load the morbidity rate for all labourers as much as is usually thought.

TABLE " F."

MORBIDITY RATE FOR NATIVES OF THIS GROUP EXCLUSIVE OF " TROPICALS."

1938	1939	1940
236	185	205

(2) There has been a significant decrease in the accident morbidity rate shown in Table " G," which is probably due in part to the feeding, but more probably due to the measures which the mines themselves have taken to prevent accidents.

TABLE " G."

ACCIDENT MORBIDITY RATE FOR THIS GROUP OF NATIVES.

1938	1939	1940
260	250	210

(3) The assumption that there would be a significant decrease in the total " short weights " is shown to be correct in the table below. Unfortunately, the figures for 1940 were adversely affected by the new regulations regarding short-weights which were introduced in the first three months of 1940 and thereafter discarded, and are therefore useless for comparison.

TABLE " H."

	Total Strength.	Total Shortweights	Per-centage.
1938 ...	15,523	3,774	24·4
1939 ...	15,921	1,870	11·7

It was thought that weight and increase in weight might be used as an index of the effect of diets, and the weight cards taken at random of 1,000 Natives for 1938 and 1,000 Natives in 1939 were submitted for statistical analysis. The weight distribution curves show that there was a significant increase in the average weight of both groups ; although the average weight on discharge of the 1939 group was ·6 lbs. higher than the 1938 group, the result is not significant. One may merely infer that the Natives respond very quickly to any form of diet which is better than the one they receive at their homes. But individual weight and increase in weight may very well be used to classify the physical grades of Native labourers—one means of ensuring that Natives are allocated to tasks of which they are physically capable, and, therefore, one means of conserving labour. We have for a long time used such a classification method in which weight is roughly correlated with height and a visual assessment of muscular development. By this method, no actual index is obtained, but the labourers are roughly divided into grades A, B, C, and D. We are now experimenting with a sitting Pignet index—the result of which will be published later. It appears, however, that it might be well worth while to try out such an index as the Arms-Chest-Hips index or to devise one even more accurate for the sorting out of physical types and as a possible aid for the detection of disease.

Contentment of the Labourers and Popularity of the Mines.

Although the difference in underground working conditions on our various mines undoubtedly plays some part in the difference in popularity of those mines, I believe that food and feeding play an even greater part. It was a common experience in our early investigations to hear interrogated Natives say that such a mine was better than another, not because it was better ventilated underground or that working conditions were easier, but because the food was better and more plentiful, or because the beer and marewu were better in quality and quantity. And this, I believe, largely accounts for the variations disclosed in Table " A." There is a laudable ambition on the part of compound managers to increase the contentment of Natives, and the popularity of their mines as a field of labour. From the point of view of our group—and I believe it should apply equally to the Industry as a whole—there seemed no valid reason why one of our mines should be more popular than another because of differences in food issues, especially if it leads to completely haphazard expenditure. Differences in working conditions are in themselves sufficient handicaps for any mine to contend with in the free attraction of Native labour. Under present conditions of recruitment and allotment of labour, popularity is somewhat difficult to gauge, but the increase in the numbers of " old boys " returning to work on the same mines and increases in the number of " voluntary " Natives presenting themselves for work would be a fair index of popularity. Many factors would influence such increases, such as good bonus schemes, a heavy managerial hand on assault cases, sympathetic compound management and so on, but as important as any of these is feeding. Figures are shown below and there are strikingly significant increases in general.

PERCENTAGE OF VOLUNTARY ENGAGEMENTS.

	1938	1939	1940
Mine A	55·7	65	70·72
Mine B	40·7	47·3	44·52
Mine C	83·4	87	97·3
Mine D	All volu	ntary lab	our
	(shaft si	nking).	
Mine E	69·6	93·5	(Suspen-
		ded ope	rations).

PERCENTAGE OF " OLD BOYS " RETURNING FOR WORK. (ONE MINE ONLY WHERE ACCURATE RECORD HAS BEEN KEPT).

1938	1939	1940
No record	25·08	32·58

No significance can be attached to this increase in one year, but it might be an indication of a very real increase in popularity.

Increase in Physical Efficiency.

I am unable to give any reliable figures on this point at this stage, but I think it may be generally accepted as a scientific fact that physical efficiency depends largely on wise and adequate feeding. There is scope for immense research on the relation of diet to physical efficiency in the Native labourer.

The National Institute of Industrial Psychology has made observations on the effects of instituting rest pauses and mid-shift refresh-

ments in several industrial areas. The findings, in general, favour their introduction. Certain mines (Rand Mines Limited Group) have experimented with the issue of a sugar phosphate syrup to underground Native labourers, work which might well be followed up in view of the modern physiological theory of the part played by phosphates in the metabolism of sugars in the body. These are indications of the lines of experimental research which we might follow.

All our findings are the result purely of empirical work, trial and error on a mass of Natives, but they do suggest strongly that there is a great deal to be gained by the introduction of better control and balance of the diet of Natives.

The Importance of Correct Feeding.

Having said, earlier in this paper, that one aim of our scheme was to give a better " balanced " diet, I must admit that the word " balanced " is used with the utmost diffidence and with a full realization that there is a great deal more to be done before a dogmatic definition can be made about human requirements in feeding. Nutritional knowledge is, however, making rapid strides and no one can dispute the importance of the subject. You will have been struck by the almost frenzied efforts and research that are being made in the belligerent countries to utilize the readily available, simpler, foodstuffs. The healthier properly fed people will wield the lustier blows and vitamins will be mightier than the sword. But you are equally aware that the nutritionist may be a voice crying in the wilderness, for the average people find it difficult to adjust their tastes to the occasionally uninteresting foodstuffs recommended by the scientists. They don't like good brown bread full of wheat germ—it gives them dyspepsia. They dislike vegetables raw or semi-raw. Milk in the nude makes many positively shudder. Golden brown chips may be infinitely preferred to potatoes boiled in the jackets.

This perversity and ignorance can only be effectively and ideally countered by a steady policy of education and propaganda in correct feeding with, of course, a certain mixture of social reform in the matter of wages, housing, and so on. But it is a long-term policy, and one must recognize that conditions may demand immediate remedies. Our problem with the Native feeding is an immediate one. Their stay on the mines is relatively short, so that in order to build them up quickly, we have perforce so to utilize available foodstuffs that we get the maximum health value from them, and we must use tactics of disguising and bolstering the foods so that prejudice and ignorance will be outwitted. At the same time, however, it is necessary to educate the Natives steadily on what is good for them, so that in future contracts here they may be more amenable and so that they may spread the teaching amongst their brethren.

