A Study of Industrial Health amongst African Workers employed by The South African Rubber Manufacturing Co. Ltd., at Howick, Natal.

Being a thesis submitted to The Faculty of Medicine of the University of Cape Town for the degree of Doctor of Medicine

by

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GENERAL VIEW OF SOME OF
THE BUILDINGS AT SARMCOL

INTRODUCTION

In the latter half of 1956, the Management of The South African Rubber Manufacturing Company Limited (SARMCOL) initiated discussions about the general state of health of their African workers. Mr. W.Sage, the General Manager of Sarmcol, aware that deficiency diseases are common amongst Non-Europeans, and particularly common in Africans, was anxious to ascertain to what extent this applied in his own organisation, and how these conditions might affect efficiency and absenteeism.

Mr. D. de Cuevas, Chairman of the Company, suggested that I prepare a written report incorporating recommendations for improving the medical services at SARMCOL.

Mr. R.W.Lunn, C.B.E., the Chairman of the Leyland & Birmingham Rubber Company, England, parent Company of SARMCOL, who was present, showed particular interest in the subject and contributed valuable suggestions for a thorough study. It was decided to launch a specific and detailed investigation into the background, living conditions, nutritional state, general health, and family commitments of a sample of three hundred African employees of the Company. The results of this investigation are presented here.

The final writing of this thesis was completed in November 1962.

June 1963.

ACKNOWLEDGMENTS

To Mr. R.W. Lunn, C.B.E., for his constructive criticism, steady encouragement, helpful advice, loyal direction, and the invaluable references which he kindly made available.

To Mr. W. Sage, General Manager, of SARMCOL, for his constant interest, endless patience, helpful support, and for affording me the facilities for doing this investigation. To those members of his staff who have so ably and unselfishly assisted me in the completion of this work, I owe a very special debt of gratitude.

To Professor J.F. Brock, D.M., F.R.C.P., Professor of Medicine at the University of Cape Town, for the invaluable guidance I have obtained from reading certain of his publications, and for his courtesy in granting me an interview in Cape Town in August 1962.

To my wife, for her help in checking the calculations in the analysis of food eaten, and to my wife and daughter for their inspiration when the task on so many occasions seemed insuperable.

To the authors quoted in the Bibliography for the help I have derived from reading their work, and to Dr. F. Friedlander, M.R.C.P. for kindly reading the proofs.

To Mrs. G. Glickman and the librarians of the Medical Library, University of Cape Town, for making available so many of the works I have been able to study, along with the help of the excellent photostats supplied by the University Library.

Finally, to the Management of The South African Rubber Manufacturing Company Limited for granting me very assistance in completing this study, and for their permission to submit it as a thesis. The inadequacies found in this work are therefore entirely my own responsibility.

M.J.F.D.

Howick. June 1963.

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CHAPTER 1

THE DRIFT OF AFRICANS TO THE TOWNS

In all parts of the world where industry has commenced to overlay the life of elementary communities great stresses have arisen. The time taken to adjust those stresses has usually been long and filled with extreme difficulties for those engaging themselves in industry. In Western Europe and in North America which are the most highly industrialised regions in the world, the process of adjustment has achieved much but it is still proceeding.

In South Africa the difficulties are greatly exaggerated because natives with no experience beyond their tribal lives have been and are being drawn into industries which are already as highly developed as their counterparts in Europe and America. There is no period for the gradual development of these people. It is a shock translation from a familiar world to an entirely strange one. Great difficulties are inevitable.

The absorption of Africans into Industry started in a very small way. Work in industry was regarded as something of an adventure. It is important to remember that these men did not come in to work regularly. Many of the workers remained migratory workers, coming in from the Reserves, or from farms, to work for a few months to accumulate means in the form of money, to enable purchases to be made. The most important purchases were:

(a) Oxen;

(b) Cattle for "lobola";

(c) Cash for taxes;

(d) Food to tide over periods of famine caused by failure of crops, often caused by drought, hail or pestilence.

There were other much less substantial reasons too, such as the purchase of

(i) Attractive but valueless trinkets;

(ii) clothing;

(iii) musical instruments.

Problems began to arise immediately, however. Those who were least affected probably were those men who took their families with them and worked in agricultural activities under European farmers. In these cases tribal control responsibilities were replaced in some measure by the farmer. The families who live on the farm expect to be guided and cared for by the farmer. This is a far less violent change than the change from tribal life to the freedom and responsibilities falling upon a man earning a wage in industry. Rarely can this man make a completely successful change and in many cases he may go very badly astray. There are great contrasts between life on a European farm and life in a town supported by work in industry.

Translation from a rural to an industrial life poses tremendous problems, the chief of which were -

(a) Problems of protection from the elements, i.e. housing.

(b) Problems of nutrition.

(c) Problems of social discipline.

The Reserves now are no longer capable of supporting even the subsistence economy of their inhabitants. The economy of the Reserves was essentially pastoral. Every adult individual contributed to the raising of food. The men, traditionally did the ploughing in the spring, and helped in the building of the huts. The sowing, tilling and reaping was entirely the work of the women. This simple economy was suited to unrestricted shifting from place to place, or expansion by conquest. It is entirely unsuitable, however, for Reserves which are restricted in size, and overpopulated. The inevitable results are seen in soil erosion, overgrazing and general impoverishment. The sequel was that the men had to seek employment elsewhere.

Prior to the limitations imposed by residence in the Reserves, crops and lands were adequate and there was no compulsion or necessity to work. Allen[1] drew attention to the fact that under these conditions the Bantu lived an easy, lazy life, and that the diet was monotonous, but adequate. Essentially milk, meat and mealies formed the background to the diet, enhanced by wild fruits, berries, honey and sea foods in tribes living along the coast.

In 1957 Dr. van Eck, the Chairman of the Industrial Development Corporation, said "Even today our mining industry finds it necessary to import 62% of its Native labour from adjoining territories". Since then the pace has quickened and the needs of both mines and general industry have increased and continue to increase.

The result has been that an ever-increasing number of these African workers have become caught up by the process of absorption into industry - a process which, starting with a trickle, has been accelerated by the rate of industrial expansion to become a flood, overtaxing the capacity and resources of urban local authorities to accommodate and to control the flood. In every industrial centre, housing and administrative resources have been swamped by the influx of African industrial workers, many of whom have brought their families from the farms, while a few from the Reserves have brought their families to the urban or peri-urban areas. The majority of the men whose origins are in the Reserves, have left their families there, but no longer return for the seasonal work, which is now largely left to women, children and old men, resulting in further deterioration of the land and greater dependence upon wages earned in industry. Whereas formerly labour was migratory and remained attached to the rural set-up and tribal system, or to the labour-tenant contracts on farms, today the accent is on complete urbanisation. Housing, however, is invariably inadequate, hence the growth of slum belts. As pressure within the Reserves gradually forced men to seek employment, the tribal laws were inevitably relaxed. Family life has deteriorated and all the traditional bonds are loosened.

The plight of the old people comes to ones notice almost daily. In the tribal society the old men were honoured members of the "ibandhla" or Council of Elders. Their judgments were respected and valued. They also remained the heads of their families. The older women in turn were responsible for the upbringing and behaviour of the children. They passed on the folk lore, knowledge of tribal customs and taboos, maintained the tradition of the tribe. Sons, when they married, built their huts in the ancestral kraal and remained subject to the authority of the kraal-head. Inevitably, a scattering of this patriarchal type of family has occurred. Despite this, many Africans still consider themselves bound by the authority of the kraal-head, and are reluctant to make decisions without prior consultation. It is, however, not obligatory for a man to remain under the authority of the kraal-head, and as a result a steady drift of young men to the towns occurs, followed in turn by their families. The normal contributions in kind and in cash are then forgotten, and many of the elders abandoned by their kraal inmates, eke out the remainder of their lives on the Government Old Age Pension of £2 a month. This has resulted in a steep rise in the number of cases of pellagra in old people, seen at one's surgery.

That many Africans in the townships do recognise the tribal authority, is to their credit. In general, these more conservative elements have been able to preserve the concept of the family, and have been able to meet the stresses and strains of urban life without moral and social disintegration so commonly seen in others. Where the traditional authority is replaced by an emancipation into a society whose standards and values are not comprehended, disaster invariably follows.

Thus, the urbanised African is in a transitional phase. It is clear that the simple tribal laws could have no place in an overcrowded, urbanised environment. Other values must be found to replace the advice of the elders. To this end, all educational programmes are of value. Religion helps in producing stability and balanced behaviour. Advice in the use of money, clubs for young people, the teaching of parental responsibility and easing the burden of poverty, should all have their place. The restoration of a normal family life is considered very important. This would help too in the great problem of illegitimacy, infants cared for by indifferent older women, and the problem of kwashiorkor and other results of malnutrition. What is still urgently needed is an extension of the positive educational programme for those remaining in the Reserves. Controlled farming, crop rotation, the use of fertilisers, contour ploughing and the value of irrigation; all have their part to play. The essence of the matter is that farming must become much more productive and efficient. This sets enormous problems but the problems set by the conditions which arise out of industrial development are even more complex. Our study of nutrition in one factory presents one face of the problem.

REFERENCE:

(1) Allen F.: Observations on the state of nutrition in South Africa. Leech, Dec. 1946.

CHAPTER 2

AN ANALYSIS OF HOUSING AND LIVING CONDITIONS

Dr. Albert Schweitzer has stated that changes affecting the African need to be made gradually, otherwise harm will result.[1] "Schweitzer learned early that when the white man destroys and discredits the African way of life, he is in danger of destroying the African's whole reason for existence. Only with the greatest gentleness and tact can the African be led into the strange pathways of modern civilisation."

Natives who enter Industry from the Reserves are beset by conditions which are entirely foreign to their accepted experience of life. There appears to be very little guidance given in how to meet these new problems. In the Reserves life tends to be easy. They are friendly, sociable people to whom conversation is the breath of life. Family ties are very strong, and revolve around a simple patriarchal system, where no decisions are taken without consultation with the family head. There is a pleasant lack of responsibility and an absence of ambition. There are no material standards of comparison. Wealth revolves around cattle, which is essentially a simple system of social wealth.

When the African moves into an Industrial environment and lives in an urban area, three main problems tend to appear, i.e.

(i) Housing:
(ii) Feeding:
(iii) Social discipline.

Transport from his home to work can also constitute a considerable problem, and an expense.

1. Housing:

This is no problem in the tribe - another hut is built when the demand makes this desirable. In an urban community, particularly in the slum areas, an irregular, non-permanent type of housing is resorted to. This is referred to under the section on the Local Health Commission. Three areas in which our workers live will be discussed.

(i) Saracol Compound:

The first of the three main residential groups is the Factory Compound, which accommodates 240 men in 30 rooms, each 12' x 20' x 10', giving 30 sq. ft. of floor space and more than 300 cubic feet per occupant. The rooms are not ceiled, hence the hip-roof gives an additional 90 cubic feet of air-space. These figures comply with the requirements of the Native Labour Regulation Act of 1911 and amendments up to June 1952. Eighteen men occupy 9 rooms, each 10' x 10' x 9', two in each room, and one has a room to himself, making a total of 259 men in the Compound. The Compound is situated in shady pleasant grounds near the works.

The buildings are surrounded by lawns which are kept tidy by the Company. There are 4 main accommodation blocks. These buildings are long, low buildings with red-brick walls and neat painted corrugated iron roofs. In three buildings there are 10 rooms, and each room houses 8 men. Most of the rooms are provided with 2 rails running longitudinally down the centre of the room. These rails provide the foot support for bedding boards. The heads of these beds are supported on a shelf built out from the wall.

The remaining building also consists of 10 rooms, but the rooms are smaller, and there are only 2 men in most of the rooms. Here the beds are iron divans. Mattresses are home made, and cover many styles and shapes. Blankets were issued by the Company at one time, but now each man provides his own.

In general, the rooms are neat, but congested. There are no proper wardrobes, but many men have fashioned rough boxes for their belongings which are kept locked. Horse saddles and bicycles are hung from the ceilings of the rooms. Cooking pots litter the floor, and dried meat is hung from hooks in the wall. The boards used for cutting meat and vegetables present a greasy, rather unpleasant appearance. There seems to be considerable reluctance to washing these boards.

Each building is separated from an open kitchen by a concrete path. Methods of cooking are discussed later, under the heading "Feeding".

View of one of the Compound Buildings.

Interior of one room in Compound.
Note bicycles, home-made cupboards and type of bed.

Interior of a different type of Compound Room.
Double-decker beds are provided.

When the men are not working, they are free to move as they please. They visit the Beer Hall run by the Local Authority, the shops in Howick, and visit their friends. They also travel a lot, and in this way maintain contact with their families in the Reserves. A sample group of men studied, provided the following information. Of 100 originally investigated, 89 were still participating in the scheme when these notes were made. Of these 86 are married, 9 having two wives, and one having three wives. One single man and seven married men may be classified as urbanised, five of them having been born in urban areas, and still have their families living in towns, and three have become urbanised by family domicile in peri-urban townships under the administration of the Local Health Commission. A discussion of the movement of the workers from their homes in areas near Howick and the factory, will be found under the sub-heading "Transport".

There is usually a waiting list of from 300 to 400 men who want Compound accommodation. It is anticipated that many of these will be catered for in single-quarter hostels when these are built in the new location by the Howick Town Board.

The Sarmcol Compound is not comparable with the system of Compounds where the labour is recruited from areas hundreds of miles away from where the industries are sited, these latter types of Compounds being necessary where migratory labour is employed.

The latrine and washing arrangements in the Compound are rather crowded. There are 6 latrines

(Septic tank system), 3 showers and 10 washing basins. This is being modified.

(ii) <u>Local Health Commission</u>:

Before discussing the types of accommodation occupied by our workers in the Local Health Commission and other slum areas, a brief history of the development of the Local Health Commission is appended. In Howick the Local Health Commission area is known as "Riversdale". A note on the development of "Black Belts" in general closes this chapter, and further mention is made there of conditions in "Riversdale".

The Local Health Commission area houses approximately 865 Natives employed by the Company, the number varying with the fluctuations in Factory strength. This group lives either as lodgers, away from their families, in or adjacent to Howick, or within a 15-mile radius of the township, or dwell with their families in the same radius. The area straggles untidily over more than four hundred acres of land to the south of Howick. HOWICK WEST consists of two portions of the farm "Riversdale", the sub-divisions being named "Dale" & "Quail", after the two surveyors who were employed by the land-company to subdivide the two portions into 5-acre blocks. These were sold to Indians and Coloureds at a price of £35 per acre in 1937. The land, 402.5 acres in extent, was rapidly sold. There are three Coloured owners; most of the other plots are owned by Indians.

Water supplies were the barest that could be provided for the sub-divisions to be registered by the

Deeds Office. Water was pumped from a polluted spring (not fenced off) through a water-main with communal water points. When the majority of the plots had been sold, the land company intimated that plot-holders should form a management committee to take over the responsibility for the water supply. Three Indian plot-holders were elected, but through inexperience were unable to maintain the supply and the pump ceased to operate. Thereafter, residents had to draw their water supplies by hand from the polluted source referred to above.

No building or health regulations existed to control the spread of slums outside the municipal boundaries of existing local authorities, and in these areas there were no statutory bodies to make and enforce by-laws and regulations, or to exercise any kind of authority.

The phenomenon of this uncontrolled growth of slums near cities, towns and villages soon became a major national problem, a menace to public health and a potential threat to law, order and safety, with the position deteriorating every day.

Municipalities and Town Boards, though empowered under existing legislation to apply for incorporation of settlements within 5 miles of their boundaries, were generally reluctant to accept the liability of these areas, because of the financial implications involved. About 1941 the Natal Provincial Council offered the Howick Town Board a subsidy of £2,000 to incorporate the Dale and Quail area and Merrivale. This amount was considered quite inadequate to meet the costs involved, which included the provision of roads and other services, which were non-existent at that time, and negotiations fell through.

The Government appointed a Committee, under the Chairmanship of Sir Edward Thornton in 1938, to enquire on a Union-wide basis, into the dangers of uncontrolled urbanised areas which were arising. The report of the Thornton Committee comprises an important survey of irregular urbanisation, which was stated by that Committee to mean "the settlement of any class of the community in or around urban areas in contravention or evasion of the law, or resulting in conditions arising, which are not subject to proper control."

Arising out of the findings of the Thornton Committee the Natal Provincial Council, recognising the nature and urgency of the problem, promulgated an Ordinance early in 1941 (Ordinance No. 20 of 1941) constituting the Local Health Commission, and defining its functions and powers to administer squatter settlements and to exercise the duties and functions of a local authority in such areas. The Local Health Commission is known to Africans by the name "Poyinande" - a term derived from the name of an Indian landowner at Edendale, near Maritzburg, - the first slum area to be taken over by the Commission.

The Commission was set up on the 1st November 1941, the first few months being spent in getting its machine ready for work. The first Public Health Area to be proclaimed was Edendale and District, effective as from 1st April 1942, followed by the Public Health Areas of Clermont, Wilgefontein, Waschbank and Hilton

Road (subsequently de-proclaimed.) The Public (or Local) Health Area of Howick West was proclaimed with effect from the 1st June 1947, and an office was set up and a clinic arranged. This is conducted by the Commission's Medical Officer of Health, and for some months we conducted the clinic to assist the Local Health Commission.

Insofar as Africans are concerned, their presence in Howick West is in itself a contravention of the law, but the Commission has recognised that to eject them without providing alternative accommodation, is no solution - it merely transfers the problem to another area, which would in turn have to be taken over. According to the Annual Report of the Medical Officer of Health for 1956, there were 1972 Africans, 764 Asiatics and 242 Coloureds in Howick West. The numbers had increased by 1960.

Of the 80 sub-divisions, 68 are Indian-owned, 3 owned by Coloureds, 1 belongs to a European, 3 belong to religious denominations of European origin, 4 belong to the Local Health Commission and 1 belongs to the Government. There are 280 inferior-type dwellings which, because they were in existence when the Commission assumed control of the Area, are not constructed in accordance with approved plans. One hundred and sixty-five wattle and daub dwellings have been erected in accordance with plans approved by the Commission and 15 such dwellings are in the course of construction.

These buildings are only approved as an interim measure, to replace existing shacks. It is realised that in the case of Africans who cannot own land, their illegal occupation will terminate when a proper Native Location is developed by the Howick Town Board.

Water Standpipes: There are 18 public water standpipes at Howick West. No charge is made for water drawn from the standpipes, but a water rate of 1d in the £1 is levied on the value of the land situated within a distance of 220 yards from any of the Commission's water mains.

Rates: Threepence in the £ on land and twopence in the £ on buildings is charged, with a minimum of 16/8d.

The Local Health Commission has under its control 26 Public Health Areas. Those of Howick West, Lions River, Tweedie, Lidgetton West and Cedara house a large proportion of the Factory's Non-European workers. Total inhabitants, according to the Commission's Medical Officer of Health 1960 Report are:

	Africans	Asiatics	Coloured	Total
Howick West	2377(2377)	1082(1082)	327(327)	3786
Lions River	279(279)	248(248)	10(10)	537
Lidgetton West	139(139)	85(85)	22(22)	246
Tweedie	48(48)	57(57)	- (-)	105
Cedara	99(99)	104(104)	10(10)	213
Total for 5 Public Health Areas	2942(2942)	1576(1576)	369(369)	4887

Figures for 1959 in brackets

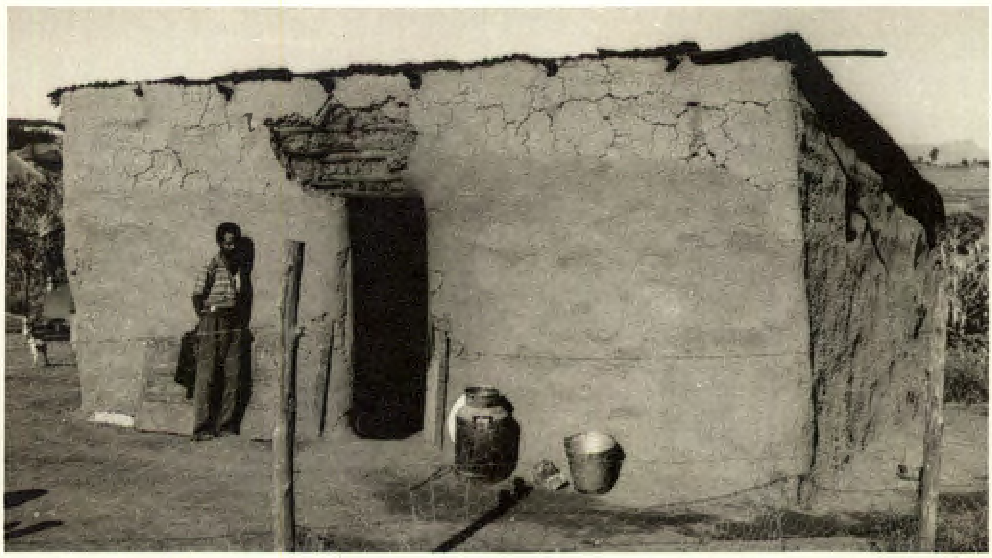
Details of the sexes and number of adults in the above figures are not available. It is known however that more than 800 Africans employed at Sarmcol and the majority of the Asiatics and Coloured employees live in the Local Health Areas.

"As most of the Commission's work is among Non-Europeans, the challenge confronting it and its staff has been to perform its routine function of safe-

The home of Ronald Maseko Co. No. 6457/209. He occupies 2 rooms and has lodgers in the three remaining rooms. This is one of the worst shacks in Howick West. It is in a very poor state of repair and patches of sky are visible through the roof.

Some of the occupants of the above house.

In this room of Ronald Maseko's house cooking is done on the brazier in the foreground. The angle of the door joint is shown at the left foreground, evidence of the condition of the house which leans over and soon may become dangerous.



The home of Thabethe Co.No.2064/217 at Howick West. There are 4 rooms 10' x 8': back wall 5' high: front wall 7' high. No chimney, and the hearth is in the centre of the diningroom floor. Small window apertures 14" x 14" are provided in the bedrooms.

guarding the health of its constituents and also of helping to advance the under-privileged members of the community to a stage at which they will be enabled to undertake both the duties of local authority and of councillors."[2]

The work done in Howick West, which was formerly described as a "Devil's Playground" has a long way to go, but it has already produced order out of chaos and a respectability out of squalor.

The presence of Africans illegally resident in the Local Health Areas is regarded as a temporary emergency measure - permitted, but not approved by the Commissioners - until such time as an adequate housing scheme has been provided by the responsible authorities.

From the Local Health Commission's point of view, there are approximately 3,000 Africans living in the Local Health Areas of Howick West, Lions River, Lidgetton, Tweedie and Cedara for whom housing in a Native location is required. To this figure should be added, probably 100 to 200 not resident in those areas. This is only an estimate - the figure may be higher. Of this number, an estimated one-third would probably only require single quarters, that is, approximately 1,000. There would be approximately 600 married men with their wives and children, making a total of, say, 2,000 people in family units.

African housing may be considered under five headings:

(1) The traditional or indigenous type of architecture, with later modifications.

(2) "Shacks" - usually erected from scrap materials,

such as oil drums flattened out, paraffin tins, pieces of corrugated iron, packing cases, etc. patched together to form some kind of shelter. Roofing is frequently of tarred wrapping paper.

(3) Houses built according to Local Health Commission plans, copies and details of which are appended.

(4) Sub-economic types of housing built by the Local Authorities in Native Townships adjacent to the town.

(5) "Backyard" rooms, usually shared with servants of Europeans or Indians, with or without the knowledge and consent of the owners of the premises.

(1) <u>Traditional or Indigenous Houses:</u>

These huts vary in design and material according to the district, and in Basutoland are sometimes built of stone. Materials usually involve no financial outlay, with the possible exception of poles and timber where they are not available. Most of the materials lie readily to hand in situ. Floors are of rammed earth, surfacing being of cow-dung and clay. The better type of floor is polished by rubbing the moistened surface with a smooth stone. Chimneys are not provided and fire-places are near the centre of the hut. Some of the cooking is done outside, but this is not common in tribal life.

The siting of kraals is usually within easy reach of water, this being carried by the women from a stream or river. Each kraal has its own water-point where water is drawn. The lay-out of kraals follows a traditional pattern, generally circular with the indlunkulu or chief hut at the top side and the other huts grouped according to the status of the inmates, the Right-hand or imGqadi taking precedence over the

Left-hand or iKhohlwa wife. These traditional kraals (villages) are found in the Native Reserves and to a lesser extent on the more remote farms. They form the permanent homes of many of Group "A" workers.

(2) "Shacks":

These are erected by squatters living in the slum areas. As this type of squatting is illegal, the squatter has no security of tenure, and is loath to build anything of a more permanent nature, even if he had the means to do so. As a result they are constructed of a variety of materials which are available, are invariably badly constructed and conform to no health regulations at all.

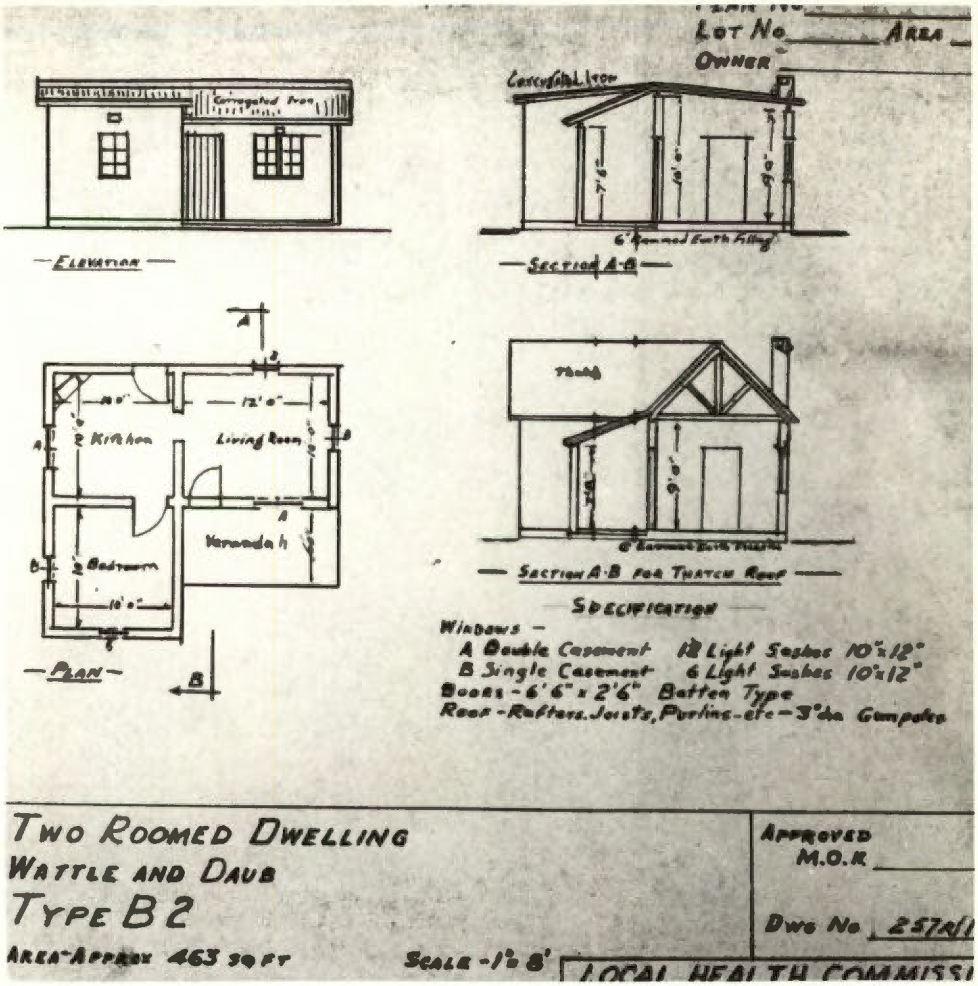
(3) Houses built according to Local Health Commission plans:

These houses are built according to plans and specifications drawn and supplied by the Local Health Commission at a charge of 1/- per set. Six types of plans are available, but as this report is concerned only with Native housing, only three types are applicable, these providing for the use of wattle and daub structures, which are permitted as a temporary expedient.

(a) Type "B" 2: Two-roomed dwelling of wattle and daub, rammed earth floors. Roof: thatch or corrugated iron. Area approx. 462 sq.ft. Estimated cost £60.

(b) Type "C" 1: Three-roomed dwelling. Construction as for "B" 2. Area 876 sq.ft. Estimated cost £100.

(c) Type "E" 1: Four-roomed dwelling. Construction as for "B" 2. Area approx. 780 sq.ft. Estimated cost £100.

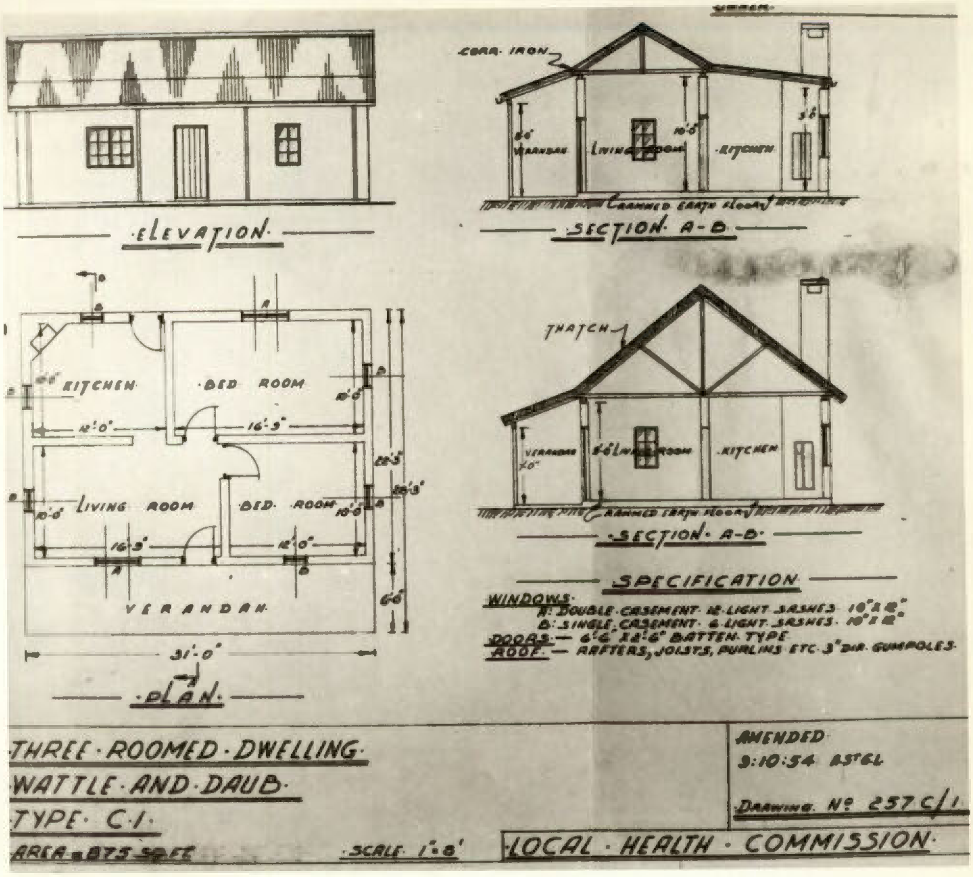


Type B2. Two-roomed dwelling of wattle and daub, with rammed earth floor.

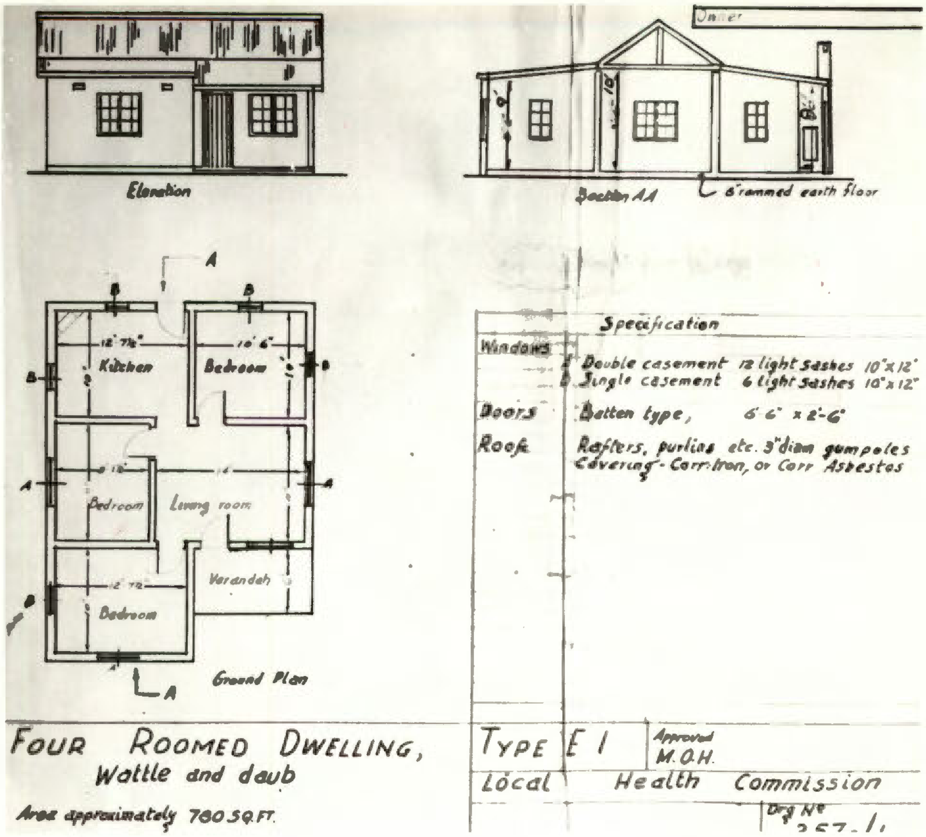
Roof: Thatch or corrugated iron.

Area: Approximately 463 sq. ft.

Estimated cost: £80.



Type C1.	Three-roomed dwelling.	
	Roof:	Thatch or corrugated iron.
	Area:	875 sq. ft.
	Estimated cost: £100.	



Type E1. Four-roomed dwelling.

Roof: Thatch or corrugated iron.

Area: Approximately 780 sq. ft.

Estimated cost: £100.

The home of Phineas Butelezi, Co. No. 6393/239, at Howick West. The house is constructed according to the type E1 plan. The house is in a fair state of repair.

Interior scene in the home of Phineas Butelezi.

The interleading rooms are designed to discourage sub-letting, but the majority of householders have tenants in one or more rooms. A Ranger inspects the area every week, and checks on new buildings, additions and alterations. Pit privies are compulsory and must conform to specifications as regards dimensions and fly-proofing. Pre-cast concrete slabs, seats and risers are supplied by the Health Commission for £2.13.1. Sentry-box types of shelters are optional at £8.1.11., but Natives generally prefer make-shift structures which cost nothing to build.

Water Supplies: Standpipes are placed along the water main at approximately 220 yard intervals in the Local Health Commission area, along the roadsides.

(iii) The Local Authority.

(4) Sub-economic Housing:

Whilst not ideal, sub-economic-type housing is a considerable improvement upon the shacks and slum conditions of the "Black Belts", and is undertaken by the local authority, in this case, the Howick Town Board, who in 1938 built the first 8 houses in the Howick Native Village, and in 1940/41 a further 8 houses, and in 1944/45, 37 three-roomed "breeze-block" houses, and then in 1954 a further 100 houses, when the Minister of Native Affairs intimated that no further development or extension of this Native Village could be considered, and that this area was to be regarded as a temporary

This house has four separate rooms and a common chimney in the centre. There are no interleading doors, each room opens to the outside. Each house has a common bathroom and a closet (bucket style) thirty feet from the building. Normally these are let as single rooms, but some rooms are occupied by small families.

The front view of one of the 3-roomed concrete houses erected in 1940/1 at a cost of £175 each. Bucket latrines are provided.

Front view of one of the three-roomed "Breeze Block" houses erected in 1944/5 at a cost of £367 each.

location, to revert to use by some other racial group eventually. The Minister indicated that he would approve a housing scheme for Natives if it were sited some distance from Howick. This scheme, as yet, has not been finalised.

The striking difference between accommodation in the Howick Location and other areas is the fact that adequate shelter is now provided for a man, his wife and family. The attempt is perhaps on an elementary scale, but it gives a greater chance to correct defects in feeding than either of the other groups previously discussed. This Village group is probably more amenable to education and an understanding of dietary problems than the other groups. They form too, the beginning of a new tradition of labour in industry. One hundred and forty-seven factory employees live in the village.

There are four different types of houses in the Howick Native Village:

(a) A house of 4 separate rooms, having a common chimney in the centre, no interleading doors, but each room open to the outside only. These are used mainly as single quarters, or for families with only 1 child occupying a single room. Each house has a common bathroom and a closet about 30 feet from the dwelling.

(b) 1 bedroom, diningroom and kitchen.

(c) 2 bedrooms, diningroom, kitchen with communal ablution block to serve 10 houses. These houses are built of reinforced concrete, roofed with corrugated asbestos, and were erected in 1954.

(d) 2 bedrooms, diningroom/kitchen, bathroom and pantry.

Back view of the above house with bathroom, pantry and kitchen in the flat-roofed section.

This house has two bedrooms, a dining-room and kitchen. One hundred of these semi-detached houses were erected in 1953/4 at a cost of £293 each. A wood and coal shed is provided at the back, together with a bucket style latrine.

Interior scene in one of the above houses, showing the tendency to live in European style, and the typical furnishings.

All but two of the householders state that they cultivate vegetables on their allotments in the Native Village.

House rents are on a sliding scale based on the income of the tenant. In the case of the single rooms the basic rent is 10/- per month for men earning less than £15 per month, and 13/- monthly for those whose earnings exceed £15. Rents for the houses range from £1.5.0. for incomes of less than £15 per month, to the full economic rental of £2.9.0. For the purpose of assessing incomes in order to fix rentals, half the earnings of lodgers are added to the tenants earnings, and the rent is based upon the gross figure. All earnings in excess of £19 per month are treated as economic and the full economic rental is charged.

The scale of rentals is laid down by Government regulation and incomes are reviewed periodically, rents being revised accordingly.

The number of lodgers allowed in the Native Village is strictly controlled to prevent overcrowding. Lodgers pay the Administration 1/- per month for a permit and no one, other than householders and their families, is allowed to reside in the Native Village, unless in possession of a lodger's permit; these being issued only when approved by the Superintendent. Lodgers may pay as little as 10/- per month, but it is unlikely that householders would charge a rental that does not at least compensate for the increased rental which they incur as a result of taking in lodgers.

(5) Backyard Rooms:

Many workers share rooms in Howick with servants in domestic employment. This unsatisfactory arrangement is resorted to because of the overall difficulty of finding adequate accommodation.

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11. Feeding:

In our Compound, cooking is often shared, as mentioned later. In the "Black Belts" this is seldom the case. The Mines feed their Native employees in Compounds, and this is possible where migrant labour is employed. In Industry, however, a stable labour supply is established in the immediate area. Many industries - and this applies to Sarmcol - provide a canteen service where certain foodstuffs can be purchased.

The rural African thinks only of food as a day to day measure to relieve his hunger. In an urban area, he soon finds he wants European foods. The popularity of white bread, or a bun and a mineral water, is too well known to require further comment. However, when buying European foods, he doesn't know how much to buy or what kind of food to eat. He takes his standards from the wares displayed in the shops, and this is frequently his only standard. Many of the health-giving elements of the traditional diet cannot be obtained in towns.

The year 1897 saw the great cattle disease, rinderpest, sweep the country. This constituted an epoch in the dietary habits of the Natal Zulu. Up to that time, amasi (sour milk) was the staple food with adjuncts of maize and kaffir corn. From 1897 onwards, amasi ceased to be a principal food and maize superseded it as the staple food of the Zulu.[3] Other elements of the natural diet, e.g. wild and cultivated roots, herbs and vegetables are in many cases not available. These when added to maize, help to balance the diet and include many types of wild spinach, such as imbuya (amaranthus thumbergii) iselwa (calabash), imfe (sorghum saccharatum), roots and tubers of several kinds, and a great many fruits and berries.

In the Compound, the "kitchens" are long buildings closed on 3 sides and provided with 2 metal rails just above ground level as a support for the cooking pots. Open fires are the rule, and this is preferred, as it conforms with tribal practice. The cooking is characterised by an economy of effort, and the pegging of expenditure to a regular weekly sum. Men often eat well once or twice a week, and for the remainder of the time subsist on tea and bread. Foods which require considerable preparation are not popular here, hence few of the men cook dried beans which require a preliminary soaking overnight, and then being cooked for some time. Only 16% cook mealie rice, compared with 60% in the Native Village. Five per cent of the Compound men cook beans, whereas 52% of the Native Village use beans in their diet. The average diet in the Compound is based upon the familiar Bantu foods - phutu, amasi, meat, marewu and mcubu, a mixture of soured phutu and marewu, made by thinning the phutu with water, and adding the marewu and leaving to stand overnight. Cabbage, tomatoes, potatoes and onions are also eaten.