What is a Good Diet? In devising a diet-scale it is difficult, I reiterate, to be dogmatic about human food requirements, but it is a good safe plan to adopt what might be called the majority opinion of the experts. It is generally agreed that there are certain dietary essentials, of which a short résumé is given below.

Calories.—It is, perhaps, unnecessary to warn you that too much importance can be attached to the calorie value of a diet. If the number of calories in a diet were a real criterion of its value, then a daily diet of mealie meal and sugar would be ample, but you know the consumer would, in truth, soon be a very sick man. Widdowson, in one of her papers, quotes the example of two people of similar build and occupation on a fair mixed diet. One was overweight on 2,000 calories daily, while the other was underweight on 4,000 calories. Although there is this variation in individual calorie requirements, yet it is safe to assume that the requirements of the average manual worker would be of the order of 4,000 to 6,000 calories daily.

Proteins.—In past days it was thought that muscular work was performed at the expense of protein in muscle, and therefore rich protein diets were considered absolutely necessary to perform hard physical work. But a study of the nitrogen output in the urine and of the respiratory quotient before, during and after muscular work has led to the general conclusion that carbohydrate is the main source of muscular energy. But it is not the whole source, and fat may be used with almost the same facility by the muscles when the carbohydrate stores are no longer available. Even later evidence shows there may be some increase in the catabolism of protein during muscular work. In any case, proteins are generally considered a dietary essential, since they contain certain amino acids which the body cannot synthesize for itself. Proteins are usually differentiated into first class proteins, i.e., those which contain fair quantities of essential amino acids and which are mostly derived from animal sources, and second class proteins which, to a greater or lesser degree, lack some of the essential amino acids and which are derived from vegetable sources. It becomes obvious therefore that the total protein requirements of the body

are derived chiefly from meat and vegetable sources, but that it is somewhat essential that the quantities from meat should constitute a fair proportion of the total protein.

Fats.—Fats are regarded as essential because they provide a further source of energy, have a vitamin content and a Vitamin " B " sparing action, assist digestion, reduce the whole bulk of food eaten because they have a high satiety value. The Japanese, whose diet has a very low fat content, are martyrs to fermentative dyspepsia. It has long been known that fat can be synthesized in the body from carbohydrate (although the reverse process does not occur), but it has only been shown lately by laboratory workers that, in the rat at any rate, whose dietary requirements are so close to those of the human being, certain fatty acids present in fat—linoleic acid and linolenic acid—are absolutely essential for normal growth and maintenance of weight. On these grounds it would be wise to see that any diet-scale has a sufficiency of fats.

Carbohydrates.—Although the average Native diet on the mines is never likely to lack this essential, since so much mealie meal is consumed, it has never been adequately determined how much of the carbohydrate food is absorbed. Generally the mealie meal is coarsely ground and if in addition it is badly cooked, it is possible that much less carbohydrate is absorbed than the quantities in the diet would lead one to suppose. There is scope for a good deal of research on this point.

Mineral . Salts.—Salts of such minerals as calcium, iron, phosphorus, magnesium, sodium, etc., are present in practically all foods and all are regarded as dietary essentials. We have, however, no certain knowledge of the amounts of these mineral salts that are available or absorbable. We know the effects of deficiencies of some, e.g., iron deficiency anaemias and experimental rickets produced by low calcium and phosphorus intake combined with a Vitamin " D " deficiency. While the average Native's diet is admittedly low in calcium and the calcium-phosphorus ratio is more often 1 : 4, 5, 7 or 8 than 1 : 2 which is considered optimum, there is very little evidence of diseases due to calcium deficiency. The relative frequency of un-united fractures on our mines may, in part, be due to calcium deficiency, if the Wasserman cannot be seriously implicated.

Vitamins.—There is no need here to detail all the diseases which may result from deficiencies, nor to elaborate upon the less widely known vitamins such as " K " and " P." Doubtless, in years to come there will be a host of newly discovered ones, all proudly bearing a letter of the alphabet or a little numeral. There is no clear-cut picture of clinical effects caused by complete or partial deficiencies of any one, with the possible exception of Vitamins " B " and " C." We know little of action and interaction between the vitamins, or whether all depend for their efficiency upon a grand synergism. But what evidence we have goes to show that it is safer to have adequate supplies of all vitamins than risk disease by limiting the intake to minimal amounts.

How adequate or inadequate are the diets of mine Native labourers can only be determined in the broad sense by analyses of the daily diet and by comparing the analyses with others of diets generally considered by the experts to be necessary for the average human being. (Appendix VI) makes the comparisons.

The comparisons indicate at once how far we have progressed in the scientific feeding of our labour force and in what items there are still some glaring deficiencies. It might be profitable therefore to discuss in some detail the usual constituents of the mine Native's daily diet and consider the means of fortifying that diet.

Usual Articles of Diet.

Mealie Meal.—The usual grades supplied to compounds are Grades 3 and 4, both of which are coarsely ground and contain most of the maize germ. It is therefore a source, however small, of Vitamins " A," " B," and " E " and any tendency to use the more refined grades should be checked.

Meat.—The total daily ration per Native is about 9 ozs. for five days of the week, and 1 lb. of raw meat twice a week. Twice a week offal is used in place of beef. The Natives' craving for meat may be physiological. It certainly has a psychological value. We have instituted a good midday meal with beef stew on Sundays and it is as popular, if not more popular than the meal on weekdays. Whether this daily amount of animal protein is necessary is, of course, debatable. The vegetarian, full of the bloom of health, would probably dispute the necessity, but we have acted simply in an endeavour to raise the first class protein intake and to add to the contentment of the labourers.

In regard to offal, we use the small intestine with the mesentery with all its fat as well as the usual type. It would, of course, be tremendously advantageous to include the livers, which are a highly valuable source of Vitamin " A." Offal is very popular amongst all Natives.

With the exception of the raw meat issues, all the meat is stewed, but since Natives traditionally grill their meat, it has occurred to me that some form of grilling machinery might be devised and we are at present experimenting with a model. There is no doubt that grilled meat is more valuable nutritionally than stewed meat.

Beans.—We have gradually come to use no other beans than the humble kaffir bean. It has a food value almost as high as any other type and in addition is more easily germinable, and in that condition most palatable and a source of Vitamin " C." They can be bought ready " processed " and as such are free from husk, grit and weevils.

Mealies.—Samp mealies, although of very little real value are very popular and are used extensively. Yellow mealies would be much more valuable because of the pro-vitamin carotene content, but the Natives have a fairly general prejudice against them as being cattle feed. An endeavour should always be made to introduce a proportion into the daily diet.

Peanuts.—These are issued as an occasional variation and are well liked. They have a definite food value and help to increase the vegetable protein and fat content of the diet. (28 per cent. protein, 40 per cent. fat.) How much of their Vitamin " B " content is available after the Natives have roasted them is uncertain.

Bread.—Since bread is now made of whole meal and mealie meal, a valuable addition to the Vitamins " A," " B," and " E " content of the Native diet has been made, and because of this it seems rather essential that all labourers—surface as well as underground—should receive it. For our group we add 3 to 4 per cent. soya-bean flour to the meal, which does not detract from the taste and which certainly fortifies the food value of the bread.

Fish.—Unfortunately fish is not liked by all the Natives, but it should be provided for those who like it once or twice a week in lieu of beef. It has an almost equal food value. You are all aware of the enormous quantities of sardines bought by East-coasters and I am surprised that no industry has arisen to provide fish, ready cooked and impregnated with fish oil. Such a food would be invaluable not only to the mine labourer but to the poor in general in this country as it would contain large quantities of Vitamins " A " and " D." It is said that our oceans abound with small fish such as harders and sardines just waiting to be caught to serve such a purpose.

Sugar.—Our standard scale provides a daily ration of 2 ozs. of Government No. 2 sugar. Apart from the fact that the Natives like it immensely, there is, I think, sound evidence that it should be given to those who have to perform hard physical work. The researches of the Harvard Fatigue Laboratory and studies on marathon runners in Boston showed that those who took extra sugar before extra efforts were called for, even if their diet contained generous carbohydrate quantities, emerged from the tests in better physical shape than those who had not so sweetened themselves.

Rice.—Useful as a variant in the diet. Tropical Natives should have rice once a week at least, as they are accustomed to it, but we issue it to all Natives on the same day to eliminate any discrimination. The brown unhusked rice is valuable for its Vitamin " B " complex content.

Oranges.—Most mines issue these nowadays as a very useful adjunct in the fight against scurvy or the sub-scorbutic condition. I may be taken to task if I say that although florid scurvy is fairly rare, yet great numbers of our labour force are on the border line. Acting on the principle that it is safe to give more Vitamin " C " than a minimal quantity, we have gone a step further by issuing orange juice. A simple crushing machine has been made to crush the whole orange, skin, pips and pulp. The juice is issued fresh at the compound gate three times a week (2 to 3 ozs. per Native) and is adequately sweetened. It is much appreciated and contains a high amount of Vitamin " C." The average cost per Native for the juice is about 2s. a year, including sugar and labour. The pulped mass from the machine is made into marmalade in the compound kitchen and issued to the Natives, providing a popular extra and a small further dose of Vitamin " C."

Beverages.—Tea, coffee or cocoa are usually given. After a series of experiments, there is no doubt that tea is more popular than either of the other two. It is also a good deal cheaper than the others if made with infusers. Cocoa has small value because of its fat content. None can be highly regarded for their use as stimulants, but their chief value lies in the fact that they are useful vehicles for sugar.

Beer.—As you are perhaps aware, beer was first brewed and issued on the mines about 1910, with the specific purpose of controlling scurvy which was then rife. Since then it has become a traditional issue, or what one might almost term a contractual obligation. But it still serves

a very useful dietetic function in that it is a very appreciable source of Vitamin " B " complex and does contain some Vitamin " C." In the last two years, some very valuable work has been done investigating the whole process of the production of kaffir beer, but this will form the subject of a later paper.

Marewu.—Probably the most popular drink of all, and must contain, because it is a fermented grain drink, some Vitamin " B " and some " C." Made as suggested in Annexure VI, the mealie meal used is more digestible than it is in Marewu made in any other way, since the starch granules are broken up more completely.

Vegetables.—The vegetable ration in our standard diet is 7 ozs., including the tops which frequently contain more Vitamin " C " than do the roots themselves. Vegetables should be contracted for on a strict schedule which defines the percentage of different vegetables in the daily requirements (Appendix VII). Otherwise there is a great danger that the weights will be made up with too much pumpkin, which has little nutritive value. We urge that all vegetables and tops, with the exception of potatoes should be minced and cooked for not longer than one hour before issue. It is obvious in using our big type of pots that those served last will have lost much of the Vitamin " C " that it was intended they should have. However, the loss is not so great as was previously thought if the minced vegetable is put into stew which is actually boiling. On no account should they be put into cold water and brought to the boil, for between 30 and 40 degrees Cent. there is great enzymic destruction of Vitamin " C." It requires a little organization, too, to see that the vegetables are not minced hours before they are needed, because once again there is a big loss of Vitamin " C " by oxidation when vegetables have been cut or bruised. A consideration of the points raised here indicates that it might be advisable to use much smaller meat stew pots than is generally the case.

Soya Bean Flour.—The high food value of this product makes it an excellent addition to the diet. It cannot as yet be extensively used, as there is no great production in the country and most of it is imported and expensive. The flour has a most unpleasant bitter taste if not properly " treated," but treated flour has a sweet, nutty flavour and is most palatable. It is extremely rich in protein (40 per cent.) of as good quality as the protein of whole wheat. The fat content is about 20 per cent. which is considerably higher than ordinary beans and peas, but less than pea nuts. The flour therefore has a high calorific value, about 470 calories per 100 grams. The mineral salt content is valuable and the calcium is ·2 per cent. or 10 times as much as white flour, although there is no certainty about how much of this is available. Vitamin " B " is present in relatively large quantities, five international units in one gram of dried bean, which is a somewhat higher value than whole wheat. The Riboflavin content is also appreciable. It is apparent therefore that an ounce or so of this flour added to stews and breads provide a wonderful means of bolstering the diet and this flour should be considerably used. The supply may become adequate throughout this country if production is encouraged to meet what should be a huge internal market.

Fat.—It is our custom to add rendered beef fat to the samp and mealies. Such dripping has no vitamin value, but does add to the total fat intake. Further endeavours to utilize fat are made by splitting or crushing bones, especially the long ones. Some are boiled in the stews, and others in the samp and bean mixture.

Salt.—Salt is boiled in practically all the food, as well as being provided for the Natives to help themselves. There is a very big loss of body salt in the sweating of underground Natives, so that it is important to ensure some replacement by actually putting the salt into the food rather than by depending on the amount the Native will take voluntarily.

Mineral Salts.—Whilst the diet apparently supplies adequate amounts of mineral salts, there does appear to be a deficiency in Calcium salts. To increase the intake we have boiled split and crushed bones in strong vinegar solution and used the extract in stews.