The routine of preparing and cooking meals varies alternately week and week about, according to the shift worked. In some cases, two or more men will pool their supplies, taking turns at cooking for the group. Often in such arrangements, those working nightshift will do all the cooking during the day, at about 11 a.m. This generally serves for two meals - midday and evening. The man on dayshift has his breakfast at morning tea break in the Canteen, while his opposite number on night shift sleeps until nearly 11 a.m.

The Factory Canteen, when this investigation was started, served bread, tea and a soup. Marewu was available, but the taste of the preparation did not appeal to most of the workers. All foodstuff available was paid for, on a coupon basis. As far as normal purchases of uncooked food are concerned, the normal habit is to purchase meat and vegetables once or twice a week. There are no adequate storage facilities for food in the Compound. It may be mentioned here that a surfeit of food on one day followed by days of inactivity, as is often the case in tribal society, does not fit in with the requirements of the worker when he is employed in industry.

In the slum areas, the cooking differs from that in the Compound in the sense that there is little pooling of effort or supplies, but in certain cases, women are available and do the cooking for their husbands and children. In the Howick Native Village this is the rule, and the type of housing and the living conditions which apply here seem to be the nearest approach at guidance of the African in assuming an urbanised way of life.

It is of interest to note that the group of men living in the Native Village are also partial to tribal foodstuffs. The cooking, however, is done on conventional wood or coal burning stoves, and many of the dishes served are patterned on those seen in European homes.

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111. <u>Social Discipline</u>:

As mentioned in the section on feeding, the Local Authority's African Village provides housing and conditions in general which are the most favourable for industrial African workers in the process of urbanisation. Here a discipline prevails, but it is essentially the discipline applied by the villagers themselves, and it is a noticeable fact that sub-economic houses, while not perfect, are very much better than the shacks in the slum areas and are a great attraction for lodgers.

The moment the African moves into an urban area, he is confronted by the discipline of the community. Everything of value known in the tribal society loses its meaning now. He finds he has nothing to hold on to; the discipline is one he cannot understand, and to him it is a false discipline. He may find himself sentenced to prison for an offence he cannot understand. This in itself is no real punishment, as he is well fed and housed. There appears to be a lack of any attempt on the part of authority to indicate what would be construed as correct conduct. This is in direct contrast with his tribal life where he is one of an age group, and is guided continually by his superior (nogada) by his own father, and by the headman.

The only way a tribal way of life can be maintained to some degree, is by living in controlled compounds. Here it is achieved under strictly barrack room conditions, where a fairly strict discipline prevails.

Industrialisation, particularly as it affects the African, is a radical step and the African by reason of his background needs to be helped towards integration into this urban life. Constructive measures are needed to minimise the harm and create the conditions in which the adoption of Western ways and the complete adaptation to the requirements of living in modern urban communities can proceed at a rate which will keep pace with industrial development.

Industry is vitally concerned in facilitating adaptation to the urbanised environment because adaptation based solely on personal experience may be unsatisfactory, or even destructive. The presence of the rural African is impossible to evade in a small town like Howick. The existence of these problems impinges on the consciousness, with the mushroom growth of adjacent "Black Belts". Within the township the continual requests for compound accommodation, the constant importuning of householders for a place to sleep, the stream of workers on every road into Howick at the change of each shift, the large numbers of natives idle at weekends, are all evidence of the existence of a sociological problem - one not peculiar to Howick and possibly not as acute in Howick as it is in certain other centres.

A great many African workers reflect an appearance of extreme poverty, their attire consisting mainly of cast-off clothing, generally ragged and soiled, sometimes held together with bits of string and safety pins, which can do nothing to enhance self-respect, or to exclude cold and wet. On the other hand, the tendency among those housed in comparatively decent conditions, seems to be to engender a self-respect, reflected in neatness and personal cleanliness.

One real and immediate impact of urbanisation, is a change of values, as far as "wealth" is concerned. Money now replaces cattle. Allied with this dramatic departure from accepted custom, is the difficulty of keeping money in safety, and the initial distrust of Banks and Post Offices. Unwise spending is a constant problem too. "Shebeens" thrive in all the slum areas. The week's wages are often dissipated in a wild spree, that has its aftermath in a hungry week ahead, aggravation of malnutrition signs, and frequently the appearance of venereal disease.

In industry too, he soon finds that the easy tribal life has gone. Tasks are set, often repetitive and boring, and yet he is expected to conform to a set standard. This may make for bigger demands on him physically than anything in his past. Where is the energy to come from to meet these demands? His diet is inadequate because -

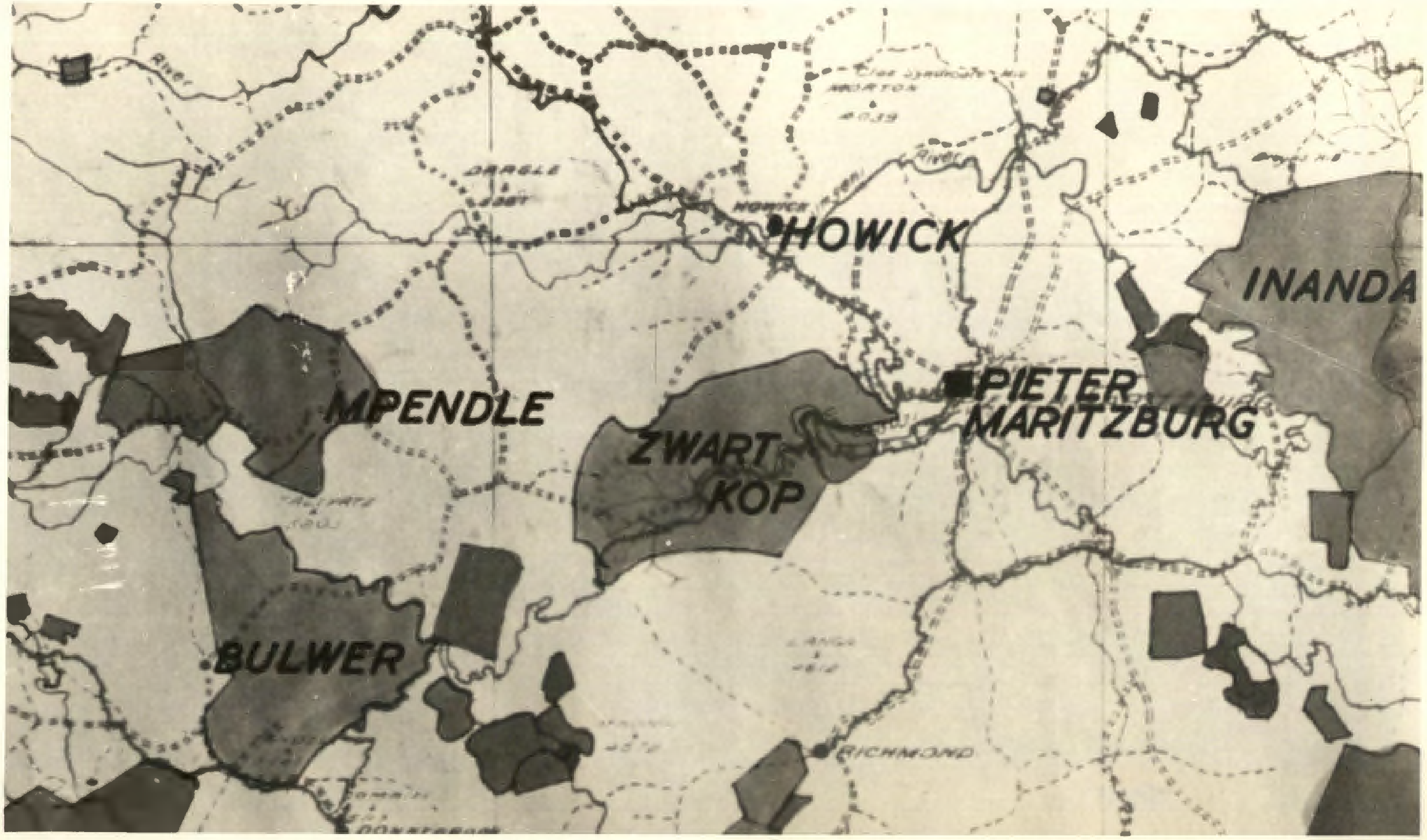
(a) There is more work to be done;
(b) The foods to which he is accustomed are no longer available, as was mentioned earlier.

<u>Transport and residential distribution of workers</u>:

<u>Group A</u>: The problem of transport concerns mainly those men who are housed in the Company Compound, but whose homes in general are in the Native Reserves. This group is known as Group A. Originally 100 were examined and after a year 89 were still participating in the investigation. A few dropped out in the second year of the investigation. 81 of these men still have their families in the Reserves or other rural areas, distributed as follows:

Swartkop Location	40	by	road	15	miles
Impendle Location	14	"	"	48	"
Elandskop Location	10	"	"	20	"
Dargle	1	"	rail	14	"
Nottingham Road	1	"	road	30	"
Rosetta	1	"	rail	32	"
Cedara	1	"	road	8	"
Loteni	1	"	"	55	"
Bulwer	2	"	rail	110	"
Umkomaas	2	"	"	112	"
Camperdown	3	"	"	43	"
Msinga Reserve	2	"	"	117+	"
Dundee	1	"	"	182	"
Empangeni	1	"	"	214	"
Pinetown	1	"	"	74	"

It will be seen from the above residential distribution of the families of Compound occupants, that the majority are within comparatively easy reach



Map of Reserves in close proximity to Howick.

of their homes and, though too far to travel to and from work daily, are able to return at frequent and regular intervals, and the majority do so. The break-up of family life, with the evils attendant upon separation of workers from their wives and families, which is generally attributed to the Compound system, does not appear to be a factor in the Saracol Compound. Whilst this is true, it must be admitted that this is achieved only at the expense of money and effort. Money could be better spent on many things and the effort of travelling over bad roads is wasteful of time and energy. That travelling over long distances can be tiring is common knowledge, and this is aggravated if the roads are bad, bumpy, dusty, or muddy in wet weather. When townships are planned for Native workers, these points bear remembering. A tired worker may well be a danger to himself and to others.

All 40 Swartkop Location residents say they go home every weekend at an average cost of 5/4d. per return trip, or £1.1.3. per month. Costs vary according to the part of the Reserve in which they live. Those who travel by train pay from 8/- to £1 per month. Others, using buses or sharing taxis, pay from £1 to £2 per month.

Of 14 men from Impendle Location, 7 go home once a month, at a cost of between £1 and £1.17.6., an average of £1.7.4., and the other 7 visit home on two weekends a month at a cost of between £2 and £3.15.0. or an average of £2.15.0. per month.

Travel is by bus or in shared taxis. The bus, a privately-owned transport firm, travels from Howick via Elandskop, 25 miles away, and on to its terminus at Brook's Store, 48 miles from Howick. The route runs along the fringe of the Swartkop Location for a short distance, 9 miles from Howick, and also passes through a section of Elandskop Location. Some passengers alight at points from which they journey on foot to reach their homes. Some homes are close to the road and others at distances of up to eight or ten miles from the bus stops. The terrain, in general, is mountainous and inaccessible to motor transport.

All ten men at Elandskop Reserve go home every weekend, travelling in the Impendle bus, or sharing taxis and cars. The cost varies from £1 to £2.8.0. per month, an average of £1.2.5. One at Dargle goes home every weekend, travelling by train at a cost of 9/- per month. One at Nottingham Road visits home every weekend, cycling both ways. One at Loteni, some miles on foot beyond the Impendle bus terminus, goes home every weekend by bus, at a cost of £5 per month. One at Rosetta goes home twice monthly by train at a cost of 16/- a month. One at Cedara cycles home every weekend.

One at Bulwer visits home twice a month by train at a cost of £1.10.0. per month, and the other goes home once a month at a cost of £1.4.6. One goes home to Umkomaas twice a month by train at a cost of 17/- and the other from Umkomaas travels home once a month at a cost of £1.10.0. One man at Camperdown travels home every weekend by train at a cost of £1.4.8. per month.

Four men in the Compound Group "A" go home only once yearly when the Works close down for the Christmas break. All travel by train, one to Dundee at a cost of £2, one to Weenen at a cost of £2.10.0., two to Msinga at a cost of £1.8.0. and £2, the latter going by bus from the railhead. Three men, whose families live in the peri-urban area of Edendale, go home by train every weekend at a cost of 17/- per month, and four go home once a month at a cost of 8/- to 10/- per month. The other urban resident goes to Inchanga twice a month by train at a cost of £1.

The above details of the residential distribution of the 89 Test Group men are considered to be typical of the 259 housed in the Compound. It will be observed that a total of 59 of the 89 go home every weekend, 11 go home once a fortnight, 15 once a month and that there are only 4 out of 89 who go home once a year. It is evident that in some cases these visits home are expensive, out of proportion to their wages and their expenditure on food. Offset against this expense is the fact that only 11 of the Group pay rent for their homes - from 6/8 to £1.5.0. per month. The cost of living is undoubtedly lower in the Reserves than it is in towns and cities, where the bulk of the food consumed has to be bought. Travelling, thus becomes a costly burden to many of the men, but it enables them to maintain contact with the tribal way of life, and they do not have to pay rent for their dwelling.

Only three of the 89 in Group "A" have less than three years' service with the Company. The others are 23 with 4 to 6 years, 38 with 7 to 9 years, 9 with 10 to 12 years and 16 with 13 to 35 years' service. These figures would appear to indicate that the men in the compound form a stable element in the Factory's labour force, and there can be little doubt that their preference for Compound accommodation lies in the fact that it enables them to maintain their contact with the tribe. Compound occupants seldom seek housing in the Howick Native Village or at Howick West. The only known exceptions have been single men, who have married and set up house locally and, have for one reason or another cast off the authority of the head of the family.

The conservative element of the Native population is very averse to bringing the womenfolk into contact with the conditions which exist in and around towns. Where the authority of the head of the family is still recognised, married men are forbidden by their fathers to bring their wives and children to town, excepting for a brief visit. The wives and children remain with the husband's father, whose authority as family head is undisputed.

The men living in the Howick Native Village do not require transport, as the works are only a short walk from their homes, and as has been mentioned, they constitute the most stable group of the Africans employed in this industry. A description of the men from the village follows. They are known as Group "B".

<u>Group "B"</u>. The investigation again involved one hundred men, of whom 87 were still participating in the scheme when these comments were written. A further drop in

numbers occurred in the second year of the investigation. Sixty-two are married and 25 single, all of whom are living with their families. In addition, 9 married and one single man are lodgers, whose families are at Inchanga; Zululand (2), Stoffelton, Sobantu Villege (Pietermaritzburg's Native Village), Msinga, Richmond and Hammersdale (2).

One of the Group has two wives and two families. One is housed in the Village, and one at Howick West. Residents are not allowed two wives in the Howick Native Village. Three of the lodgers are classified as rural, because their wives and families reside in Zululand, Msinga and Stoffelton. The remaining 84 may be considered as urbanised, although 10 of them still own stock, kept on their behalf, presumably by relatives in the rural areas, such stock being used to help support dependants and to provide lobola when required.

The necessity of preventing overcrowding in the Native Village has resulted in regulations which allow only the wife and children of a man to reside with him. Other dependants for whom he may be responsible under Native custom must reside elsewhere. For example, the widow and children and cattle pass to the eldest brother of a deceased man, and become his responsibility. Probably some of the dependants and stock belonging to men in the Howick Native Village accrued from this custom. Cattle may also have been derived from the marriage "lobola" of a sister or daughter, or may have been owned before the worker moved into the urban area.

Of the urbanised class, 29 were actually born in the urban or peri-urban area of Howick, and 8 were born in other urban areas, giving a total of 37 men born and brought up knowing no other way of life but the urban life in which they now live. Forty-seven have become urbanised by domicile, having been resident in this or other urban areas for periods of one to 32 years. Twenty-five of this latter number came from the Reserves and Native Territories; only 4 of them came from Impendle Reserve, 1 from Swartkop and 1 from Elandskop. The rest have come from further afield - including 1 from Swaziland, 2 from Nyasaland, 1 from Basutoland and 1 from Pondoland. The remaining 22 were born on farms.

Twenty-two urbanised men and 2 rural in this group had under 3 years service in the Company's employ. This figure includes a number who came straight from school to the Factory (25 in the group have never worked anywhere but at Saracol). Fifteen had 4 to 6 years service, twenty had 7 to 9 years, 7 had 10 to 12 years, and 20 had from 13 to 30 years' service with the Company.

Group "C". Of those living in the slum areas, many walk or cycle to work, and although a private Indian bus is available, transport cannot be said to constitute an essential expense for these workers.

This study involved a group of 100 men, of whom 99 were still participating in the investigation when these notes were compiled. As in the two other groups, a drop in the number participating occurred in the second year. They are known as Group "C".

There were - 37 married and 10 single men living with their families, and

44 married and 8 single men lodging away from their families.

Of this latter group of 52 lodgers, there are 13 lodging in backyards in Howick, most in servant's quarters of European or Indian houses, 1 at Merrivale, 1 at Lions River, 2 at Tweedie, 1 in Howick Native Village and 34 lodge in the Local Health Commission area of Howick West: (Riversdale).

Only 9 of the lodgers can be classified as urban, having their families in other urban or peri-urban townships and settlements (Edendale 6, Umzinto 1, Shongweni 1, New Scotland 1). The remaining 43 lodgers have their families in the Reserves and rural areas of Impendle, Swartkop, Msinga, East Griqualand, Basutoland, Nyasaland, Himeville-Bulwer-Umkomaas-Umzimkulu area, Pinetown (District), Dargle, Estcourt (district), Inchanga and Richmond (district).

Thirteen men live with their families in rural areas which may more correctly be described as peri-urban - 2 at Tweedie, 10 at Lions River and Lidgetton and 1 at Hilton, all of which are now under the control of the Local Health Commission, and though rural, are possibly on the verge of urbanisation.

Sixty-eight of the 99 men in Group "C" reside in Howick West, of whom 34, as detailed above, are lodging away from their families. The other 34 reside with their families and may be classified as urban dwellers, being at present in a transition stage from rural life to urbanisation. Only 9 were born in this urban area, or its environs, 1 came from another urban area and the remaining 24 came from various rural areas (farms, Native Reserves, Basutoland and Nyasaland).

68 out of 99 live at Howick West;
10 out of 99 live in other local Health Commission areas;
43 are classified as urban;
56 " " " rural;
47 are living with their families;
52 are lodging away from their homes;
18 are single;
81 are married.

Brief mention has been made of some of the relevant facts applicable to our workers, and a section on the transport arrangements of the Compound has been included.

Investigation of the housing conditions is in no way detailed, as factual surveys were not made in situ. This field was well covered by the work of the Natal Regional Survey[4], undertaken by the Department of Economics of the University of Natal, and Additional Report No. 1 "Experiment at Edendale" contains a survey of the identical conditions under which a large number of our African workers are living.

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Black Belts:

Immediately before the outbreak of World War 11, the public conscience had been stirred on account of the acute housing problem which already existed in the vicinity of all the large towns in the Union. It was seen that this problem was most acute in respect of the housing needs of the lower income groups.

There is no doubt that at that time sub-economic housing schemes had been completed by local authorities, as well as by the S.A. Railways, and the position appeared to be under control. The intervention of War brought most of such schemes to a standstill for the duration, thus causing a backlog of housing requirements.

The position was further aggravated by an unprecedented and apparently unforeseen rate of industrial development and expansion. The influx of Non-Europeans into industrial areas on a scale hitherto unknown swamped the resources of the local authorities. The position was aggravated by wartime shortages of manpower and materials, as well as by steep rises in building costs. Even before the war, land speculators had been quick to perceive and exploit the position. Companies bought up land wherever they could in the vicinity of towns where industries were established. Near Howick, the land was sub-divided into 5-acre blocks ("Riversdale") the smallest unit which would enable them to evade the proclamation of townships. These plots were offered for sale to land-hungry Indians and Coloureds. Natives were debarred by existing legislation from acquiring such plots.

Sometimes the Indian buyers built houses on their plots, but a great many leased the plots or portions of them to Africans who, for a monthly rental were allowed to erect dwellings of any kind they chose. As buildings erected on a property accrue to the owner of the land, it is manifestly unsound to invest money in the erection of a permanent and expensive building on such a property. The result is that the Africans, even if they could afford to build proper houses, which in any case most of them could not do, were not prepared to risk their money in this way.

It is obvious that the more shacks and hovels which could be erected, the higher the return to the landlord. This is evidenced by the mushroom growth of slums of the worst type near most towns. Sanitation and water supplies were non-existent or inadequate and the areas became potential reservoirs of disease. Vice and serious crime are rampant, with brewing and trafficking in illicit liquor, robberies and assaults everyday occurrences, and murders not uncommon.

Chadwick[5] in 1834 in Britain, drew attention to the relationship between insanitary housing and sickness. Further reference to his contributions to public health and social welfare appear in Chapter 3.

In 1843, the conditions in many large towns in England were appalling. "The proportion of privies to houses reads like a nightmare. There were parts of Manchester where thirty-three privies had to supply 7,095 persons. In the town of Sunderland, the proportion was one privy to seventy-six persons."[5]

Howick West (or "Riversdale"), besides being the largest slum in the Howick area, also houses the largest concentration of African employees of this Factory. It is typical of the other peri-urban areas at Cedara, Tweedie, Lions River and Lidgetton, and typical too of the housing and living conditions of an estimated 60% to 70% of the African and, possibly, a similar percentage of the Coloured & Indian workers employed at Sarmcol.

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CHAPTER 3

HOW THE STUDY DEVELOPED : PART ONE

Introduction:

The reasons for the initiation of this investigation are mentioned very shortly in the Introduction. The work was undertaken for the practical guidance of the management of The South African Rubber Manufacturing Co. Ltd. Their plant is near the main Durban-Johannesburg road at Howick, Natal. Howick is quite a small township and the rubber factory is the only large industrial organisation in it.

The Company takes an enlightened view of its responsibilities to its staff at all levels. The Non-Europeans who make up the main body of workers present special problems. African workers are by far the largest proportion of the Non-Europeans and this work was directed upon them.

Initially the problem was set in broad practical terms which were later resolved in some detail. The medical aspects were obviously basic but the end of it all was intended to produce a practical outlook which could be applied and developed in the common life of the factory. This aspect is discussed further in chapters six and seven. This emphatically practical outlook had a very considerable influence in determining the course of the work. Earlier medical work in the factory had suggested that many of the problems were centred around nutrition, and that the nutritional defect was a relic of childhood, which continued through the rest of a man's life.

The problems and effects of diet are, therefore, regarded as the keystones of this study. Living conditions could exert a critical effect on diet and therefore problems of housing go hand in hand with those of diet.

This s tudy is essentially one of industrial health, and what follows must be seen against a busy factory background. It concerns the translation of men with tribal conditions and traditions very near to them, from that state to one of an organised, urbanised community. This latter state has evolved from the European development of industry. The European development was an evolution - the impact on the African however, is that of a sudden, shock development. They might be said to be bridging a gap of many years of evolution in a day.

The problem of the study revolved around what number of men might represent a factory of about 1200 African workers. In making a decision, two other factors were considered. Firstly, the people concerned lived under three different sets of conditions, each one sharply divided from the others. There were thus three groups which must be recognised as each containing the possibility of important characteristics peculiar to themselves. The distinctions had to be drawn, or those characteristics might be lost in an average.

The factory population, therefore, breaks down into three sub-populations clearly distinguished by their conditions of shelter.

The second problem concerned the time factor. No point would be achieved in a study of this kind which must spread over several years unless the majority of the men involved in the study are going to be available through the whole period, and in numbers which will give the work some substantial significance. It was decided, as a result, to choose 100 men in each group so that the minimum participating after two years should not be below 50 in each group. In actual fact, the figure remained well above 50.

Interpretation of Results:

At an early stage during the planning of the work it was thought that it might be possible to apply rigid statistical methods of interpreting the results. This idea had to be abandoned almost at once. The requirements of the mathematical conceptions involved in statistical analyses could not be fulfilled. There are a number of good reasons for this.

(1) The sample was too small for a rigid statistical treatment of this kind of problem although it took in about 25% of the African labour force and involved dealing with about 300 men.

(2) The sample was not a random sample in any mathematical sense. It was chosen by eliminating men who were unwilling to co-operate, men who for various reasons were unlikely to co-operate and men who were unlikely to stay in the employment of the Company for the time necessary to do the work.

There is nothing random about a sample chosen under these conditions. The choice of men was put in the hands of a man who was carefully briefed. The man chosen was the manager of Non-European affairs. He knew all the men well, and it was considered an advantage that he was completely without any medical knowledge which might have given a medical bias to his selection.

(3) Some of the important information required in the work had to be obtained from statements obtained directly from African workers. This was done most patiently and carefully but it would be folly to pretend that that information had a positive mathematical accuracy which could be brought into a statistical analysis. Some of these considerations are mentioned in the body of the thesis. The statements however, contributed materially by indicating defects or omissions in the dietary pattern. The omissions represented gaps in diet which had to be closed. It could be said now that an immediate purpose of this investigation was to discover those gaps, to find means of closing them, and to foresee some course of action to prevent their recurrence. Many of the limitations displayed in this work were inevitable and we came back to the point that any conclusions which might be reached must be supported by careful investigation, so that the results might be acceptable to men who were seeking advice on the solution of an important practical problem.

Literature:

A large literature has grown up on the subject of nutrition. In surveying it special attention was given to matters bearing directly on the work in hand. The choice was made the background of a lengthy contact with men in the factory, and on a wider and reasonably lengthy contact with Africans whilst in general practice in Howick and other rural areas of the country.

Any medical practitioner in South Africa who deals with the coloured population cannot fail to be well aware of many of the aspects of malnutrition. This is no new subject and the general historical aspects are dealt with later.

At this stage, however, one must acknowledge that stigmata of precise nutritional deficiency raise the presumption of a defective diet, but occasionally the deficiency state may be conditioned by disease or gastro-intestinal disorder in the presence of a satisfactory or even an optimum diet.[1] Also, that if the results of a dietary survey indicate a deficiency of calories it is perhaps reasonable to assume that undernutrition is present, but on the strength of the fact that certain nutrients fall below some recommended allowance, it is not justifiable to assume that a proportion of any group is suffering from malnutrition. In such circumstances, the possible presence of malnutrition may be inferred, but the dietary survey per se provides no evidence of its existence.[2] The historical background is dealt with in the books mentioned below.

1. THE LIFE & TIMES OF SIR EDWIN CHADWICK
S.E.Finer (Methven & Co. Ltd. London 1952)

Sir Edwin Chadwick (1800-1890) was a lawyer who spent his lifetime in public service. He was not a medical man and this record depends upon the observations of a man who was much concerned by the effects of a rapid industrial development on a population which had depended mainly upon agriculture.

Chadwick first distinguished himself by his work for the Royal Commission of Enquiry of 1832 into the administration of the Poor Laws. In April 1833, faced by a rising wave of strikes for a ten-hour working day, the Cabinet of the day called another Royal Commission on the "State of the children in Factories". Chadwick was one of the three commissioners. The first Factory Act of 1833 was largely Chadwick's work. There were excellent clauses, including compulsory education for children, reduction of the hours of work, plus the appointment of Government Inspectors to check the workings of the Act. Chadwick followed that up by his "Poor Law Report" of 1834 in which he showed the relationship between insanitary housing and excessive sickness and mortality. He suggested that to spend money on the improvement of such dwellings might prove an economy. He also analysed the connection between pauperism and intemperance. He drew attention to the fact that high earnings and skill frequently went with education. Lack of education promoted poverty, crime and social problems.

The period of the Industrial Revolution in England was characterised by appalling conditions of work in many industries and mines, and by the exploitation of women and children. The slums of England and particularly those of London were utterly horrifying. The ravages of fevers including smallpox, typhoid and cholera, the dirt and destitution, cannot adequately be compared with the position of the Black Belts and slum areas in South Africa today, because of the improved medical knowledge and services which prevail even in the poorest of the slum areas in this country. Conditions in our slum areas are highly unsatisfactory, usually grossly overcrowded, and lacking reasonable sanitary conditions. The inhabitants of these areas usually subsist on a diet well below nutritional requirements and their conditions of shelter are miserable. In an African context the conditions have a notable similarity to the conditions which Chadwick worked to improve during the period of the Industrial Revolution in England.

The results of maternal malnutrition and post-natal undernutrition upon the industrial workers in Britain produced results on stature, condition of teeth, general ill-health, premature senescence and general debility which are mirrored today in one's experience of work in Bantu communities.

Chadwick was deeply impressed by the miserable state of health of the inmates of the workhouses. These institutions were for the relief of people who were entirely without means of support. They were run under conditions of extreme economy which did little more than keep the inmates alive. The effects were seen clearly in the inmates of workhouses in the Industrial Revolution.

The picture of malnutrition so common at the time is shown clearly by Gibbon Wakefield's description : "What is that defective being with calfless legs, and stooping shoulders, weak in body and mind, inert, pusillanimous and stupid, whose premature wrinkles and furtive glance tell of misery and degradation?

That is an English peasant or pauper, for the two words are synonymous."

Chadwick with little to guide him, attempted to improve the diet of the workhouse inmates. As a comparison he used the average dietary of independent labourers. It was calculated that in a family, 110 oz. of bread and 4 oz. of bacon per head were consumed. Assuming that the head of the family ate twice as much as any other member, this diet would only have yielded 2252 calories per day. The basic minimum workhouse dietary was therefore set at 129 oz. 'of solid food' per week, which was an improvement on outside scales.

The parallel between the undernourished labourer of that time and many of the Africans in industry in our time, is a very real one. Whilst it is not the intention to house needy families in workhouses, the need to improve housing and dietary intakes in many underprivileged communities is essential.

Although Chadwick tried to modify and in some measure succeeded in modifying many of the evils of the Industrial Revolution in England, he recognised very clearly the overall need for general education. In this work we are trying to deal specifically with problems of diet, but we are forced to the conclusion that the overall need is for a higher standard of education. To us in South Africa this presents a problem of much greater difficulty and complexity than anything experienced in England or in Western Europe. In this complexity of needs the growth of industry creates its own special needs and perhaps the most important of them is the need for an adequately fed community of industrial workers.

8. THE HISTORY OF NUTRITION

MC.COLLUM E.V.

(World Review of Nutrition & Dietetics)
(Pitman Medical Publishing Co. London 1959)

Most of the earlier beliefs credited certain foods with magical properties, and the eater might acquire qualities of courage or weakness from the animal he ate. These food superstitions are common in rural Africans today. From this same belief grew the knowledge of the medicinal value of many plant substances, and the basis of this idea was that different principles occurred, each one effective in curing a different disease. Actual reasoning about why herbs possessed medicinal properties, however, was impossible, so long as philosophers believed that water, air, fire and earth were the primordial materials from which all things, even the human body, were formed. It was their belief that health and sickness depended upon the harmony or disharmony of the four humours, blood, phlegm, black bile and yellow bile. (Hippocrates)

The actual founder of iatrochemistry was F. de le Boe Sylvius (1614-1672) who assumed that the processes of physiology and pathology resulted from "fermentation." The philosophy of Sylvius was inadequate to a comprehension of the properties of foods, and the processes of nutrition. The view that certain plants had medicinal properties suggested the idea that in disordered states, something missing in the body was supplied by the remedy.

To H.M. Rouelle (1718-1778) in Paris goes the credit for evolving a basis of "dissecting" plant material by applying a succession of organic solvents. By 1800, T. Thomson of Glasgow was able to list 21 organic substances which had been derived from various plants and animal tissues. This was the beginning of food analysis.

From Popin's pressure pot (1679) which allowed the heating of organic substances with superheated steam, came the idea that all animal tissues so heated yielded gelatin. This led Albrecht von Haller (1707-1777) the Swiss physiologist to express his belief that half the human body was gelatin.

Wheat gluten was prepared in 1742 by Beccani by washing the starch out of dough. This putrefied easily and he concluded it was "animalized" matter. Beans were found to possess this matter, and Vauquelin and Fourcroy attributed to this vegetable product high nutritive value. Starch had been known since Pliny's time (A.D. 23-79), and oils had been pressed out of seeds from early times. Lavoisier who established that respiration involves oxidation was aware that ordinary foods contained starch, fat and "animal matter".

In 1811 Gay-Lussac and Thenard devised the method for quantitatively determining the percentages of carbon, hydrogen and nitrogen. From this grew the knowledge of the high nitrogen content of animal tissues with the exception of fat. This led Liebig in 1841 to suggest that the nutritive values of foods could be estimated on the basis of their nitrogen content. The 'albuminous' or flesh-forming food, he called "plastic" food. In 1840 Mulder interpreted his experimental observations to signify that there was but one 'protein' in nature.

CHEMICAL ANALYSIS OF FOODS:

In 1860 Henneberg and Stohmann devised a system of food analysis which enabled figures to be produced for protein, fat, ash and crude fibre, and what was called a "nitrogen-free extract". It was thought that the analysis represented like nutritive worth in foods regardless of their source, and that the protein and fat from milk, meat and egg had the same nutritive values as those from vegetable sources.

This was followed at the end of the nineteenth century by great interest in protein and energy requirements from which two opposing schools of thought emerged. That led by Voit, Atwater, Benedict and Sir James Crichton-Browne, believed in the merits of high protein consumption, while Chittenden, Irving, Fisher and J.H. Kellogg in America, and Hindhede in Denmark urged abstemiousness in protein eating. Little attention was given to the importance of the inorganic moiety of dietaries.

The Discovery of Vitamins:

J.B.A.Dumas in 1871 in the siege of Paris noticed that babies fed on a 'synthetic' milk, sickened and died. He postulated the idea that a diet which supplied only protein, carbohydrate and fat was inadequate for the support of life. Experiments on mice proved this to be true, whereas those fed only on milk survived for 60 days. Lunin who carried out these experiments stated that milk must contain essential nutrients other than the principal constituents, lactose, casein and milk fat. Pekelharing in 1905 also observed that mice fed on a diet of purified food substances were greatly improved in health by a small allowance of whey. In 1907 McCollum found that rats fed on a diet of purified foods sickened and died when the fat supplied was lard or olive oil, but grew for a time when butter fat or egg yolk was added. This proved conclusively that certain fats contained an essential nutrient, which is absent in others. This factor was known as Vitamin A.

The work of Eijkman and Grijns (1896-1901) was epoch-making. They observed that chickens fed on polished rice developed multiple neuritis, with head retraction and paralysis, which quickly improved if they were given unhusked rice or water or alcohol extractions of rice polishings. Eijkman noticed the similarity of certain of these symptoms to human beri-beri. In 1910, Fraser and Stanton showed that beri-beri was due to a definite deficiency. Funk in "Die Vitamine" in 1914, proposed his vitamin hypothesis which postulated the existence of a number of unidentified nutrients.

The observations of Lind in 1753 had shown that scurvy could be prevented or cured by fresh fruits or vegetables. Following the pasteurization of milk which became fairly general after 1890, scurvy in bottle fed babies became common. A.F. Hess in 1914 rediscovered the fact that heated foods for infants must be supplemented with fresh fruit or vegetable juices in order to safeguard the health of the blood vessels.

Pellagra although known, did not prove a scourge in the United States until after 1900. Opinions differed widely as to its causation. Common beliefs were that it was due to eating mouldy maize, that it was an infection, that it was a manifestation of sensitization to sunlight, or that it was due to the bite of the stable fly.

Joseph Goldberger showed that the disease was caused by a deficiency in the diet. The solution was achieved through the experimental production of the disease in an animal followed by systematic study of the factors involved in its aetiology. T.N. Spencer in 1916, demonstrated that "blacktongue" in dogs could be cured by milk, meat and eggs. Goldberger demonstrated the association between blacktongue in dogs and pellagra in man. In 1938, Spies and others showed that pellagra was curable by the administration of nicotinic acid (niacin) or its amide.

Rat pellagra ("Rat acrodynia" György) was not cured by niacin, but was found to be due to a deficiency of pyridoxin, which had formerly been known as Factor Y, Factor 1 and Vitamin B_6. It was named pryidoxin at the suggestion of György. True rat pellagra was shown by Chick and her associates in 1938 to be curable either by niacin or tryptophan, and also that tryptophan can be converted into niacin in the body.

Nicotinic acid was known to organic chemists for some years before its physiological significance was realised. Riboflavin was known to Blythe in 1879, and was described in some detail by Bleyer and Kallmann in 1925 - both investigators secured it from whey.

The "yellow enzyme" of Warburg-Christian was shown to serve as an oxygen transport system between molecular oxygen and the substrate. In 1932 Bourquin and Sherman devised a diet for assaying vitamin B_2 (vitamin G was another term) which later became known as riboflavin. Ariboflavinosis in man (Spies et al 1940, Sebrell and Butler 1939) is evidenced by cheilosis, eversion of the lips, fissures at the mouth angles, scaly greasy desquamation about the nose and ears, and also a sensation of roughness in the eyes and itching, burning and photophobia. The cornea is often invaded by capillaries and the symptoms often complicate pellagra. Riboflavin participates in at least 18 enzyme systems, so if a true deficiency could occur it would result in profound metabolic disturbances.

Biotin (Bios 11, vitamin H and co-enzyme R) was found to inflict a severe injury on the skin of rats, if fed a diet deficient in this fraction. It occurred if rats were fed raw egg white and a deficiency caused eczematous dermatitis, alopecia, blepharitis, spasticity and haemorrhages into the skin. Egg white contains avidin which binds biotin and prevents its absorption from the digestive tract. Biotin was synthesized by Harris and his associates in 1943 and symptoms of deficiency were produced experimentally in men by Sydenstricker and his colleagues. Biotin is an essential nutrient for mammals, birds and yeasts.

Pantothenic acid was described by Williams and named because of its wide distribution in nature. It is an essential nutrient for mammals and yeasts. A deficiency dermatitis in chicks has been described and a loss of colour of the hair has been seen in deficiency states in rats and foxes. It was known as "co-enzyme A" (A for acetylating), and where failure of acetylation occurs in several metabolic steps, profound physiological disturbance results.

Para-amino benzoic acid was also known to organic chemists, but in 1940 it was shown by Woods and Fildes to be essential in bacterial metabolism, and the following year Ansbacher showed that its presence in a diet in rats could cause new hair to be black, where previously, despite the presence of pantothenic acid, the hair was turning grey.

I - inositol was found to be widely distributed in animal and plant tissues, and was found to be an essential nutrient for yeast, and for the maintenance of a good coat in mice.

Folic acid: In 1931 Lucy Wills described a macrocytic anaemia in women in India, alleviated by giving extracts of yeast. Mitchell extracted a substance from spinach which was essential for the growth of certain bacteria and gave it the name folic acid. It is also of benefit in the anaemia of sprue, but does not relieve all the symptoms of pernicious anaemia.

Vitamin B_{12} was discovered as a result of the extensive studies directed to the isolation from liver of the factor responsible for producing remission in pernicious anaemia. In 1948 E. Smith isolated the active principle from liver, and in the same year Ryckes crystallised a red cobalt containing substance which was called B_{12}. Apart from its effects in pernicious anaemia it functions in many metabolic processes. It is able to bond certain other organic complexes so that there is a shifting of radicles, the end result of which is a synthesis of the sulphur containing amino acid, methionine. Methionine is an essential amino acid. It can be synthesized by the rumen bacteria of ruminants provided inorganic compounds of cobalt are present. In man, the complex organic substance B_{12} must be supplied however, as the intestinal flora do not effect this synthesis. Diets of vegetable origin which contain proteins of low biological value can be greatly improved by supplementing with an animal protein, or the provision of B_{12}, which is effective in very minute amounts.

Fat Soluble vitamins:

In 1919, E. Mellanby demonstrated that the diet of puppies could be adjusted so that they either did, or did not develop rickets, and offered evidence that some fat soluble substance could prevent or cure the disorder; he thought that it might be vitamin A.

The importance of the ratio between calcium and phosphorous and the production of rickets was demonstrated by biochemists and paediatricians at John Hopkins University between 1918 and 1922. McCollum and others showed that a factor apart from vitamin A was partly responsible for the production of experimental rickets, and that it functioned by regulating the content of inorganic phosphate ions in the blood plasma. It was called vitamin D, as by that time the accessory food factors, A, B (anti-beri-beri factor) and C were known. It was found to be abundant in several fish livers, and occurred too in butter. Animals in direct sunlight while kept on rickets-producing diets had no bone defects. In 1927 various workers reported that the precursor was ergosterol, the principle sterol in oil of ergot, yeast and other fungi, and occurring widely in nature in smaller amounts. Other sterols when activitated, possess anti-rachitic properties, so several forms of vitamin D are known.