Pepper and Curry are merely used to vary the monotony of the diet, and they should be used frequently, for the Native appreciates the change in tastes.

These then are the common articles of the mine Native labourer's diet. There is no doubt that in certain directions the diet could be still further fortified. Experimental work is going on now to produce cheap Vitamin " A " with " D," and to incorporate it in sweets or peanuts. In this way it would be invaluable.

I still am convinced that more Vitamin " C " should be ensured, especially in those months when it is impossible to give orange juice. Dried sweet peppers could be used which contain relatively enormous amounts of Vitamin " C." Dried vegetables of all sorts could be utilized

especially at the time of the year when vegetables are distinctly hard to get. Rich sources of Vitamin " B " complex are present in yeast, and most palatable meaty tasting extracts can be made. About the only certain source of the whole " B " complex is in Kaffir Beer and the amount might well be supplemented by other articles such as yeast preparations. Milk powder would be most valuable as a supplementary article of diet.

How much and how many of these additional foodstuffs could be incorporated into the diet scale of the mine Native labourer to his obvious advantage depends upon the cheapness of their production. It would be far from economic to bolster a diet, which is already very good, with expensive products however much one might desire to do so. But all the items discussed above should be cheap. The problem of providing good cheap food for people is not for the Mining Industry only. There are vast numbers in this country to whom the daily diet of the mine labourer would be a heaven-sent blessing. Properly planned production, control of prices and the encouragement of food industries would put good food within the reach of all.

In conclusion may I voice my thanks to Dr. F. W. Fox for his inspiring interest, help and advice given freely to me over some years, to Dr. T. W. B. Osborn for the compilation of the diet analyses and notes thereon, to the Bedaux Company of South Africa for advice and suggestions in the early stages of the scheme, and to all my colleagues and friends who directly or indirectly evinced interest in the matter and prodded me on to record a system for the control of the food and feeding of mine Native labourers. I hope it will be of some value to all employers of Native labour.

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Recipes.

Lambalaza : Is prepared as follows :—

(*a*) 22–30 lbs. mealie meal per 100 Natives is mixed with warm water (120°F.) to form a thick paste.

(*b*) This is left overnight to sour. 12/24 hours may be necessary. Initially the souring may be started by a little kaffir beer, but thereafter some of the initial mixture may be kept each day to start the new lot.

(*c*) When sour, the mixture is stirred into boiling water and the whole is brought up to 150 pints, i.e., $1\frac{1}{2}$ pints per Native.

(*d*) $1\frac{1}{8}$ oz. of sugar is added for each Native, that is 112 ozs. sugar.

(*e*) Boil sharply for 20–30 minutes. Result is a thin porridge slightly sour but quite sweet and much appreciated by all Natives.

Marewu is prepared as follows :—

(*a*) Mix mealie meal into a thin paste with water. Add this paste to boiling water and boil sharply for 20–30 minutes.

(*b*) When boiled allow to cool and between 70–75°F, add flour by sprinkling and stir in.

(*c*) Allow to stand. Fermentation begins almost at once and when ready the mixture is slightly gassy and has a thick foamy scum on top.

(*d*) Our best results come from a mixture which contains 1–$1\frac{1}{4}$ lbs. mealie meal to each gallon of marewu. The amount of flour used is variable from 5–15 lbs. to each 100 gallons of the mixture. Larger amounts of flour cause fermentation at faster rates.

Appendix I.

COMPOUND FOOD CONTROL RECORD.

FORM A.

NAME OF COMPOUND_____ WEEK ENDING _____

ARTICLE OF DIET.	Units.	STANDARD RATIONS. Per 100 Natives. Issue.	Issues per week.	Total per week.	Total Standard Quantities.	Unit Cost.	Total Standard Cost. £	ORDINARY NATIVES. QUANTITIES ISSUED. Strength Fed. 4,210	4,198	4,277	4,250	4,209	4,233	4,212
								Meals Taken. 10,641	8,979	10,389	9,940	9,203	11,049	10,303
								Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.
Meal—Lambalaza ...	Lbs.	22	7	154	6,520	0·73	19 16 8	1,260	1,080	900	900	1,080	900	900
Meal—Porridge ...	Lbs.	80	7	560	23,680	0·73	72 0 6	2,700	2,700	2,700	2,700	2,700	2,520	2,880
*Beans—Kidney, Sugar, Jugo	Lbs.	12½	4	50	2,115	1·69	14 17 10	500		500		500		500
Beans—Germinated ...	Lbs.	10	2	20	846	1·69	5 19 2		500		500		400	
Samp	Lbs.	25	6	150	6,345	0·87	23 0 0	1,000	1,000	1,000	1,000	1,000	800	1,000
Vegetables and Tops ...	Lbs.	44	5	220	9,310	0·54	20 18 11	1,925	1,925	1,936		1,860	1,861	
Beef Raw	Lbs.	100	2	200	8,280	3·25	112 2 6				4,165			4,115
Beef Stew/Fish ...	Lbs.	54	3	162	6,850	3·25	92 15 2	2,282	2,283			2,295		
Bones, Heels, Trotters	Lbs.	8	5	40	1,692	1·0	7 1 0	337	338	335		340	335	
Offal	Lbs.	54	2	108	4,570	1·8	34 5 6			2,265			2,275	
Fat, 1½ lb. Stew Days	Lbs.	1½	5	7·5	318	4·5	5 19 5	50	50	50		50	50	
3 lbs. Raw Meat Days		3	2	6	254	4·5	4 15 4				100			100
Sugar in Lambalaza ...		10	7	70	2,960	2·22	27 7 6	600	300	300	400	400	300	400
,, ,, Beverages ...	Lbs.	2½	7	17·5	740	2·22	6 16 10	100	100	100	100	100	100	100
,, ,, Marmalade ...														
Salt in Stew	Lbs.	1	5	5	212	0·3	5 4	40	40	40		40	40	
Salt Loose	Lbs.	3	7	21	888	0·3	1 2 2	60	60	60	300	60	60	300
Monkey Nuts	Lbs.	12½												
Soya Bean Flour ...	Lbs.	5	5	25	1,058	3·42	15 1 6	200	200	200		200	200	
Rice	Lbs.	20	1	20	846	2·36	8 6 5						800	
Coffee	Lbs.	1½	3	4·5	190	5·5	4 7 1		20		20		20	
Cocoa	Lbs.	2												
Tea	Lbs.	¾	4	3	127	16·5	8 14 7	6		6		6		6
Pepper	Ozs.	1	2	2	85	0·74	5 3		48			48		
Curry-Powder ...	Ozs.	3	3	9	381	0·74	1 3 6	128		128			128	
Vinegar	Pts.													
Marmalade	Lbs.	12½												
Oranges...	Orgs.	100												
Orange Juice (Whole)...	Pts.	15												
Bread	Lbs.	37½	6	225	9,518	1·4	55 10 5		1,047	1,239	1,155	1,138	1,106	1,105
						Drums of Waste		5	5	4	4	5	4	5