Vitamin E.

Sterility, premature delivery, and foetal death before or at term, had often been observed by nutrition investigators. H.M. Evans and his associates showed that one cause was a deficiency of a nutrient, "substance X", later named vitamin E (1922). Evans introduced histological techniques into this nutritional study, and these were the earliest studies of that kind.

Various paralyses in rats, and muscular dystrophy in rats and guinea pigs were ascribed to deficiency of vitamin E, or alpha-tocopherol. A long debate has ensued as to whether vitamin E deficiency plays any roll in human metabolism, but it is felt by McCollum that tissue alterations and perversion of function occur where deficiency is marked.

György and his associates (1949, 1952) demonstrated haemolysis of red blood cells in adult rats deficient in vitamin E, and newborn rats, from mothers on normal diets, in the presence of dialuric acid, allantoin or hydrogen peroxide. Vitamin E protects the red cells against these reagents.

Vitamin K.

Delayed clotting time in chickens was noticed between 1929-31 by Dam, Horvath and McFarlane working independently. Dam in 1934 found that cerebral haemorrhages in chickens fed on a certain type of diet were due to a deficiency of prothrombin. He gave this factor the name of vitamin K, and traced it to the non-sterol fraction of the non-saponifiable fraction of pig liver fat. In 1939, Almquist and others respectively identified several napthoquinone derivatives which in different degrees possessed the properties of naturally occurring vitamin K. It was later shown that a bacterial synthesis of vitamin K exists.

New viewpoints on Protein nutrition after 1900.

Mulder, Liebig, Voit and others had assumed that all sources of protein had the same nutritive value. That this was not so had actually been shown by Braconot in 1818 who crystallised glycine from gelatin, and leucine from the hydrolysis of muscle or wool with sulphuric acid.

Nasse in 1872 hydrolysed with sulphuric acid several kinds of protein from plant and animal sources. Arginine was isolated from germinating seeds in 1886 by Schulze and Steiger. Lysine and histidine were discovered by other workers shortly after.

The importance of tryptophan in nutrition was shown by Willcock and Hopkins in 1906. Hopkins and Cole showed too that zein, the principal protein of maize, lacked tryptophan and on a synthetic diet in which zein was the only protein mice only survived 14 days, but lived for 28 days when tryptophan was added. The later studies of Hopkins, Osborne and Mendel dramatised the fact that proteins were in fact as different in biological values as the chemical analyses had suggested.

McCollum in 1912 showed that by adding calcium, casein and butter fat to the maize diet fed to pigs, their general condition was greatly improved. The same facts applied if wheat or rolled oats were the cereals used. McCollum and his associates followed up this work by demonstrating the fact that the leaves of plants were differently constituted from seeds and that cereal diets were greatly improved by adding green forage.

<u>The essential fatty acids</u>:

Between 1840 and 1850 a controversy raged between French and German chemists over whether animals could synthesize body fat from carbohydrates. Liebig maintained that that was possible. Analytical data showed that animals laid on more fat reserves, or gave out more fat in milk than was contained in their food. The fact that animals can synthesize fats and use them as sources of energy led nutrition investigators to believe that there was no physiological need for fats in the diet.

In 1913 it was discovered that certain fats contained an unidentified essential nutrient. In 1929 Burr and Burr gave a fat free diet to rats and on which the rats failed to thrive. A supplement of fatty acids caused their recovery. They found that linoleic acid

(2 double bonds) supplied the nutritive needs of animals. Later studies showed that linolenic (3 double bonds) and arachidonic (4 double bonds) could replace linolenic acid. Turpeinen in 1938 proved that arachidonic acid is the indispensable nutrient and that it can be synthesized in the body when either of the others named is provided in the food.

Inorganic elements in nutrition:

Iodine was discovered by Courtois in 1811 and used by Coindet in 1820 for endemic goitre. Baumann in 1896 showed that the thyroid gland contains more iodine than other tissues. It was shown later that iodine is an essential nutrient (Marine and others) and where iodine is deficient in water and soil, perversion of thyroid function follows.

Copper was shown by botanists in 1917 to cure or prevent exanthoma of fruit trees. Hart and his associates in 1925 limited young animals to milk and noticed they developed anaemia. The ashes of corn, lettuce and liver cured the anaemia and iron did not. They proved that copper was an essential nutrient in the absence of which iron cannot be utilized for conversion into haemoglobin.

Manganese deficiency in rats causes testicular degeneration. In poultry in the growing period, manganese deficiency causes skeletal defects and low egg hatchability.

Zinc: In 1937 Hubbel and Mendel observed beneficial effects in young rats when zinc was added to the diet. Hart and his associates demonstrated that it was an essential nutrient in animal nutrition.

Zinc is a constituent of carbonic anhydrase, an enzyme, which in the blood catalyses conversion of carbonic acid to carbon dioxide and water. It is associated with insulin and five other enzymes. Zinc is also positively correlated with thiamine and may be partly responsible for the polyneuritis which occurs in thiamine deficiencies. The uric acid content of the blood was found by Hart to be twice normal in the presence of a deficiency of zinc and could be restored to normal by providing zinc. It is also associated where deficient, with a dermatitis in swine.

Cobalt deficiency causes a nutritional anaemia in sheep and cattle. In Australia it is known as Morton Mains disease, and in other parts of the world as pines, or bush sickness. Only ruminants are able to utilise inorganic salts of cobalt; man, omnivores, and carnivores must obtain it in the form of an organic compound, and this is mentioned in the paragraph on vitamin B_{12}.

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It is likely that molybdenum and selenium are essential elements for animals and molybdenum is known to be an essential nutrient for plant nutrition.

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Physiological chemists were led by the results of many experiments to conclude that both the vitamins and trace elements or micronutrients perform their most important functions in the nutrition of plants and animals by participating in catalytic functions in enzyme systems. Certain of these determine the paths and steps in carbohydrate metabolism; others play similar roles in fat and amino acid metabolism and include both anabolic and catabolic processes and so determine the metabolic characteristics of organisms having different enzyme patterns.

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Educating people in nutrition:

Health is universally acknowledged to be a precious possession and no one now doubts the importance of nutrition to health. Many people however, who accept sound teaching in principle, are deficient in awareness of the importance of right eating, and are not sufficiently interested to alter established habits to realise the rewards which nutrition has to offer.

The establishment of sound eating habits in childhood affords the greatest promise of success in safeguarding health through the right use of foods.

Understanding the chemical working of living things connotes discovery of techniques for preserving their integrity and harmony, and the realisation of perfection of physiological well-being. The path to success in the management of one's life so as to promote optimum physical well-being from birth to old age, lies in the application of all available knowledge of foods, in sound systems of dietetics.

Other Literature:

The most valuable specialist literature to be examined prior to an investigation of this kind was of South African origin. The reasons for this are fairly obvious. South African conditions are specific to South Africa in terms of the people and their background and their state of development. Special difficulties lie in the capacity for communication between Europeans and South African natives being limited by language and, very emphatically, by educational levels. There is little in common between these natives and the present industrialist communities of Western Europe or America. The most important studies which would have a direct and detailed bearing on the problem we were to study, were necessarily of South African origin.

Of the literature which was not of South African origin the following items were of special interest, and are summarised briefly for that reason.

(1) Smith, Dean A. & Woodruff M.F.A.[3] (Deficiency diseases in Japanese prison camps).

The problems of nutritional oedema, due to protein deficiency and the oedema of beri-beri are discussed. Reference was made to the deficiency syndromes relating to inadequate intake of the vitamin B complex, e.g. orogenital syndrome, manifestations of the pellagra symptom complex, burning feet, and those of more doubtful etiology, e.g. keratitis, corneal degeneration, and disorders of the central nervous system, including retrobulbar neuropathy. The vulnerability of nerve tissue soon became apparent under the imposed dietary restrictions. Peripheral neuritis, single nerve palsies and the neuritic form of beri-beri were all recorded, as were cases of spastic paraplegia and haemorrhagic encephalitis.

Nutritional anaemia was recorded, as were manifestations of vitamin A deficiency and a number of other conditions of doubtful etiology. Some of the most troublesome symptoms recorded in the latter category were constipation, nocturnal polyuria, dyspepsia, irritability of the skin, blood blisters in the mouth, hernia and chilblains. Fatigability of the eye muscles, the premature onset of presbyopia and the fact that myopia appeared to progress abnormally rapidly, were mentioned.

(2) Bartley, W., Krebs, H.A. & O'Brien J.R.P.:[4]
(Vitamin C requirement of human adults).

This investigation was conducted on twenty volunteers. Scurvy developed in all those completely deprived of vitamin C, but could be quickly relieved by a daily dose of 10 mg. ascorbic acid. The 20 volunteers received a diet containing less than 1 mg. vitamin C a day. Three received a supplement of 70 mg. vitamin C, seven received 10 mg. a day, and ten had no supplement. No signs of deficiency were seen in those receiving supplements. The period of s tudy was fourteen months.

Signs of scurvy in the deprived group developed gradually. 17 weeks after the start of the trial, enlargement and keratosis of hair follicles occurred, leading on to the characteristic haemorrhagic scorbutic spots. Gum changes appeared after 26 weeks. Acne in five was greatly aggravated, starting after the 22nd week. Effusion into both knee joints occurred in one case, and cardiac complications were recorded in two. Pains in the back, joints and limbs were common.

10 mg. vitamin C daily given to 6 of the scorbutic volunteers removed the clinical signs of scurvy in all cases. The scorbutic spots faded within 2 weeks, the gum lesions resolved within 14 weeks. 10 mg. of vitamin C per day were thus regarded as the minimum protective dose, and to cover individual variations, a dose of 30 mg. per day, in keeping with the League of Nations Health Organisation Technical Commission on Nutrition 1938, was suggested. The National Nutritional Council U.S.A. in 1948 recommended an allowance of 75 mg per day.

(3) Hume E.M. & Krebs H.A.:[5] (Vitamin A requirement of human adults)

Sixteen volunteers received a diet virtually devoid of vitamin A and carotene, seven other volunteers served as controls, having the same diet but receiving a supplement of vitamin A, or carotene. The trial lasted 2 years. After 8 months there were no discernible changes in the volunteers beyond a lowering of blood carotenoids. This was followed by a drop in the level of vitamin A in the plasma, and a deterioration in the capacity for dark adaptation. No other unequivocal signs of deficiency were found in any of the sixteen deprived subjects at any time during the whole course of the experiment. Such abnormalities as follicular hyperkeratosis, conjunctival degen erations, or undue fatigue, all commonly associated, or thought to be associated with A deficiency, were either absent or equally present in the deprived and the non-deprived group, or present in the same subjects both before and after depletion.

It is clear that vitamin A deficiency is much less easily or rapidly induced in hitherto well-fed adults, than has previously been supposed. The scope of the investigation did not of course apply to children, pregnant or nursing mothers, or the chronically under-nourished.

2,500 I.U. of vitamin A per day were tentatively suggested to cover individual variations and to leave a margin of safety. If a single value of carotene is put forward, the authors suggest 7,500 I.U. per day, but stress again that this does not necessarily apply to children, pregnant or lactating women, and diseased persons.

(4) Dean R.F.A.:[6] (Plant proteins in child feeding)

Mixtures of cereals and legumes may largely replace milk protein in the diet of children, in countries where milk is scarce. He stresses that for protein supplementation to be a success, all the amino-acids must be present simultaneously. Rats fed on yeast and gluten together, thrived; if fed alternately at 10 hour intervals, no growth occurred. Similar results were obtained with skimmed milk powder as a supplement to bread.

The heat effects on proteins are discussed, and mention is made of the vulnerability of lysine. Autoclaving and cooking under pressure followed by sudden release of pressure was particularly harmful. Boiling of soya bean meal for 12 hours, or careful dry heating, actually seemed to increase the amount of amino acids which could be released by subsequent enzymatic treatment. This is due probably to inactivation of the trypsin inhibitor. Similar results were obtained with haricot bean and cottonseed meal. The changes caused by heat appear to be in the way in which amino acids combine with reducing sugars at different states of humidity and temperature.

Dean[6a] mentions the preparation in East Africa of a locally available protein food for children. 45 parts of groudnuts, 20 parts of maize flour, 12 parts of cane sugar, 8 parts edible oil, 15 parts of dried skimmed milk powder, are all cooked together to form a biscuit. This is essentially a cheap food, and can be used in a variety of ways. If ground to a powder and mixed with water, it becomes either a thick or a thin porridge, or a milky drink. It can also be stirred into flavouring agents and used as a gravy. It keeps well and is less likely to be shared by the whole family than skimmed milk powder. Trials showed that 15 parts of skimmed milk was the best proportion of animal protein.

SOUTH AFRICAN LITERATURE

Many writers have drawn attention to the problem of malnutrition in South Africa, and references are used throughout the work. The preliminary background to our reading and knowledge was gained in various directions, and is acknowledged at this juncture.

(a) **Nutrition:** (Cluver E.H. 1939[7], Fox F.W. 1939[8], Gillman, J. 1950[9], Odendaal W.A. 1948 & Theron[10], Brock 1946[11], and Brock & Latsky 1943[12])

(b) **Amino acids & vitamins:** (Cawston F. 1940[13], Golberg,L.194[14] Odendaal W.A.1949[15], Golberg L. & Thorp J.M.[16] [17] [18] [19] Berstein R.E. & Wiener J.S. 1937[20], Brock 1942[21] Walker A.R.P. & Arvidsson U.B.1951[22], Fox F.W. 1936[23])

(c) **Social Welfare:** (Maister M.[24])

(d) **Deficiency diseases:** (Squires 1941[25], Gorvy S. 1951[26], Brock 1943[27], Laidler 1938[28], Gillman J.&T, Till W.M., Mandelstam & C.Gilbert[29], Gilbert C. & Gillman J.[30])

(e) Diet & Metabolism: (Gillman J.1944[31], Gillman T.& J, Mandelstam[32], Fox F.W.1934[33])

(f) Dietary requirements: (Buttner E.B.[34], du Plessis A.J. Wall, G.v.d., Smit R.J.[35], National Nutritional Council 1942[36]).

(g) Cereals & Bread: (Seath, W.1943[37], Walker A.R.P. & Arvidsson Ulla B. 1950[38], le Riche F.J. & H. 1946[39], Walker A.R.P. 1951[40])

(h) Kaffir Beer: (Fox F.W.[41], Fox F.W. & Stone W. 1937[42])

Further discussion of the literature at this stage is not intended, but it is proposed instead to mention some of the signs and symptoms which might lead one to consider a diagnosis of malnutrition, or undernutrition.

SIGNS AND SYMPTOMS OF MALNUTRITION

It is realised that great difficulty is experienced in apportioning specific symptoms and signs to particular deficiencies. In 1931, the German clinician, von Bergmann, remarked that it was only on the dissecting table that undernourishment can be proved![47] The examinations in the factory series were purely clinical ones, and it was unfortunately not possible to support impressions with corresponding laboratory investigations.

Hair changes:

Moni 1904 mentioned "die Kopfhaare glanzlos" -

or dull staring hair. The hair in kwashiorkor is characteristically lighter, straighter and in some cases of a reddish or golden tint. The texture too is changed, and the hair often feels brittle or soft. We have observed a scantiness of hair often in children, with the result that the scalp is not adequately covered. The adults examined in this study did not show any characteristic hair changes.

Eye changes:

Many signs have been described, the most common being circumcorneal vascularisation and linear striation of the conjunctiva. This is described under ariboflavinosis and under vitamin A deficiency. This linear thickening of the conjunctiva is seen often after years of exposure to heat, dust, smoke and sunlight.[43] Xeropthalmia is taken to mean a dryness of the cornea and conjunctiva, and is seen in vitamin A deficiencies. Bitot's spots (chalky white, foamy spots) at the limbus conjunctivae are mentioned by Radhakrishna Rao[44] and McLaren.[43]

Extension of the xerosis to the cornea results in keratomalacia. Night blindness is described too in cases of vitamin A deficiency, as is angular conjunctivitis. This symptom often occurs in association with muco-cutaneous lesions elsewhere and is frequently described as being due to ariboflavinosis.[44]

A patchy or diffuse pigmentation of the conjunctiva is often seen in children and adults, but the clinical significance and etiology are doubtful. Pinguecula and Pterygium, two common eye conditions and often seen locally are not regarded as having any nutritional significance.

Face and Scalp:

Enlarged parotids have been described in undernutrition.[1,43,45.] These swellings are usually painless, and the swelling is usually soft. An associated enlargement of the male breast is also mentioned,[45] and this sign is often observed in the Bantu, but one is uncertain of its exact significance. The enlarged parotids described in the German study[45], slowly subsided as metabolic equilibrium was achieved. A different swelling of the parotid has also been described where the swelling occurred at the time when starved people were being fed additional rations. This is probably a hypertrophy due to additional work.[45]

Naso labial follicular hyperkeratosis is often seen in conditions of malnutrition, and a suggested relationship between deficiency of vitamins A, B complex or vitamin C has been postulated.

Aggravation of acne vulgaris and mild persistent furunculosis are often mentioned. Enlarged cervical, lymph glands, particularly in the poorer sections of the population have been described in South African surveys during and after the 1939-45 war. A prickly condition of the scalp due to a follicular hyperkeratosis is commonly mentioned.[45]

Mouth Conditions:

A description of our own cases appears in chapter five, and at this stage mention will be made of conditions commonly associated with defective nutrition.

Cheilosis, angular stomatitis, and various forms of glossitis are described. The term stomatoglossitis is used later in the thesis. The tongue commonly presents with a raw, red appearance, or a magenta coloured hue. The role of riboflavin, niacin, folic acid and vitamin B_{12} in the causation of these lesions is not yet clear cut.[44] The tongue is commonly glazed (from the disappearance of the filiform papillae) sore and tremulous.[46] Squires[46] describes too a dryness of the mouth and pharynx, and a general pale colour of the gums. This dryness of the mouth has been observed here but on questioning, all men deny that they are conscious of it in any way.

Dysphagia[47] is mentioned as a common feature, but was not observed in our series. Bansi mentions the fact that glossitis and cheilosis suggest an anaemia due to deficiency of iron and vitamins.[47]

<u>Skin signs</u>:

These are also discussed in chapter five, and the intention here is to review some of the signs which have been ascribed to deficiency states. The commonest sign is probably a dryness of the skin. Squires[46] mentions a thickening and glazing of the skin often with hyperpigmentation and best seen over the cheeks. He regards this as a pre-pellagrous condition.

Anderson[48] suggests that an enzyme deficiency, not necessarily related to a deficiency of a specific nutrient, may be responsible for dyspigmentation, hair and nail changes and scaling dermatoses. He points out that hyperpigmentation best seen in the flexures, palms and over scars is common in coeliac disease and non-tropical sprue. It may also occur in secondary malabsorption states, of which protein deficiency with secondary villous atrophy of the intestine may be included. A derangement of tyrosine metabolism has been postulated but this awaits confirmation. Where a true deficiency does exist, he considers that vitamin A deficiency results in follicular hyperkeratosis, and xeroderma. Malabsorption, or deficiency of the water soluble vitamins leads to pellagra-like states, and protein deficiency to kwashiorkor with the mosaic type of skin known as "enamel paint dermatosis". This consists of waxy plaques which later desquamate leaving the dermis exposed.

McCance and Barret[45] working in Germany made several comments about skin conditions. A dryness of the skin covered in some cases by a fine scurf was noted, as was a "crazy pavement" type of picture which Williams described in 1933 when discussing kwashiorkor. Spiny excrescences, particularly over bony prominences were seen, hyperkeratosis pilaris was seen commonly, as was phrynoderma, in which plugging of hair follicles with flakes of shed epithelium occurred. Desquamation of the skin and itching were also observed. Mention is made of the uncertain etiology of these lesions, but that vitamin A deficiency is commonly blamed. Other suggestions revolve around a deficiency of the B vitamins or vitamin C. Cold, trauma, vascular changes or lack of calories would all demonstrate similar lesions to those discussed; so would a fat-free diet. Patchy pigmentation of obscure etiology was a feature of many of the cases seen in Wuppertal, as were transverse fissures, permanent goose flesh and chronic ulcers of the legs.[45]

Desquamation of the skin, called "giraffe skin" is discussed by Radhakrishna Rao[44] as being due to vitamin A deficiency - the large scales separating easily. He also calls the dry icythosis on exposed areas "fish skin". When discussing the papular eruption (phrynoderma) which occurs at hair follicles and is best seen over the antero-lateral aspect of the thighs, and the postero-lateral aspect of the arms, he also mentions the lack of fatty acids as a causative factor. Changes occur too in the nails - pitting, opacities, partial or complete onycholysis and paronychia.[48] No nail changes were recorded in our series.

Teeth:

Caries has been mentioned as resulting from a defective diet, and in many of our cases there appeared to be a defective dietary intake. Examination of underprivileged children at district surgeoncy, and Local Health Commission clinics has strongly influenced one, as the rate of dental caries is particularly high. In a recent study of Bantu school children, we found that 53 Bantu children between the ages of 6 and 12, exhibited suspicious muco-cutaneous stigmata of defective nutrition, and 27 had carious teeth out of a total of 74 examined. No skeletal evidences of deficiency were found.

General symptoms and signs:

Here one enters a large field and a brief review only will be attempted. Vague muscular pains and backache are often encountered and Hawkins in 1593 mentioned the "cricke of the backe" as an early sign of scurvy. In an industrial medical service these symptoms are particularly common in the Bantu.

Anaemias have been described extensively, even where iron intake appears adequate, iron deficiency anaemias have been shown, and the question which arises is how much of the iron is biologically available, and how far protein deficiency is responsible for the anaemia?[44] The anaemia of scurvy is wellknown and yet Walker[49] mentions that infantile scurvy is virtually non-existent in prematurely weaned Bantu infants, even those with kwashiorkor, and whose dietary intake contains no vitamin C at all. Their serum levels are normal for vitamin C, and it must be assumed that under specific conditions a measure of intestinal biosynthesis takes place. Scurvy, however, occurs in older children and adults. Parasitism (malaria, ancylostomiasis, shistosomiasis, ascariasis etc.) will aggravate under-nutrition and iron deficiency anaemias. Vitamin B_{12} is often deficient in low protein diets and a macrocytic anaemia may occur. A relative lymphocytosis is described as well.[47]

The subject of oedema in hunger states has been of considerable interest to medical writers, and an early reference appears in Hesiod (c700 B.C.). McCance[45] reviews the subject very well and contributes a section on hunger oedema. In the subjects examined in Wuppertal, there appeared to be an excess of extra-cellular fluid, which fell with recovery. When these subjects stood for 1½ hours, the haemoglobin concentration rose, as did the serum proteins and serum calcium. The serum chlorides dropped. Lying down for 1½ hours had the reverse effect. Prothrombin (a protein) does not show an early fall in undernutrition, so clotting time is not prolonged. In our series, there were only 3 cases of oedema; one was of cardiac origin, one was due to impaired circulation following an old compound fracture of the tibia and fibula, and the other case was of doubtful etiology.

Loss of weight is frequently a feature of undernutrition, bearing in mind that there may be an increase in circumference, particularly of the legs, due to extra-cellular fluid. A slow pulse is often described and in the Wuppertal investigation[45], an average pulse of 58 was found in civilians, but in returned prisoners of war a rapid pulse was observed. An average pulse rate of 77 was recorded in our investigation.

A low blood pressure is a common feature, an average figure of 113/70 being recorded in Wuppertal.[45] Our figure was 130/78. Both in the study in Wuppertal and that of Smith & Woodruff[3], attention is drawn to the frequency of nocturia and polyuria, sufficient in many cases to seriously disturb sleep. These symptoms did not occur in our group.

No special comment could be made on the tendon reflexes after the examination here, but brisk reflexes have been described in other series.[3,45] These were associated in Germany particularly with a tendency to sweat profusely after the lightest exertion. This latter symptom in turn was related to breathlessness on effort, praecordial discomfort and anxiety which was not substantiated by any organic heart lesion, and was labelled as an effort syndrome. In some of these cases and in the Japanese prison camps, an interesting type of insomnia occurred. Sleep would come immediately on going to bed, but wakefulness would intervene in the early hours of the morning. Despite being comfortable in bed (particularly did this apply in the German series) the subject would only drop off to sleep again in the early morning, to wake shortly after, drenched in sweat and thoroughly exhausted. A giddiness, associated with epigastric discomfort and hunger is commonly described. A reduction in sexual potency is seen and this can be confirmed as a result of ones experience of Bantu clinics.

The children in the German series were shorter and lighter for their age than comparative groups in England and America. Otherwise they appeared healthy and lively, and there was no noticeable tendency to suffer from minor ailments.

Osteoporosis and osteomalacia are features of defective nutrition. No evidence of their presence could be found in the German series, or in the factory group which comprises this study.

Where the diet of a pregnant woman is defective, lactation is often markedly impaired. The milk is usually reduced in amount but not in composition. Gunther and Stanier[45] showed that the amounts of vitamin C, riboflavin, and total N in milk of 60 German (undernourished) mothers showed no material difference from the milk of English women between 1941 and 1945. The size of the baby too may be slightly below normal and the period of gestation shortened. This is a common experience in Bantu areas.

McHenry[50] mentions in this connection that our knowledge of nutritional requirements is far from precise, and cautions that to assume that a housewife who requires about 2,400 calories a day of which about 70g is protein, and who only gets 2,000 calories of which 45g is protein, is seriously undernourished, is incorrect. She is probably a little underweight, but otherwise healthy. If in turn she gives birth to an infant, the baby may be a little smaller and lighter than normal but also healthy, because nutrition adaptation has occurred to the special set of circumstances which apply. This adaptation with regard to protein, calcium, iron and other nutrients is known to occur in many parts of the world. Low haemoglobin levels too occur in certain communities and a degree of adaptation to this probably exists. How far apparently successful adaptation occurs, or whether in its presence body reactions are changed and account for subsequent ill health and premature loss of life, cannot at present be answered.

<u>Other effects of defective nutrition:</u>

Yoshimura[51] claims that a low protein intake may have the following consequences: The red blood corpuscles decrease in number, and the percentage of haemoglobin falls. The serum protein falls too in keeping with the drop in haemoglobin. Ratio of albumen to globulin decreases significantly, and the fraction of gamma-globulin may increase. The leucocyte count falls, and a relative lymphocytosis occurs. The volume of body fluids, particularly the extracellular fluid increases, and oedema appears.

The B.M.R. falls. Urobilinogen appears in the urine, indicating impaired liver function. Creatinine clearance is a useful indication of glomerular filtration rate. The following enzymes are reduced: cathepsin, arginase, catalase, xanthine, dehydrogenase and xanthine oxidase. Urinary excretion of 17 ketosteroids falls. Hypofunction of sexual organs is recorded. Degenerative changes have been described in pituitary, adrenal, thyroid, Langerhans' cells, testicle and ovary. The activity of the anti-diuretic substance in the serum increases and may be responsible for an increase of extracellular fluid, or oedema. The anti-diuretic substance (ADS) may increase because of impaired liver function.

The protein bound iodine (PBI) in the serum falls - parallels that of theBMR. Thus a decrease of thyroid activity occurs. The impairment of physiological functions may be attributed to loss of reserve protein in the body.

The plasma and urinary excretion levels of sodium chloride and potassium may be valuable guides to the state of malnutrition.

Hutchinson, McCance and Widdowson[45], in discussing an insufficiency of calories, record a lowering of the P and to a lesser extent the T cholinesterase activities in the serum of man. Serum cholinesterase also falls in liver disease, and in malnourished infants; it rises as the state of nutrition improves.

In large groups the activity of the serum cholinesterase may provide a sensitive index of nutritional status and the response to treatment. Undernutrition, even if fairly severe, does not affect the activities of T cholinesterase, phosphatase, catalase or glyoxalase in the r.b.c's: slight increase in carbonic anhydrase activity was reported in undernourished subjects. No changes were found in the cell enzymes comparable in magnitude or interest with the fall in the activities of P & T cholinesterase which occurs in the serum in undernutrition. (Hutchinson[45]).

Table 1

	Normal Average	"Less" undernourished		"More" undernourished	
		Average	% below normal	Average	% below normal
Whole Blood					
Haemoglobin(g/100cc)	16.0	12.9	19.4	12.2	23.7
Haematocrit(percent)	48.9	41.6	14.9	37.4	23.5
Serum					
Proteins (g/100cc)	6.96	5.76	17.3	5.42	22.2
Albumen (g/100 cc)	4.81	3.62	24.8	3.24	32.7
Globulin(g/100cc)	2.06	2.20	Nil	2.19	Nil
A/G Ratio	2.345	1.745	25.6	1.462	37.7
T-cholinesterase (c.mm.CO_2/cc/min)	1.001	0.956	4.5	0.608	39.2
P-cholinesterase (c.mm.CO_2/cc/min)	73.4	53.4	27.3	32.9	55.2

In undernutrition the sedimentation rates, even where considerable oedema and slight anaemia were present, were normal in the Wuppertal investigation. Other workers mentioned by L.A. Thrussell and R.A.McCance[45] found greatly increased sedimentation rates in conditions of undernutrition, which bordered in fact on starvation.

The provision of adequate calcium, magnesium and phosphorus is important in any diet. Raising the calcium intake facilitates its absorption. Raising the phosphorus intake depresses the calcium absorption, particularly if phytic acid phosphorus is produced, which may occur if extensive use of unrefined cereals containing phytic acid are used.

It is not proposed to make further observations on vitamin deficiencies at this point. Our observations in this survey were of necessity centred round the clinical stigmata of malnutrition.

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Basic Dietetic need.

Many different standards have been compiled and generally acceptance has met with a mixed response. It is true, however, to say that there is no racial difference in requirements, and consequently no distinction between the standards proposed for whites and non-whites should be made.[2]

Nutrient requirements are influenced by sex, age, activity, ideal weight, external temperature and other factors. There is, too, a close relationship or interaction of the different nutrients, e.g. the thiamine requirement is determined by the calorie content of the diet: both folacin and vitamin B_{12} play a part in the synthesis of choline, which is essential for the maintenance of liver morphology and function. Vitamin D promotes the absorption and metabolism of calcium; niacin deficiency occurs particularly in diets low in complete proteins because such diets are usually deficient in tryptophan which is a niacin precursor.

It is stressed[2], that dietary standards cannot be used as the only criterion for judging the nutritional state of a person, or group, and that failure to comply with these standards will not necessarily lead to deficiency diseases. The value, however, of dietary surveys is that they indicate where further investigation may be needed, and which dietary defects need most consideration in food and nutrition programmes. The survey under discussion in this thesis, yielded information which called for immediate action on the part of the management of The South African Rubber Manufacturing Company Limited, and as was mentioned in the introductory paragraphs of this chapter, gave an indication of what practical steps could be taken to deal with the problem. These steps are discussed in chapters six and seven.

The recommended minimum daily standards of the National Nutrition Council[2] should be regarded as adequate for the maintenance of health without allowing for a safety margin for ill health, or for great individual differences in absorption and metabolism. These standards for men are given overleaf.

Table 2.

	Calor.	Prot. (g)	Calc. (g)	Iron (mg)	Vit.A Int. Units	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vit.C (mg)
Man(average weight 160 lbs.) moderately active	3,000	65	0.7	9	4,000	1.0	1.6	15	40
Sedentary worker	2,800	65	0.7	9	4,000	0.8	1.6	12	40
Heavy worker	4,500	65	0.7	9	4,000	1.6	1.6	18	40

The figure for calories is obviously an average. There is a natural individual range and the calorie needs should preferably be adjusted to the needs of the individual so as to achieve and maintain his desirable weight. A man weighing 200 lbs. will need more calories than a man who weighs 120 lbs.

Riboflavin requirement is calculated on the basis of 0.025 mg. per g of protein. The thiamine variation alluded to earlier is demonstrated in the table. The metabolic pathways of tryptophan and niacin also referred to, are intimately related. Niacin requirements are usually regarded as being ten times those of thiamine, but in the table above they have been increased because in the dietary pattern of the majority of the inhabitants of this country, the trytophan intake is apt to be low.

If one-third of the vitamin A is present as such, the figure of 4,000 I.U. per day is considered adequate, but 5,000 I.U. per day are advised if only one-fifth is present as vitamin A, and four-fifths as carotene.

All the figures given are for nutrients in foods and do not allow for losses during transport, storage, preparation or serving. Little is really known about these losses, and protein and carbohydrate loss is probably minimal but loss of fat may occur in broiling and roasting. Calcium may be leached out of vegetables during cooking in water, and losses of vitamins, particularly vitamin C, may be high. A table of figures follows indicating the loss of nutrients in cooking.[2] The low figure is for waterless cooking, and the high one when the food is covered with water. Riboflavin and niacin are leached out, vitamin C is destroyed, and thiamine is both leached out and destroyed.

Table 3. Loss of Nutrients in Cooking.[2]

Carotene	5 - 21%)	The men in our series show that their cooking methods involve cooking for a long period of time and all vegetables are covered with water.
Thiamine	9 - 37%)	
Riboflavin	12 - 37%)	
Niacin	9 - 41%)	
Ascorbic acid	27 - 47%)	

Ascorbic acid is progressively destroyed by an oxidising enzyme liberated in many fruits and vegetables after they have been picked, and it is desirable, therefore, that the interval between picking, preparing and serving these products be as short as possible.

Walker and Arvidsson[52] sampled the vitamin C content of stews in Native compounds on the Mines. Open cooking gave a retention of 89%, and pressure cooking a value of 79%. The value chosen in the factory study was 5 mg higher than the minimum figure recommended by the National Nutritional Council. Vitamin D is essential for the absorption and metabolism of calcium and phosphorus. Usually exposure to sunlight is adequate, but where this may not occur, an intake of 400 I.U. per day is recommended. Eggs contain a high level of vitamin D.

Mention has been made of unrefined cereals containing phytic acid, and the effect on the absorption of calcium.

Protein:

The view that a person requires less protein than was previously thought necessary, is gaining ground.[2] If the diet is mainly a cereal one, it should be supplemented by animal foodstuffs or legumes. Where maize is the cereal concerned the protein standard should be raised. Protein is vital for body-building and functioning and for protection against tuberculosis, and probably other infections, and it is advisable that one-third of the protein intake should be of animal origin. Part of this figure can be replaced by dry legumes, which supports Dean's views, which were mentioned earlier.[6a] When calorie requirements are not met, some of the protein is metabolized to provide the deficit, so less is available for body building, protection and regulation.

Yoshimura[51] found that a daily intake of .5g/kg of protein per day was sufficient for an adult, and that .35g/kg should be enough if the quality of protein is good enough to provide a safe level of all the essential amino acids, but this is probably a minimum figure.

The League of Nations in 1935 suggested 1g/kg body weight per day, as did Darke[53] in 1959. In terms of optimum requirement, which is one which maintains normal physiological functions and is not very different from the safe intake or practical allowance, Yoshimura found that athletes doing very heavy exercise required 2g/kg a day, provided that animal protein supplied 25% of the total dietary protein. This figure (2g/kg of body weight per day) prevented reduction of blood protein including haemoglobin.

Calcium:

Nutritional adaptation has already been referred to, and it has been mentioned that calcium intake in parts of the world is very low. Where this applies the body may function effectively at levels of calcium intake considerably lower than normal. In South Africa intakes are often one-third of recommended allowances, and mention will be made of this in chapter 8. There is no evidence of any syndrome caused solely by calcium deficiency or remediable by calcium supplementation only. However, a negative calcium balance is liable to occur (in studies on well-nourished white people) if the intake is below 10 mg. calcium/kg body weight.

Dean suggests 1g a day as an average requirement. The British Medical Association Committee on Nutrition 1950 recommended 1.5g daily in late pregnancy. Arroyave[54] states that the optimum intake of this mineral is unknown. Thomson[55] working in Scotland, found in a dietary survey involving primigravidae of 3 different social strata, the intakes of protein and vitamins A, B & D were adequate, but that in the lowest social stratum the intake of calcium was low 0.92g/kg instead of the 1.5g recommended by the British Medical Association above. In our study, a figure of 800 mgm per day was selected and the impression created was that many men did not achieve this figure.

Iron:

The precise requirements here again are not established, but it is known that iron deficiency anaemia is commoner in women than men, and reference has been made to anaemia in states of defective nutrition. When the intake of other nutrients is satisfactory, there is no difficulty in obtaining the level of iron recommended. An additional 3 mg per day is advisable in pregnancy. There is evidence that a considerable number of Bantu people receive a theoretical excess of iron in the diet, from the use of iron pots. The figure of 12 mgm per day was accepted in the factory group.

Fat:

The fat should produce 20-30% of the total calorie intake, and for children, adolescents and very active adults, it might constitute 30-40% of the calories. High fat diets are seen in conditions of economic privilege, and have their dangers in middle age and sedentary occupations. This factor however is not of immediate concern in our series, and in fact the subject of fat intake was particularly difficult to cover. The impression created was that very little fat is taken, but this is not considered to be necessarily correct. The essential fatty acids, linoleic, linolenic and arachidonic are easily covered where fat provides 20% or more of the calories in a diet. This is discussed also in chapter four.

<u>Carbohydrates:</u>

Among western populations, carbohydrate usually supplies less than half the total energy value of the diet. This does not apply among the poorer sections. Nor does it apply among many tropical and sub-tropical populations, where carbohydrate may contribute three-quarters or more of the calorie requirements. In these conditions the practice of refining cereals to produce a flour of improved appearance, palatability and keeping quality, is to be deplored. The protein quality is greatly reduced and there are losses of mineral salts and vitamins. Of particular interest is the loss of thiamine which is essential for carbohydrate metabolism.

Where adequate provision in a diet is made for proteins, and B vitamins from natural sources, there will be no deficiency of pyridoxine or other members of the B complex, as successful vitamin therapy depends on the presence of adequate protein. This was stressed by Latsky.[56]

Further consideration of the basic dietary needs is undertaken in the chapter on diet, but it is considered appropriate to conclude this section with a food balance sheet, published in 1951,[57] and our own figures.

Table 4.

Nutrients:	Per Capita daily requirements. European, Coloureds & Asiatics:	Bantu:
Calories	2,500	2,900
Protein (gms)	66	66
Fat (gms)	70	65
Calcium (gms)	1	1
Iron mgm	12	12
Thiamine "	1.28	1.28
Vitamin C "	36	36
Vitamin A I.U.	3,250	3,250

These are weighted figures, i.e. an average representing the requirements of the various groups based on age, sex and activity. Considered in that way the figures are comparable with the table published in this section (Table 2) and our own figures which follow. The distinction between Bantu and others is of importance only in that a higher calorie intake is accorded the Bantu.

Table 5.

Calories	SARMCOL Survey : Daily requirements. Protein (g)	Calcium (g)	Iron mgm	Vit A I.U.	Thiamine mg	Riboflavin mg	Niacin	Vit C mgm
[illegible],500	70	0.8	12	4,000	2.0	1.5	15.0	45

CHAPTER 3 : PART TWO

The first part of this chapter has discussed the literary background, the medical considerations which might justify a diagnosis of malnutrition or under-nutrition, and has given a brief survey of certain dietetic requirements.

General remarks of an introductory nature concerning proteins and kwashiorkor follow. A fuller discussion appears in Part 11, Chapter 4 and in Chapter 5.

THE PROBLEM OF PROTEIN MALNUTRITION AND UNDERPRIVILEGE

It is intended to use Brock's[58] classification of the clinical results of malnutrition to further this discussion.

(1) Subnutrition: (subclinical malnutrition).
 (a) Without demonstrable biochemical abnormality.
 (b) With demonstrable biochemical abnormality.

(2) Reversible clinical syndromes of malnutrition.

(3) Irreversible structural damage.

(4) Constitutional susceptibility (diathesis) from chronic malnutrition.

The latest trend in nutritional thinking has been to place an emphasis on the importance of the quality or make-up of proteins, fats and carbohydrates. These three should be regarded not as nutrients, but as constellations of nutrients.[58]

Whilst protein malnutrition is most evident in the post weaning period, it is reasonable to assume that it may have effects on constitutional susceptibility at all ages. It is with this thought that our study developed further, leading on to a consideration of diet, a discussion on build, height and weight, a reference to sickness records and a poverty datum line applicable to our own people.