ACTUAL RATIONS. Total Quantity Issued.	Per 100 Natives.	Total Actual Cost. £	AVERAGE STRENGTH FED, 4,230
7,020	23·7	21 7 0	
18,900	63·8	57 9 9	
2,000	11·8	14 1 8	
1,400	16·6	9 17 2	
6,800	26·8	24 13 0	
9,507	45·0	21 7 10	
8,280	100·0	112 2 6	
6,860	54·1	92 17 11	
1,685	8·0	7 0 5	
4,540	53·7	34 1 0	
250	1·18	4 13 9	
200	2·36	3 15 0	
2,700	9·1	24 19 6	
700	2·36	6 9 6	
200	0·9½	5 0	
900	3·0½	1 2 6	
1,000	4·72	14 5 0	
800	18·9	7 17 4	
60	0·47	1 7 6	
24	0·1¼	1 13 0	
96	1·14	6 0	
384	3·03	1 3 8	
15 pts.			
6,790	26·8	39 12 2	

SPECIAL NATIVES. (Raw Rations). STRENGTH 150. Actual. Quantity.	Cost. £	MINE DETECTIVES. STRENGTH 50. Quantity.	Cost. £
1,440	4 7 6	360	1 1 10
400	2 16 4		
400	1 9 0		
850	1 18 3	150	6 3
1,400	18 19 2	200	2 14 2
500	4 12 6		
400	3 18 8		
150	3 8 9		
2,250	13 2 6	350	2 0 10
Value £	£54 12 8		£6 3 1

DRUMS (40 GALLON) OF WASTE PER DAY 4·6. TOTAL WASTE 32 DRUMS.

	Lbs. per 100 Gals.	Total Gals. Required.	Total Lbs. per week.	Unit Cost.	Total Standard Cost. £	Sunday.	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.	Total Lbs. Issued.	Lbs. per 100 Gallons.	Total Cost. £	Total Gallons.	Cost. £	Total Gallons.	Cost £
Beer		4,000				2,000			2,000										
Mealie Meal	121·5		4,860	0·73	14 15 8			2,160			2,700		4,860	121·5	14 15 8				
Malt	94·5		3,780	1·1	17 6 6			1,800			1,980		3,780	94·5	17 6 6				

BEER/GAL. ... ... 1·92d.
MAREWU/GAL. ... 0·95d.

Marewu		5,700				900	900	1,800			2,100								
Mealie Meal	120·0		6,840	0·73	20 16 1	1,080	1,080	2,160			2,520		6,840	120·0	20 16 1				
Flour	5·75		300	2·35	2 18 9	60	30	60		60	30	60	300	5·75	2 18 9				

TOTAL COSTS ... £598 9 7

£558 5 2

TOTAL ACTUAL COSTS, £558 5 2. TOTAL STANDARD COSTS £598 9 7. VARIATION FROM STANDARD (less) £40 4 5.

Compound Manager_____

Secretary _____

* Only Beans now used are Kaffir Beans and Jugo. Both germinate easily.

The Standard Quantities per 100 Natives are merely set as a guide to the official in charge of feeding to estimate the amounts of foodstuffs required each day. The total *standard* quantities and costs can only be estimated at the end of each week and serve as a comparison with the *actual* total quantities and costs. The standards refer only to the ordinary Natives and the quantities of food and the cost thereof issued to rationed Natives and Police are shown in separate columns.

The Estimation of the N° of Natives to be Fed Daily.—It is obvious that the nominal strength of the compound on any one day is not the strength to be fed, for there will be Natives in hospital, on leave, in gaol, numbers of new arrivals looking for work, numbers of discharged Natives who for one reason or another are staying on for a few days at the compound, rationed Natives who have already received their food and so on. After a long study, the following formula was evolved to estimate the number to be fed each day in the compound:

N° to be fed = (Nominal strength—(N° in hospital + N° on leave and in gaol + N° of rationed Natives who do not feed in the compound) + 2½ per cent. of this difference to allow for all possible exigencies mentioned above.

This figure is calculated each evening at 5 p.m. for the following day, when accurate weighed quantities of foodstuffs can be issued. It is hardly necessary to say that the total weekly quantities consumed should tally with the records of issue by the mine store.

Appendix II.

RATIONED NATIVES SCALE OF ALLOWANCES.

	SCALE—PER WEEK.									
	Bread 6 oz. loaves	Beef lbs.	Sugar lbs.	Coffee lbs.	M. Meal lbs.	Beans lbs.	Rice lbs.	Samp lbs.	Vegetables lbs.	Beer gals.
INDUNAS	36	10	3	1½	10	5	4	4	10	8
MARRIED NATIVES (all grades)	24	6	2	1	10	1½	2	1½	7	4
ALLOWANCE each child ...	6	1	½	—	2	1	½	1	2	—
SUB INDUNAS (single) ...	18	6	1	½	—	—	—	—	—	6
POLICE BOYS AND CLERKS (single)	12	4	1	½	—	—	—	—	—	4

BREAD is issued daily except Sundays.
BEEF is issued twice a week.
SUGAR is issued once a week.
COFFEE is issued once a week.
MEALIE MEAL is issued once a week.
BEANS are issued once a week.
RICE is issued once a week.
SAMP is issued once a week.
VEGETABLES are issued twice a week.
BEER is issued twice a week.

Appendix III.

FOOD.

When you come to the mines you have to work very hard, much harder than you have ever done before, and under very strange conditions. To do this, you must feed properly. A horse will have its hunger satisfied after hard work if it is given mealies and water because such foods produce a full-feeling in the stomach. But you know that such a horse will lose its strength if it does not get good grass to eat. Mealies, mealie meal, and marewu are pleasant foods to eat when you are hungry, but under mining conditions, your bodies will lose strength and vigour unless you eat the other foods provided. We know they are good for you. If they were not, we would not waste money in providing them for you. Such foods particularly are :—

(*a*) *Vegetables.*—You must not think of this food as "women's food." They contain much medicine to protect you from that disease called scurvy, which causes your bodies to ache with pain and your gums to bleed.