Kwashiorkor. (Mehlnährschaden, sindrome pluricarencial infantil)

It is agreed that kwashiorkor means "the deposed child".[1] The condition is very common amongst the Bantu in Natal. It is particularly common in summer, and poverty, bad housing, deprivation of maternal care, high illegitimacy rate and ignorance are all contributing causes. An associated infection e.g. measles, or dysentery in a child maintaining a precarious nutritional balance on a grossly inadequate diet may precipitate kwashiorkor.[1,59] There are many pre-kwashiorkor cases for every case of kwashiorkor, and all these children have partially impaired health and increased susceptibility to infantile diseases like gastro-enteritis and respiratory conditions. Many will obviously not survive; infection and other stresses may precipitate irreversible deterioration, (Group 3 of the classification) and death.[1,58]

With the development of teeth, however, and increased physical activity, the child will achieve a better intake of protein, and having a lesser requirement of protein per 100 calories by comparison with its infancy, it will begin to pick up the retardation of growth which it experienced in the first 3 or 4 years of life. It is reasonable to assume however, that full vitality and normal development will be permanently retarded through minor degress of continuing protein malnutrition.[1,58]

Kwashiorkor will represent Group 2 of the classification of malnutrition, i.e. a reversible syndrome of malnutrition. If protein undernutrition is universal in the community, the older children up to puberty, and young adolescents, and some adults will fall into Group 1, i.e. subnutrition in which impaired health can be improved by better feeding. The subgroup (b) with biochemical abnormality will be represented by those who have hypoalbuminaemia (definite or marginal). Others may show no biochemical abnormality (subgroup (a)) but balance studies on a good diet may show nitrogen retention greater than normal.

The picture of irreversible malnutrition, Group 3, is not so clear cut, but reference has been made to the effects of infection and other stresses which may precipitate irreversible changes culminating in death.

In primitive communities without the benefit of public health services mortality of kwashiorkor may be as high as 90%. Personality changes and impaired mental capacity as a sequel to protein malnutrition are a reality, as nerve tissue is more susceptible to irreversible change than most other tissues. This is mentioned later. Where community figures for mean height and weight which are below similar figures in privileged communities occur, and where diet is liable to cause kwashiorkor it is probably reasonable to assume that irreversible retardation has occurred during the growth period. Many factors, dietary and non-dietary enter into this end result of underprivilege.

Protein undernutrition has two distinguishing points:

(Brock)

(a) It is due to over-dependence on starchy foods.

(b) No combination of nutrients will achieve initiation of cure unless it contains a suitable pattern of amino acids.

Other causes of Protein deficiency:

Climatic stresses, psychic stresses, disturbance of the gastro-intestinal tract and of metabolism all help to condition malnutrition on marginal diets. Some of the conditions of gastro-intestinal upset and metabolism were initiated by malnutrition and in turn will have aggravated and been aggravated in a vicious circle. This is especially true in infant diarrhoea. Malnutrition almost certainly upsets the intestinal flora, which in turn paves the way for further bacterial invasion, and gastro enteritis is a common cause of death in Bantu babies.

Where undernutrition occurs and produces marasmus, provision of calories alone must produce an improvement in growth and development which will be slowed or halted by the absence of the most limiting nutrient.[58]

The diagnosis of kwashiorkor in many instances is not in doubt, but anaemia, nephrotic syndrome, tuberculosis and hookworm require to be differentiated.[60]

Two extreme clinical pictures often seen in practice are -

(i) Kwashiorkor; pitting oedema and muco cutaneous lesions.

(ii) Atrophic or marasmic type, with few or none of the above signs. Marasmic kwashiorkor falls in between the 2 groups. The types have the same lethality, respond to the same treatment and recover, following a strikingly similar pattern. Breast milk alone can only adequately nourish a baby up to the age of 20 weeks.[61]

Frenk[61] supports the fact that protein undernutrition can result in impaired mental capacity as shown in the following table:

Table 6.

% of Normal weight.	No. of cases.	Av. Intellectual Quotient.
51-60	8	65.25
61-70	22	69.91
71-80	102	80.50
81-90	88	81.55
91-100	56	86.94
101-110	23	89.39
	299	

Protein is lost by endogenous metabolism and a deficient intake of protein does not allow of the building up of a protein reserve. In the absence of such a reserve it is claimed that the body is unable to cope with the demands made by infections and injury. Protein reserve is therefore considered necessary for optimum protein nutrition. The resolution of the difference between optimum and minimum protein requirements depends still upon further investigation, and average figures only were presented in the section on basic dietetic requirements. Where protein deprivation occurs, skeletal muscle is lost to protect more essential tissue. Decreases in muscle mass are more sensitive than decreases in body weight and height as a result. The use of skeletal muscle, parenchymatous organs and serum albumin for protein reserve, spares cardiac muscle and nerve tissue.

That there are general differences between privileged and under-privileged communities is taken for granted, and some of the effects of underprivilege have been discussed briefly. Other writers have been impressed by the same problem.

J. Gillman[62] mentioned that as a result of maternal malnutrition and the effects of postnatal malnutrition, the entire life track of the African differed very significantly from that of the European. The high infantile mortality rate, the frequent nutritional breakdowns during infancy and especially at the time of weaning, the delayed puberty, the high incidence of primary carcinoma of the liver, in young African males, the great frequency of liver disease and of malnutritional syndromes in adults, the increased susceptibility to infections, frequency of sterility in both male and female and the prematuresenescence and death of the African, could not be attributed to his genetic peculiarities, but were evidence of a perverted development attributable largely to malnutrition. McCoy however, noted that dietary insufficiency may prolong the life of the experimental rat, and delay senescence. Moderate underfeeding also reduced the incidence of spontaneous tumours.[66]

Whilst providing the above patterns of reaction at the same time diseases common in Europeans, e.g. hyperthyroidism, peptic ulcer, gastric carcinoma, diabetes, and coronary thrombosis are decidedly rare. Walker[63] found that the birth weight of present-day Bantu babies is inferior to that of present-day white babies. There is also a higher percentage of prematurity in the Bantu and other non-white population in South Africa. Further, at all ages over 1 year, Bantu are inferior in weight in comparison to present-day whites. Also in contrast with the latter, weight does not increase significantly with age.

Despite the fact that Bantu males in their tribal environment enjoy a reasonably leisured life, under conditions where heavy manual work is required, as for example in the mines and in industry, their capacity probably exceeds that of white workers.[63]

The effects of urbanisation are undesirable in many instances, and here one may mention -

(1) Most Bantu mothers breast feed their babies in rural areas. In townships it is becoming increasingly common for infants to be fed on unsatisfactory proprietary products, prepared invariably in too dilute a strength with resultant semi-starvation.

(2) In rural areas too, few children wear clothes and as a result rickets is virtually unknown. In the Native townships, however, it is a common disease.[63]

Dancaster and Jackson[64] found that the prevalence of rickets in a Coloured out patient population between the ages of 3 and 12 months was certainly over 30% and possibly as high as 80%, depending upon the diagnostic criteria selected. The authors recommend that the most reliable criterion for diagnosis is radiological. A raised serum-alkaline phosphatase level was found by the authors to be the best biochemical index of activity. They concluded that rickets was so common despite the sunny nature of our climate, because of insufficient exposure to the sun in those affected. Another important aetiological factor was the period of breast feeding. There appeared to be a significant increased likelihood of this disease in children who had been on the breast for less than 3 months. It is curious perhaps that this should be so, since both the calcium and the phosphorus content of breast milk is less than that of cow's milk, and breast milk contains very little vitamin D.

Premature infants were not more liable to rickets in their series, nor did the actual intake of calcium appear to have any relation to the development of rickets. The question of a hereditary diathesis was considered possible as the authors noted the frequent occurrence of rickets in several members of single families.

Although the incidence of overt rickets in kwashiorkor does not seem high, Dancaster and Jackson found no support for the popular idea that undernutrition protects against active rickets. In fact, lack of growth affords no protection against rickets whatever.

- - - - - - - - -

To round off these introductory remarks on the subject of protein malnutrition, and underprivilege, the concept of which is basic to our study, the definition of protein malnutrition of the 3rd Joint F.A.O./W.H.O. Expert committee on Nutrition, 1953, is attached. (Quoted also by Brock[65]).

"This term (protein malnutrition) cannot at present be defined within narrow limits. It is used here to indicate in general a state of ill health occurring where diets are habitually poor in protein, while they are more nearly adequate in calories. Clinically, protein malnutrition is most easily recognised when there is a relatively high intake of calories, from starchy foods together with an insufficient intake of protein. The concept includes the effects of deficiency in the quantity of protein consumed, of imbalance of amino acids and deficiency of factors, such as vitamin B_{12}, commonly found in foods in association with animal protein and concerned with protein metabolism."

THE THREE GROUPS STUDIED

Having mentioned some of the factors which provided the essential foundations on which this study was developed, it remains now to consider how the experimental group was arranged, the supplement selected and the reasons for the choice of the supplement.

As was mentioned in the introduction to this chapter, personal discussion and probing formed the basis of many of the opinions expressed. The results quoted in this study, whether they involve the diet, the housing or expenditure, were arrived at as a result of very detailed questioning. The answers were subjected to careful scrutiny and likelihood at times was used to temper improbable exaggerations. In general however, one is satisfied that the answers represent a sincere attempt to portray the background accurately, and are submitted as an honest assessment of that background.

The matters set out so far represent the fundamental preliminaries, and they lead on to a practical conclusion in the succeeding sections.

The Group selected:

The Manager of Non-European affairs interviewed 354 men and finally selected 301. The remainder declined to co-operate for various reasons, and some were actively hostile. The interest, as well as the co-operation of the men was encouraged by a careful explanation of the purpose of the work. How far this succeeded is difficult to judge; perhaps the possibility of a food supplement was more important than the explanation.

After careful explanation of the nature of the investigation, the 301 men mentioned all agreed to participate in the study. Thereafter records were prepared. A record card was evolved showing the medical aspect of the examination on one side and relevant social data on the other side. A photograph of the card is included.

Allowance was made for progressive measurements to be recorded. At no time did we know what group the men belonged to. This process of 'blind' examination was followed at all subsequent re-examinations, in an attempt to avoid prejudice in the interpretation of results, particularly as no actual control group was available.

The group was subdivided as follows:

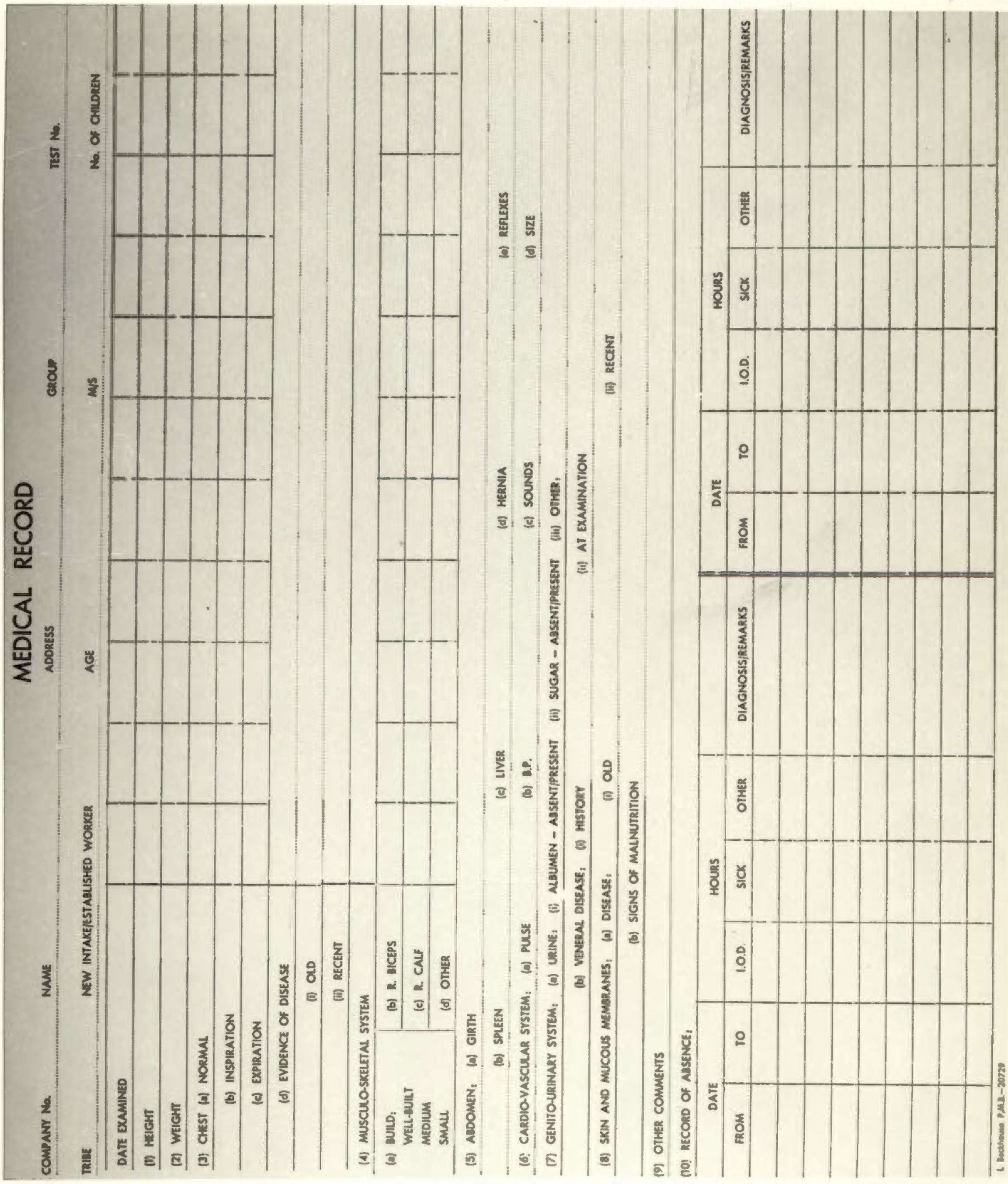
(1) Group "A": Those staying in the Company Compound.
   (a) Initially 100.
   (b) After two years, 81.

(2) Group "B": Those resident in the Howick Native Village.
   (a) Initially 101.
   (b) After two years, 78.

(3) Group "C": Those who lived in other areas. This group, in the main, is housed in poor conditions in the slum areas around Howick.
   (a) Initially 100.
   (b) After two years, 86.

After two years, 245 men out of the original 301 were still co-operating in the investigation. 56 had dropped out for the following reasons.

Medical Side of Record Card



MEDICAL RECORD

COMPANY No. NAME ADDRESS GROUP TEST No.

TRIBE NEW INTAKE/ESTABLISHED WORKER AGE M/S No. OF CHILDREN

DATE EXAMINED										
(1) HEIGHT										
(2) WEIGHT										
(3) CHEST (a) NORMAL										
(b) INSPIRATION										
(c) EXPIRATION										

(d) EVIDENCE OF DISEASE

(i) OLD

(ii) RECENT

(4) MUSCULO-SKELETAL SYSTEM

(a) BUILD: WELL-BUILT MEDIUM SMALL	(b) R. BICEPS										
	(c) R. CALF										
	(d) OTHER										

(5) ABDOMEN: (a) GIRTH

(b) SPLEEN (c) LIVER (d) HERNIA (e) REFLEXES

(6) CARDIO-VASCULAR SYSTEM: (a) PULSE (b) B.P. (c) SOUNDS (d) SIZE

(7) GENITO-URINARY SYSTEM: (a) URINE: (i) ALBUMEN – ABSENT/PRESENT (ii) SUGAR – ABSENT/PRESENT (iii) OTHER,

(b) VENERAL DISEASE; (i) HISTORY (ii) AT EXAMINATION

(8) SKIN AND MUCOUS MEMBRANES: (a) DISEASE: (i) OLD (ii) RECENT

(b) SIGNS OF MALNUTRITION

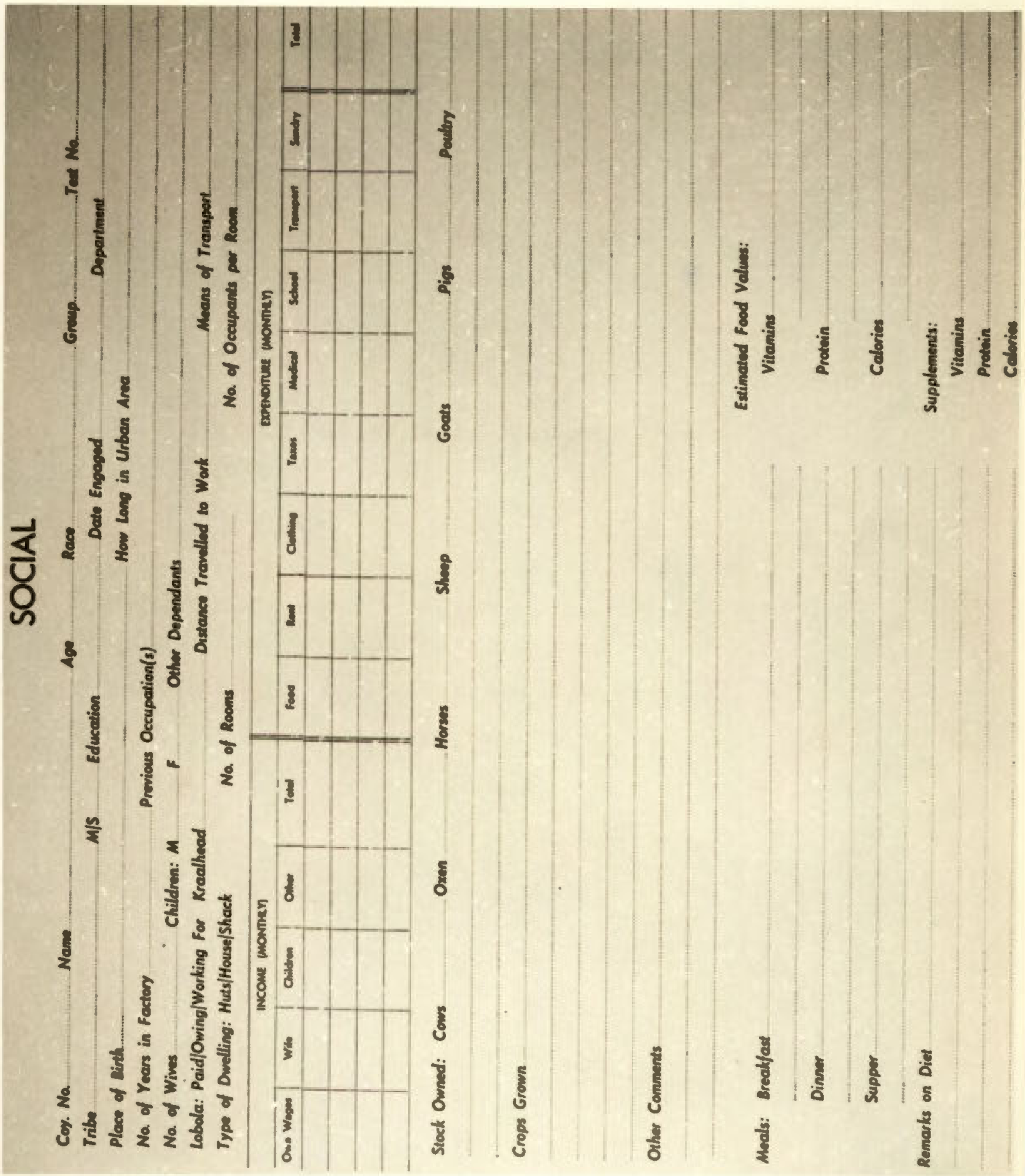
(9) OTHER COMMENTS

(10) RECORD OF ABSENCE:

DATE		HOURS				DATE		HOURS			
FROM	TO	I.O.D.	SICK	OTHER	DIAGNOSIS/REMARKS	FROM	TO	I.O.D.	SICK	OTHER	DIAGNOSIS/REMARKS

L. Backhouse P.M.B.—20729

Social Side of Record Card



SOCIAL

Coy. No. .... Name .... Age .... Race .... Group .... Test No. ....

Tribe .... M/S .... Education .... Date Engaged .... Department ....

Place of Birth .... How Long in Urban Area ....

No. of Years in Factory .... Previous Occupation(s) ....

No. of Wives .... Children: M .... F .... Other Dependants ....

Lobola: Paid/Owing/Working For Kraalhead .... Distance Travelled to Work .... Means of Transport ....

Type of Dwelling: Huts/House/Shack .... No. of Rooms .... No. of Occupants per Room ....

INCOME (MONTHLY)					EXPENDITURE (MONTHLY)								
Own Wages	Wife	Children	Other	Total	Food	Rent	Clothing	Taxes	Medical	School	Transport	Sundry	Total

Stock Owned: Cows .... Oxen .... Horses .... Sheep .... Goats .... Pigs .... Poultry ....

Crops Grown ....

Other Comments ....

Meals: Breakfast .... Estimated Food Values:

Vitamins ....

Dinner .... Protein ....

Supper .... Calories ....

Remarks on Diet .... Supplements:

Vitamins ....

Protein ....

Calories ....

Paid off from the factory	33
Died	3
Irregular attenders	11
Struck off at their own request	9
	56

The first steps were taken in January 1957. An office was provided by the Company. This was equipped with an examination couch, a scale, a height rule, and the necessary reagents for routine urinary examinations. Mr. D. McEwen was made available as a record clerk and assisted throughout the whole investigation. Mr. Elias Xulu acted as interpreter and general assistant.

Choice of a Supplement:

This will be dealt with after the chapter on diet. At this stage, it suffices to mention that a supplement of animal protein with a good aminogram, providing easily assimilable protein, valuable minerals and vitamins, plus a multivitamin tablet which provided at least the daily requirements of vitamins, was selected. This is in keeping with nutritional practice.

A complaint often mentioned was that the supplement (skimmed milk 1 pint, plus a multivitamin tablet per day) caused epigastric discomfort, and even vomiting. Further mention of this is made in the chapter on medical observations. (Chapter five)

McCance et al,[45] in the Wuppertal investigation recorded that a post-war German diet which yielded only 1,052 calories per day, was supplemented in the case of children between the ages of 1-6 years with 500 c.c.

per day of whole milk. This was done because it was realised that the provision of firstclass animal protein, particularly in childhood, was essential.

The next chapter will deal with the food habits of simple rural Africans, transitional diets, modern supplements and the cost of various selected diets.

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CHAPTER 4

DIET

This chapter on diet will be presented in two parts:

PART ONE

PART TWO : Discussion

Part One: THE TRADITIONAL BANTU FOODS

Though the nutritional requirements of the human body are the same, regardless of race, there are considerable differences in the dietary habits by which these nutritional requirements are obtained, in variations, based upon racial or tribal traditions and practice.

The Bantu, in particular, is very conservative and does not change readily to unfamiliar diets and, although he has abandoned many of his traditional foods in favour of European foodstuffs, the basic composition of his menu is generally the traditional Bantu diet with modifications brought about by contact with Europeans, Asiatics and with other Bantu groups.

Many food taboos are observed by Africans who have lived for long periods - even generations - in contact with Europeans. In this Industrial Health Study Test Group, the Zulu Group predominates, comprising over 91% of the total. For that reason, and because basically the diet of all Bantu groups in South Africa is similar, the traditional Zulu foods will be dealt with first. These have been extensively investigated by competent authorities who have published their findings in such works as "The Social System of the Zulus".[1]

The main difference between the Zulu diet and that of other Bantu groups appears to lie in their reluctance to use fish and eggs. There are variations of cooking and brewing methods, as well as in tribal taboos and customs in the use of foods by different age groups and sexes. The staple diet of the Bantu consists of maize (Zea mays linn)[2], kaffir corn (Sorghum spp. cultivated)[2] and amasi (sour milk), with the addition of various herbs, roots and wild fruits. Amasi, in many cases, is the major source of animal protein. Meat (goat, pig, sheep or beef) is always welcomed. Wild game, once common and a major source of animal protein now constitutes a negligible proportion of the diet.

Various types of millet occur in Basutoland, the Rhodesias, Kenya and Tanganyika. These are not a common dietary factor in the Union, and are unknown in Natal. The basic diet is the mealie (Indian corn - Zea mays linn)[2] in various forms, whole milk, soured milk and mfino (spinach) of which there are a great many varieties.

The most common variety is the imbuya (pigweed or amaranthus) a common weed found in cultivated fields. Pumpkin, bean and melon shoots, and many wild spinaches and leaves, are cooked in a variety of ways. They are often mixed with the mealie meal, but often are eaten as an adjunct to the main course. It is the lack of these items which so often causes scurvy in the migrant industrial worker in towns.[3]

Mealies are often boiled green. When the corn is hardening, but still slightly milky, it is ground and cooked in the form of "isinkwa" - a type of bread. This is a very tasty and popular preparation. When dry, the grains of mealies may be boiled whole and are then known as "izinkobe". Home-ground mealie meal is ground when required, by hand, between two stones and contains almost the whole nutritive value of the original grain.

From the home-ground mealie meal, a variety of dishes consumed in every Zulu household, can be prepared. A thick lumpy porridge (uphuthu) is the most popular. A thick porridge made with a mixture of mealie meal and pumpkin is also a popular dish. A thin, soured mealie meal porridge is used in the preparation of "marewu" - a slightly fermented beverage, and in the brewing of "utshwala" (beer). Utshwala, had an important place in the traditional Zulu diet, but owing to Government regulations and missionary influence, now tends to be looked upon less as a food and more as an intoxicating drink. In the Transkei it is known that Native men can, and do, live for a considerable time solely on beer.[4]

In the reserves and rural areas, utshwala is still made in accordance with established Zulu customs, but the illicit home-brews made in and around towns are invariably detrimental and often dangerous with various additives such as carbide, Methylated Spirits, Methyl (wood) Alcohol and dashes of conventional spirits, brandy etc. (if available) to give them "kick". These illicit brews[4] score over the conventional beverages in two ways which appeal to Natives:

(a) They are more quickly prepared than traditional liquors and therefore the risk of detection is lessened.

(b) They are designed to give a greater "kick" to the consumer.

These preparations are known by many names and the method of preparation varies from place to place and even from person to person.

"Skokiaan" (or "Sakonvani") is prepared from yeast and sugar; two gallons can be made from a relatively small quantity of yeast, and one shillings worth of sugar.

"Isishishimeyane" (or "Shimeya") was first made in the sugar cane fields. The word is onomatopoeic, and suggests the swaying gait and slurred speech of an intoxicated man. Preparations vary again - some use cooked potatoes to which yeast, sugar, syrup and brandy are added. Some prefer hops, golden syrup, brown sugar and yeast. Brown bread, brown sugar, malt and yeast were detailed by a local informant.

"Babaton" (or "Barberton") made from yeast, stale bread, white sugar and "imithombo", which refers to the basic malt, from which normal beer (utshwala) is made.

"<u>Gavine</u>" made from brown bread and brown sugar which is left to ferment for three days, "and then distilled in a very scientific fashion indeed", as our local informant expressed himself.

<u>Pineapple or "Mfula-mfula"</u>: this is probably similar to shimeya, but pineapple skins are added to give it a sweet taste.

<u>"Mkumla-Bantji" (Take off your coat</u>)is basically shimeya, except that carbide is added. This causes effervescence due to acetylene being liberated. The mixture appears to have a distinct "kick", but it is not clear just how the effect is achieved.

The danger of these concoctions lies in the harmful effects of the ingredients used in their manufacture rather than their alcoholic content. In most of them the alcoholic content is between 3.06 and 7.12 per cent. A certain proportion of the alcoholic content is explained by the presence of small quantities of methyl alcohol. This is almost always the case where yeast fermentation occurs, but is particularly a problem where distillation is attempted.

Methyl alcohol has a lower boiling point than ethyl alcohol, and as a result the first running of the distillation will contain most of any methyl alcohol which may be present. If this were to be thrown away, the danger of "the brew" would be greatly lessened. However, to throw away any alcoholic product is not the custom of the illicit brewer.

All illicit brews are based on fermentation of a carbohydrate product, the variation occurs in using different sources of carbohydrate. The commonest sources appear to be cane sugar, golden syrup, mealies, potatoes, bread, fruits e.g. pineapple, banana and peach and occasionally rice. The latter concoction may resemble the Japanese "Saki".

It is extremely difficult to get authentic information about these brews. The very fact that they are all illicit makes the brewers understandably reluctant to discuss the exact method used in preparation. Mr. B. Khoapa (Social Worker at Sarmcol) was able to glean a little information locally, which has been referred to in the preceding paragraphs.

L. Golberg[5] mentions that in the preparation of the traditional soured porridges e.g. "marewu" and "lambalaza", "utshwala" is often used to start the process. Lambalaza is then allowed to stand over-night. Marewu is soured after cooking.

Kaffir beer shows evidence of a remarkable degree of vitamin synthesis during its preparation. The value to the whole African family of "small" beers and other by-products of the kaffir-beer brew is emphasised. Replacement of the traditional tribal beverages by tea or coffee is detrimental to the nutritional status of the African.

Fox and Stone[6], Biochemical Department of the S.A. Institute for Medical Research, have reported on the Anti-Scorbutic value of kaffir-beer. "Although the minimum amount of vitamin C needed daily is not definitely established, it is commonly accepted as ranging from about 15 to 30 mg. Assuming the lower figure to be adequate, it would be available in two quarts. A gallon of beer a day may be regarded as being well within the capacity of a native living in the kraal, and considerably larger amounts are often consumed when available."

It is known that 10 mgm. of Vit.C a day will cure Clinical Scurvy in human adults.[7] The period of treatment would probably be from 10 to 14 weeks, if prominent gum lesions are present. An allowance of 30 mgm. daily is in accordance with the recommendation by the League of Nations' Health Organisation Technical Commission on Nutrition (1938). It will, therefore, be appreciated that kaffir-beer occupies a valuable place as an antiscorbutic in diets which consist largely of mealie or kaffir-corn porridge. Its practical value, however, depends solely on the large amounts usually consumed, and not on the actual concentration of vitamins present.

Thus, the amount of ascorbic acid present in one quart of beer would be supplied by a pint of milk, half an ounce of orange juice, or one-tenth of an ounce of fresh lucerne leaf. Any consideration of the food value of kaffir-beer however, must also take into account the considerable amounts of yeast present, which as is well known, is a rich source of the vitamin B complex.

Fox[4] stresses the value of kaffir-beer as a food rather than as an alcoholic beverage, in that it is consumed as a thin gruel which has a filling effect, and it contains valuable vitamin supplements, often lacking in the African diet. Until such time as protective foods, like milk, vegetables and fruit are in free supply and are priced so that the African can buy them, kaffir-beer has a valuable part to play in the dietary picture. In rural areas, kaffir-beer is often consumed in large quantities - in fact, "It is the daily task of the menfolk to find and help consume it".[4]

"Beare"[8] featured more prominently than milk in all hospitals and institutions in Medieval England. Tea was introduced into Britain at the end of the 17th century. It soon became popular, the price fell, until it was available to the poorer classes. It ultimately replaced beer, and the feeling of warmth and comfort engendered by drinking tea, resulted in less food being taken and frank malnutrition developing. A small beer would have a calorific value of 150-200 cal. per pint, plus calcium, riboflavin, nicotinic acid, pyridoxin, pantothenic acid and some vitamin C.[8]

As is the case with beer, so with some other constituents of the traditional diet, their consumption has been replaced in urban conditions with other elements more readily available, but often having little nutritional value, though some of the items of Bantu diet have been preserved in town life.

Although it is true that kaffir-beer possesses valuable nutritive properties, it has been noted in this study that the amount sometimes spent on kaffir-beer is excessive in proportion to income earned.

A table of the nutritive value of the basic diet formerly in common use in the Transkei[9] shows that "given an adequate supply of maize, milk, 'mfino' (wild) spinach), meat and kaffir beer, the large majority at the present time would not only be satisfactorily nourished, even according to modern conceptions of the various elementary constituents which the adequate diet must contain, but what is also important, they would be well satisfied with such a diet." (Fox) The basic diet quoted for the Transkei is substantially the same as for the Zulu group in rural areas.

TRADITIONAL DIET AS USED BY THE PONDOS IN THE TRANSKEI.

This discussion of traditional and modern foods used by the Pondos in the Transkei, is quoted because the diet represents more accurately the primitive diet enjoyed by the Zulus, than is applicable in many Zulu reserves today. The changes which have occurred in Zulu diets are due to many external pressures and are dealt with later.

On the feeding of infants:

Milk from cows and goats forms an essential cornerstone of the diet. Infants are fed on milk when breast feeding fails. The method of feeding is a highly dangerous one. The mother cups her hand and this is filled with milk or other liquid. The infant is firmly held, the head tipped back and the intended food forced down the mouth. The baby struggles and splutters and, in many cases, inhales some liquid into the lungs. A colleague has actually seen a baby suffocated in this way. Milk is often boiled, not not routinely.

TABLE 7

NUTRITIVE VALUE OF THE BASIC DIET [9]

FORMERLY IN COMMON USE IN THE TRANSKEI

	Amount	Protein		Fat		Carbohydrate (less fibre)		Calories	Calcium		Phosphorous		Iron		Vitamin	
		%	(gm)	%	(gm)	%	(gm)		%	(gm)	%	(gm)	%	mgm	%	Sl ma U
Whole mealies or "straight run" mealie meal	2 lb.	8.63	78.3	4.56	41.4	71.50	648.5	3,280	0.020	0.180	0.203	1.84	3.8	34		
Whole Milk	1 pint	3.30	18.7	3.60	20.4	4.80	27.2	367	0.122	0.690	0.096	0.54	0.2	1	200 to 1, 600	
"Mfino" e.g. Amaranthus leaves or "Umbuya"	2 oz	3.00	1.7	0.25	0.1	8.14	4.6	26	0.80	0.446	0.052	0.030	22.9	13	4,000 to 20,000	5
Total			98.7		61.9	680.3	680.3	3,673		1.316		2.410		48		6
Estimated Daily Requirements			70 to 100		50 to 100	Depends on activity.		Moderately active man needs 3,000		0.68 to 1.0		1.3		10 to 20		A 4

NOTES: 1. In actual practice this skeleton diet would usually be supplemented by small amounts of pumpkin, beans, meat etc. which
monotony and still further improve its nutritional value.

2. Much of the phosphorous and iron may not be fully available (i.e. present as phytin etc.) but correct estimates vary too
satisfactory corrections possible.

3. Vitamin values are also very uncertain, depending on the actual sample; values given are for the uncooked food. There w
marked increase for the intake of Vitamin A (carotenoid pigment) if, as is often the case in some districts, yellow meal
(There is a strong prejudice against the use of yellow mealie meal).

4. Milk from native cows is apt to be somewhat concentrated, but probably much lower in vitamins than that obtained from co
good pastures.

Where milk is unobtainable, "Nembe" is used. This is made by boiling the mealies, crushing the tips and mixing them with the water in which they were boiled. A fine watery soup is produced, which is then fed to the infant in the above manner. This carbohydrate diet results in many disabilities. Abdominal distension is almost universal in these babies. Gastro-enteritis is very common and is associated with a high mortality. It is probable that infection is directly introduced by the mother's hand which represents a failure of normal hygiene. Kwashiorkor is often seen and in many cases is fatal. These facts one can confirm after practising for five years in the Transkei and nine and a half years in rural areas of Natal.

A puzzling feature is the refusal of rural Native women to consent to Wet Nursing. Many African babies die because of lack of milk. This is in direct contrast to European customs in Medieval England.[8] Wet Nursing in those days was regarded as normal although the criteria for accepting a Wet nurse were rather involved. If a Wet Nurse could not be found, artificial feeding was resorted to, and was done via a cow's horn, using milk.

Gastro-enteritis is never accepted as a natural event in Native life. It is always thought to be due to witchcraft. The Tokoloshe (evil spirit) or the "lightning bird" being regarded as the common agents which cause the condition. The "lightning bird" or "Bateleur" or "Ingqanga"[10] (Plate 1X, 151) with its striking appearance and rich colouring, is greatly feared.

ADULT PONDO WOMAN IN NATURAL SURROUNDINGS

All illness, in fact, is attributed to "Mtakati" (witch-craft), even such common events as Coryza and Influenza which are called "Efeva" or "Umkuthlane".

Adults:

"Amasi" (soured milk) is still popular.

"Enkobe" (boiled mealies) which are hard, corresponds to the Zulu "izinkobe".

"Ncatsha" - hard mealies put on to a hot pot lid. These burst like popcorn and are scraped off. For the purpose the Pondo likes to keep two or three nails of one hand relatively long, to avoid burning the fingers.

"Umpotulo", dried hard mealies which are first boiled then crushed between stones and made into a type of mealie bread. The other common mealie bread is known as "Isonke som Mbona" which, translated literally, is "bread of the mealie". Umpotulo may be mixed with amasi to make a very tasty and popular dish.

"Sequampa" refers to mealie meal porridge which may be mixed with any greens, e.g. nettles, pumpkin tips etc.

"Umqa" is the name given to mealie meal mixed with boiled pumpkin.

"Maqabengwane" is used when travelling. Essentially, these are round, flat, dry cakes made from a mixture of mealie meal and sweet potatoes. Pondos grow sweet potatoes but not madumbies.

"Enkuku" - a chicken - always popular and invariably boiled, as this is regarded as the easiest way to cook the bird.

"Amaqanda" - eggs - are only eaten by men. They are regarded as being an undesirable food for females, as it is thought they cause sexual precocity and lasciviousness in women. This creates a further problem when attempting to correct dietary deficiencies, as eggs are readily available, but not to females.

Wild fruits are always sought for and are popular, e.g.

"Entongwane" the fruit of the milkwood tree.

"Umtentsema" - a fruit resembling a wild litchi.

"Umkewane" - a wild fig.

"Maqunube" - a wild blackberry.

"Tungululu" - a wild fruit found at the Coast.

Coastal Pondos eat fish and shellfish. In this connection it is of interest to record that we are indebted to Mr. H.V. Clarke of Kohlo Store, Port St. John's, Transkei, for the information presented about the Pondos' diet. He lives 14 miles from the sea, and the Pondos in his area do not even know about the sea foods which are mentioned below:

"Embaza" - black mussels.

"Embatyesa" - oysters. (The word literally means something which is an aphrodisiac).

"Entalanzi" - fish. This is popular, and fishing is now a common pastime, either by spearing or using a conventional fishing rod.

"Amasenene"[11] refers to red bait, and is usually eaten raw.

Meat is always a popular dish and all forms are eaten, e.g.

"Ebokwe" - a goat.
"Ehagu" - a pig.
"Egusha" - a sheep.
"Enkomo" - a beast, either a cow or a bull.

Bakers' bread is now a popular item of food. It is called "Esonka" by the Pondos and today a hungry Native will regard it as natural to walk to the Trading Store and there purchase Esonka and "Ndlelalula" or brown sugar. This latter word which sounds attractive when spoken means "easy to buy". Now that it is disappearing from the stores, presumably "Etshukela" or "Eswekele" (white sugar) will be purchased instead.

In Britain, bakers' bread has only been available for approximately fifty years.

<u>The crops in Pondoland</u>:

The main crops are mealies and beans. A good land is approximately 1½ morgen in extent, and a married man is entitled to an extra land for each additional wife. The main farm lands are usually situated some distance away from the huts, and where possible are to be found in the valleys or near the main rivers and streams. These lands are well shown in the distance, in the photograph of an adult Pondo woman. In good districts and in favourable years, enough mealies are grown for the family use and there are usually some for sale. A land is known as an "Entseme" as opposed to the "Egadi" which is the smaller garden plot next to the hut.

It is a normal custom for men between 18 and 45 years of age to leave the Reserves to seek employment.

Adult Pondo males who have returned from service on the Gold Mines and who will probably spend three or four months at home prior to returning to the Mines.

Pondo children set against a typical rural background.

The older men as a rule go to the gold and platinum mines of the Transvaal. Some find their way to the coal mines of the Transvaal and Natal. The youths seem to favour the Natal cane fields where they provide the majority of the labourers, responsible for cutting the cane. A few men find their way into industry.

Beer is an popular and as acceptable as it is amongst the Zulus. The preparation is essentially the same, and it occupies the same place in the Pondo dietary.

The article by Dr. Fox on Nutritional Problems amongst the Bantu[9] was published in the S.A. Medical Journal on 11th February 1939. Since that date there have been three events of major significance in their affect upon those nutritional problems. These were:

(1) The 1939-45 war, with its wartime shortages;

(2) A severe drought during the war years;

(3) A period of industrial development and expansion: This commenced during the war and gained considerable momentum after the war.

It may be assumed that the nutritional problems of today were inherent in the trends observed in 1939 and are a legacy of those years. The conclusions reached by Fox at that time are therefore pertinent to the situation as it exists today. He stressed the rapid deterioration of the nutritive state of the Bantu, the over-stocking of their reserves with resultant deterioration in quality of stock and increasing soil erosion. These factors were inevitably precipitating a serious position where the main reservoir of labour was being affected. The war years (1939-45) which coincided with prolonged droughts affected the economy of the reserves.

The drastic reduction in cattle as a result of drought was indirectly beneficial to the pastures, and lessened soil erosion.

Import restrictions and the extra demands upon the country's food resources by the armed forces accentuated the scarcity of foodstuffs. These same restrictions however, gave impetus to the industrial development which had been taking place steadily, but now became spectular.

The planning of agricultural production was made easier by the existence of war measures. In addition the position was vastly improved by the passing and implementation of the Soil Conservation Act, so that in many of the Reserves progress has been made in halting the approach of desert conditions so marked in the 1930's. At the same time, although the Reserves are still not producing enough for their own subsistence, the cash incomes of the inhabitants have improved as a result of their employment in the mines and industry.

It has been noted that the transition from primitive tribal life to peri-urban conditions is frequently accompanied by a significantly increased incidence of deficiency disease.[5] The balance of vitamins in the primitive diet is delicate and precarious at the best of times. The scales can be tipped in the wrong direction very easily. The difference between 2 lbs. of cereals and 1½ lbs. per day (or less) can mean the difference between an adequate and an inadequate intake of riboflavin and a drastic reduction of nicotinic acid intake.[5]

The studies made by qualified observers lead to the conclusion that the traditional Bantu diet at its best is adequately balanced, but precarious, fluctuating between seasons of plenty to periods of near famine.

The increasing use of European milled meal has led to the consumption of meals refined to such an extent that the carbohydrates go to man, the vitamins and other nutrients to animal feeds! In rural areas however, the primitive equipment available in the African kraal for milling and sifting cereals, results in the inclusion of a considerable proportion of bran and germ in the meal. The meal produced, thus possesses almost the whole nutritive value of the original grain. The wide use of legumes in the Bantu diet replaces, to a large extent, the shortage of proteins and vitamins in the cereal diet.

The extermination of small game in the Native Reserves has done away with one of the sources of meat, but goats are still kept for slaughter, though they present a problem in their destruction of gardens, trees and crops. The type of goat kept is almost useless as a source of milk supply, whilst the cattle are also of poor quality. All calves are kept - whether bull or heifer - with the result that there is a high proportion of oxen, mainly of scrub quality.

The lobola system under which the price of a bride is reckoned in terms of the number of head of cattle (irrespective of the size of the cattle), is mainly responsible for the poor quality of cattle. In the past, traders have made big profits by buying up scrub stock on sales for barter with natives at the rate of two scrub stock in exchange for one large beast. Official action to improve the quality of the stock has often been met with hostility by the natives and progress in this direction is slow.

Urbanised natives practise the lobola system and when the family has relatives in the Reserves, as most do, the cattle are kept there, adding to the burden on the Reserves. If no facilities exist to keep the lobola cattle, a cash equivalent is accepted. Young educated men favour the lobola system as they believe they will, in turn, benefit by it when their own daughters reach marriageable age.

The place of cattle is deeply rooted in the social system of the Zulus, an integral part of all tribal ritual, the symbol of wealth and the only link between the ancestors and their living descendants.[1] For all important occasions cattle are considered the only proper sacrifice. "The cattle in a Zulu kraal are thus regarded not as mere domestic animals, kept for their utility, but as an essential part of the village." "The burden of wealth is a phrase that takes on added meaning when cattle become symbols of wealth and a form of currency, when the herd is not an economic unit".[1]

In present day conditions, the survival of these customs lies at the root of much of the poverty of these people.

MODERN FOODS

There is the quite natural assumption that European foods must be superior - especially as they cost more. It is hardly surprising that Africans should be ignorant and unable to discriminate in the matter of a healthy diet when numbers of Europeans are often equally ignorant or, in many cases, disregard the known facts of sound nutrition.

The use of modern foods in the diet of the Bantu has resulted mainly in the consumption by them of refined foods, from which some of the essential substances have been removed in processing. Even maize products, the staple diet of the Bantu, have been refined so that the only unrefined mealie meal now consumed is in the remoter areas. The refined meal is universally preferred and, from the point of view of uphutu, has a much better consistency. Other maize products are mealie rice, and samp; baby foods, e.g. incumbe (thin porridge made of finely ground meal and water) and marewu.

In Cape Town a study on diets in common use by the Bantu showed that mealie meal, crushed maize (samp) with sugar and black coffee, were the staples.[12] Tables published by Golberg[5] show the amount of B vitamins which are extracted in the refining of maize and he states that "samp and mealie rice, consisting as they do of almost pure starch, are ideally suited for inducing multiple vitamin B deficiency".

"Not only is the consequence of using rice, samp and mealie rice serious in itself, it is also serious in that the foods are regarded as vegetables and in the diet of the urbanised African they tend to replace the valuable legumes and leaves so widely employed in the tribal dietary". In this connection, it is interesting to note that the natives seldom cook samp by itself - it is almost invariably mixed with dried beans or whole mealies - generally the former. Mealie rice is sometimes cooked with beans too. This starchy diet is easily compared with the poor man's food in England in the 19th Century. The paucity of protein, the general lack of milk, and the preponderance of starch in England produced the same effects. Eighty-three per cent of the children of Bethnal Green in 1892 had no other solid food except bread, for 17 out of 21 meals in a week.[8]

The addition of beans to samp and mealie rice appears to have been spontaneous or instinctive, but it is a very sound practice. The beans are rich in protein and are also a valuable source of the B vitamins.

TABLE OF AMOUNTS OF B VITAMINS PROVIDED BY 2 LBS. OF MILLING PRODUCTS FROM EUROPEAN MILLS[5]

Table 8.

Product	Thiamine	Ribo-flavin	Nicotinic Acid
Unsifted crushed maize	2.8 mg.	1.1 mg.	18 mg.
Unsifted mealie meal	2.6 "	1.05 "	17 "
Sifted crushed maize	2.5 "	0.95 "	15.5 "
Fine granulated mealie meal	2.5 "	0.9 "	15 "
+ Special or No.1 m/meal	1.7 "	0.5 "	16 "
+ Samp	0.5 "	0.4 "	7.5 "
+ Mealie rice	0.4 "	0.35 "	7.0 "
+ Maize flour	0.4"	-	-
Bran	1.9 "	2.7 "	27 "
Maize germ meal	5.8 "	3.0 "	62.5 "
Hominy chop	2.9 "	-	-
Grits	0.3 "	-	-

+ These items are sold for human consumption. The other items are used as stock feed.

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The most notable change to modern food is the almost universal use of bakers' bread as a staple food by urbanised Africans. A common feature which has been repeatedly remarked upon is the diet of white bread and a mineral, or white bread and tea, favoured by many because of its simplicity. It has been noted in this study that the popularity of brown bread in place of white is steadily growing. This is a possible result of discussion and education about dietary matters.

There is evidence amongst urbanised Africans of a growing awareness of food values and the role of Nutrition Education in focussing attention upon the correct foods cannot be over-emphasised. Cheese is one of the recommended items of diet which is becoming popular. Fish, margarine and eggs are also becoming recognised as valuable and acceptable foodstuffs.

Tinned foods have, of course, been adopted on a large scale, even to the extent of a preference for condensed milk. These foods, whilst providing many of the nutrients deficient in the maize diet, are at the same time expensive and the vitamin content has generally been completely destroyed. The fact that condensed milk can be stored without refrigeration, is one of the principal reasons for its use. The high sugar content is also welcomed.

Dumplings are one of the commonest of the modern foods. A dumpling is made of wheaten flour and frequently takes the place of vegetables in stew.

In communities such as the Howick Native Village, there is a strong tendency to adopt European living habits and, where possible, European standards. Whereas it is native custom for the head of the house to be given his food separately, it is quite usual for the modern family in the Village to sit down to table together, even though the head of the house is still given the lion's share of the meal and is served first.

The relatively low purchasing power of African workers is unquestionably a factor in their nutritional problems. The temptation to spend money on luxury items and not food is well-known, but makes serious inroads into the family income.

It is regrettable that in this matter of diet, as well as in other aspects of civilised life, many of the less desirable European practices are adopted by the Africans. The ignorance of many Europeans concerning simple nutritional facts is, in many cases, counterbalanced by the greater variety of foods concerned. In the case of the average African, however, the use of luxury foods of low nutrient value in relation to cost, is only possible at the expense of other more essential foodstuffs.

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(2) TRANSITIONAL DIETS

An assessment of the nutrient intake of the Test Groups is of primary importance in this Industrial Health Study. A dietary survey under conditions where the employer supplies all the meals is relatively simple. Even in the Company Compound, where the men find their own food, it is comparatively easy to assess the diets consumed. Most of these men live on an unvarying weekly food budget, spending the same amount each week on each article of diet. Those living with their families, however, present a different problem. Their expenditure on food is the amount spent for the whole household, and although many of the men say that they budget for a definite amount of food, this is usually bought by the women.

It is sometimes the practice when meat is served for the head of the house to have most of it, leaving the gravy and scraps for the rest of the family. It seems a fair assumption to say that the wage-earner will have a plateful of whatever dish is served and that the quantity will be the same as, or not much less than that consumed by a man lodging on his own.

It has been found that the lodgers in the Company Compound generally spend a regular weekly amount on their own food, a definite weekly amount being allocated for each item, - usually from 8 to 12 lbs. of mealie meal, one to 4 lbs. of meat weekly, and 1 or 2 pints of milk daily. The diets consumed in the Compound may therefore, be considered as a fairly stable index of the amount of each foodstuff consumed.

By European standards the quantities consumed may seem incredibly large, but the Bantu believe in quantity rather than variety, and it is not uncommon to see a man consume half a two pound loaf of bread in about 5 to 10 minutes during the tea break. In terms of nutrient intake this "snack" would represent between 28 and 35 gms. of vegetable protein - more than 50% of the recommended daily intake of protein for an adult man.

This dietary survey is actually an estimate based upon replies to questions about the times and places of meals, kinds of food usually eaten, the amount of money allocated for food and upon observation of dietary habits.

It has been found that there are instances where the amount stated to be spent on food is very much in excess of the quantities which could probably, or even possibly be consumed, of the foods stated to comprise the diet. The difficulty is admitted of giving correct replies about either the amount spent on food or the actual foods eaten. Added to this is a human tendency to exaggerate the high cost of living and at the same time to stress the low standard enjoyed. In spite of this, it is felt that the replies to questions were, with few exceptions, generally bona fide attempts to give correct information.

Analysis sheets of Nutrient Intake were prepared on the basis of a five-day week. The tables used in assessing nutrient intake have been derived mainly from S.A. Food Tables by Fox and Golberg[13] with certain modifications supplied by the Department of Nutrition[14] as a result of recent research.

In considering estimates based upon such food tables, it is accepted that methods of investigating and analysing the values of foodstuffs, especially in respect of vitamins, are continually undergoing refinement, and that different investigators produce variations, as Fox and Golberg point out in their work. Different varieties of foodstuffs, seasonal, cultural and soil differences, maturity and freshness as well as methods of storage, all tend to contribute to these differences. They have, therefore, endeavoured to select typical figures, bearing local conditions in mind.

It will be apparent from the foregoing that the analyses produced in this dietary survey may be considered as arbiyrary figures, and are submitted as an exploratory probe in which an attempt has been made to present a picture consistent with known facts, and local custom.

MEAL TIMES:

Breakfast

Group A: 81 men. 26 have their first meal in the Company Compounds before coming to work. 54 have their first meal in the Factory Canteen during 9.15 tea break. 1 of the 81 does not have breakfast.

Group B: 78 men. 27 have their first meal at home before coming to work. 50 have their first meal in the factory Canteen at 9.15 tea break. 1 of the 78 does not have breakfast.

Group C: 86 men. 11 have their first meal at home before coming to work. 75 have their first meal in the Factory Canteen at 9.15 tea break.

Midday meal

Group A: 81 men. 60 have lunch in the Company Compound. 3 have lunch at the tea room at the Beer Hall. 11 have lunch in the Factory Canteen; 2 of the group lunch (beer only) at the Beer Hall.

Group B: 78 men. 41 have lunch in the Factory; 36 have lunch at home. 1 lunches at the Tea Room adjoining the Beer Hall.

Group C: 86 men. 73 have lunch at the Factory; 10 lunch at the location tea room; 1 lunches at home; 2 have no midday meal.

EVENING MEAL

Group A: 81 men. 78 have their evening meal in the Compound. 3 men go to the location tea room. 2 of these men also lunch there and one has all three meals there.

Group B: 78 men. All this group have their evening meal at home.

Group C: 86 men. 84 have their evening meal at home, 2 eat at the location tea room.

Breakfast. Foods eaten - Group A : 81 men

61 have bread or scone and tea for breakfast.
11 have phuthu as the main dish, with tea, cabbage, meat etc. sometimes.
8 have some of the following - samp, dumpling, mealie rice, amasi.

Group B: 78 men

43 have bread or scone and tea; 19 have one or other of the following regularly: Porridge, bread and tea; porridge or phutu and tea; porridge only; meat, phuthu and tea; amasi only; marewu only; vetkoek (scone fried in fat) only. 10 have a breakfast varied from day to day with meat and some of the following: phuthu, mealie rice, cabbage, potatoes, bread, samp, beans, onions, tomatoes and dumpling. 5 have a breakfast varied throughout the week, without meat, but with some of the following: milk, eggs, scones, bread, mealie rice, potatoes, porridge and milk.

Group C: 86 men

57 have bread, scone or dumpling and tea regularly; 2 only have porridge or phuthu and tea; 4 have porridge or phuthu and bread or dumpling and tea regularly; 1 has only porridge; 1 drinks whole milk only. 21 have some of the following, varying their meal from day to day: phuthu and meat, dumpling and meat; samp and meat; mealie rice and meat; bread and tea; meat, cabbage and phuthu; meat and potatoes; amasi and mealie rice; bread and meat; samp and beans; sandwiches and tea; stew etc.

Midday meal: Foods eaten - Group A: 81 men

66 take meat, in conjunction with other foods, but not necessarily every day; 36 have the same menu for lunch and the evening meal, cooking just once a day. 2 have only utshwala at midday; 2 have only marewu; 1 has amasi and utshwala; 1 has amasi, samp and mcubu; 9 have phuthu or bread and tea.

Midday meal. Foods eaten - Group B. 78 men

11 have a meal of bread or scones and tea at midday. 1 has only vetkoek; 3 have amasi only; 1 has bread and cheese; 1 has bread and marewu; 1 has mealie rice; beans and amasi; 10 have stew with bread or mealie rice; 48 have varied menus throughout the week, including some of the following foods - samp, beans, mealie rice, meat, dumpling, phuthu, cabbage, carrots, bread, onions, rice potatoes, amasi, tomatoes, cheese and milk. One includes eggs sometimes with varied foods; 1 has amasi, phuthu and utshwala.

Group C. 86 men

2 have no midday meal. 32 eat bread or dumpling and tea; 1 has bread, marewu and tea. 1 has bread and amasi. 3 have phuthu and amasi; 13 have meat and bread, meat and dumpling or meat and mealie rice; 1 has phuthu, cabbage and potatoes; 1 takes marewu bread and meat; 1 has amasi, meat, samp and beans; 4 have amasi with mealie rice or samp or bread; 3 have phuthu, meat and tea; 1 has meat, cabbage and phuthu; 1 has meat, bread, potatoes and tea; 21 say they vary their lunch throughout the week with meat plus one or more of the following: amasi, milk, phuthu, mealie rice, samp, rice, potatoes, dumpling scones, bread, cabbage, beans. 1 varies his midday meal as above, but has no meat.

Evening Meal: Foods eaten. Group A. 81 men

48 have their main meal in the evening. This usually includes meat and is varied from day to day in many cases. Potatoes, tomatoes and onions are often cooked with the meat. The remainder have the same kind of fare in the evening as they do at midday, probably finishing what was left over and sometimes adding phuthu.

Group B .78 men

76 have meat with some of the following for their evening meal: samp, beans, mealie rice, potatoes, amasi, cabbage, rice, dumpling, tomatoes, onions carrots, eggs. 1 has bread only, 1 has phuthu only.

Group C.86 men

42 apparently did not vary their evening meal during the week and regularly had meat, plus one or more of

the following: cabbage, mealie rice, beans, amasi, marewu, potatoes, samp, dumpling, bread. 42 stated they varied their evening meal throughout the week as follows: meat plus one or more of the following: samp, beans, phuthu, cabbage, scones, amasi, bread, potatoes, dumpling, mealie rice, rice, porridge, stew. 2 varied their evening meal with potatoes, samp, mealie rice, amasi, phuthu, rice, bread, but with no meat.

USE OF TRADITIONAL BANTU FOODS

Traditional Bantu foods include the indigenous products of the land, prepared and cooked in accordance with native usage as well as some crops introduced by the early European settlers and since adopted universally by the Bantu. Maize is the staple food and predominates in the diets of most Africans, both rural and urbanised.

Group A. 81 men - Compound

Amasi (curdled milk)	38
Beans (dried)	4
Marewu (thin fermented maize gruel)	21
Mcubu (a mixture of phuthu and marewu)	1
Meat	81
Phuthu porridge (dry crumbly porridge made of mealie meal)	69
Utshwala (Native beer)	55
Number eating one or more items of traditional Bantu diet, other than meat	78

Group B. 78 men - Native Village

Amasi	25
Beans (dried)	41
Marewu	3
Milk	9
Meat	77
Phuthu or porridge	64
Utshwala	43
Number eating one or more items of traditional Bantu diet	75

Group C. 86 men

Phuthu or porridge	75
Amasi	30
Beans	28
Marewu	4
Meat	83
Utshwala	40
No. eating one or more items of traditional Bantu diet	83

MODERN FOODS

Vegetables such as cabbages etc. which were introduced by European settlers and are very extensively used by the Bantu have not been included in the category of modern foods. They are dealt with under the heading "Use of Vegetables".

Group A. 81 men - Compound

Bread	63
Coffee	1
Dumpling	87
Mealie rice	18
Samp	27
Rice	2
Tea	74

Sugar is used universally. Condensed milk is used, but exact information about the extent of its use has not been obtained.

Group B. 78 men - Native Village

Bread	46
Scones, buns or cakes (home made)	27
Dumplings (home made)	30
Vetkoek	1
Pudding, custard and jelly	1
Tea	61
Coffee or cocoa	1
Butter	2
Condensed milk (probably more)	1
Cheese	2
Eggs	5

Sugar used universally.

Group C. 86 men

Bread	68
Dumpling and scones	22
Buns and cakes	1
Samp	39
Mealie rice	24
Rice	6
Butter	2
Cheese	2
Tea	76
Meat pies regularly	1

One only was on record as using condensed milk, but the figure is certainly higher.

The use of condensed milk is widespread because of its keeping properties. Refrigerators are non-existent among Bantu factory workers. Although dumplings and scones are included in the category of modern foods, these are an adaptation by the Natives. In one recipe, flour and utshwala are mixed, the dumpling being cooked in the stew whilst the scone is baked in fat.

The nutrient value of white bread has been adopted for scones and dumplings. Any difference in the analysis of the actual nutrient in the scone/dumpling mixture and that of white bread, would probably be insignificant.

USE OF VEGETABLES:

Factors that govern the use of vegetables vary in the three residential groups. Among these factors are cost, availability, storage facilities and whether vegetables are grown at home. Replies on the use of vegetables show a certain degree of uniformity, in that the vegetables eaten are generally available locally throughout the year. There are other vegetables of a seasonal type which are very popular and are undoubtedly eaten when in season, e.g. green peas, green beans and broad beans, beetroots, and turnips, which many of the men grow in their gardens, and sweet potatoes and madumbies. The latter is an edible tuber, Colocasia antiquorum. Neither sweet potatoes nor madumbies are grown much locally, but are on sale in season and are very popular with the Bantu. No analysis has been published for madumbies, but it is probably similar to that of the Jerusalem artichoke, which they resemble when cooked.

Sweet potatoes are rich in vitamin A, being far superior to potatoes in this respect; (65 times as much) and only slightly inferior in protein content. The use of vegetables is considered of prime importance as these supply the necessary vitamin A and C elements besides useful amounts of other vitamins and minerals, thus replacing the valuable imfino (wild spinach) and other natural foods found in the indigenous diet. Further mention is made of vegetables in the discussion.

Group A. 81 men - Compound

Cabbage regularly	30
Potatoes "	40
Tomatoes "	17
Onions "	11
No vegetables	36

Group B. 78 men. Native Village

Cabbage regularly	34
Potatoes "	44
Onions "	9
Tomatoes "	6
Carrots "	4
Dried beans only	13
No vegetables	8

The majority of the B Group grow vegetables in their allotments in the Native Village.

Group C. 86 men

Cabbage	34
Onions	3
Potatoes	38
Tomatoes	4
Dried beans only	6
No vegetables	29

Many of this group lodge in rooms and have no facilities for growing vegetables.

(8) DIETETIC REQUIREMENTS
A BALANCED DIET

The seven basic groups of important foodstuffs will be discussed.[14]

The quantitive analysis of nutrient intake undertaken in the diet survey of the test group gives the estimated weekly and average daily intake of each nutrient, but in evaluating the adequacy of the diet it is necessary to make a qualitative analysis as well. This was confirmed by a dietician in the Department of Nutrition.

The normal diets of the test group are therefore broken down by qualitative analysis into seven basic foodgroups, so that deficiencies will not be reflected only by statistical deficiencies of calories, protein, minerals and the various vitamins, but by the actual food groups which supply those necessary elements of diet.

Comparisons follow of the actual diets of the test groups, with minimum and optimum standards laid down by nutritionists, as well as with the ration scales provided by certain Mine compounds, the Government Standard ration scales and the S.A.Railways Compound, Cedara, Natal. The costs of various actual and recommended diets is appended.

BASIC FOOD GROUP 1:

Consists of protein foodstuffs, viz. meat, liver, fish and eggs. Beans, peas and lentils are included in this group because of their high protein content.

It would appear from the diet survey that only some of the men take more than one item of Group 1 daily. Some doenot eat any of this group of foods and others only sometimes - perhaps once or twice a week. The following table shows the weekly consumption of meat by the Test Groups, according to the estimates compiled from information obtained by questioning:

Table 9 Basic Food Group 1 : Meat

Test Group	No.	Meat eaten Total Weekly	Average Weekly	No.who do not eat meat.
A	51	1-2½ lbs.	2.4 lbs.	-
	28	3-5 "	3.71 "	
	2	6-7½ "	6.75 "	
	81	1-7½ "	2.72 "	
B	23	1½-2½ "	1.91 "	
	54	3-4 "	3.375 "	-
	77	1½-4 "	2.94 "	1
C	40	1-2½ "	1.82 "	
	42	3-5 "	3.53 "	
	1	10 "	10 "	
	83	1-10 "	2.78 "	3

Note: The recommended ration is 7 oz. beef per day in a ration which includes all the items necessary for a balanced diet.

Table 10. Basic Food Group 1 : Eggs

Test Group	No.	Eggs eaten per week.	
A	Nil	-	
B	1	1	Eats meat and beans as well
	3	3	2 eat meat and 1 eats meat and beans as well.
	1	5	Eats meat and beans as well
	5	1-5 eggs	
C	1	2	Eats meat as well

Table 11 Basic Food Group 1 - Beans

Test Group	No.	Beans eaten per week.	
A	3	½ lb.	All eat meat as well.
	1	1 "	" " " " "
	4	½-1 lb.	
NOTE: Low figure here is due to the difficulties involved in cooking beans.			
B	35	½ lb	6 eat 1-1½ lbs.meat and 29 eat 2-4 lbs.
	7	1 lb	6 eat meat and 1 meat and eggs as well.
	42	½-1 lb	
NOTE: Here a high figure appears, and it can safely be said that the women cook the beans.			
C	7	½ lb)	All take meat as well
	2	¾ lb)	
	16	1 lb)	
	2	2 lb)	
	1	2½lb)	
	28	½-2½ lbs.	

NOTE: In all probability women also cook the beans in this group.

Basic Food Group 2.

This group consists of milk and milk products, excepting butter which contains only the fat of the milk. Milk in any form, dried, condensed or as cheese is an excellent food. Suggested intake is over ½ to ¾ pt.

daily for adults, and children $1\frac{1}{2}$ to 2 pts. Skimmed milk contains all the protein of whole milk. In the tables which follow, estimated milk consumption will be shown, including milk taken in tea.

Table 12. Basic Food Group 2 : Milk, weekly

Form in which taken:	A		B		C	
	No.	Amount	No.	Amount	No.	Amount
Amasi only	4	5-10pt	6	2-10pt	3	5-10 pt.
Milk in tea and amasi	34	$4\frac{1}{2}$-10	21	$2\frac{1}{2}$-10	26	3-8
Milk in tea only	40	$\frac{1}{2}$ - 3	36	$\frac{3}{4}$- $2\frac{1}{2}$	45	$\frac{1}{2}$-$2\frac{1}{4}$
Milk with porridge only		-	3	4-5		-
Milk with tea and porridge		-	2	$2\frac{1}{2}$-5	2	1-5
Fresh milk and milk with tea		-	2	5	2	5-$5\frac{1}{2}$
Fresh milk only		-	1	5	1	5
Fresh milk & amasi		-		-	1	10
Condensed milk	1	1 tin	1	1 tin	1	1 tin
No milk taken	2		6		6	
	81		78		86	
Total taking milk	79		72		80	

The analysis of milk in the above table refers to the use of this as an item of diet and does not include the supplementary ration of skimmed milk supplied to the members of the Test Groups. The quantities are in some cases amounts actually given in reply to questions and in other cases are assessed on the basis of allocating a probable share of the family milk supply.

Milk taken in tea has been assessed on a basis of from 1 to 2 fluid ozs. of milk per mug of tea. If this is a little high, it will possibly offset some items which have been omitted in the survey. The only other dairy product used, apart from a little butter, is the limited consumption of cheese, though this commodity is gaining popularity. The high price of cheese is the main factor limiting its use. Milk is taken with porridge but seldom with phuthu, which is generally eaten dry.

Because of its sugar content, a tin of condensed milk has a calorific value equivalent to 3.48 pints of whole milk. Its protein content, however, is only equivalent to 1.48 pints of whole milk, calcium equivalent of 1.9 pints, iron equivalent of 1.78 pints, vitamin A equivalent of 0.616 pints, vitamin B1 equivalent of 1.92 pts. No vitamin B2 and no niacin; a vitamin C content of .438 pints of whole milk. Its use as a substitute for whole milk or even skimmed milk can only be recommended when whole milk is unobtainable, but it is preferable to doing without any milk. The majority of those who use condensed milk buy one tin per week. When this is the only source of milk, it is inadequate.

According to the diet survey, 6 in Group B and 6 in Group C do not drink milk at all.

Two men in Group B state that they eat cheese; 1 who eats no meat, but has approximately 1½ pints of milk in his tea in a week, eats 2 lbs of cheese per week, or 6.2/5 oz. daily. The protein content of this is 43.5 gm. the equivalent of 2.25 pints of milk, which added to the milk used in his tea gives a daily ration of over 2½ pts. of milk.

Only 2 men in Group C take small quantities of cheese in sandwiches, but these quantities, about 1 oz. per day, in conjunction with milk taken in tea, bring their ration of Group 2 foods to approximately the recommended level.

None of Group A take cheese.

BASIC FOOD GROUPS 3, 4 & 5

Fruit and vegetables are divided into three different groups, because certain fruits and vegetables are exceptionally good sources of specific nutrients, particularly the vitamins.

Group 3 comprises those fruits and vegetables which are very rich in vitamin C (the antiscorbutic vitamin)[15] It is concerned with the formation of colloidal intercellular substance of mesenchymal origin: i.e. collagen of fibrous tissue structures, all non-epithelial cement substances including the intercellular substances of the capillary wall, dentin cartilage and the matrices of bone. It is a reversible oxidising agent. It is recognised as a factor in the healing of wounds.

It is possible that consumption of vitamin C containing foods is more general than the replies elicited in our diet survey.

It is known that green mealies, pumpkins, calabash, sweet potatoes and madumbies are popular items of diet in season, though admittedly they are seasonal. Fruit pedlars near the Factory gates do an extensive trade - mainly in oranges, and during the yellow peach season in February, these are available in large quantities. Blackberries (Australian bramble) grow in wild profusion and are popular. The extent to which other fruits are eaten needs to be investigated, if a more exact picture is to be drawn, but there are medical grounds for believing that there is a lack of vitamins, especially A and C. These deficiencies will be dealt with more fully under the chapter on medical observations, but listlessness, fatigue and susceptibility to colds are commonly ascribed and may be due, in part, to avitaminosis. In the early stages of deficiency states, a clinical diagnosis is a tentative one only.

Basic Food Group 3 consists entirely of foods rich in vitamin C, the main sources being guavas, citrus fruits, pawpaws, mangoes, berries, tomatoes and raw cabbage. The latter can easily supply the body's total requirements of vitamin C.

Table 13. Basic Food Group 3 : Cabbages & Tomatoes

Group	Cabbage only No.	Cabbage only weekly lbs.	Tomatoes only No.	Tomatoes only weekly lbs.	Both Veg. No.	Both Veg. Weekly lbs.	Total No.	Total weekly lbs.
A	18	2 lbs.	4	1 lb	13	3-5	35	1-8 lb
B	34	2 "	3	1-3	2	3	39	1-3
C	33	1-7½	3	1-3	1	6½	37	1-7½
	85	1-7½	10	1-3	16	3-6½	111	1-7½

Cabbage and tomato are not eaten raw; they are invariably cooked with meat. Vitamin C is easily destroyed by heat, and therefore only one-third of the vitamin C content of the raw vegetables has been allowed in the analysis of nutrient intake as Native cooking methods are particularly destructive.

<u>Basic Food Group 4</u> consists of yellow or green vegetables, rich sources of carotene, the precursor of vitamin A. This vitamin promotes growth and protects the body against infection. It ensures the health of the mucous membranes and is essential for normal vision, particularly night vision. The main foods in this group are carrots, pumpkin, lettuce and yellow mealies; all the above-mentioned foods are consumed to some extent, though there is little record of this in our diet survey. This is perhaps as well, as the actual use of these vegetables is probably spasmodic. Cabbage has already been dealt with under Group 3, being a very rich source of both vitamins A and C. There is a strong prejudice against yellow mealies among the Bantu, and the greater proportion of mealies eaten will be white. The use of basic food group 4 actually recorded, including cabbage, is:

Table 14.

Test Group.	Carrot only. No.	Amount	Cabbage & Carrot. No.	Amount	Cabbage only. No.	Amount.
A	1	1 lb.	-	-	18	2-3 lbs.
B	1	1 lb	3	3 lbs.	33	2 lbs.
C	-	-	-	-	34	1-7½ "
	1	1 lb	3	3 lbs.	85	1-7½ "

We have noticed that carrots are not a popular item of diet at SARMCOL.

<u>Basic Food Group 5</u> consists of all other vegetables and fruit not included in Groups 3 and 4. These are not specially rich sources of vitamin, but make an important dietary contribution in protein, mineral salts, vitamins, as well as roughage. This group

includes potatoes, squashes, turnips, beetroot, cauliflower, green mealies, onions, bananas, grapes and apples. Besides the nutrients already mentioned, fruit is rich in organic acids which stimulate the digestion. The total daily ration of groups 3, 4 and 5 should include not less than 10 oz. of these foods (raw weight of which 4 oz. should be potatoes and the balance other vegetables and fruit, with preference being given to the green and yellow varieties.) The important foods recorded in Group 5 are onions and potatoes.

Dried beans have been included in this analysis of the Basic Food Groups under the heading of Group 1, but as adequate portions of meat are eaten by those who take dried beans, this item may for practical purposes be regarded as a Group 5 vegetable, although it has not been included in the tabulated figures either in respect of Group 5 foods or of the consolidated table of Groups 3, 4 and 5. The recommended allowance of dried beans as a substitute for potatoes is 1 oz. daily, in place of 4 oz. of potatoes.

Basic Group 6 consists of butter, margarine, bacon, fat and plant oils. These foods are concentrated sources of heat and energy and are therefore of special value in the diet of very active workers. Furthermore, fatty foods delay digestion and prevent the individual from feeling hungry too soon. Apart from the high calorie value of fats, butter and enriched margarine contain vitamin A as well - 560 I.U. per ounce in the case of butter, and 565 I.U. per ounce for margarine. South African margarine is enriched to make it a suitable substitute for butter. The recommended daily allowance of butter or margarine is ½ oz.

Although no information has been obtained in the dietary survey about the use of cooking fats or margarine, most of the householders living in the Native Village and in houses which are equipped with stoves, do use cooking fat - either vegetable oils or dripping being used. In other cases, the only fat consumed is derived from the meat ration. It seems probable that the reason for the absence of any record of cooking fat being used is that this was not looked upon as a food in itself, but only as an adjunct of the cooking process.

There is no record of butter being eaten by the Compound A Group, and only two men in Group B have been assessed at 4 oz. butter each per week, and only 1 in Group C. The actual consumption of butter is believed to be much higher than is recorded, though the majority seem to prefer to eat their breaddry and to wash it down with tea or dip it in gravy. Jam is preferred without butter on the bread.

<u>Basic Food Group 7</u> includes sugar and cereals which supply heat and energy. The whole-grain foods are more valuable than the refined cereal products since, in addition to starch, they provide protein, mineral salts and vitamins which are concentrated in the bran and the germ of the wheat grain. At least one portion of whole grain food should be eaten daily. The foods in Groups 6 and 7 are usually considered fattening. If a sufficient quantity of the foods in Groups 1 to 5 is

is eaten, there is little danger that too much will be eaten from the other two groups.

With few exceptions, the African's staple diet consists of Group 7 foods, but unfortunately the refined products are frequently preferred, though recently nutrition education has brought about a noticeable improvement in this regard.

In assessing the food value of mealie meal consumed, the values originally accepted were for unsifted granulated meal, described in Fox and Golberg's "S.A.Food Tables" as "household meal". However, owing to the significant difference in the vitamin B content of unsifted meal, as compared with sifted, it was decided to enquire which meal was actually used. This enquiry revealed that only 9% used refined sifted meal exclusively, and that 43% used the unsifted "household meal" and 48% used both "household and refined" meal, but only insignificant quantities of refined meal were bought. Of those who ate bread, 24% ate brown bread only, 24% only white bread and 52% ate both brown and white bread, probably in equal quantities.

The following table summarises the use of items of diet grouped under Basic Food Group 7.

Table 15. Basic Food Group 7 : Cereals used

No. of users: Groups.				Weekly quantities used: Groups.		
A	B	C		A	B	C
81 100%	77 99%	86 100%		lbs. $2\frac{1}{2}$-30	lbs. $3\frac{1}{2}$-$17\frac{1}{2}$	lbs. 8-20

Cereals eaten were:

(i) Maize products, e.g. phuthu) mealie meal) porridge)	211	users	86%
mealie rice	91	"	37%
samp	100	"	45%
marewu	32	"	13%
(ii) Rice	19	"	7.8%
(iii) Wheaten products e.g. bread	178	"	73%
Home-made scones & dumplings	102	"	41%

In addition to cereals, sugar is used universally in quantities varying between 1 to 5 oz. daily. It is noticeable that the majority of Africans are very partial to sugar and it is not uncommon to add one or two tablespoonsful of sugar to a mug of tea.

It is again stressed that the figures tabulated in respect of food eaten are estimates only, and are based upon the replies to questions. Under prevailing conditions it is not possible to compile a statistically accurate diet survey. However, an attempt was made to obtain actual weights of food eaten by certain members of Group A living in the Company Compound. Even these results do not have the value of a statistical record made under controlled conditions. Some of the information obtained for 25 men is fragmentary, as they did not always cook every day and sometimes went out for meals. Their habits appeared to be somewhat erratic, as regards diet and meal times.

The value of the figures obtained by weighing actual food cooked is further diminished by a possible tendency in some cases to cook larger than normal quantities when the food was being weighed. It is a further possibility that the amount of vegetables consumed at that time was above normal, owing to a seasonal glut. A comparison of various diets follows:

(4) DIETARY STANDARDS

In the tables presented below, in five cases an analysis of recommended diets is shown. In the sixth column, an average diet as assessed for 25 men in Group A is presented.

Diet 1: A minimum daily diet for a Bantu manual worker (Union Department of Nutrition Bulletin).

Diet 2: Ration scales for Natives doing hard work as recommended by the National Nutrition Council.

Diet 3: S.A.R. Tunnel Construction Camp, Cedara, Ration Scales.

Diet 4: Government Minimum Ration Scales - Native Labour Regulations Act of 1911 (as amended)

Diet 5: Mine Standard Ration Scale for Experimental Group of Natives.[16]

Diet 6: Average diets assessed for 25 men in Group A residing in the Sarmcol Compound, based on estimates made after interrogation.

Table 16. Comparison of Diets(Daily Allowance)

Basic Food Group.	Diet 1. oz.	Diet 2. oz.	Diet 3. oz.	Diet 4. oz.	Diet 5. oz.	Diet 6. oz.
1. Meat, eggs, fish,etc	3½	5.6	10	11	12	9
2. Milk, cheese, etc.	5 fl.	10	-	-	-	13
3,4 & 5. Veg & fruit	10	10	8	5	8	11.6
6. Fat, butter etc.	1	1	-	-	0.36	-
7. Cereals	24	25	40	30	36	42
Sugar	3	2	1	-	2	1

Table 17.

Analysis of Nutrient Intake in Table 16 Diets

Nutrient.	Min. Diet 1	Hard Work Diet 2	SAR Diet 3	Gov. Min. D 4	Std. Mine Diet 5	Average Diets Group "A" 6
Calories	3400	3532	5781	3864	5433	5219
Protein:						
Animal (gm)	12.7	39.2	34.2	28.0	51.0	57.8
Plant (gm)	74.3	70.8	154.2	112.0	138.5	119.7
Total (gm)	87.0	110.0	188.4	140.0	189.5	177.5
Calcium (mgm)	750	566	509	338	513	863
Iron (mgm)	22.3	32.7	35.1	54.5	75.4	58.7
Vitamin A: Int. units	2536	2859	6969	966	2905	2477
Vitamin B_1 (mgm)	1.8	2.3	4.2	2.86	3.3	3.5
B_2 (")	1.2	2.7	1.7	1.5	1.6	1.4
Vitamin C (")	64.2	60.7	84.0	28.0	80.0	35.0
Niacin (mgm)	14.4	16.1	37.2	30.3	33.0	23.9

Table 18.

COMPARISON OF DIETS OF TEST GROUP

ESTIMATED AVERAGE DAILY INTAKE

Basic Food Group		A	B	C
		oz	oz	oz
1.	Meat, eggs, beans	9	10.5	10
2.	Milk, cheese etc.	13	11	12
3,4 & 5.	Veg. and fruit	11.6	11	12
6.	Fats, butter etc.	-	-	-
7.	Cereals	42	38	41
	Sugar	1	1	2

The above tables of averages would be misleading if taken to represent the nutritional state of each member of the Test Group. It will be observed that the estimated average diet of Group A presented, compares very favourably with the recommended scale of rations laid down in Diet 2.

Diet 2. A more accurate reflection of the nutritional state will be found in the following table showing the percentage estimated to consume less than the recommended scale of rations referred to in Diet 2, and the average of each basic food group consumed.

Table 19.

Percentage of men in the Test Groups estimated to consume less than the amounts of the 7 Basic Food Groups recommended in Diet 2.

Basic Food Group	Diet 2 (oz)	Group A		Group B		Group C		Combined Test Groups	
		%	Av. Ration oz.	%	Av. Ration oz.	%	Av. Ration oz.	%	Av. Ration oz.
1	5.6	39.5	4.4	27	4.7	37.2	4.5	35	4.5
2	10	51	2.9	58	4.3	63	4.5	58	4.0
3,4,5	10	30) +41%) ++71%)	6.7 Nil	49 24% 73%	7.3 Nil	38 38% 76%	4.6 Nil	39 35% 74%	6.7 Nil
6	1	No record of fat etc. consumed.							
7	25	7.4%	15.8	25.6%	18.6	10.5%	19	14.3%	18.2
Sugar	2	88%	0.9	86%	0.9	87%	0.8	87%	0.9

\+ Percentage consuming no vegetables.

++ Total percentage consuming insufficient vegetables (Basic Food Groups 3,4 & 5), plus those consuming none of these food groups.

An interesting comparison may be drawn here between Recommended Minimum Daily Dietary Standards (a) and the full ward diet (b) provided at Baragwanath Non-European Hospital, Johannesburg,[17] and also between Diets 2 and 6.

Table 20. Recommended Minimum Daily Dietary Standards

(a) Man (average weight) 160 lbs. Moderately Active.

Calor.	Prot. (g)	Calc. (g)	Iron (mg)	Vit.A Int. Units	Thiamine (mg)	Riboflavin (mg)	Nico. Acid (mg)	Vit. C (mg)
3,000	65	.7	9	4,000	1.0	1.6	15	40

(b) FULL WARD DIET BARAGWANATH HOSPITAL

Average adult patients

calor.	Prot. (g)	Calc. (g)	Iron (mg)	Vit.A Int. Units	Thiamine	Riboflavin (mg)	Nico. Acid (mg)	Vit. C (mg)
3,000	110	1.2	27.8	5,529	1.5	2.26	19	130

Diet 2:

Calor.	Prot. (g)	Calc. (g)	Iron (mg)	Vit.A Int. Units	Thiamine (mg)	Riboflavin (mg)	Nico. Acid (mg)	Vit. C (mg)
3532	110.0	566	32.7	2859	2.3	2.7	16.1	60.7
Diet 6:								
5219	177.5	863	58.7	2477	3.5	1.4	23.9	35.0

McCance and Widdowson made several interesting comments after their experiment in September-December 1939.[18] The diet aimed at was regarded as a minimum even if England was in dire straits as a result of enemy attack.