(*b*) *Beans.*—These are good foods, but they are even better when slightly sprouted. In this condition, they contain medicine to protect you from the same disease.

(*c*) *Oranges and Orange Juice.*—Oranges are good to eat, but the juice is even better. It will help you to recover much more quickly if you are sick or injured.

Therefore always take these foods even if they are strange to you. Remember you are working in a different manner on the mines, and it is very necessary to keep your bodies strong and well. These special foods are just as necessary as those to which you are accustomed.

Meat.—All men would like great quantities of meat to eat, but if this were allowed, you understand that soon there would be insufficient meat to feed all the people in this country. Therefore, in all compounds—in fact everywhere—meat is rationed. It is for this reason that the tickets are punched or marked. We must know how many have received their portion of meat so that none may go short. But if you are hungry, you may have as much as you like of all other sorts of foods whether your ticket is punched or not, but do not take more than you can eat and waste the food. If you are greedy and take more than you can eat, your brothers may go hungry. You will see the waste bins in front of your rooms. When they are full, it shows that food is being wasted, which is a wicked thing.

Complaints.—We wish to put right any grievances, which are just and true. Therefore, if you have a genuine complaint, make it at once to your police boy, induna, or compound official. To wait until you get home before making complaints is of no help to us who wish to put right any difficulties at once.

Appendix IV.

DIRECTIONS AND SUGGESTIONS FOR PREPARATION AND COOKING OF FOODSTUFFS.

Breakfast Meal.

Lambalaza is most popular amongst the Natives whatever their race or tribe. It should be adequately sweetened and cooked to the consistency of moderately thick gruel. The issue is usually 1½ pints per Native, and it should be cool enough to be eaten rapidly as the Native is, as a rule, in a hurry to go to work. Thick porridge may be issued in addition, but it is our experience that very small amounts are required. A few pots may be prepared and any left over is carried on to the midday meal.

Tea, *coffee* or *cocoa* should be issued daily. About ⅞ oz. of sugar is used to each pint.

Bread should be issued at breakfast time, and if possible to all labourers, whether surface or underground. This is especially advisable now that wholemeal is being used in the manufacture.

Midday and Evening Meal.

A certain small number of surface labourers return to compounds for a midday meal and their requirements can usually be met by giving mealie meal, lambalaza—if there is any over from breakfast—beans, samp and gravy. It is useful to have one or two pots of gravy made for the purpose. However, it is our finding that lambalaza is the most popular midday dish amongst the surface Natives.

The main feeding commences as soon as the underground labourers begin to return, and the compound kitchens should be opened immediately. Careful census of the numbers taking meals during each hour will give a reliable guide to the amounts of food that should be ready hour by hour.

Stews : In addition to the bi-weekly issue of raw meat (1 lb. per Native), it is suggested that there should be three beef stews and two offal stews per week. Meat for such stews should be cut into pieces of approximately uniform size. There is no greater cause of " grousing " than unequal issue of meat. It is also advisable not to mix beef and offal in stews, as again there may be discontented Natives who would have liked a piece of beef rather than offal. Bones should be split by band saws or crushed to expose the marrow. A few are boiled with the stews and some with the beans and samp to improve the taste and add valuable fat. The cutting of meat and splitting of bones require a little organization obviously, but it can be done. Weighed quantities of meat or offal should be put into pots according to the predetermined feeding capacity of each pot. The meat should be boiled at first with a small quantity of water which can be increased later. Salt should always be cooked in the stews. Weighed quantities of minced vegetables are added to the *boiling* stew about 20 minutes before the issuing commences. The contents of each pot should be emptied within an hour. Vegetables lose too much Vitamin " C " if heated for more than one hour, so that with care this should not happen. Stews should be varied in taste. " Treated " (i.e., without bitter principle) Soya bean flour with or without ground peanuts is useful for this purpose, as are curry and pepper. Flour should be occasionally used for thickening.

Offal is well liked and an excellent food, especially if the liver is included. Liver should be minced. We utilize the small intestine as well as the mesentery with all its fat. Do not allow " heads " to be included in the offal weight. Offal should be thoroughly washed before cooking and the vegetable trommels are excellent for this purpose. There is no excuse for the sickening stench in some kitchens when offal is being cooked, which is always due to improper cleansing. It should frequently be curried as a variation. Bones may be boiled with offal stews to increase the " meatiness " of the gravy.

Vegetables.

The vegetable contracts lay down specific quantities of each vegetable. It should be insisted upon that they are delivered in separate packages so that the percentage of each vegetable in the total weight may be known at any time. Pumpkins are frequently used to excess to bring up the total weight, but it is an almost useless food, being nearly 97 per cent. water. All vegetables, with the exception of potatoes, which should be steamed in the jacket, should be minced finely and the tops of turnips, leaks, etc., should be used and not thrown away. They are valuable as sources of Vitamin " C." It need not be said that the vegetables should be thoroughly washed. As mentioned above, weighed quantities to each pot must be used. The vegetables are put in the boiling pots 20 minutes before issue and the steam turned off. Each pot should be empty within an hour. The

stew must be constantly stirred while the issue is being made, so that the fine vegetables will be uniformly distributed and issued.

It is recommended that vegetables are always boiled in the meat stew. On raw meat days they can be mixed with beans and samp or in the gravy.

Beans.

The kaffir bean is by far the most useful and economical bean. It is as nutritious and tasty as any other and more easily germinated than the others. All kaffir beans should be germinated, for in this state they are an additional source of Vitamin " C " and are more digestible. Special trays can be made. The beans should be soaked for 24 hours and then germinated in the dark for a further 24 hours, so that a constant reserve should be prepared in the kitchen at least two days ahead of requirements. Kidney beans, sugar beans, etc., ought only to be used as occasional variations. Germinated beans take only about one-half of an hour to cook and should not be cooked longer than this. An excellent plan is to mix beans and samp, but obviously if this is done, the beans must be admixed about one-half of an hour before issue. It is a good practice to cook animal fat, i.e., dripping, with beans or bean-samp mixture, and a few cut bones add greatly to the flavour. Over-germination of beans causes sourness and should be avoided.

Samp (Crushed White Mealies).

Much liked by Natives, but often with mealie meal the source of the greater part of the wastage. If admixed with beans, the recommendations under beans should be observed. It is advisable to try to replace a certain proportion of samp by yellow mealies, which have a valuable pro-Vitamin " A " content.

Porridge (Thick).

Great care should be taken in the mixing of this. The optimum amount per pot can be estimated and no more should be mixed in the pot, otherwise it is likely to be undercooked and therefore wasted.