In essence they showed that if people are living under conditions of stress and qualitative restriction of food, a diet which is biologically good need not be attractive nor varied to be compatible with good health.

Table 21

The experimental rations were as follows:

	Quantities in ozs. per week.
Bread	Unrationed.
Meat, poultry and rabbit, fish	16
Cheese	4
Butter	0
Margarine	4
Cooking fat	0
Total fats	4
Sugar (including jam, marmalade etc.)	5
Oatmeal	2
Rice	4
Dried fruits	10 (could have been omitted)
Eggs (no.)	1
Whole milk	35
Potatoes and other vegetables	unrationed
Fruit	6 (home-grown e.g. apple)
Sweets and pastries	0

Cost of food = 7/- per head per week.

The bread was made from 92% extraction flour (wheat). Large quantities of potatoes and vegetables were eaten - up to 3 lbs. a day of potatoes in one case.

It was shown that on the above simple diet the subjects were maintained in normal good health and, at the end of the three months experiment, were able to successfully tackle very strenuous physical activity without undue fatigue.

In most of the subjects who participated, the quantity of vegetable protein consumed was 2 to 3 times more than the amount of animal protein. The total protein consumed, however, was adequate. The diet provided adequate calcium, phosphorus, iron and other minerals and more vitamin B & C than most English diets. They also showed in a study of German children[19] that diets in which 75% of the calories were derived from wheat flour and 21% from vegetables and which contained only 8 gm. of animal protein a day, undernourished children aged 5-15 years were provided with all the nutrients required for a high rate of growth and development.

The addition of approximately $\frac{7}{8}$ of a pint of reconstituted full cream dried milk per day over a period of six months caused no apparent improvement in the growth or health of the children. The children studied (in two German orphanages in 1946) gained on the test diet $1\frac{1}{2}$ times as much weight as the "normal" growth rate of American children. In this diet, various extractions of wheat flour were studied, i.e. 100%, 85% and 70%. All these were found to be equally nutritious and the enrichment of the white flour with B vitamins and iron, did not improve its nutritive value. The fact that the actual extraction rate of the flour did not materially affect the study is of interest.

In a controlled trial affecting young children at an institute, Krut studied the effect of lysine supplementation of bread.[20] The bread was baked from 87% extraction flour with added calcium carbonate (0.5%). It provided 88.8% of the protein and 52.4% of the calories in the diet. Butter, margarine, jams, low protein vegetable and fruit were also given plus a multivitamin preparation and iron tablets.

Two matched groups participated in the trial. The one group first received a supplement of lysine, the other an iso-nitrogenous amount of glycine. The supplements were reversed after a period. The lysine supplemented group gained more weight than the glycine supplemented group. The serum albumin concentration fell in both groups but less so in the lysine group. The fall in serum albumun concentration showed that a bread diet such as has been described, cannot be suitable for young children, certainly not at such low protein levels. It was felt that the increase in weight of the lysine supplemented group was due to greater nitrogen retention.

In McCance's study[19], lysine was no longer limiting.

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Standard of Nutrition

The average standard of nutrition of the 25 men in Group A (see Table 16, p.170) may be a cross-section of the Factory as a whole, and would appear from Table 17 to be satisfactory, with the exception of vitamins A and C. However, we are not dealing with average statistics, but with individual human beings and their nutritional requirements, though these statistics do serve to show that some of the African workers appear to maintain a satisfactory standard of nutrition, especially in the case of men living away from their families.

Basic Food Deficiencies:

According to the Diet Survey made, only 7.3% of the Test Groups showed no dietary deficiencies in respect of six of the seven basic food groups. The percentage estimated to be deficient varied in the food groups.

Group 1.(Meat, fish, eggs, beans)	35%	were	deficient.
Group 2. (Milk, cheese etc.)	56%	"	"
Group 3. (Tomatoes, cabbage etc.)	55%	"	"
Group 4. (Carrots etc. for Vit.A)	56%	"	"
Group 5. (Potatoes, onions etc.)	49%	"	"
Group 7. (Cereals)	11%	"	"

It was estimated that the deficiency of Group 6 foods was almost general. This group consists of butter, margarine etc. These deficiencies lead one to speculate on the causes of malnutrition, and how Africans may be affected.

The three principal causes of malnutrition in any society are probably poverty, ignorance and scarcity of food. Amongst Africans, all these conditions are sometimes found, either separately or in extreme cases all together when drought produces famine or near-famine conditions, particularly in the reserves. Given normal conditions, the African in his primitive tribal way of life, seems to have had an instinctive selectivity of the foods which gave him an adequate and balanced diet. The destruction of that way of life in a large part of the country has brought about conditions in the reserves where the majority of the people live from hand-to-mouth and famine is never very far away.

Ignorance of the principles of correct nutrition the non-availability of traditional foods and the high cost of protective foods, leads to a precarious nutritional level amongst African workers in towns and cities. The tendency to reject some of the more nutritious foods and to take large quantities of the more bulky foods, in the belief that quantity satisfies the needs of the body, is a considerable factor in malnutrition states.

Malnutrition in children is common and carries its effects into adult life. A large proportion of the workers available to industry suffer from the effects of malnutrition during childhood. The foundations of a strong constitution are undoubtedly mainly dependant upon two factors: heredity and nutrition. Correct nutrition during childhood is of the utmost importance in laying the foundations of health, strength and efficiency.

Table 19, giving the percentage of men estimated to consume less than the recommended amounts of the basic foods, is an attempt to present an accurate assessment of nutritional deficiencies. It excludes all those cases who consume as much as, or more than the recommended scale of diet. This table is admittedly one of averages, but has not been weighted by the adequate or better-than-adequate levels.

A proper evaluation of this table and of all the tables and explanations depends upon an understanding of the dietary habits of the people studied.

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(5) FAMILY STUDY

To study the families of some of the men, visits were made to the homes of men falling in different groups. The areas visited were Howick West, and the Impendle Reserve, 47 miles from Howick. Certain examinations of the members of the families and enquiries regarding diet, water supplies, crops and sanitation were made.

Impendle Reserve:

At Impendle, the family visited consisted of the wife, three daughters and two sons, ages from 1½ to 10 years. They have two living huts and a storeroom. In front of the huts is a small vegetable garden enclosed with wire-netting for protection against goats. The main crop in this garden is maize, much of which is eaten green. There are also a few potatoes. There is a notable absence of trees, and all firewood and building poles have to be bought from European farmers near the Reserve. Houses are built of sod under thatch and are considered to be an improvement upon the traditional "beehive" type of grass hut, which is no longer found in this area. Most of the kraals are on the hillsides with small cultivated patches, but the main fields are in the valleys where the residents have been allotted fields by the local chief. The field of Mnikathi, whose family we visited, is about 1,500 sq. yards in extent, on which maize is grown. He reaps about 4½ bags (900 lbs.) of maize in a normal season, which lasts from late May until about the end of August, after which they have to buy mealies and a certain amount of mealie meal. The mealies are ground by hand between two stones and are used for phuthu, marewu and utshwala, as well as for fowl food. Mnikathi has another field about half the size of the above, which is planted to mabela (kaffircorn).

It is evident that the occupants of this kraal which is typical of the Reserve area in which there are about 36,000 inhabitants, are not particularly industrious. Cabbages and peas and other vegetables have not been grown and they appear to live with the minimum of effort. It is also obvious that the acreage cultivated would be inadequate, even if more scientific methods of agriculture were practised. The family must live mainly on the wages of Mnikathi who earns about £17.15.0. per month at the Factory, and goes home once a fortnight.

Meat is sold in the Reserve when cattle die of disease or are slaughtered. This is a somewhat irregular supply but many of the men take meat home when they return, usually every second weekend.

Water at Mnikathi's is drawn from a small stream about 50 yards from the huts. Contamination of this supply seems probable, if not inevitable, it being quite unprotected. The same stream serves several households at different points.

Latrines are the exception, the open veld or mealie fields being used without regard to fly-borne diseases or the possible pollution of water supplies.

The children appeared to be fairly well nourished, but all had pot-bellies, suggesting a carbohydrate diet and a possibility of intestinal parasite infestation. A stool test done subsequently on one of the children when his father brought him to Howick, confirmed the presence of intestinal parasites. The Union Health Laboratory reported "Ova of A lumbricoides present".

Howick West:

Four households were visited at Howick West. One of these, the home of Phineas Buthelezi, who is employed in the Factory at about £17 per month, is built according to Local Health Commission plans. The family living standards and state of nutrition appeared to be satisfactory, though Buthelezi himself has a long-standing chest condition.

The other three houses are slum-type shacks, two of them in advanced states of disrepair. George Zuma, whose wages at the Factory are approximately £13 per month, and whose income is augmented by a daughter earning £2.10.0. monthly, is in poor general health.

His wife exhibits cheilosis, and the five children are thin with dry skins, coughs and running noses.

Ronald Maseko, whose house has the sad distinction of being one of the worst shacks in Howick West, earns £13 monthly. He is under-weight, with spongy gums and has pulmonary tuberculosis. Following a severe attack of broncho-pneumonia in March 1959, his condition has deteriorated still further. His five children are very dirty but well-covered.

These family units are important in illustrating some of the environmental factors as well as the background which govern the state of health of both present and future African workers in this industry. The cases cited at Howick West may appear to be extreme, but are by no means exceptional. Many workers do manage to live under better conditions, however.

A subsequent survey was conducted in which 22 families living in the Howick West area were investigated. The study centred round the financial and dietary status of the families, and the general health of the children. The Social Worker at SARMCOL was responsible for the home visits and the interviews with the families. The medical examination of the children was our responsibility. Household sizes ranged from 3 (man, wife and 1 child) to 10 (man, wife and 8 children).

Table 22.

Incomes. Range £4.0.0. to £7.5.10d. per week.					
	No. above P.D.L.	Range	No. on PDL.	No. below P.D.L.	Range
Poverty Datum Line	12	£1.5.0.- £8.10.0.	1	9	18/5d.- £11.10.0.
	No. above E.M.L.	Range	No. on EML	No. below	Range
Effective Minimum Level	1	11/-	Nil	21	£ 1.0.0.- £23.0.0.

Table 23.

Diets : 22 families

Food Group.	Item.	Short-fall. (families)	Range of deficiency.	No. Exceeding.	Range of Excess.
			(ozs)		(ozs)
1	Animal protein	6	2-36	16	2-82
	Vegetable "	10	9-58	12	1-58
			(pts)		
2	Milk	22	$4\frac{1}{2}$-25	-	-
			(ozs)		
3,4&5	Fresh veg.	10	17-189	12	36-400
	Potatoes	-	-	22	20-828
6	Butter & Marg.	18	$1\frac{1}{2}$-$36\frac{1}{2}$	8	3-$7\frac{3}{4}$
	Other fat	13	$1\frac{1}{4}$-$50\frac{1}{2}$	8	2-23
7	Mealie Meal	4	24-110	18	2-612
	" Rice	7	8-268	12	12-556
	Sugar	1	0-7	15	5-395
	Bread	19	72-496	1	0-180

Health of the children.

24 children were medically examined.

22 children were actually weighed and their heights recorded.

8 were underweight, 7 were underweight and below normal height.

2 were below normal height.

The children's heights and weights were compared with the tables found in the May & Baker Medical Diary 1960 and the Burroughs Wellcome Medical Diary 1960. The following clinical signs were regarded as suggestive of defective nutrition. Soreness of the tongue, stomatitis, gingivitis and magenta hued tongue, inflamed appearance of the buccal surface of the lips, fissures at the corners of the mouth and on the lips (cheilosis, perleche). Dry scaly skin, particularly affecting the legs and arms. "Crazy pavement" skin of the anterior tibial aspect of the legs. Follicular dermatosis or seborrhoea in the naso-labial folds, nose, cheeks or skin; Hyperkeratosis affecting the sebaceous glands, resulting in a rough feel to the skin, loss of pigment in the hair with thin dry lifeless hair. Very carious teeth associated with gingivitis and stomatitis.

Malnutrition		Intestinal Parasites	
No. examined.	Malnutrition signs present.	Stools examined.	No. with parasites
24	17	19	9

Six children had malnutrition signs plus intestinal parasites. The stool specimens were all examined in a reasonably fresh state and were presented so that we were not aware which child had submitted the specimen. The microscopical examination was conducted on a straight saline smear. It was not possible to attempt any concentration technique prior to examining the specimen.

Ova of Ascaris lumbricoides were present in 8 specimens. Ova of Trichuris trichiura was present in 1 specimen. The high rate of intestinal parasitism and malnutrition in this series is suggested by these figures.

Dietary Survey. 12 Families living above the P.D.L.

All diets were compared with Diet 1 in this chapter - p. 170. There was a general deficiency in the use of milk in all the families.

5 families used less vegetables in groups 3, 4 and 5 than recommended. All 12 families however, used more than the recommended minimum of potatoes and sweet potatoes.

9 families showed a deficiency in the use of butter, margarine and other fats.

10 families used more than the recommended minimum per week on mealie meal.

9 families used more rice, mealie rice and samp than recommended.

9 families used more sugar than the recommended minimum.

10 families used less bread than recommended.

9 families living below the P.D.L.

6 families showed a deficiency of vegetable protein and 4 of animal protein. There was a general deficiency of milk in all 9 families.

5 families used less than the recommended minimum of groups 3, 4 and 5 vegetables. No family however, used less potatoes than recommended - in fact, they all exceeded the minimum requirements. All 9 families used

less butter than recommended. 2 families used less mealie meal than recommended. 7 families used more mealie meal than recommended. 4 families were below the recommended minimum in their use of samp, rice and mealie rice. 6 families used more sugar than recommended. All 9 families used less bread than the recommended minimum.

The statements above applied equally to the family above the effective minimum level. The main deficiency noted was that of milk. The use of fruit in general was so irregular that it was impossible to form an estimate of how much was used in the diets.

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The general deficiency of milk, vegetables and fats in the diet of the average urban African family is again suggested by this study. The overall lack of protein was noticeable, and the preponderance of cereal foods was very striking. An interesting item however, was the universal use of potatoes in more than adequate quantities. The use of sugar too was above the normal requirements.

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As a reflection of the general social background and health of Africans, as compared with Europeans, Asiatics and Coloureds, figures are quoted from recent Annual Reports of the Medical Officer of Health of the Local Health Commission. Although not concerned only with diet, the figures are nevertheless considered to contribute to the background of the thesis as a whole.

Table 24.

1958. All areas under the Commission's Jurisdiction[21]

	Bantu	Indian	Coloured	European
Birth rate per 1000 population.	34.14	37.16	32.08	21.71
Death rate per 1000 population.	20.24	7.62	13.45	7.24
Infantile deaths	425	47	7	1
Infantile mortality rate (deaths under 1 year per 1000 live births.)	206.51	59.49	140.00	55.14

The population figures were: European 829
African 60,284
Indian 21,260
Coloured 1,561

Table 25.

1958. Public Health Area of Howick West.[21]

	Bantu	Indian	Coloured	European
Birth rate per 1000	24.40	5.55	15.29	-
Death rate per 1000	15.99	0.93	18.35	-
Infantile deaths	12	-	2	-
Infantile Mortality rate (deaths under 1 year per 1000 live births.)	206.90	166.67	400.00	-
Number of deaths	38	1	6	-

Population figures: Bantu 2,377
Indian 1,082
Coloured 327
European 0

Of the known causes of death, where the figures are of significance, Bronchitis and Pneumonia are the major causes amongst the Non-Europeans generally. In the Africans, Gastro-enteritis and Colitis (under 2 years) are the second major cause. In Indians, Cardiac diseases came into this category.

At the clinic at Howick West, the proportion of sick to healthy babies attending was 2,7 : 1.

Table 26.

1959. All areas under the Commission's Jurisdiction.[22]

	Bantu	Indian	Coloured	European
Birth rate per 1000 population.	30.11	31.00	30.02	17.42
Death rate per 1000 population	20.29	7.29	6.88	9.29
Infantile deaths	427	35	0	0
No. of deaths	1253	170	11	8
Infantile mortality rate (deaths under 1 year per 1000 live births.)	229.57	48.41	-	-

Population:		
	European	813
	Coloured	1,599
	African	61,755
	Indian	23,379

Table 27.

1959. Public Health Area of Howick West.[22]				
	Bantu	Indian	Coloured	European
Birth rate per 1000 population.	32.81	5.55	15.29	-
Death rate per 1000 population	18.51	2.77	3.06	-
Infantile deaths	12	-	-	-
Infantile mortality rate (deaths under 1 yr. per 100 live births)	153.85	-	-	-
No. of deaths	44	3	1	-

Population:		
	African	2,377
	Indian	1,082
	Coloured	327
	European	0

Of the known causes of death where the figures are of significance, Bronchitis and Pneumonia (all forms) are the major causes amongst the Non-Europeans generally. In the Africans, Gastro-enteritis and Colitis (under 7 years) are the major causes of death.

At the clinic the proportion of sick to healthy babies was 2.7 : 1, which was the same as in 1958.

Malnutrition:[22]

The problem created by malnutrition is so complex and widespread that whatever action is taken on the social side, the effect is of comparatively minor degree. Lack of maintenance, not only of legitimate but also of illegitimate children is one of the most important contributory factors to this problem of malnutrition and the work of social workers is considerably hampered in the application of native law practices and lack of efficient remedies to enforce maintenance of children.

Table 28.

1960. All areas under the Commission's Jurisdiction.[28]

	Bantu	Indian	Coloured	European
Birth rate per 1000 population.	23.26	32.85	17.72	14.79
Death rate per 1000 population.	15.92	6.83	7.33	4.55
Infantile deaths	413	52	1	1
No. of deaths	1175	164	12	4
Infantile mortality rate (deaths under one year per 1000 live births)	240.54	65.91	34.48	76.92

Population:

European	879
African	73,828
Indian	24,019
Coloured	1,687

Table 29.

1960. Public Health Area of Howick West.[28]

	Bantu	Indian	Coloured	European
Birth rate per 1000 population	10.94	6.45	18.35	-
Death rate per 1000 population	14.30	3.70	6.12	-
Infantile deaths	14	-	-	-
Infantile mortality rate	538.46	-	-	-
No. of deaths	34	4	2	-

Population:

Africans	2,377
Indians	1,082
Coloured	327
European	0

Where the cause of death has been ascertainable, Bronchitis and Pneumonia have been the major causes, and Gastro-enteritis and Colitis the next most common causes in Non-Europeans.

The remarks covering the subject of malnutrition are essentially the same as those mentioned for 1959. It seems reasonable to draw the following conclusions from these figures.

(1) The birth rate of Africans where the composite figures are concerned, is lower than that of Indians, but higher than that of Europeans and Coloureds. The birthrate of Africans in Howick West however, is higher than that of the other groups.

(2) The death rate of Africans is considerably higher than that of all other groups, with the exception of the figure for Coloureds in Howick West in 1958. In general, the death rate of Coloureds is next to that of Africans. There has been a noticeable drop in the death rate of Africans for 1960.

(3) The Infant Mortality Rate (deaths under 1 year per 100 live births) is considerably higher for Africans than that of any other racial group.

(4) The causes of death, although generally applicable to all races, show that gastro-intestinal conditions are a special hazard of Africans. This fact, taken in conjunction with the high death rate and high infant mortality rate is indicative of the low social standard experienced by Africans in general. It also raises the question of the effect of malnutrition on the figures as a whole.

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(6) A MINIMUM STANDARD OF NUTRITION AND ITS COST

In Table 16 on page 170 of this chapter on Diet, a comparison was presented of six different diets analysed in the seven basic food groups. The nutrient contents of these diets are analysed in Table 17, p.171.

Diet 1 in the Tables referred to represents a minimum daily diet for a Bantu Manual worker, according to the Department of Nutrition's pamphlet No. V.N.420, and has been adopted as a standard for the assessment of a minimum cost of an African worker's food. It is not presented as a recommended or an adequate level of nutrition. It also served as the background for the discussion of the 22 families studied at Howick West.

It will be noted that this minimum diet scale adopted falls short of the recommended intake of nutrients as shown in Diet 2. Costs of the specific foodstuffs which comprise these diets have been calculated at local retail prices on a monthly basis, and are as follows:

Table 30. Costs of Diets - monthly basis.

Diet 1	A minimum diet for a Bantu Manual Worker	£2.10. 9.
Diet 1	A minimum diet for his wife	£2. 7. 9.
	" " for a child 2-6 yrs	£1.16.11.
Diet 2	A Ration Scale for natives doing hard work	£3. 1. 0.
Diet 3	S.A.R. Tunnel Construction Camp, Cedara	£3. 9. 1.
Diet 4	Government Minimum Ration Scales - Native Labour Regulations 1911 (as amended)	£2.17. 2.
Diet 5	Mine Standard Scale for Experimental Group of Natives[16]	£3. 6. 0.

PART TWO

DISCUSSION:

It has been said that an adequate diet is no panacea for the ills of mankind, but without adequate nutrition man cannot be efficient.[24] The essential criterion of subnutrition is that the physical and mental efficiency, stamina and resistance to disease can be improved by the provision of more protective foods.[24]

The "laziness" and " stupidity" of the African may well be a physiological adaptation to under-nutrition.[9] The rural diet however, can be nutritionally adequate, and the information given by Mr. M.V. Clarke in the section on the Pondos' diet supports this. Utshwala too can be a valuable supplement to the African dietary. "Small beers" prepared from the dregs after the utshwala has been drained off, are also valuable additions.

Turning from the rural scene to the impact of industrialisation, an ever increasing population in industrialised countries lives under city, suburban or even slum conditions.[25] Their provisioning requires transport and storage of foods and care to prevent deterioration in appearance and nutritive values. Food sanitation has assumed great importance in human experience and public health. The canning industry has accomplished much in conserving desirable qualities in foods, as have investigations related to drying and freezing of foods. Much can be done to add essential nutrients to foods which contain too little of them, either naturally, or because of refining or steriliz-ation.[25]

The grand scale use of poisons as insecticides is a cause of concern from their danger of acting as food contaminants. The growing use of antibiotics in animal feeding and the recent practice of administering tranquillisers to increase rates of gain by animals for meat production, is also of concern until more is known of their effects.[25]

In modern nutrition two principles have lately emerged. (Brock)

(a) The era of optimum dietary intakes is not necessarily leading to health;

(b) In at least one respect recommended allowances may have been set dangerously high, i.e. fat. The picture of atherosclerosis exhibited in privileged communities all over the world bears this out.

Human nutrition may be defined as those aspects of structure and function which are particularly dependent on proper feeding. This is only a relative definition since in the last resort all structure and function are dependent upon proper feeding and "optimum health" becomes dependent upon "optimum feeding". Health, of course, depends on many factors apart from nutrition.[26]

Nutrition is important to man's existence.[27] Not only does it profoundly influence almost every aspect and phase in the life of individual man, both in health and disease, but to a great extent it can be said to shape human society. It is a vital determining factor in man's motivation and capacity to work and think, and it affects human behaviour, not only in the individual, but of communities and social classes, and even of nations and races. In underdeveloped countries, like the Afro-Asian and South American, many of the teeming millions are unable to satisfy their hunger, let alone achieve adequate nutrition. In addition, the world is doubling its population every forty years, thus aggravating the picture. Resultant deficiency states cause chronic ill health, a lowered capacity for work and resistance to infections is lowered. Under conditions of stress accepted optimum requirement may become subminimal. This applies particularly to the injured and sick, because of the catabolic effect of trauma and disease.[27]

The impact of a deficiency is greater during periods of growth and development. The earlier the stage of development at which the deficiency occurs, the more profound the ill effects, and the greater the possibility that the effects may be permanent. Infants suffer severely from poor feeding due probably to the fact that their homeostatic mechanisms for defence against stress are limited.[27]

If essential nutrients are unavailable to the foetus, physical abnormalities may result. There appears to be little maternal storage during pregnancy of vitamin B_1, riboflavin, pantothenic acid and biotin.[28] In experimental studies, maternal deprivation resulted most commonly in a small embryo. In countries subsisting on a low level of food intake during the last war, sterility, miscarriage, prematurity and still births were frequent.[28] Experimental deprivation of vitamins resulted in a variety of gross physical abnormalities in embryos, affecting often the face, eyes, ectopia of thoracic and abdominal organs, hydrocephalus, etc. Resorption of embryos was common, as were lesions of the heart, liver and veins in survivors. High foetal and post-natal death rates were common. If deficiencies were marked, female experimental animals did not have normal cycles and were sterile. A lesser deficiency produced fertile ova, but they died and became resorbed. Lesser degree of deficiencies resulted in abnormalities, ranging from slight to gross, and if the deficiencies were slight, normal development without anomalies occurred, but the offspring were smaller and underdeveloped. The stage of embryonic development at which the deficiency occurs is important and general deficiencies did not seem to exert as bad an effect as specific deficiencies.[28]

At a definite time early in development, the embryo is the subject of particular mechanisms of morphogenesis, and if these are disturbed, malformations occur. Their appearance is therefore characteristic of nutritional disturbance at this stage, especially of vitamin deficiencies. The proper nourishment of the maternal organism therefore, is of very great importance to the production of healthy, properly formed young.[28]

In the human field, the mortality rate in children aged 1-4, and that due to tuberculosis in this age group, serve as fair indices of nutritional status in a community. By comparison with white children in South Africa, the mortality is five times greater in Asiatics, 15 times in Coloureds and 32 times greater in Bantu. For each white child within this age group that dies of tuberculosis, there are 8 Asiatic, 70 Coloured and 120 Bantu children, and furthermore, deaths reported as being due directly to malnutrition occurred 1000 times more frequently in Bantu children.[27] The very high mortality rate in Africans locally has been commented upon in the last section. Life expectancy of the African in the Union has been assessed at 36, as compared with the European figure of 70 years.[30]

Education in dietary matters amongst the poorer sections of the community has many difficulties. Any instructions given are unlikely to be well or fully understood and economic reasons alone may prevent full compliance. It has been said that without an intimate knowledge of Bantu psychology and tribal customs, our efforts in the nutritional field are doomed to failure.[29]

However, the possibility of enriching food with suitable supplements should be considered to increase the proportion of protein. More will be said about this in the discussion on protein. It is a known fact that if calorie requirement is adequate, it is remarkable how little additional high-class protein is needed to ensure good nutrition.[27] This in turn is of vital importance, as malnutrition so affects the poorer sections of the community as to be a serious economic burden because of the cost of hospitalisation, absenteeism and fall in productivity.

The inadequate dietary of the African from infancy may cause premature ageing, sluggishness and liver degenerations. 60-70% of African schoolchildren are recognisably malnourished.[30a] The fact that 90% of cancers in African males arise primarily from hepatic epithelium, is of considerable interest.[31] The African liver is severaly injured with great frequency, virtually from birth. The frequency of primary liver cancer in the African may perhaps be due in large measure to the virtually continuous repair of the chronic hepatic lesions which are so often present in Africans.[31,50]

The inadequate diet of Africans must play the dominant note in the fact that so many Africans are underweight. In Northern Rhodesia, the average weight of the adult male Native has been reported as being 10 lbs. lower than the European standard.[30] 25% of Natives from African territories seeking work on the gold mines between 1940 and 1943 were rejected as physically unfit. This is mirrored in the experiences in Britain at the opening of the twentieth century, where malnutrition was more rife than in the great dearths of Mediaeval and Tudor times. 40% of recruits examined at the time of the Boer War were physically unfit.[8]

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CONCLUSIONS DRAWN FROM THE DIETARY SURVEY

Whilst many of the men studied at SARMCOL achieved an adequate diet, certain deficiencies were noticeable and the following facts emerged from the dietary survey.

(i) The diet is relatively monotonous.
(ii) Large amounts of cereals are consumed.
(iii) Very few of the men eat eggs.
(iv) 73 eat no vegetables.

Group B, resident in the Native Village, Howick, and living with their families, have the lowest figure (8) of those not eating vegetables. Group A has 36, and Group C 29. A natural tendency towards a balanced diet seems to be exhibited by the most settled group studied.

(v) 67% of all groups show a deficiency in the intake of fruit and vegetables. 30.3% were deficient in protein foodstuffs in Group 1, and 56% were deficient in protein foodstuffs in Group 11. The deficiency of Group 6 foods (butter and margarine etc.) appeared almost general.
(vi) Acknowledging the limitations of our study and the admitted impossibility of achieving mathematical accuracy, and also the fact that a dietary survey may suggest the possible presence of malnutrition but does not prove it,[32] there was reason to suspect a deficiency of vitamin A and vitamin C.
(vii) 179 out of 245 men have their first meal of the day at 9.15 a.m. As the normal shift commences at 6.45 a.m., this is an obviously undesirable state of affairs. The usual shift worked is one of 10 hours,

which includes an hour break for lunch. Two tea breaks of 15 minutes each are provided.

(i) <u>Monotony</u>:

Reference has been made in the first part of the discussion to the inadequacy of the African diet in general, and to the effects on weight, longevity and mortality rate.

That monotony alone need not impair the value of a diet was shown by McCance and Widdowson.[19] To the teeming millions of underprivileged people, which includes many Africans, satisfaction of hunger is difficult, if not impossible to achieve, and the question of monotony hardly arises.

The commonest method of varying the flavour of the Bantu diet seems to be the employment of soured foods. Golberg pointed out that in marewu the thiamine content drops by 30% due to the preliminary boiling of the preparation. Riboflavin and Nicotinic acid levels increase.[5] Golberg and Thorp showed that sprouting of seeds results in an increase of vitamin C, and also of riboflavin and nicotinic acid. They also demonstrated that extra water, nitrogen, phosphorus, potassium and manure served to raise the thiamine content of wheat.[33] Ground nuts contain four times as much riboflavin and nicotinic acid as most cereals, are well liked, and could be used to bring variety into a monotonous diet.

Odendaal showed that food yeast (Torula utilis), whilst it lacks methionine and cystine, is nevertheless a useful additive to cereal diets, and it has a high protein and vitamin content.[34]

The composition of food yeast is as follows:[35] (The authors quote the figures of Fox and Golberg 1944.[13])

	(gm per 100 grammes)
Water	10.0
Proteins	39.6
Solids	90.0
Fat	3.1
Carbohydrate	3.4
Calories per pound	910
Ash	0.952
Phosphorus	28.8 mgm
Iron	16.0 mg
Calcium	33.0 mg
Thiamine	2.3 mg
Riboflavin	5.6 mg
Nicotinic acid	40-50 mg

Soya bean as an additive will be considered in the section on Protein.

The canteen services at SARMCOL have been considerably improved since the investigation was undertaken, and the meals available now will be discussed later. (Chapter 7.) The canteen service however has clearly shown that if alternatives are available, the African will be most willing to vary his diet. Soup and mealie rice have become popular locally, and legumes too play a part in lessening the monotony of the diet.

(ii) <u>Cereals</u>:

The diet in Japan contains a large percentage of carbohydrate as shown by Suzukis' figures[36], namely carbohydrates produce 75% of calories, protein 13% of calories and fat 12%. The predominantly carbohydrate diet is matched by the Africans, whose staple foodstuff is maize. By European standards the amount of maize consumed per day is staggering. It also provides the main article of food in large parts of Central America, and other regions of the world. Its nutritional importance is heightened by the small consumption of animal foodstuffs in the populations mentioned.[37]

Columbus first saw maize on November 5th. 1492, on the island of Cuba. It was, however, grown in South America hundreds of years before that. When the first white men landed at Jamestown (U.S.A.) in 1607, they learnt from the Indians how to grow maize. Fish was used as a fertiliser - the departed spirits of the fish were supposed to improve the yield. The fact that the fertiliser used had a high protein content is now obvious.[38]

In July 1658 van Riebeeck received a sample of maize from New Guinea, and from that time it has been grown in South Africa. The word mealie comes from the Portuguese word "milho" which actually means millet.[38]

After the South African war, and the demand created by the mines, maize became an important crop in South Africa. In 1906-7 the production was 2,500,000 bags; 8,000,000 at the time of Union, and today it is over 50,000,000 bags. Given the right incentives, demand and price, it would be possible to produce twice as much in a good season within the next 20 years. It is a particularly adaptable crop and will grow well at sea level and at altitudes over 12,000 ft. It grows from the Cape to the Limpopo, and from Natal to South West Africa. Because of the low rainfall, millet does better than maize in Bechuanaland.

There are many different varieties. The quickest growing will produce seed in two months; a variety grown in Mexico takes a year to mature.[38]

Average amino acid analysis of whole maize shows a relative deficiency of tryptophan and lysine whether compared with estimates of the requirements of amino acids for man, or the pattern of essential amino acids in hen's egg or human milk.[37] There is evidence that some amino acids are poorly released during digestion of maize or zein. It is also likely that the excessive proportion of leucine in maize produces an amino acid imbalance and increases the need for iso-leucine and possibly valine.[37] The leucine/iso-leucine ratios are:

Egg	1.36
Milk	1.53
Maize	3.18 [39]

Amino Acids in Maize:

The order in which amino acids are limiting in maize (with adequate vitamins provided) are as follows:

(1) Nitrogen balance was increased by lysine, not by tryptophan, therefore lysine was the first limiting amino acid.

(2) Nitrogen balance with the subjects receiving maize plus lysine was improved by tryptophan, therefore tryptophan was the second limiting amino acid.

(3) Nitrogen balance with the subjects receiving maize plus lysine and tryptophan was increased by adding isoleucine, but not by the addition of methionine, therefore isoleucine was the third limiting amino acid. When methionine was added to maize, plus lysine and tryptophan, an amino acid imbalance effect was observed.[46]

(4) Improvement with the first two or three limiting amino acids appeared comparable to the effect of a generous supplement of casein. It therefore seems unlikely that there is a serious deficiency of any other amino acid in maize.[37]

Scrimshaw in South America had similar results. The lysine-tryptophan ratio of the diets used by Scrimshaw was 9.8 : 1, compared with 4.8 : 1 in the series here discussed.[37]

Supplementation of maize must include tryptophan and lysine because maize is likely to be deficient in available niacin and tryptophan has a sparing effect on niacin. If lysine is given alone without vitamins, it seems to exert little effect.

Maize Protein:

In Truswell and Brock's series[37], protein intake was near 1 gm/kg body weight per day - providing 9% of dietary calories from protein. The protein in maize as the major source of dietary protein has two disadvantages:

(i) Its total protein content is low in this country - between 8 & 11% in common with other cereals.

(ii) The protein is made up of an unbalanced pattern of amino acids.[40] As has been mentioned[37] the lysine and tryptophan is low and the leucine, isoleucine ratio is high when compared with egg, milk or the ideal pattern of amino-acids as proposed by F.A.O. Therefore beans, peas and pulses which are rich in lysine may be used to supplement maize.[41,42,43,44].

Supplements:

In Hansen's[40] series, weight gain was steeper and more consistent on milk formulae, and least on unsupplemented maize formulae. The supplement with pea flour improved weight gain, but not as well as on milk diets. The same effects were seen in the serum albumen concentrations.

Maize and pea flour mixtures are bulky and difficult to give, but did achieve initiation of cure in mild cases of kwashiorkor. If enough can be given to ensure nitrogen absorption above 400 mgm/kg/day they are adequate as sources of protein.[40] Supplementation of maize with milk or pea flour made its nutritive value equal to that of milk mixtures, providing total protein intake was more than 2.5g/kg/day.

Amino acids have been shown to be the chief limiting nutrients of the diets on which kwashiorkor may develop. A synthetic mixture of 18 amino acids based on casein was no different from milk in its power to induce positive nitrogen retention.[40] Nitrogen retention depends on level of nitrogen intake. L-amino-acids were more acceptable in Hansen's trials, particularly to children, than racemic forms. 2.3 to 2.7 meq of potassium should be retained for each gram of nitrogen. This is close to the ratio of potassium to nitrogen in protoplasm.[40]

<u>Protein Fractions</u>:

Maize has 3 physically separable protein fractions.[39]

(i) Zein which is alcohol soluble and accounts for half the total protein.

(ii) Glutelin which is alkali soluble, alcohol insoluble and accounts for a quarter of the total protein.

(iii) Globulin which is soluble in neutral salt solutions.

Zein is deficient in tryptophan and lysine, but the aminogram of maize glutelin is well balanced.[39]

Table 31.

Aminograms of zein and maize glutelin

Grams of amino acid per 16 g.n.

	Maize glutelin	Zein
Cystine	3.14	0.9
Histidine	2.11	1.2
Isoleucine	4.14	7.3
Leucine	11.87	22.3
Lysine	3.60	0.1
Methionine	2.24	2.1
Phenylalanine	7.21	6.4
Threonine	3.72	2.7
Tryptophan	0.92	0.1
Valine	6.18	2.6

The deficient aminogram of the total protein of maize results from mixture of the very poor protein zein with the good proteins glutelin and globulin.[39]

Other constituents of Maize:[39]

Maize contains more fat than other cereals, except oats, and breeding may produce different values. The maize oil is unsaturated; it has an iodine value of about 122, and a high content of essential fatty acids (53.5% linoleic). Maize is low in sodium (3.8 mg/100g) and calcium. Calcium values range from 3-18 mg/100g. American reports give values between 7.0 and 11.0 mg. Potassium ± 295 mg/100g. Phosphorus 187-260 mg/100g. In quality 2/3 is present as phytite. Magnesium: 101-109 mg/100g.

Iron: 3-4 mg/100g. so maize contains an important quantity of iron. Further iron is added in the traditional method of cooking in heavy iron "kaffir pots".

Vitamin A: Yellow maize has values of 250-640 i.u. per 100g. ½ of the vitamin A activity is cryptoxanthine and half is carotene. White maize contains no vitamin A.

Thiamine: Maize is a rich source of thiamine. .3 to 0.5 mg/100g.

Riboflavin: More than in wheat and rice. 0.08 to 0.15 mg/100g.

Niacin: Less than in wheat, barley, sweet corn, sorghum or millet, but more than in oats and rye. S. African maize seems to have less niacin than American maize. Range .8-5 mg/100g. - latter figure occurs in an American strain. All or most of what is reported as niacin in maize on standard analysis is in the "bound" form. Its chemical nature is unknown but it is converted to "free" nicotinic acid by acid or alkaline hydrolysis.

Pyridoxin: low - 0.19 mg/100g.

Pantothenic acid: 0.61 (0.26-0.94) mg/100g.

Choline: Low - 40 mg/100g.

Folic acid - small quantity 0.026 mg/100g.

Vitamin B_{12} - None.

Vitamin C: in green mealies, 10 mg/100g. None in mature ordinary maize. A little is found in sweet corn.

Vitamin D: Insignificant.

Vitamin E: Appreciable amounts 1.5-3.6 mg/100g.

The germ contains 22% of the total protein and the endosperm 76%. The quality of the proteins differ in the two parts of the kernel. In endospern ½ is zein, and glutelin and globulin each make up a ¼. In the germ most of the protein is glutelin and globulin, zein only accounts for 5-10%. 80% of the oil is found in the germ, plus all the vitamin E. 80% of the thiamine is in the scutellum; niacin is in the aleurone and subaleurone layers. The germ contains most of the minerals.[39]

Most maize in South Africa is cooked by boiling. Some thiamine and riboflavin loss occurs. The increase in the proportion of free niacin more than compensates for a slight reduction in total niacin. Some loss of lysine may occur when browning occurs, as in bread making. Cooking does not cause any important change in the aminogram.[39]

Zein is a very poor quality protein. When it is the sole dietary protein rats lose weight and will die in a fortnight. By contrast, rats grow well on maize glutelin, and when half the zein is replaced by glutelin, slow growth is obtained.[39]

When maize is milled, a variable proportion of the germ is lost, depending on the extraction rate. Maize glutelin is a by-product of the corn starch industry. It has a high protein concentration - about 40% - but more than 2/3 is zein. Much of the glutelin and globulin of maize is either lost in milling or washed out.[39]

<u>Trace elements:</u>

The effects of trace elements on plant protein composition, particularly that of maize, requires a brief mention. Trace elements are essential components of enzyme systems and vitamins (e.g. molybdenum in the xanthine oxidase system and cobalt in vitamin B_{12}). Trace element deficient soils may affect the protein composition of plants grown on them. Cobalt, manganese and zinc deficiency may affect nutrition through specific effects on intestinal flora.[45]

Protein rich foodstuffs are important vehicles, not only of essential amino-acids, but also of essential vitamins and trace mineral elements. Iodine deficiency is recognised, and so is fluorine and its relation to dental caries. In human diets built up on a vegetable basis, which applies so typically to many Africans, the possibility of a cobalt deficiency occurs.[26] It has already been mentioned that maize contains no vitamin B_{12}.

Trace element nutrient levels do affect the amino acids or protein composition. Experiments with nitrogenous fertilisers show that increasing soil nitrogen increases the yield and protein content of maize.[47] The nutritive value of this maize is appreciably less than that of unfertilised maize, however. Its protein contains less tryptophan and lysine. The alcohol soluble protein zein increases, and this is markedly low in tryptophan and lysine.

Boron has been found necessary for adequate tryptophan synthesis in soya-bean and lucerne, and sulphur for methionine formation in these plants. As methionine is low in legumes this point is of significance. Tryptophan formation in the tomato is dependent on zinc which also has an effect on both tyrosine and tryptophan formation in barley.[47] Schutte and Schendel[47] quote Koehler and Albrecht's work which showed that on mineral deficient soils to which only trace elements and magnesium had been added, the total nitrogen content of the plants was not altered, but the tryptophan and methionine content was increased markedly. The trace elements supplied were manganese, copper, boron, zinc and cobalt. Maize grown on soils treated by fertilisers and trace elements, was preferred by rabbits to maize grown on fertilised soil only. Maize supplied with both major and trace elements produced twice as much growth in rabbits as other maize.

Nitrogen therefore seems to be mainly concerned with the amount of protein produced, but trace elements are concerned with the quality of the protein found. This is because the role of trace elements in metabolism is to be constituents of enzyme systems.

The composition of plant proteins can be controlled to an appreciable degree by proper fertiliser practice. Nutritive value of maize protein is already poor, but it can be affected by present fertiliser practice which frequently results in an increased percentage of zein in maize protein. As the balance of amino acids is of the utmost importance in health, crops which have a balanced amino-gram would provide protein much more economically.[47]

When a dietary constituent present as the sole source of protein has a biological value of less than 60, some form of supplementation is required. Maize has a biological value of 54 and forms essentially the sole source of protein to an appreciable number of people in South Africa and elsewhere. If, therefore, trace element fertilisation can improve the amino acid content of maize, thereby raising its biological value, it would provide a major step forward in nutritional practice in this country.[47]

Vitamin Values:

The vitamin values of maize have been mentioned on page 207, and a table comparing the values for maize and kaffir corn is of interest.[35]

Vitamin Values : Maize & Kaffir Corn

(From Fox & Golberg[13] 1944)

Table 32. Per pound

Type	Vit. A	Thiamine mg	Ribo-flavin mg	Nico. Acid mg	Ascorbic acid mg
Yellow maize	1100 i.u.	1.32	0.59	6.8	0
White maize	0	1.36	0.59	6.8	0
Yellow 96% extraction	900 i.u.	1.14	0.54	5.4	0
White 96% extraction	0	1.14	0.54	5.4	0
White refined meal	0	0.27	0.14	2.7	0
Kaffir corn whole	0	1.36	0.54	15.9	0
Straight run meal	0	1.27	0.45	13.6	0
Table meal(bran removed)	0	1.18	0.36	11.8	0

It shows the higher level of nicotinic acid found in kaffir corn.[35]

The growth inhibitory effect of zein, in the absence of vitamin B_{12}, has been related to the leucine content.[48]

It is known that in maize-eating countries, pellagra is common. It is seen in Yugoslavia, Roumania, Egypt and Southern Africa, whereas it is uncommon in Indian populations of South America, despite the fact that there too maize is a staple article of diet. The reasons for this appear to be that beans are commonly eaten with the maize, and the population drink quantities of roasted coffee which can supply ample niacin.[49]

In Asia too, maize-eating populations are not subject to pellagra, the reason being that maize is eaten in more or less equal proportions with rice and other cereals. Niacin must be considered as the most limiting nutrient in a complex deficiency state in pellagra. Deficiency of other members of the B group is always present; also total protein and serum albumin are usually low.[50]

The discussion on pellagra is taken further in the section on vitamins, in chapter five.

Fat in maize:

The majority of the fat in the Bantu diet is derived from maize, and has a high content of unsaturated fatty acids. The small quantity of saturated fats in the Africans' diet comes from sour milk and the rare meat feasts. More will be said on this point in the section on fats.

Other aspects of a maize diet:

A high carbohydrate, low protein diet, which occurs in South Africa where maize is the staple foodstuff, is associated with a high incidence of megaloblastic anaemias. It is likely that these diets produce an intestinal environment inimical to the synthesis and utilisation of vitamin B_{12}.[48,51,52]

The amount of maize consumed per day varies widely but large amounts are commonly eaten. In Truswell and Brock's series[37], 500-600 gm of maize per day were consumed. Our figures vary between 453 gm per week (or 90.7 gm per day calculated on our 5-day working week) to the enormous figure of 18 lb. per week, or 1635 gm per day! The amount seems impossibly large but the individual concerned is particularly definite in his statements, and is extremely corpulent. His weight was 40% above the normal standard.

Most maize consumed has been milled, and mention has been made of this in the first part of this chapter. There are sound reasons for milling white wheat flour and degerming maize which, in many cases, must be shipped long distances, and undergo storage for considerable periods. Rancidity and infestation with insects are the two most serious hazards to the marketing of whole wheat or corn meal.

There is no health hazard in the consumption of refined cereal products provided their nutritive deficiencies are supplied by other foods like milk, or other dairy products and green vegetables.[25] This aspect of nutrition however, is not understood by most Africans employed in industry and forms the basis for further educative work in the future.

It has been mentioned that the practice of good principles of dietetics requires not only knowledge but a certain degree of conviction and self discipline. Many people who accept teaching in principle are deficient in awareness of the importance of right eating, and are weakly motivated to alter established habits.[25] It is on this basis, and with the experience that maize plays too dominant a role in the Africans' dietary, that further canteen services must be envisaged.

(iii) The deficiency of eggs:

Mention has been made of the reluctance of the Zulus to eat eggs, and the special difficulties of persuading the female sex to use them. In this field nutrition education could play a valuable part.

100 gm of dried hen's egg gives a calorie value of 604 - higher than that of dried milk powder.[34] One medium egg would contribute the following analysis per 100 mgs edible portion:

Table 33.

Raw:	Cals	Prot. gm	Fat	Carb. gm	Calc. mg	Phos. mg	Iron mg	Vit. A i.u	Thiam. mg	Ribo. mg
Whole	162	12.8	11.5	.7	54	210	2.7	1140	.10	.29
White	50	10.8	0	.8	6	17	.2	0	0	.26
Yolk	361	16.3	31.9	.7	147	586	7.2	3210	.2	.36

	Niacin mg	Vit.C mg[53]	
Whole	.1	0	The vitamin D values are not given, but eggs are one of the few natural foods which are rich in vitamin D.
White	.1	0	
Yolk	Trace	0	

The values for protein, fat, calcium, phosphorus, vitamin A and riboflavin would contribute considerably towards balancing the common African type of diet.

In Germany after the 1939-45 war, blood donors received 30 eggs for donating ½ litre of blood.[54] It is known that egg albumen has a high nutritive value for growth and contains all the essential amino acids.[55]

In the following table the nutritive value of five proteins are expressed relative to egg white as 100 (F.A.O.)[56]

Table 34:

Animal	Egg white	Whole egg	Beef	Casein	Peanut flour	Wheat gluten
			(a) for growth.			
Rat	100	95	84	80	31	8
			(b) for maintenance			
Rat	100	87	73	54	49	69
Dog	100	76	68	64	49	39
Man	100	103	74	74	62	46

Differences between the biological values of proteins are less accentuated in man than they are for small animals. A difference appears too between the needs for growth and maintenance. Wheat gluten which is deficient in lysine is as good as casein for maintenance in the adult rat, but not for growth in the young rat, showing that lysine is not essential for maintenance in the rat. Where there is depletion however, and protein repletion is necessary as in the growing rat, then wheat gluten has a low nutritive value. The comparison between the nutritive value of wheat gluten and egg white is well shown in the table. The essential amino acids are all present in egg white, but György draws attention to the fact that all proteins must not be thought of only as amino acids. Intermediate degradation products such as peptides, may be of importance for man, as they are for some micro-organisms.[56]

A table follows, showing the percentage of essential amino acids in proteins, of some common foods. (Truswell)[39]

Table 35:

Food.	Total essential amino acids including tyrosine & cystine but excluding arginine and histidine.	Leucine(G/16GN) included in total essential amino acids.
Hen's egg	51.7	9.4
Maize meal	41.9	12.7
Cow's milk	50.4	9.9
Peas & beans	41.8	8.1
Rice meal	41.0	8.8
Wheat	35.9	6.9
Oatmeal	38.1	7.2
Sorghum	45.6	16.1

The value of the egg protein to diets habitually low in animal proteins, is again obvious. As fowls are easily kept, even in poor households, their value to the family as a whole could be considerable.

(iv) The place of vegetables in the diet:

78 men eat no vegetables, but the majority of the men studied eat and enjoy vegetables. 67% of the group studied however, ate less fruit and vegetables than the recommended minimum. The aim of nutritional education is to present a varied diet of naturalfoods, eggs, bread, butter, milk, meat, fish, vegetables and fruit, in quantities sufficient to make maize comprise a much smaller part of the total food consumed. This will result in a lessening of the thousands of Africans seeking medical help for conditions which are largely the result of chronic malnutrition.[30,87.]

The part played by legumes is also important. They are regarded as appetisers and meat substitutes, and as they contain adequate thiamine levels, plus protein, they are particularly acceptable. Dietary custom is thus again found to be in keeping with the teaching of modern nutritional science.

The tendency to cook all vegetables, particularly tomatoes and cabbage, in water for a considerable period, is almost general, and is regrettable. This however, is subject to the general programme of re-education in dietary matters, which has already received its initial impetus in the new canteen services. Lectures to selected groups, and it is hoped to their wives, are envisaged, and should do much to bring a greater awareness of food values and a more balanced approach to nutrition in general. The bright colours of vegetables and fruits, e.g. tomatoes, red cabbage, mangoes, apricots and yellow mealies, could have an educational appeal if backed up by encouragement and explanation. The value of the green leaves for imfino, also pumpkin leaves, carrot, beetroot and turnip tops need stressing, as they can contribute considerably to avoidance of scurvy. The tops of beetroot and turnip contain more calcium, iron and vitamins A and C than the vegetable itself.

8 oz. of vegetables and 4 oz. fruit would be an advisable minimum in the diets of industrial workers,[58] which should also include a minimum of 8 oz. brown bread, 4.6 oz. mealie products, dried beans 2½ oz. alternated with milk, meat or fish at a minimum level of 4 oz. Peanut butter or margarine, ½-1 oz. per day, plus 4 oz. sugar and ¼ oz. of tea are included. Milk, either fresh, skimmed or powdered, should be given at a minimum of ½ pint a day.[58] The diets planned in this publication yield 2,100 cals. with 62 mg protein, of which 30 mgs comes from animal sources. They cost ± 1/- per day per man, but are not intended to cover the total requirements which would be in the region of 3,500 to 4,500 calories.

In nutrition education the part played by colour in vegetables is important. The outside leaves of lettuce have a higher food value than the inner leaves. Pumpkin is cheaper and contains more vitamin A than gem squash, marrow and other white squash varieties.[59]

Potatoes, sweet potatoes, madumbies and raw cabbage are important sources of vitamin C, and care must be taken that their place is not usurped by samp and mealie rice. It was interesting to find in the family study mentioned earlier (p.186, Part 1, chapter 4) that potatoes played so prominent a part in the dietaries investigated.

In nutritional education programmes the need to change cooking methods to prevent covering vegetables with water and over-cooking them, should be stressed. The advisability of scrubbing carrots and potatoes and cooking them in their jackets should be made clear. Where possible, vegetables and fruits should be bought in larger quantities to save income. Many will keep adequately and oranges and potatoes could easily be bought by the pocket. Items which wilt easily, however, should be bought in small quantities, as the food value of wilted vegetables is reduced. The loss of vitamin C due to an oxidising enzyme liberated in many fruits and vegetables after picking, has been mentioned. (p.98 chapter 3.)

The use of seasonal vegetables and fruits should always be encouraged. Out of season products are invariably expensive, and do not contribute anything of importance to the diet. Where incomes are limited, encouragement should be given to the purchase of meat and other protein foodstuffs, vegetables, unrefined cereals and margarine at the expense of refined cereals, jams, sweets, sugar, biscuits and other luxuries, as mentioned earlier.

Certain less commonly used vegetables have a definite place from a nutritional and educational point of view in the diet. Endive and broccoli are examples. Endive makes an attractive addition to salads and broccoli is probably tastier than cauliflower and both have high levels of vitamin A. Other useful additions are artichokes (Jerusalem & Globe), kohlrabi, Brussels sprouts which are rich in iron salts and phosphorus, sorrel, which makes a tasty salad and soup, and Swiss Chard which is easily grown, has a better flavour than spinach and is rich in vitamin B_1. Lima beans are of value, and may be eaten green or as dried beans. Edible pods (sugar peas) are sliced, pod and all, and cooked like beans. They have a pleasant and individual taste quite different from that of beans or peas.[60] If the men have a diet low in protein, it is virtually certain their wives and children are similarly affected. This is supported by the results of the family study reported on page 185, Part 1, chapter 4. It would therefore be reasonable to discuss the place of protein foods and the effects of protein deficiency in diets in general.

(v) <u>Protein foods</u>:

This study again suggests the shortage of protein foodstuffs in the diet of the average African in industry. Table 19 on page 172, Part 1, chapter 4, shows that 35% of the men consumed less than the recommended minimum of group 1 foods (animal proteins, plus legumes) and 58% consumed less than the recommended minimum of group 2 foods (milk and milk products.)

Only 14.3% consumed less of the cereal foods than was recommended.

In Chapter 3, a definition of protein malnutrition (3rd Joint F.A.O./W.H.O. Expert committee on Nutrition 1953) was given and certain introductory remarks were made concerning the effects of underprivilege and kwashiorkor. This discussion will attempt to enlarge on those remarks.

Mulder[8] in 1837, deduced that there was one complex nitrogen containing component of all living matter, both plant and animal which was of fundamental importance. He coined the name "Proteine" (Greek - I take first place). Baldwin[61] said "we arrive from several different lines of approach at essentially the same conclusion that there exists a common fundamental chemical ground plan of composition and metabolism to which all animals and very probably other living organisms also conform, and that superposed on these foundations there are numerous secondary specific and adaptational variations, some of addition and others of omission. This is not a hypothesis that is susceptible of direct proof or disproof in the present state of our knowledge, but it does provide us with that most valuable of conceptual tools, a working hypothesis."

Proteins are the matter from which all living structures are built. The higher forms are found in animal tissue, the simpler proteins occur in vegetable tissue. All the essential amino acids tend to occur in animal proteins, whereas vegetable proteins are deficient in certain amino acids, e.g. lysine in maize and wheat.

The following amino acids are essential for rats (F.A.O.)[56], Histidine, lysine, tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine. Histidine is not required as an essential by man. These amino acids in short term recovery experiments were sufficient for plasma and erythropoiesis.[62]

In chronic malnutrition, deficiency of a single nutrient as a natural event in man (with the possible exception of vitamin C deficiency) is almost unknown. Malnutrition, therefore, almost always represents the effects of deficiency of different nutrients and sometimes a relative excess of some nutrients produces nutrient imbalance.[50,63]

Most diseases have multiple causation. Malnutrition syndromes may result occasionally from grossly deficient diets but usually are conditioned by a variety of causes in persons living on marginal diets. These contributory or conditioning causes include:

(a) Disturbances of the gastro-intestinal tract, especially malabsorption and diarrhoea.
(b) Disturbances of metabolism - inborn or acquired.
(c) A variety of stresses, e.g. heavy infections and parasitic invasions.

In part, malnutrition may cause these contributory factors and in this case a vicious circle is created, best exemplified by diarrhoea in infants and young children.[63]

Clinical results in Malnutrition[50,63].

(1) Subnutrition: (Subclinical malnutrition).

(a) The milder degrees are not clinically recognisable except by assumption, but their effects may be detected by biochemical tests.

(b) The mildest degrees, where biochemical tests may be inconclusive because of difficulty in defining the normal range, may only be shown conclusively by improvement in health by better feeding. Community statistics for weight, stature and life expectation where these differ from equivalent figures from more privileged communities may provide another criterion, indicating that subnutrition is one of the components of underprivilege. The reports of the M.O.H. Local Health Commission[21,22,23] are of interest, and show the high infant mortality rate in Africans.

(2) Reversible syndromes of malnutrition occur where there is a deficiency of a dominant, or most limiting nutrient, e.g. scurvy, pellagra etc. In effect there is invariably a mixed deficiency of several nutrients. The disorder is reversible by adequate dietary treatment.

(3) Irreversible structural damage may occur where the dietary deficiency is severe or prolonged, e.g. death of neurones in beri-beri.

(4) Constitutional susceptibility (diathesis) from chronic malnutrition. The effects of the suboptimal diets may have been recognisable over many years, e.g. reddish-brown dyspigmentation of the hair in chronic protein malnutrition or the skin lesions of chronic pellagra. In these cases the malnutrition may have been

subclinical as described in (1) subnutrition.[50,63]

The liver is important in this concept. Speculation has suggested that long continued protein malnutrition may be the cause of widespread cirrhosis occurring among adults in regions where kwashiorkor is endemic at earlier ages. The geographical correspondence between this "nutritional" cirrhosis and kwashiorkor is not complete, especially in Central America.[63] Gillman[64] feels that the results of maternal malnutrition and postnatal malnutrition affect the entire life track of the African. (Chapter 3; page 109)

A likely possibility is that chronic protein malnutrition alters constitutional susceptibility to cirrhotigens and carcinogens with resultant cirrhosis and eventually primary carcinoma of the liver. These diseases may be due in part to the effects of exogenous agents such as tropical parasites and toxic alkaloids which, in more adequately nourished people, would not be effective in causing liver disease. If this possibility is accepted, then malnutrition in general and protein malnutrition in particular, may condition the appearance of other diseases which are prevalent in underprivileged communities.[46,65.] e.g.

(i) Unexplained congestive cardiac failure which is associated with large hypodynamic, dilated, but not often hypertrophied hearts.

(ii) Endomyocardial fibrosis. Seen in Uganda and probably other parts of Africa. Its etiology is obscure but its possible relationship to other obscure tropical diseases affecting endothelial membranes is worth mentioning - namely veno-occlusive disease of Jamaica and idiopathic thrombo-phlebitis of Rhodesia.[65]

(iii) Tropical ulcer, usually affecting the leg; also tropical pyomyositis.

(iv) Kerato-conjunctivitis; (Blumenthal[66] and McClaren[67]).

(v) High incidence of gynaecomastia and testicular atrophy. Uterine rupture is common in females in Uganda.

(vi) Chronic parotid enlargement.

(vii) Albuminuria as is seen in kwashiorkor. In this condition there is little evidence of renal damage either temporary or persistent, but it is of interest that a nephrotic syndrome with a peculiar variety of renal amyloidosis has been recorded in Uganda.[65]

There is evidence that toxic substances contaminating food (synechio alkaloid) and viruses may play a part in the aetiology of liver cirrhosis, although the improvement in diets is probably the most important public health measure to adopt. Tropical parasites, viruses and other infections, toxic contaminants in food and even climatic stresses, all play an important contributory role, but chronic protein malnutrition probably plays the central part in the aetiology of liver cirrhosis and primary hepatoma.[50,65,69] In chronic protein malnutrition, almost every system of the body is affected by diseases which are seldom if ever encountered in temporate climates and more privileged communities.

In mild cases of kwashiorkor, correction of the condition occurs as the child's teeth appear and there is little, if any, evidence that the damage done to pancreas, liver and other organs, cannot be completely and permanently reversed by sustained good feeding.[65]

In any mention of protein malnutrition, it must be remembered that protein is an indefinite term for a great variety of combinations of amino acids. Proteins also contain vitamins and minerals, as well as amino acids. In classic kwashiorkor calorie intakes are often adequate as evidenced by the thick layer of subcutaneous fat often found at autopsy. Many children however, showing kwashiorkor are also undernourished in respect of calories and if calorie needs are not met, then some protein will be wasted in the production of energy and less will be available for tissue building. Such diets occur commonly in many parts of the world, including Central and South America and the name 'Sindrome pluricarencial infantil' has been used in Central and South America to describe the clinical picture which results.[50,65.]

Oedema is associated with kwashiorkor, and it is reasonable to postulate that in chronic malnutrition all systems of the body may be impaired in function and later in structure, and that therefore chronic malnutrition may cause oedema by many of the pathogenic mechanisms producing oedema in well-nourished people. Facial oedema is common.[12]

Mention has been made of the effects of chronic protein malnutrition and that many organs may suffer damage. The question of liver damage particularly in the African requires further mention.

<u>The liver in chronic protein malnutrition:</u>

Hepatomegaly in cases of undernutrition has been reported by several workers. In a series of male

Africans in Durban, Gillman, Hathorn and Lamont found siderosis in 85% of cases examined by needle biopsy.[69] In 71.5% of cases, the iron deposits involved the liver and portal tracts. In the remainder, the iron was confined to the liver in 12.5% and to the Kupffer cells in 4%. Portal fibrosis occurred in 43%, portal cirrhosis in 18.5%, post necrotic scarring in 10.5% and mixed cirrhotic lesions in 4% of all patients.[69]

The authors suggest that in the hepatic siderosis described, portal iron deposits may provoke widespread fibrosis or cirrhosis of the liver in a manner analagous to malaria in West Africa. Especially may this be so in the presence of co-existing chronic protein malnutrition. Gillman suggests that siderosis itself is a function not of the dietary iron content alone, but rather of the overall inadequacy of the diet. It is possible that intermittent nutritionally induced cellular hypoxia may be the critical mechanism underlying nutritional siderosis as well as other nutritionally induced derangements of iron metabolism.[69] This accumulation of iron is thought to produce disease of the liver, and atrophy of the testes.[70.]

The maize diets of Africans are rich in iron and probably relatively low in phosphate. In adults this diet is supplemented by an iron-rich brew - kaffir beer, which has a low p H. The balance of iron, calcium and phosphate peculiar to maize may also play some part in facilitating the uptake of iron from the food - a probability strongly suggested by experimental studies in rats.[71]

There are apparently other peculiarities of maize (perhaps the nature of its carbohydrates and its amino acid content) which may also directly or indirectly facilitate absorption of iron from the gut. Endogenous metabolic changes induced by the consumption of a maize diet may also play a role in promoting excessive uptake of iron. It is possible too that the increased uptake of iron may occur intermittently - perhaps as one aspect of overall seasonably determined variations in metabolism. The seasonal incidence of pellagra in Durban supports this possibility.[71]

Once absorbed, the excess iron accumulates primarily within the hepatic epithelium. When the liver cells become laden with iron granules, the pigment forms clumps scattered throughout the cytoplasm. Thereafter siderosis of hepatic reticulo-endothelial cells supervenes. With the continued absorption of large quantities of dietary iron, the siderosis of the hepatic epithelium, Kupffer cells, portal phagocytes and spleen proceeds apace. In a liver previously damaged by a lifetime of chronic malnutrition, the accumulation of iron in the portal tracts may facilitate fibrosis.[71]

The authors[71] studied 410 livers of male Africans - the material was obtained by biopsy and at necropy. The commonest forms of liver disease found were: hepatic siderosis with varying degrees of portal fibrosis and cirrhosis, hepatic amoebiasis and post necrotic scarring. Patients with carcinoma of the liver and with a form of hepatic fibrosis associated with porphyria were also encountered.

"Nutritional" siderosis was also recorded in an Indian who had an essentially maize diet, and who consumed kaffir beer in some quantity.[72] He exhibited clinical features suggestive of hepatic siderosis, e.g. grey black pigmentation of the face, (coal heaver's look) alopecia of the outer one-third of the eyebrows and of the axillae and pubis, the latter resembling the female escutcheon, testicular atrophy, and hepatomegaly with a firm liver edge. The kaffir beer yielded a high level of iron, 4.8 mgm/100 ml. The liver biopsy revealed essentially a diffuse hepato cellular and portal siderosis with moderate portal fibrosis but no cirrhosis.

Gillman[31] in discussing siderosis mentions ascites, gynaecomastia, absence of axillary hair, pubic alopecia, labial stomatitis, a deposit of iron pigment in the limbic portion of the cornea, associated with a marked pigmentation of the exposed conjunctiva and often diagnosed as "arcus senilis". In his opinion, chronic long term malnutrition is an important aetiological factor. The rapid industrialisation of South Africa has been noticeable by a change in the habits of Africans and at the same time a deterioration of the agricultural value of African lands, further aggravating the picture of malnutrition.[31]

In another study[73] Lamont et al described hepatomegaly in porphyria as being more common than in cases not suffering from porphyria. Their patients too, lived on a maize diet, perhaps better than average, but associated with an intake of ethyl alcohol. In these cases there was a progressive darkening of the face associated with skin lesions (ulcers and blisters) often misdiagnosed as pellagra.

Where biopsies of the liver were done, fibrosis of the liver plus the presence of iron was noted but the distribution differed from that usually encountered in Africans in this country. Their opinion was that the porphyria was acquired, possibly following ingestion of ethyl alcohol in a particular dietary setting. Eales noted a correlation between porphyria in Africa and hepatic siderosis.[68]

Nutritional siderosis seems common in males and uncommon in females, possibly because of pregnancy and menstruation. An association between a poor dietary in Africans and hepatic amoebiasis has been postulated by Lamont who comments on the extraordinary immunity of the Indian, despite ample exposure. The African female too suffers from bowel amoebiasis, yet seems less prone to hepatic involvement and as mentioned above, females have a low figure for nutritional siderosis.

A poor diet (maize) plus ingestion of kaffir beer led to a significantly higher incidence of advanced siderosis than a better grade of diet, accompanied by consumption of kaffir beer. In patients whose biopsy picture showed post necrotic scarring in which the iron distribution was extremely variable, and was usually mild, no such dietary relationship could be established. In people eating diets approaching acceptable standards (e.g. Indians and African diabetics) it was noted that liver disease, either siderosis or amoebic abscess was uncommon.[73] The work in Durban suggests that amoebic liver abscess is frequently superimposed upon a previously damaged and siderotic liver.

Gillman[31] suggests that siderosis may commence between the ages of 15 and 16, and progress rapidly after 20, at a time when clinical syndromes of pellagra and the like occur.

The areas of the world where kwashiorkor is prevalent, are very similar to, but not identical with the areas in which cirrhosis and primary carcinoma of the adult liver occur.[74] Mention has been made of this fact, and that the correspondence does not seem to apply to Central America.[63]

Siderosis comes from the Greek word, 'Sideros' meaning iron. Brock[51] considers the term should be used in a broad way to cover excess iron in a tissue or in the body generally, whether the iron present be demonstrable or not, by staining in histological techniques, and whether it be intracellular or extracellular. In other words, although siderosis is often demonstrable histologically, the ultimate criterion is chemical analysis and involves the establishment of biochemical norms for healthy people. Haemosiderosis was used to indicate siderosis where it has resulted from abnormal destruction of haemoglobin.

Gillman and Gillman suggest that the siderosis in liver cells is attributable to disordered metabolism (cytosiderosis) of the hepatic cells. Walker and

Arvidsson feel that the siderosis is due to a dietary iron overload and that the iron storage of Bantu siderosis is mainly in the reticulo-endothelial system and liver, and that it is not primarily a parenchymatous siderosis, as appears to be the case in classical haemochromatosis. These views are not necessarily in conflict, since the absorption and perhaps the metabolism of the excess dietary iron may be determined by the co-existing malnutrition.[51]

The ratio of iron to phosphorus in the intestine is important in animals and man. Excess iron can produce rickets in rats and impaired phosphorus absorption in man[50] by causing precipitation of phosphorus.

On the metabolic side, there is the problem of the relationship between "nutritional cirrhosis" and "siderotic cirrhosis". Nutritional cirrhosis and its apparent sequel, primary carcinoma of the liver, is prevalent throughout a large part of the African continent, whereas siderosis is patchy in its distribution. This suggests that the cirrhosis may be explained by locally varying patterns of nutritional disorder, such as protein malnutrition, combined perhaps with toxic factors. The siderosis on the other hand may be due to dietary iron overload. Nutritional cirrhosis, common in Uganda, is prevalent without siderosis, and malaria and parasitism is common. In the Bantu in South Africa who show siderotic cirrhosis, parasites causing haemolysis and blood loss are a minor part of the picture, whilst the haemoglobin, serum iron, total iron binding capacity, and iron intakes are high.

Repeated venesection is of benefit in classical haemochromatosis. Iron in large quantities in the body is felt to have a toxic action.[51]

Siderosis is an acknowledged characteristic of Bantu pathology in some parts of Southern Africa and affects, as has been mentioned, the liver and other organs. Iron consumption of the order 100-200 mgm per day (European intake 10-20 mgm) from the use of iron pots, and particularly in the brewing of fermented porridge and liquors, is common in Africans.[3,51.]

Gillman's opinions concerning the cytosiderosis and siderosis and the relationship to dietary malnutrition have been mentioned. The siderosis of dietary iron overload may be, as it were, "conditioned" by malnutrition. The further relationship of siderosis and cytosiderosis to fibrosis and cirrhosis of the liver is complex and although a close relationship between siderosis and fibrosis has been described in Johannesburg, it does not occur in Kampala, Uganda.

It was thought that the ova of shistosomes were responsible for the cirrhotic livers in the Bantu. However, the same cirrhosis has been shown without the shistosome ova, and in people who have never been exposed to the common tropical parasites. It is reasonable to speculate therefore on the role of malnutrition and toxic contaminants in food, in the causation of many diseases widely prevalent in tropical areas.

Campbell[78] in experimental work on rats, produced heaptofibrosis regularly by injecting egg yolk. Other proteins used were whole egg, egg white, livetin and lipoprotein. Portal and hepatic vein constriction with reduction of sinusoidal circulation was felt to be partly responsible for the development of fibrosis and the effect was possibly brought about by histamine liberation.

Malnutrition has a part to play in liver damage which is accepted.[74] Whether the fibrosis which may follow malnutrition is permanent in the absence of other cirrhotigens and in the presence of a full diet, is questionable. Continuing protein malnutrition however, may be an important factor in determining the progressive evolution of adult cirrhosis.

The place of cirrhotigenic agents like viruses, tropical parasites, alcohol, hepatotoxic alkaloids, excessive intakes of iron, and also genetic influences, must play their part in liver damage.[74] Environmental factors are probably more important than genetic in the aetiology of primary carcinoma of the liver.

The possibility that pigmented people have a metabolism more conducive to the development of primary cancer must be mentioned. They also tend to inhabit tropical areas, where malnutrition is rife, and either tropical parasites or malnutrition may equally play their part. Where pigmented people live outside the tropical belt, there is little or no evidence of cancer of the liver, e.g. Indians of North America. The Japanese show an incidence of primary cancer of the liver, intermediate between the tropical world and Northern Europe and America.[74]

Whilst it is accepted that a deficiency of amino-acids is responsible for kwashiorkor, when the condition is reversed even by very indifferent diets, there is no necessary or inevitable progression of liver pathology to cirrhosis.[76] This statement applies however, only to one temperate area (Cape Town) where there is probably little if any exposure to hepatotoxic food contaminants, and certainly none to strictly tropical parasites, such as malaria.[76]

It is of interest that pellagra in Coloureds does not appear to predispose to siderotic cirrhosis or primary cancer of the liver, whereas Bantu malnutrition cases with pellagrous dermatosis (Bantu pellagrins) have a high incidence of the above.[74]

Generally speaking, dietary protein has little or no effect on tumours arising from any organs or tissues other than the liver. An increase of dietary protein was shown to cause a retardation of hepatoma function, whereas no difference had been noted in the incidence, time of appearance, or rate of growth of spontaneous mammary carcinomas, and neither was the occurrence of metatases or prolongation of life affected after the appearance of these spontaneous tumours.[77] An increase in dietary protein has been shown to enhance the formation of spontaneous benign hepatomas, but inhibited the incidence of malignant hepatomas induced by azo dyes. Tannenbaum (1958) concluded that "the liver stands out as a unique tissue with regard to the incidence of nutrition on tumour formation."[77]

Riboflavin appears to protect against hepatomas, but the effect can be masked in a multiple vitamin deficiency. If all the B vitamins are reduced, tumour formation is reduced. If riboflavin alone is reduced, hepatoma function is encouraged.[77]

Conclusion:

Some of the effects of chronic protein malnutrition on the liver have been mentioned. The liver is also an important storehouse of iron, folic acid and vitamin B_{12}. Therefore where liver disease supervenes, an anaemia is often seen and it tends to be macrocytic but with a normocytic bone marrow.[78]

Where liver disease is present, serum albumen levels are low. This is seen in hepatitis, cirrhosis and obstructive jaundice. About half of the protein synthesized by the liver becomes plasma protein. The determination of the constituent fractions of the plasma protein is a valuable diagnostic aid in cases of liver disease.[79]

The liver manufactures all the albumen, a major part of the alpha, beta and some part of the gamma globulins. Albumen is responsible for 75-80% of plasma total osmotic pressure - i.e. 4 times that of an equal amount of globulin. Albumen is the major mobile reserve of amino acids and is of major importance in tissue nutrition.[79] The effects of liver disease therefore are widespread, and the depression of the serum albumen level results in a decrease in the albumen/globulin ratio which is a very common accompaniment of protein malnutrition. Certain figures from Hutchinson, McCance and Widdowson[54] appear in Table 1,p.94, Chapter 3, illustrating this point.

OEDEMA IN UNDERNUTRITION & MALNUTRITION

McCance et al[54] in their studies of undernourished persons in Wuppertal, Germany, commented on the excess of extra-cellular fluid which fell with recovery. (Chapter 3, p. 89). Gopalan[80] uses "nutritional Oedema" to denote oedema associated with states of calorie and protein undernutrition. At one end of the scale there is classical kwashiorkor in which oedema is the predominant feature, and emaciation is not pronounced. Oedema may easily mask underlying emaciation however, which becomes apparent during treatment, when the oedema subsides.[81] At the other end of the scale are cases of classical marasmus showing extreme emaciation and little or no oedema. Between the two groups there is a considerable overlap of clinical features.

In kwashiorkor, liver biopsy reveals advanced fatty infiltration; in marasmus the liver is practically normal. Cases of marasmus are often encountered in infants under one year who are solely breast fed, but are receiving very inadequate amounts of breast milk, while kwashiorkor is seldom seen in infants receiving breast milk. In marasmus quantitative deficiency is involved, while in kwashiorkor both quantitative and qualitative dietary inadequacies are present.[80] In marasmus, the diet is deficient in calories and proteins, but the calorie/protein ratio is physiological. Kwashiorkor occurs where the diet may be moderately deficient in calories, but highly deficient in proteins with resultant abnormal calorie-protein ratio. It is difficult in humans to establish this point beyond doubt because of the interplay of additional factors.[80]

In nutritional oedema, oliguria is a striking feature. Gopalan feels this is due to an increased secretion of anti-diuretic substance (probably A.D.H.) Diminution of urinary excretion in the erect posture is due to the increased secretion of A.D.H. in this posture. The liver is capable of inactivating A.D.H. And in states of calorie and protein malnutrition, varying grades of liver damage are encountered so that increased levels of A.D.H. might be the result of defective inactivation of the hormone by the damaged liver.

Ferritin, which is not present in the circulation under normal circumstances, may acquire anti-diuretic properties.[80] It occurs in kwashiorkor, hepatic cirrhosis and toxaemia of pregnancy. Following nutritional rehabilitation with the disappearance of oedema, the ferritin disappears from the circulation. A relationship is thus suggested between ferritinaemia and oedema.

The following sequence may be involved in the pathogenesis of nutritional oedema.

Calorie, protein undernutrition → structural & functional changes in liver → defective inactivation of A.D.H.

structural & functional changes in liver

↓

Release of active ferritin

↓

Increased secretion of A.D.H.

Increased secretion of A.D.H. → Increased A.D.H. in circulation, and water retention.[80]

defective inactivation of A.D.H. → Increased A.D.H. in circulation, and water retention.[80]

Aldosterone, a salt-retaining hormone which profoundly influences water metabolism by causing alteration in the tubular reabsorption of sodium, is also inactivated by the liver. In states of liver disease therefore, inactivation may be incomplete, thus adding to the picture of oedema.

It is known that persons suffering from a deficiency of calories or proteins may become oedematous - they need show no signs of any vitamin deficiency. This condition can justifiably be called "hunger" or "inanition" oedema. "War" and "famine" oedema are probably covered by this term.[54]

The oedema of beri-beri is a well-recognised clinical entity, generally considered to be due to a deficiency of aneurin. There is often no calorie deficiency. There were a great many cases during the 1939-45 war among Europeans who were prisoners in Japanese hands.

Epidemic dropsy is mentioned only to separate it from beri-beri, and because it is thought to have a nutritional background - either a contaminant of rice (possibly a virus or bacterium) or possibly from the plant Angemone mexicana, a contaminating weed in rice fields. It occurs commonly in Calcutta and Bengal, and affects all sections of the community, and is associated with general symptoms including pyrexia, diarrhoea and often hypertension.

The infantile syndrome:

The clinical complex of malnutrition in infancy may result in oedema. Cases have been reported from the siege of Paris 1871, as well as numerous other centres including Egypt 1938, Greece 1942, Budapest 1948 and West Indies 1947.[54] There appears to be an association between a gastro-intestinal disturbance and starvation or semi-starvation in the production of infantile oedema. The serum proteins are invariably subnormal, and a "pellagroid" rash, and commonly too a fine desquamation of the skin occurs. This oedema may be due to a protein lack, or absence of specific amino acids, or even vitamins. In adults, the hunger oedema is invariably due to a deficiency of calories.

The liver in these children is often enlarged and fatty, but in the tropical forms may be small and cirrhotic. The pancreas is also affected in children, but not as a rule in adults. In adult undernutrition as seen in Europe, atrophy of the liver has been the usual finding and although fatty changes have been described, cirrhosis has not been a feature. Truswell[39] reported that a child eating only maize who appeared to be in good clinical condition, had a persistently fatty liver on biopsy. This indicated that maize alone was an inadequate source of dietary protein.

Anaemia is common and often severe in the infantile form, but not usual in the adult syndrome. The oedema in infancy is probably related to the lowering of the serum protein, and the fall in the albumen/globulin ratio. All cases do not show a low serum protein level however.

Certain unclassifiable oedemas have been recorded[54], set sometimes against an adequate dietary background, and sometimes against an inadequate dietary intake. The causes have been obscure, but an association between malaria, dysentery and a poor diet have been mentioned, as well as deficiency of vitamin A, and possibly ankylostomiasis. The latter was of interest in an epidemic oedema, affecting 3,000 men (Boer prisoners at St. Helena) in 1902 who were on a nutritionally adequate diet. Malnutrition oedema is a characteristic of kwashiorkor.

Kwashiorkor:

In our opinion, a full survey of this condition lies beyond the scope of this thesis. The prevalence of kwashiorkor in the Bantu of this area however, makes mention of the condition necessary.

Kwashiorkor[81] is recognised as a disease syndrome arising as a result of severe deficiency of dietary protein[87], relative to calorie intake and characterised typically by retardation of growth and development, oedema, apathy, anorexia, alterations in the colour and texture of the hair, lesions of the skin and diarrhoea.[8,82] Psychological changes (apathy and irritability) are often prominent. It occurs most commonly in young children because at this period of life protein requirements are relatively high and diets are most likely to be deficient in protein.[81,87] No age is, however, immune and infantile, juvenile and adult forms have been described.[50]

The syndrome also results in hypoalbuminaemia usually associated with oedema, diarrhoea, frequently accompanied by electrolyte imbalance, fatty infiltration of the liver and atrophy of the acini of the pancreas with reduction of the enzymatic activity of the duodenal juice.[45,87] A variety of dermatoses occur, plus dyspigmentation of the hair and skin, muscular atrophy and anaemia.[88] In the absence of proper dietary treatment the mortality is heavy. Skim milk, however, will result in improvement except in late or severely complicated cases.[46,87]

Kwashiorkor is in essence a state resulting from deficiency of nitrogen or imbalance of amino acids in the presence of more generous intake of calories in the form of starchy foodstuffs. A group of amino acids constitute the most limiting nutrients.[46] Denutrition due to undernutrition is mentioned later.

The skin lesions and hair changes do not seem to be directly related to the protein deficiency but appear rather to depend on other nutritional deficiencies or metabolic disorders. Hepatomegaly, anaemia (of the megaloblastic or hypochromic microcytic type) and certain abnormalities of the tongue, buccal and conjunctival mucosae may be present.[82]

X-ray findings often show delayed bone maturation and disturbances of skeletal calcification.[82]

Biochemical characteristics:[82]

The most frequent and specific findings are the very low levels of serum proteins, especially albumens, whilst nearly all the globulin fractions with the exception of the beta fraction are increased.[82,83,87] The albumen/globulin ratio is therefore reversed.