Rice.

The brown unhusked rice is the more valuable food. White rice is a very popular addition, too. It should be cooked with a minimum of water, about $1\frac{1}{2}$ pints to each pound and when cooked the steam should be turned off so that the grains separate. Soggy rice is unpalatable. Not every Native will eat rice, so that it should be given as an alternative to samp or beans.

Fish.

Stewed and issued as an alternative to meat for those Natives who like it. Vegetables should be added, especially leeks and onions.

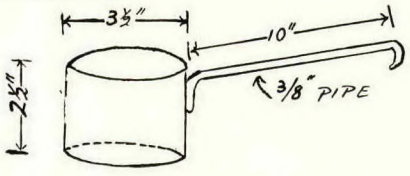
Addendum.

Tomatoes can and should be included in the vegetable issue, especially when there is a glut and they are cheap. They are an extremely useful form of Vitamin " C." They are not scheduled in our vegetable contracts because of the uncertainty of price and supply.

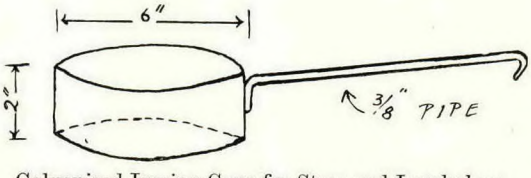
Important.

Care in preparing and cooking food is essential, badly cooked food is generally unpalatable, is therefore wasted, and leads to genuine grievances amongst the Natives.

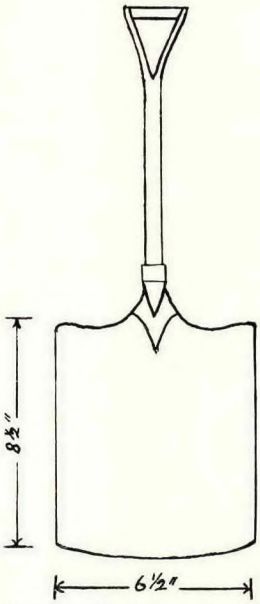
Appendix V.



Galvanised Iron " Bean Issuing Cups."



Galvanised Issuing Cups for Stew and Lambalaza.



Short-handled Shovel with Blade cut down for issuing " Porridge." (1 Helping = about $\frac{3}{4}$" thick).

Appendix VI.

ANALYSES.

STANDARD RATION SCALE FOR EXPERIMENTAL GROUP OF NATIVES.

Article of Diet.	Daily Allowance per Native in Grms.	Protein in Grms.	Fat in Grms.	Carbohydrate in MGrms.	Calcium in MGrms.	Phosphorus in MGrms.	Iron in MGrms.	Vitamin A I. Units.	Vitamin B I. Units.	Riboflavin in MGrms.	Nicotinic Acid in MGrms.	Vitamin C in MGrms.	Calories.
MEALIE MEAL in all foods including Beer and Marewu	801	73	32	580	162	1,400	32	160	160	1·2	8	0	2,840
WHOLEMEAL in BREAD	100	10	1	68	60	46	10	120	120	0	5	0	340
SOYA BEAN FLOUR	27	11	5	6	60	166	3	54	54	·1	1	0	435
BEANS	108	29	0	55·2	91	316	7	108	108	0	0	12	282
SAMP	112	8·8	·6	90	12·4	74	4·4	12	3	0	0	0	408
VEGETABLES (5 ounces)—													
Potatoes 30%	42		0	8	3·0			0	13		1	6	39
Carrots 20%	28		0	1·4	13·0			533	3			1·5	6
Turnips 5%	7		0	0	3·8			0	2		=2	1·5	1
Leeks, Onions 15%	21 =196	=2	0	1 =10·4	12·0 =100·3	= 62	= 3	0 =1,003	8 =68	= ·1	=1	1 =49	5 =62
Cabbage 20%	28	=4	0	0	8·5			250	13			4	3
Pumpkin 10%	14		0	0	5·0			30	1			1	2
VEGETABLE TOPS (2 ounces)	56	2	0	0	55			190	28			34	6
FAT (Dripping)	9	0	9	0	0	1	0	0	0	0	0	0	83
SUGAR	56	0	0	56	0	0	0	0	0	0	0	0	220
PEANUTS	8	2	4	1	5	21	0	0	16	0	1	0	44
RICE (unpolished)	13	1	0	11	1	12	0	0	5	0	0	0	50
ORANGE (Juice)	24	0	0	2	7	0	0	48	10	0	0	12	9
BEEF : Less 20 per cent. for Bone and Offal ...	250	50	50	0	13	500	15	0	75	·1	15	5	650
LIVER calculated as 10 per cent. by weight of total Offal	7	1	1	0	1		1	1400	8	·1	1	2	10
Totals	1711 =3 lbs. 14 oz.	189·8 Animal 51 Plant 138·5	102·6	879·6	512·7	2598	75·4	2905	627	1·6	33	80	5433

GOVERNMENT MINIMUM RATION SCALE.

MEALIE MEAL for all purposes 24 oz.+that used in Bread (2 oz.)	730	66	29	526	146	1274	29	146	146	1·1	7·3	0	2555
WHOLE MEAL in BREAD (6 oz.) taken at 64 per cent.	100	10	1	68	60	46	10	200	120	0	5	0	340
BEANS (3 oz.)	85	17	0	43	72	263	5	0	85	0	1	9	240
MEAT (about 5 oz. daily, excluding bone) ...	140	28	28	0	8	280	8·4	0	42	·1	8	3	364
PEANUTS (2 oz.)	56	17	27	5	5	147	1	0	112	·2	7	0	310
FRESH VEGETABLES (5 oz. daily)	140	2	0	10	47	2	1	620	38	·1	2	16	55
	1251	140 Animal 28 Plant 112	85	652	338	2012	54·4	966	543	1·5	30·3	28	3864

Appendix VI *(continued)*.

FOOD ANALYSES.

CONVERSION TABLES. — 1 ounce = 28·34 grms.

FOODSTUFFS.	Protein %	Fat %	Carbohydrate %	Calcium Mg. per 100 grms.	Phosphorus Mg. per 100 grms.	Iron Mgrm. per 100 grms.	Vitamin A I.U. per 100 grms.	Vitamin B_1 I.U. per 100 grms.	Riboflavin Mgrm. per 100 grms.	Nicotinic Acid Mgrms. per 100 grms.	Vitamin C Mgrms. per 100 grms.	Calories per 100 grms.
MEALIE MEAL	9	4	72	20	170	4	20	20	·15	1·0	0	350
WHOLE MEAL	10	1	68	60	100	10	200	120	·02	5·0	0	340
SOYA FLOUR	40	20	24	230	200	10	200	200	·30	5·0	0	435
BEANS (Germinated)	20	0	50	85	84	6	0	100	·05	1·0	10	280
VEGETABLES—												
Potatoes	1	0	20	7·5		1·0	0	30	·05	1·5	15	92
Carrots	0	0	5	48		·5	1900	10	·02	·5	5	25
Turnips	·7	0	2·3	55		·5	0	20	·04	·5	20	12
Leeks, Onions	1·8	0	5	60	32	2·0	0	40	·01	·5	5	26
Cabbage	1·1	0	1	30		·5	900	50	·04	·5	15	8
Pumpkin	0·6	0	3·4	39		·5	140	10	·05	·5	10	16
Vegetable Tops	2·7	0	·1	98		3·0	900	50	·04	·5	60	11
SAMP	8	1	88	11	66	4	11	2—3	0	0	0	360
FAT	0	100	0	0	11	0	0	0	0	0	0	920
SUGAR	0	0	100	0	0	0	0	0	0	0	0	410
PEANUTS	30	48	9	60	262	2	0	200	0·3	13	0	550
RICE (unpolished)	7	0	85	9	92	2	0	40	0·1	2·0	0	390
ORANGE JUICE	0	0	9	31	0	0	200	40	0	0	50	40
BEEF	20	20	0	5	200	6	0	30	·04	6·0	2·0	260
OFFAL, with Liver	16	8	0	8		14	20,000 (In Liver)	110	2·0	15·0	30	143

Appendix VI *(continued).*

COMPARISON OF DIETS.

		Diet (1) Health Institution.	*Diet* (2) Standard Allowance.	*Diet* (3) Government Minimum Ration Scale.	*Diet* (4) Standard Scale Experimental Group
Protein: Total	grms.	100	126	140	189·8
Animal	,,	50	78	28	51
Fat	,,	100	153	85	102·6
Carbohydrate	,,	300—500	507	652	879·6
Calories		4,500 (for very active man)	4061	3864	5433
Calcium	mgrms.	1,000	750	338	512·7
Phosphorus	,,	1,320	1740	2012	2598
Ca/P. Ratio		·76	·43	·16	·2
Iron	,,	15	32	54·4	75·4
Vitamin A.	I.U.	4000—6000	6990	966	2905
Vitamin B.	I.U.	800	460	543	627
B_1/Calorie Ratio		·15—·2	·10	·14	·11
Vitamin C.	mgrms.	30—60	88	28	80
Vitamin D.	I.U.	300—400?	85	—	—

Diet (1) Standard Allowance compiled by the Committee on Food and Nutrition, National Research Council of U.S.A.

Diet (2) Basic ration scale recommended for adult Europeans at Health Department's institutions. Drawn up by Medical Officers of Union Health Department in collaboration with Mary Higham.

Diet (3) Government Minimum Ration Scale, Native Labour Regulations Act of 1911 (as amended).

Diet (4) Standard Scale laid down as a guide for the experimental group of labourers.

ERRATA.

NOTE.—*Diet* (1) should read

Standard
Allowance

Diet (2) should read

Health
Institution.

Appendix VI (*continued*).

Notes on the Standard Ration Scale.

Total Calories appear very high, but there is a probability that the total may be very much less, since the largest amount is derived from coarse ground mealie meal, which may not be absorbed in a quantity equal to the amount given.

Protein.—Animal protein allowance is good and is equal to the standard allowance. Of the plant protein a very large amount is derived from the protein of maize, which in itself is a poor protein.

Fat is somewhat low in proportion to the carbohydrate, but for the reasons advanced above the carbohydrate total may not be so high as it now appears.

Calcium content is low on all standards. An attempt to increase it may be made by adding the extract of bones boiled in vinegar. Ordinary calcium carbonate which is cheap enough would probable be more effective.

Phosphorus.—Total is very high and is derived from mealie meal chiefly. How much of it is phytin phosphorus is uncertain.

Iron content is very high, but once again there is uncertainty as to how much is available.

Vitamins.—In considering these, there are some unknown factors. There are wide variations given for each foodstuff and there are few figures for South African foodstuffs, so that any estimations in a diet are to some extent only approximate. The daily requirements are not as yet well defined, and it is possible that larger amounts are required than normal because of the high calorie value of the diet. The Vitamin " A " is low and is derived mainly from liver, 1400 I.U. out of 2672. If the livers of every pluck were utilized, the weight of liver to the total weight of offal would be 20 per cent. and the amount of Vitamin " A " would be doubled. Yellow mealies in place of samp would increase the Vitamin " A."

Vitamin " B." At first sight the total amount appears high, but the estimates of requirements are rising. In America it is considered that 800 I.U. are the minimum requirements.

Riboflavin.—The amount now thought necessary is 2·2 to 3·3 for a very active man. More Soya bean, liver and peanuts would raise the amount in the diet.

Nicotinic Acid.—The amounts appear adequate in our standard diet. The whole " B " complex, however, is probably considerably increased by the consumption of Kaffir Beer, Marewu and Lambalaza.

Vitamin " C."—Much of the total in our diet is derived from vegetable tops and the addition of fresh lucerne would increase it still further. There is, however, an appreciable loss of the Vitamin by mincing and cooking, especially if both are done carelessly. Some further amounts are added by the germination of beans and the consumption of Kaffir Beer and Marewu.

Vitamin " D."—No figure is given for this, as our knowledge of Native requirements is uncertain. It is very probable that the diet is deficient in this vitamin, and that some could, with advantage, be added.

Notes on the Government Minimum Ration Scale.

This has been analysed as a minimum scale with the full realization that practically all mines issue foods in considerable excess of the quantities laid down. However, as a minimum scale it is extremely low by all accepted standards and might well be revised.

Appendix VII.

SCHEDULE FOR SUPPLY OF FRESH VEGETABLES FOR THE YEAR....., DELIVERED TO MINE COMPOUNDS.

POTATOES AND/OR SWEET POTATOES :	30 per cent. throughout the year.
ONIONS AND/OR LEEKS :	15 per cent. throughout the year.
CABBAGE AND/OR CAULIFLOWER :	20 per cent. throughout the year.
PUMPKINS :	10 per cent. January to August. From September to December when pumpkin is unobtainable add 5 per cent. Onions and 5 per cent. to Cabbage and Cauliflower.
CARROTS :	20 per cent. throughout the year.
TURNIPS, BEETROOT :	5 per cent. throughout the year.