Various enzymes, such as alkaline phosphatase, amylase,[87] and pseudo-choline-sterase are at subnormal levels. The non-protein nitrogen, urea and creatinine, as well as total serum lipids and their various fractions (neutral fats, cholesterol and phospholipids) are also below normal.[87] The levels of hydrosoluble vitamins fluctuate widely and are not characteristic, while liposoluble vitamins (vitamin A carotenes and vitamin E) are always below normal levels.[82,87]

Investigation of the fluid and electrolyte balance has shown a fall in the concentration of intra-cellular potassium and some sodium retention,[56,87] whilst the extra cellular space is usually increased although it may be diminished in complicated cases which exhibit dehydration. Marked changes of serum calcium and phosphorus are unusual. Serum iron and copper are very low, a finding probably associated with the fall in mineral conveying proteins.[82]

Metabolic studies show that protein absorption is not greatly impaired and that it improves quickly once a suitable diet has been instituted.[82] Hansen noted a steady, relatively high rate of nitrogen retention (when compared with normal children) of the convalescent kwashiorkor child during the first 3 months after admission.[40] He regarded this as a "catching up" process in these growth-retarded children. The high rate of weight gain during the same period supported this view.[40]

Flocculation tests for liver insufficiency seem to evidence a certain glandular change unrelated to the degree of steatosis where present. Renal function tests have shown a fall in plasma flux and glomerular filtration speed. The electro-cardiogram shows only a low voltage, without very significant changes.[82]

The globulin fractions are interesting. The beta globulins, as has been mentioned are relatively unaffected, but there is a rise in the other globulin fractions. Electro-phoretic investigations show that in kwashiorkor two different alpha-globulins are present, presumably caeruloplasmin and a macro-globulin, also two derivatives of the beta and $beta_2$ globulins. Siderophilin is almost totally absent.[83] The authors mention further that in kwashiorkor, hepatic steatosis is a regular feature (of the diffuse type) whilst in undernutrition the hepatic parenchyma has a normal structure under ordinary microscopic examination.[83]

The plasma protein values in undernutrition appear practically normal and electrophoresis does not show any abnormality in the ratio between the various fractions.[83] Clinically, in denutrition due to undernutrition, extreme and generalised emaciation (marasmus) is noted and the child appears to be just skin and bone. The facies is characteristic - the eyes remaining bright and clear. There is no obvious oedema and skin changes and nervous symptoms are absent.[83]

Nitrogen absorption:

Kwashiorkor patients may exhibit a remarkable efficiency in their utilisation of nitrogen.(Hansen)[40] A relation between retention of nitrogen and proportion of calories derived from protein exists. The optimum retention seems to be when this ratio is between 25 and 30 (i.e. 25-30% of calories derived from protein). (Senecal)[56]

Potassium levels:

Low potassium levels seen in kwashiorkor (average 3-5 meq. per litre) may be restored by giving 200-400 mgm of potassium per day. The potassium deficiency is probably due to sodium retention and oedema. As potassium is retained in treatment, there is a sodium diuresis and loss of weight. (Hansen)[56] The potassium deficiency may be increased by diarrhoea, and protein deficiency and potassium deficiency go hand in hand. This is particularly true in underdeveloped countries where potashes are used as salts.[56] Diarrhoea in these infants lowers the level of potassium, and by impairing the absorption of nitrogen and other nutrients, is a factor of considerable importance in the pathogenesis of kwashiorkor.[40] In Hansen's series there was a history of diarrhoea in 86% of the cases of kwashiorkor. Further remarks on diarrhoea follow later.

Initiation of cure means improvement in skin lesions, regeneration of serum albumen, loss of oedema and restoration of normal function. The first sign of response is often an improvement in the general behaviour and outlook and in the appetite. The child takes a new interest in its surroundings, smiles and enjoys its food.[45] Diuresis follows, with loss of weight, but with continued improvement in appearance and behaviour. Average time taken to achieve this is 10-20 days from institution of treatment.

The level of serum albumen is a sensitive measure of response. (Brock)[45] The following comments represent the experience of Brock et al.

(a) Electrolyte mixtures might result in discharge of oedema by potassium repletion, but could not initiate cure.

(b) Skimmed milk or casein emulsions with glucose and a complete vitamin supplement gave satisfactory initiation of cure in the majority of uncomplicated cases. The curative factors therefore lie probably within the casein amino-acids, not all of which are essential.

(c) There was no improvement in the slope of regression lines of rise of serum albumen when a complete vitamin mixture was added to a formula constituted from vitamin free casein with glucose and salt mixture.

(d) A mixture of 18 amino acids, glucose and synthetic vitamins initiated cure.[45,76] Cure was successfully initiated in certain cases without vitamins.

The amino acids (synthetic) used were:

L. Arginine Hcl.	19.5 g
L. Histidine HCl. H_2O	13.0 g
D.L. Isoleucine	57.0 g
L. Leucine	42.0 g
L. Lysine HCl.	41.5 g
D.L. Methionine	12.0 g
D.L. Phenylalanine	30.0 g
D.L. Threonine	36.0 g
D.L. Tryptophan	11.4 g
D.L. Valine	53.0 g
D.L. Aspartic Acid	61.0 g
L. Glutamic acid	82.0 g
Glycine	8.8 g
D.L. Alanine	30.0 g
D.L. Serine	33.0 g
L. Tyrosine	28.0 g
L. Cystine	3.8 g
L. Proline	38.0 g

This gave 595 g amino acid. Salt and vitamins were also added.

(e) In subsequent steps the vitamin mixture and/or seven of the non-essential amino acids were excluded from the formula. A decreasing order of therapeutic efficacy was demonstrated when judged either by percentage initiation of cure or by rate of serum albumen regeneration.

(f) Mucous membrane lesions and pellagroid dermatosis responded to vitamin free formulae.

A formula which would initiate cure was not necessarily capable of consolidating cure, but the nutrients which allowed initiation were presumably the most limiting nutrients in the development of the syndrome, i.e. certain amino acids. Most kwashiorkor cases have vitamin deficiencies as well, so all essential nutrients and vitamins are necessary for consolidation of cure.[45]

Liver lesions in kwashiorkor are not necessarily progressive, even on relatively poor diets.[50,76] There is suggestive evidence however that malnutrition combined with hepatotoxic agents may result in necrosis or cirrhosis.[50]

The aetiology of kwashiorkor may be briefly restated as:

(1) dietary protein malnutrition.
(2) Accessory factors, e.g. infection, parasitic infestation, vicious cycle of diarrhoea and altered bacterial flora, climatic factors, social maladjustment and even maternal deprivation.[45]

Diarrhoea:

Diarrhoea is important in the pathogenesis of kwashiorkor and has been mentioned. A survey in Guatemala, in two moderately poor highland towns, revealed an average of five separate episodes of diarrhoea per year for children in the same age range.[81] Single faecal examinations by the rectal swab technique revealed that much of the enteric infection is due to various strains of Shigella.[81] Episodes of diarrhoea are very common in African babies in our experience, and treatment on an out-patient basis often impossible, because of severe dehydration.

Principles of Treatment:

The place of amino-acids in initiation of cure has been mentioned. All investigators are agreed that large amounts of protein of high biological value are of primary importance in therapy. Amounts vary from 3-4 g of milk protein per kg body weight per day, to 8-10g per day.

<u>Maize Mixtures:</u>

Hansen[84] found that a mixture of 2/3 maize plus 1/3 pea flour (Piscim sativum var arvense) gave a protein content of 14% and feeding with this mixture resulted in nitrogen retention equivalent to milk at intakes of protein over 2.5 g per kg per day. At levels below that the nitrogen retention was significantly less than that on an iso-nitrogenous milk diet, and no better than an unsupplemented diet. Initiation of cure was achieved in mild cases of kwashiorkor only, with this preparation.

Maize 60%, pea flour 30% and fish flour 10% gives a protein content of 20%. At levels both above and below 2.5 g per kg per day, nitrogen retention was not different from that of a milk diet.[84]

Maize 60%, pea flour 30% and milk powder (18 parts) gave a protein content of 18%. Feeding with this gave nitrogen retentions that were not different from whole milk at all levels of protein intake.[84] Relatively small amounts of fish flour (10%) or milk powder (18 parts) need therefore be added to a 2 : 1 maize-pea mixture to give a protein with a nutritive value not demonstrably different from that of whole milk diet at all levels of intake. Among protein deficient populations therefore, available supplies of animal protein such as milk, egg or fish flour can be stretched much further if combined in proper proportion with staple cereal or vegetable diets.[84]

Owing to the profound anorexia, intolerance to food and the danger of abnormal distension of the stomach and intestine, it is often necessary to initiate treatment at low levels of protein intake. As has been mentioned, proteins of vegetable origin can be successfully employed in the treatment of kwashiorkor, but they must be combined so that their amino acid patterns complement each other. The tendency for diarrhoea to disappear more quickly with the use of these vegetable mixtures than with milk, has been noted,[43,81] and this may be due to differences in carbohydrate content. It is believed by some workers that the high lactose content of skimmed milk may aggravate the tendency to diarrhoea.[81] Bananas are often employed successfully in treatment as a carbohydrate supplement.[81]

<u>Calorie Intake:</u>

The calorie intake is of secondary importance in the early stages of the treatment, but the diet should contain enough calories to ensure good protein utilisation - 30-50 cal. per kg in the first day may be adequate, raised to 100 cal. per kg by the fifth or sixth day of treatment. A high calorie intake however is of particular importance in cases of marasmic kwashiorkor, or where the child is very much under weight after the loss of oedema.

<u>Fat in treatment:</u>

Initially the ability to absorb fat and fat-soluble factors is impaired, but this recovers rapidly when adequate protein is supplied. While adding fat to the diet may increase faecal fat, it also increases fat absorption so that useful additional calories are provided which spare protein and speed recovery. Fat is not only a valuable source of calories, but also provides essential fatty acids which may be of benefit to the child. This is particularly important, since the characteristic diets leading to kwashiorkor are often almost wholly devoid of fat. It is perhaps advisable to restrict fat for only the first 2 or 3 days of treatment.

Vitamins:

Vitamin A & B complex vitamins are particularly likely to be deficient. The deficiency of vitamin A is probably due to the poor fat absorption. Initiation of cure has been shown by Brock et al to be possible with vitamin free casein and with a mixture of synthetic amino acids. It has actually been suggested that B complex in treatment may be harmful, because in a trial series those receiving B complex revealed a higher mortality than those treated identically, but without B supplement. It was thought that the higher mortality was due to fatty infiltration of the liver.[81] The place of vitamin B_{12} in the aetiology and treatment of kwashiorkor is very questionable.[81]

Mineral Needs:

Iron is beneficial in treatment in doses of 300-600 mg of ferrous sulphate per day, particularly where complicating factors such as malaria and hookworm are present. In these areas a microcytic, hypochromic anaemia is often found, as compared with the more usual normocytic or macrocytic anaemia associated with kwashiorkor. Low serum levels for copper are common, so administration will prove helpful.

Detailed treatment procedures plus correction of electrolyte disturbances are outside the scope of this discussion. The necessity for potassium repletion has been stressed. It is possible that some of the psychic changes, anorexia, vomiting, abdominal distension and weakness may be partly explained by potassium deficiency.

Chemotherapy and Antibiotics:

Every symptom or sign of infection observed in a child with kwashiorkor should be energetically treated with antibiotics or chemotherapy. Infections may be more serious in kwashiorkor than they appear at first sight. Routine administration of penicillin or sulphonamides for 10 days after hospitalisation are given by many workers. (Hansen et al. Behar et al.)

Broncho-pneumonia is particularly likely to develop in kwashiorkor patients, and was present in 70% of autopsies in Guatemala.[81] The diarrhoea often settles spontaneously and specific treatment is not as a rule required. Although intestinal helminths are frequently present, and there is evidence to suggest that they may interfere with protein absorption, no specific treatment should be undertaken initially. Very often masses of helminths are evacuated coincidently with dietary treatment.

Hospital care is of great benefit, particularly if these children can be kept in semi-private wards, where the nursing staff are sympathetic and understanding. By their personal interest the staff can do much to improve the sense of maternal deprivation from which many of these children suffer. Re-education of the mother in proper dietary practice whilst the child is hospitalised may prove of incalculable value when the child leaves hospital.

Hospitalisation has often been reduced from 16-20 weeks to 10-14 weeks in conditions of semi-isolation. In these conditions more space is available, more care can be taken by attendants in washing their hands after tending cases of diarrhoea, and other general hygienic measures can be applied.

Factors responsible for development of kwashiorkor:

It is a basic concept of protein malnutrition that clinical kwashiorkor per se, is merely an indication of the total extent of protein malnutrition among children in endemic areas. Nearly all the children in these areas are affected by protein malnutrition, although many will never develop the fully fledged syndrome. Their suboptimal status is revealed however by retarded growth and development, which begins about the eighth month of life.[81] This first shows itself as a failure to reach the normal milestones of development, as far as weight and height are concerned, and later by bone maturation as compared with normal children.

It is of interest to mention in this connection that out of 22 children who had heights and weights measured in our family study, 12 were below normal standards. Kwashiorkor must be regarded only as the visible reminder of a grave and largely hidden problem.[50,81] The children suffering from sub-clinical protein deficiency tend to be apathetic, show muscular weakness and wasting, and mature slowly. They are prone to minor infections and often die as a result of an infectious illness, that is usually not fatal to well-nourished children. The physical examination however, even in cases where very inadequate diets apply, may not reveal any signs of nutritional deficiency other than retardation of growth and maturation.[81]

As breast feeding comes to an end and weaning follows, it is common to base the child's diet on starchy gruels, thin broths, bread, rice, noodles, a few vegetables, tea or coffee, and in this country on the watery soup produced when mealies are crushed and boiled in water (Nembe). Beans are seldom given to children. The parents keep the beans for themselves and give the water in which they were boiled to the children.

The problem of protein malnutrition is invariably set against a growth of population. When population pressure develops, hunger demands a full stomach, and agriculture is diverted towards foods such as cereals and tubers which have a high yield of calories per acre.[85]

Low protein foods, e.g. cereal grains, yield about 2-3 g of protein per 100 calories, i.e. they are marginal for human protein requirements. Most roots and tubers fall below 2g/100 calories, e.g. cassava flour (manioc, arrowroot) yields under 20g of protein per 2000 calories and its aminogram is unbalanced.[85] An adequate calorie intake can, to a certain extent, economise protein, but there is a limit to this process, especially if the amino acid pattern of the protein is not perfectly balanced.[85] Aminogram imbalance is characteristic of all vegetable proteins. This aspect has been mentioned in regard to maize and also that a supplement of a small amount of protein with a well-balanced aminogram (e.g. milk) will extend the value of cereal diets. Failing such compensation, protein malnutrition will result, which in the post-weaning child may proceed to kwashiorkor.[85] As the child grows, its chances of making up a protein deficiency increase. It is reasonable to assume however, that full vitality and normal development will be permanently retarded through minor degrees of continuing protein malnutrition.[85]

As a result of the poor sanitary conditions prevailing in most slum areas, prejudices against milk are common, because of its apparent association with diarrhoeal diseases. Many witchdoctors in our experience will advise an African mother to discontinue breast feeding, or milk supplements, because they are "poisoning the baby". This is invariably a misinterpretation of the fact that a basically malnourished child has developed an infection, either systemic or enteric, but it carries with it a highly ominous outlook for the unfortunate child. It has been a common and tragic experience to have to treat a lactating mother for breast abscesses following milk engorgement, and her baby for protein malnutrition.

Protein supplies for human consumption:

Products of animal origin are the major source of protein of high biological value in more technically developed countries. Attempts to develop an animal industry are therefore of the greatest importance as ruminants can thrive on foods and by-products which are not ordinarily suitable for human consumption.[81] The introduction of new grasses and better management of pastures, the use of silage and artificial feeding, mineral supplements and control of parasites, are of basic importance. All other sources of animal proteins e.g. poultry and eggs, can contribute immeasurably.

The amino acid proportions of most fishes are very similar to those of casein, and they are excellent sources of lysine, methionine and tryptophan, amino acids usually deficient in cereal proteins. The biological value of the protein in fish meals and deodorised fish flours however, may vary and careful investigation is necessary before they are used as supplements. Fish provides a good source of vitamin B_{12}, and is usually much cheaper than meat.

Legumes:

Soyabean, peanut meal and, in this country, cowpea flour, as protein sources, all contribute considerably to lessening protein malnutrition. The acceptance of these products in populations not accustomed to them, is not necessarily easy, and this applies equally to fish products as far as the Zulus are concerned. Education has much to contribute however, and fried fish is now a popular source of protein at the canteen at SARMCOL.

Oil seed meals: Cottonseed, rape seed, sunflower seed and safflower seed have all been successfully employed as protein supplements. Some require special processing as is the case with the low fibre, low gossypol content of cottonseed flour which is now available in the United States. Castor seed cake has recently been detoxified, thus making available a valuable protein feed for cattle. Buckwheat flour appears to have the highest biological value of any known plant source of protein. The biological value of the protein for rats was 92.3% of that of skimmed milk, and 81.4% of that of whole egg.[81]

Nut and Palm Kernels: The Brazil nut, black beans and milk, all have a high growth promoting factor in rats. The Brazil nut was 92% of that of milk. Other tropical sources of vegetable proteins which with further processing could find use in preparations for children, are palm nut oil meals, such as carozo, the African palm and the mbocaya palm.[81]

Leaf Protein: Alfalfa protein has a biological value of ± 60%. Methionine is a limiting factor.[81]

Yeasts & Algae: Yeasts, such a Torulopsis utilis which is preferred to brewer's yeast because of its greater economy of manufacture, and freedom from bitterness, and various algae, such as chlorella, have been enthusiastically commented upon by various workers.[81]

Reference has been made in Chapter 111 to Dean's work in East Africa, and the preparation of a locally available protein food for children. This consisted of

45 parts groundnuts, 20 parts maize flour (both used whole), 12 parts cane sugar, 8 parts edible oil and 15 parts dried skimmed milk and cottonseed oil. These were cooked together to produce a biscuit which was cheap and easily used. It could be grated to make either a thick or thin porridge, or a milky drink, and was less likely to be used by the parents than plain skimmed milk.[86] Dean also noted that the starchy pap made from bananas could be rendered curative in kwashiorkor by adding soya bean flour.

The Bushmen of Okavango in South West Africa prepare a "vegetable milk" for the weaning of infants which appears to prevent kwashiorkor. (Brock)[51]

Improvements on Vegetable Proteins:

The approach to the problem of protein malnutrition which appears to have the greatest practicability and on which work is most advanced, is the improvement of the protein content of diets by combining protein sources of vegetable origin to improve the total amino acid pattern of the diet. Several combinations have been mentioned. A mixture of 60% buckwheat, 20% soya and 16% rice proved to be better than casein when tested on rats.[81] Millet has also been shown to correct the niacin deficiency in the rat, induced by a 9% casein and 40% maize diet. If 1% lysine was added to a diet of 40% maize and 40% millet, growth improved considerably. No response was found when it was added to a diet of 80% corn and 10% millet unless niacin and/or tryptophan were also added.

Millet, therefore, improved the tryptophan but not the lysine deficiency of maize.[81]

Maize is deficient in niacin, vitamin B12, folic acid, vitamin C, calcium and sodium. The protein is deficient in lysine and tryptophan, and leucine is present in excess. The total protein content is only 9%. Therefore large amounts are necessary to cover minimal daily requirements, e.g. a 25 lb. child would need ½ lb. of dry maize per day, i.e. 60-70 oz. of porridge per day for growth and maintenance.[84] If lysine and tryptophan are added to give a mean increase of 176 mg. per g of nitrogen of lysine, and 47 mg per g of tryptophan, nitrogen retention is improved over that of unsupplemented maize. The practical usefulness of this supplementation is limited, if total protein intake cannot be increased.[84]

If protein is derived almost entirely from maize, ± 10g of nitrogen or 1g of protein per kg per day would be required in adults. These high intakes will yield adequate calories but would be intolerable to Western people because of bulk.[45] At intake levels of ± 5g of nitrogen or .5g protein per kg per day, with calories made up by sugar, there is a negative nitrogen balance.[45] If half the amount of maize is replaced by milk in an equicaloric substitution, there is a significant increase in nitrogen retention. Part of the retention is due to better absorption, and part to better utilization.[45]

The Committee on amino-acids of the National Research Council of America, on the basis of animal work has suggested that if the biological value of a protein is 60 or more, no amino acid supplementation is necessary, provided there is a sufficiently high intake of protein. Simply feeding more of a protein with a biological value of less than 60, will not improve its nutritive value unless it is supplemented by the necessary amino acids.[40]

The biological value of maize/pea mixture and its individual components (as determined by Dr. A.E. Bender through the courtesy of UNICEF) are:

Maize 34, Pea flour 42.
2/3 maize and 1/3 pea flour = 69.

The demonstrated satisfactory nutritive value for children of the maize/pea flour mixture at higher protein intakes is thus in keeping with the predictions of the committee.[40]

Local attempts at offering a supplement to needy children have concentrated on the provision of skimmed milk powder. This is available in Howick West through the Local Health Commission, and a voluntary Welfare Organisation in Howick has made an attempt to provide ½ pint of reconstituted skimmed milk daily to a group of needy African children at a nearby school. This has been in the nature of a pilot scheme and further extensions of this work are envisaged. One possibility is the provision of Pro-Nutro (Hind Bros. & Co. Ltd. Durban) as an additive to poor diets. The object of the makers of Pro-Nutro[88] was to produce a food mixture with a Biological value of at least 70, its protein and fat contents at least 20 and 12 percent respectively, and producing reasonable quantities of vitamin A, vitamins of the B group and other vitamins. The food would be a nutritious, high protein, pre-cooked food of low cost - usable by all races, primarily to prevent kwashiorkor in the pre-school child, but acceptable to all age groups.

The food evolved originally consisted of skimmed milk powder, properly processed whole soya beans, defatted peanut meal, maize and sugar, with small quantities of imported fish flour, food yeast, iodised salt, bone calcium, processed kaffircorn, with vitamin A and vitamins of the B group added.[58] The biological value and digestibility figures (University of Natal) were 75.8% and 85.7%.

The chemical data are:

Protein (Nx 6.25)	21.5g/100g
Fat	5.8g/100g
Fibre	2.1g/100g
Calcium	0.67 "
Phosphorus	0.56 "
Iron	0.012 "
Vitamin A	1880 i.u./100g
Thiamine	1.67mg/100g
Riboflavin	1.28mg/100g
Niacin	8.0mg/100g
Pyridoxine	0.31mg/100g
Calories	365c/100g

Results in kwashiorkor have shown the food equal in all respects to skimmed milk powder, and it costs less. It also has the advantage that the parents cannot use it as a substitute for milk. Compared with maize and the F.A.O. Reference Protein, the aminogram is as follows:

Table 36.

	Maize	Pro-Nutro	F.A.O. Reference Protein
	Amino acids g/100g Protein		
Lysine	2.8	4.2	4.2
Tryptophan	0.6	1.33	1.4
Isoleucine	4.1	4.1	4.2
Leucine	13.7	8.2	4.8
Methionine	2.4	1.8	2.2
Phenylalanine	5.5	4.5	2.8
Threonine	4.3	3.8	2.8
Valine	5.4	5.0	4.2

Except for the higher leucine and slightly lower methionine values (the cystine figure is 1.78g per 100g protein) the values are in close agreement with that proposed by F.A.O.

The finished food is of bland flavour and requires no further cooking. By moistening with water, it takes the appearance of a porridge - a form of food very acceptable to Africans. It can be added to other foods or used alone, and has good keeping qualities. The makers suggest that from 2-2½ ozs daily, in addition to existing food intakes, should be sufficient to prevent malnutrition (multiple deficiencies excluding vitamin C) in the pre-school child.

A modification of the basic formula exists in which whole peanuts have been substituted for the defatted peanut meal, the sugar has in part been replaced by whey powder and small quantities of stabilized wheat germ added. Properly processed S.A. fish flour replaces the imported product. The biological value and digestibility figures (Central Institute for Nutrition and Food Research, Holland) are 70 and 93 respectively. The clinical data in comparison with that of the original formula are as follows:

Table 37

	Modified formula	Original formula
Protein (Nx 6.25)	21.8g/100g	21.5g/100g
Fat	12.9g/100g	5.3g/100g
Fibre	1.4 "	2.1 "
Calcium	0.472 "	0.67 "
Phosphorus	0.620 "	0.56 "
Iron	0.017 "	0.012 "
Lysine	1.33 "	1.33 "
Vitamin A	1800 i.u./100g	1880 i.u./100g
Thiamine	1.5mg/100g	1.68mg/100g
Riboflavin	1.4 "	1.25 "
Niacin	7.05 "	8.0 "
Calories	427 c/100g	365 c/100g

2 oz. of this food supplies per day in comparison with the original formula:

Table 38

	Modified formula	Original formula
Protein	12.4	12.2
Carbohydrate g	31.0	33.0
Fat g	7.3	3.0
Minerals g including	2.6	2.8
Calcium mg	267	380
Phosphorus mg	350	317
Iron mg	9.6	6.8
Fibre g	0.8	1.1
Moisture g	2.5	4.6
Thiamine mg	0.85	0.95
Riboflavin mg	0.79	0.69
Niacin mg	4.0	4.5
Vitamin A. i.u.	1020	1065
Calories	242	207

2 ozs. of this food, expressed as percentage of the Recommended Daily Dietary Standards (National Nutrition Council 1956) for children between 1-5 yearsof age, in comparison with the original formula, supplies the following:

Table 39

	Modified Formula %	Original Formula %	Recommended Daily Req. (N.N.C.1956)
Calories	22	18.8	1100
Protein	31	30.5	40g
Calcium	44.5	63.0	0.6g
Iron	137	97	7 mg
Thiamine	112	237	0.4 "
Riboflavin	79	69	1.0 "
Niacin	66	75	6.0 "
Vitamin A	51	53	2000 i.u.

This food has been shown to cure kwashiorkor[43] in Durban. In addition, the ease of preparation where a porridge is made merely by adding water, thus saving fuel, the fact that the food is palatable and acceptable to children suffering from kwashiorkor and others, and the fact that the stools are semi-solid, brown and less numerous than in children fed on skimmed milk powder, makes it very suitable for use in welfare schemes generally.

It would seem to conform very well to Scrimshaw's suggested requirements for an acceptable supplement,[56] which are:

(i) materials should be locally available;
(ii) they should be cheap;
(iii) the product should be easy to transport and store;
(iv) it should be safe;
(v) it must be acceptable;
(vi) it must prove effective.

The discussion on protein supplements is furthered in the section on protein resources.

Antibiotics and effect on growth:

Impressive positive results with antibiotics on the growth of children have been reported by workers in Guatemala. The growth effect on children living on poor diets which followed the administration of chlortetracycline was gratifying. With penicillin it was variable. It is thought that the antibiotic eliminates bacteria which are competing for the limited products of protein digestion available. Other workers feel that antibiotics may depress the vitamin requiring bacteria, and increase vitamin synthesizing micro-organisms.

Experimentally, chlortetracycline was 30 times more effective than penicillin in promoting growth in pigs.[89] These results are of interest, although the practical application at this juncture is uncertain.

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CONCLUSION:

These comments on kwashiorkor relate to various aspects of the problem and are considered important because the investigation carried out here leads one to suspect that protein malnutrition is common in adults and children. Experience confirms the tragic fact that kwashiorkor in its full blown form and the stigmata of lesser degrees of malnutrition are everyday occurrences at one's surgery. Workers in Durban have done much to draw attention to this problem in Natal.[43,90,91] The fuller knowledge of prophylaxis should entirely stamp out this serious and widespread nutritional disorder. (Brock)

At King Edward V111th Hospital, Durban[91] 500 children out of 1,200 die from kwashiorkor. The cost of treatment for the 1,200 cases is £62,000 per year. Most cases are from outlying areas, and very few Indian cases occur. Relatively few admissions are made from the Native townships surrounding Durban, where feeding schemes are in operation.

Poverty is the main underlying cause in these cases, as the mother is often unable to buy milk supplements. Maternal deprivation plays its part. Many infants are illegitimate, and are cared for by grandmothers or other relations, whilst the mother works. Milk centres where poverty-stricken Africans can be referred, are urgently necessary. 15 gm of good quality protein per day will prevent kwashiorkor, and if each child could get 1 pint of milk a day this would yield approximately 18 gm protein. 2 ozs. of skimmed milk powder properly reconstituted would provide approximately the same figure, and in our experience in Howick this costs ± 2 cents.

Attempts to get agricultural surpluses to the needy are being made by a national, non-profit making company - the Nutrition Corporation of South Africa.[92] This will be known as "KUPUGANI" (Zulu meaning "Uplift yourself"), and intensive efforts will be made to combat malnutrition. Dr. Sen, Director-General of the Food and Agricultural Organisation of the United Nations said: "No force in history has moved so many mountains, and so many men, as enlightened self-interest, and no self-interest is so easily demonstrable as the need to eat properly."[92] Pilot schemes under the auspices of Kupugani have worked well, and milk has been sold in Native reserves for 3d. a pint.

At present a committee is being formed in Pietermaritzburg which will work in close association with welfare bodies in neighbouring areas. The main problem will be to distribute the surpluses where they are needed, and to supervise the use of these supplements. Pro-Nutro will play its part in this programme, and it is along these lines that a part of our efforts are being directed.

In closing this discussion on Kwashiorkor and suitable protein supplements, it might be said that the condition is the penalty of adopting a starchy diet on the abandonment of the nomadic way of life. Cirrhosis and primary liver carcinoma seem to be the penalty of undernutrition in later years, or athero-sclerosis in those fed on milk. The cult of moderation in eating (and other pleasures) may have material advantages in health and longevity which outweigh its penalty of smugness.[26]

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PROTEINS:

Some indication of the part played by protein malnutrition has been covered. Other facts concerning proteins and protein rich foods which appear to be of interest in a study of this sort are appended.

The German chemist, Emil Fischer, and co-workers showed that proteins are made up of many different amino-acids known often as the "building stones" of the proteins. By their combination in different ways, proteins exhibit variety and complexity and differ in nutritional value.

The digestive enzymes liberate the bonds between the amino acids, thus setting them free. Mention has been made of the essential amino acids for rats, and that histidine is not essential for man (F.A.O.)[56](p.222). In the absence of the essential amino acids, growth of new tissue stops; if inadequate in quantity, growth is retarded. Gelatin is interesting in this regard. It lacks tryptophan and is poor in other amino-acids, but has lysine in fair quantity. As the sole source of protein, gelatin results in a rapid loss of weight. Wheat and maize which lack lysine can advantageously be combined with gelatin. Wheat and rice too, if given together, can promote growth rate very considerably as compared with rice alone.[56]

Chronic protein malnutrition:

In man (it is believed) that in dealing with the underprivileged, we are dealing with a form of protein malnutrition which may have persisted through several successive generations.[56] Experiments in rats, whose mothers were deprived of protein, showed that in many cases the young were born dead and the mother ate her young. Of those born alive, many died at weaning. If protein was added as fish meal in different preparations, it was shown that not only did the weight mother's weight improve, but that the weight of the offspring approached normal controls. Young animals born of mothers who had been on a low protein diet were only about one-third of the weight of stock animals of the same strain at the same age.[56]

Following this to its conclusion in humans, an infant of a protein malnourished mother at the time of "mixed feeding" who continues to receive breast milk, is being given a life-saving measure. The nutrition of the mother in underdeveloped communities should receive every consideration.

In the underprivileged, the diets are invariably unbalanced exhibiting carbohydrate excess and deficiency of protein. Under these conditions, liver damage occurs, and this has received mention. These livers may exhibit an excess of fat. If fat is increased in the diet, growth and protein efficiency improve, but liver fat remains high. If the ratio of protein to calories is doubled, increasing the fat causes an increase in growth and in protein efficiency showing that a high proportion of fat has a significant sparing effect on protein. Where protein intake is adequate, the sparing effect of fat is unnecessary, and at this level liver fat becomes normal.[56] Fat and carbohydrate cannot be used however for repair of tissue. Where calorie intake is low, protein from the tissues will be consumed as a source of energy. To supplement a protein deficient diet therefore with fat and carbohydrate will have only limited value.[93]

Protein foods differ not only in their amino acid composition but also in the variety and quantity of other nutrients, including vitamins and minerals.[51] At least in the underprivileged, deficiency of protein means deficiency not only of amino acids but of other nutrients and especially of vitamins.[51]

In nature there is a close association between vitamin B complex and protein, and the inter-relationships which exist between the metabolism of amino acids and vitamins, particularly of the B group e.g. tryptophan and niacin.[51] The importance of trace elements in relation to vitamin and amino acid metabolism is evident in the place of cobalt in B12 (cyanocobalamin) and molybdenum in the xanthine oxidase factor.[51] The place of trace elements in fertilisers and their effect on the maize protein has been mentioned.[47]

It is reasonable to accept that as protein malnutrition is a widespread cause of ill health, almost every system of the body is affected, and that the diseases caused are seldom seen in temperate climates. (p.224, part 2.) It would appear that the scientific problems posed by recent concepts of the aetiology and pathogenesis of kwashiorkor need to be extended to cover the whole range of the mechanism and affects of chronic protein malnutrition. (Brock)[26]

Protein Requirements:

Low protein and high protein foodstuffs are recognised depending upon the number of grammes of protein yielded per 100 calories.

Cereal grains yielding about 2-3g of protein per 100 calories are low protein foods which are marginal for human protein requirements. Roots and tubers fall below 2g per 100 calories e.g. cassava, which yields under 20g of protein per 2000 calories.[26](p.254,part 2)

Among the high protein foodstuffs are animal products ranging from whole milk (5.5g per 100 calories) to dried fish ($\pm$ 15g). Nuts and legumes fall within the same range as animal protein foodstuffs, therefore the high protein foodstuffs can be divided into those of animal and those of vegetable origin.[26] Proteins however, are not considered only in quantitative terms and the qualitative aspect is of more importance than the quantitative. The quality of a protein is dependent upon its aminogram or pattern of amino acids.[26] "Protein foodstuffs" will depend upon:

(1) The quantity of protein e.g. in relation to calorie yields;

(2) The quality of protein (aminogram)

(8) The content of other nutrients of all types. Especially important will be the content of vitamins and certain minerals, particularly trace mineral elements.[26]

Protein rich foodstuffs of vegetable and animal origin can be evolved and contain the same amount of nitrogen in relation to calories, and similar if not identical aminograms. The foodstuff of animal origin would contain vitamin B_{12} in good quantity however, whilst the vegetable protein food would be largely lacking in this vitamin.[26]

Requirements in general are suggested by the following figures. The League of Nations in 1935 suggested 1g per kg body weight per day. Gyorgy[56] suggested 2g/kg per day of human or cow's milk in first 6 months of life. Up to 4 years of age the same level would be reasonable, but thereafter a level of 1.5g/kg would probably suffice.

When requirements are assessed, three methods of appraisal are advisable, namely physical, biochemical and dietary.[94] Any programme of nutritional improvement should be carefully chosen for adaptation to the geographic, economic and cultural pattern of the population concerned.[94]

25g of protein a day will produce nitrogen balance in adults if calorie needs are adequately covered.[56] We selected the figure of 30g of animal protein a day for discussion in the final analysis and summary. In children, a value of 1.5g of milk protein per kg a day has been mentioned as acceptable. Dean had good results on 4-5g of vegetable protein (a mixture of wheat and soya) per day in children. Gopalan had good results in adults as far as nitrogen retention is concerned, on vegetable diets consisting of 75% cereals and 25% pulses.[56] Hansen's [84] work on maize supplements has been mentioned(p.249) and he had good results with 2/3 maize and 1/3 pea flour at intakes over 2.5g per kg per day. Mixtures of maize 60%, pea flour 30% and fish flour 10% gave better results than the maize/pea flour mixture, at all intakes, as did a mixture of maize 60%, pea flour 30% and milk powder 18 parts. The mixture of cereals, legumes and pulses is desirable, as cereals are poor in lysine and rich in methionine. Legumes and pulses are rich in lysine and poor in methionine. Enrichment of cassava flour by maize has improved nitrogen retention in the Belgian Congo.[95]

In underdeveloped countries and on diets low in protein, children grow poorly during pre-school years, better during their early school years, and at a rate similar to that of well-nourished children during their later school years. (Scrimshaw)[56] This indicates that on a poor dietary where protein is mostly derived from corn, it is adequate in older children but not enough at 6-8 years. In fact, older children did not grow better when given a lunch containing additional animal protein, or a comparable mixture of soya and other vegetable proteins. Protein intake is increased in adolescence, and in all simple communities young people get access to more food in that period. Whether more protein is truly required at adolescence for growth, is unproved, but seems likely.[56]

In underdeveloped areas, it has been shown that on intakes as low as 25g almost all of it derived from vegetable sources, adults in Nyasaland could maintain reasonably good health even in the presence of parasites. Adults in Central America carry on a hard day's work on very deficient diets. It is questionable however if they are in optimum health. The same doubt applies to many of the Africans in industry in this country. The figure of .5g per kg per day of ideal protein is probably adequate in adults. At the level of 1g per kg per day of mixed protein, excellent health should be possible.[56]

In pregnancy higher levels are required, and if the level of protein intake is between 70-80g a day, it is considered adequate. In India, Gopalan reported on a series of pregnant women receiving between 40 and 45g protein per day and a total calorie intake of approximately 2000 calories. The incidence of immaturity was 8 times that of a control group on normal diets.[56]

Lactation is a more stressful time than pregnancy and it is very important to assure an adequate dietary. Increased protein requirement may be calculated roughly, by saying 2g of protein are needed to produce 1g of protein in breast milk. In a pilot scheme in the Belgian Congo, dried skimmed milk was distributed as follows:

> 40g dried skimmed milk powder (S.M.P.)(250cc) to nursing mothers until the baby was 1 year old.
>
> 20g of S.M.P. to child between 1 & 2 years of age. Scrimshaw recommended this figure for pre-school children in Central America.[56]
>
> 40g of S.M.P. to child over 2 years of age.

These amounts were selected because they could be consumed at one time under supervision, and not because they were considered adequate.

In lactating mothers receiving the supplement, satisfactory growth of the child occurred to 6 or 7 months. If more S.M.P. had been given, it is likely that satisfactory growth of the baby would have been maintained for a longer period.

If a child of 12 months of age was given the milk directly, the growth curve improved. It could therefore be given at say, 8 months, if good sanitary conditions pertain at home. Undernourished mothers getting S.M.P. showed significant increase of breast milk; its protein content too increased from 1g to

1.2g per cent. The increase in the output of the breast milk was felt to be very important. Where S.M.P. is given, lactose produces more calories than the protein. Any improvement noted may therefore be partly due to the extra calories.

Gopalan, working in underdeveloped areas noted that where protein in the diet was defective, there were concurrent deficiencies, particularly of the vitamin B complex, which had an aggravating effect on the clinical condition. The environmental conditions were invariably poor, leading to infections and infestations, and the clinical condition of the children exhibited classical stigmata of protein malnutrition - hair changes, stunted growth, skin dyspigmentation, and hepatomegaly. The haemoglobin averaged 8-9g per 100ml and the serum protein level was usually below 6g per 100 ml.[56]

Nitrogen retention depends inter alia upon: (a) Nitrogen intake; (b) the biological value of the protein used as the source of nitrogen; (c) the degree of depletion of the subject.[95] The authors feel that on a given nitrogen intake, the degree of nitrogen depletion is more important than the biological value of the protein. In kwashiorkor patients, retentions of 700-800 mgm per kg per day were found on intakes of 1,000 mg per kg per day. In normal American children, mean retentions of less than 100 mgm per kg per day have been recorded on similar intakes.[95]

Where protein supplements are needed, it is of interest to note that if for example 4g of protein are added to a daily intake of 40g, that 4g may be stored daily over long periods. If a limited amount of protein is available for distribution, as many people as possible should be supplied. Prophylactic increase of the protein intake above 14-15% of the total calories has no value.

In therapeutic diets however, and especially in children, 20% and more of the calories can be supplied by protein.[95]

Where protein requirements are not being met, the serum proteins exhibit characteristic changes, as has been mentioned, and Gopalan's work supports this.

Serum Protein Patterns:

The drop in serum albumen with a rise in serum globulin, and a reversal therefore of the normal albumen/globulin ratio has been referred to, and mentioned again in the section on kwashiorkor.

The serum protein pattern of many Africans differs from that of healthy Europeans, i.e. a lower serum albumen with a higher serum globulin is seen.[96,97] Possible explanations are:

(1) Dietary protein inadequacy.

(2) Chronic liver disease, prevalent throughout the African continent and associated probably with protein malnutrition. Protein malnutrition and chronic liver disease may individually or together contribute to the low serum albumen.

(3) Several tropical diseases raise the serum globulin.

(4) The difference may be genetic.[96]

In a study of Cape Town Africans, the mean values for total protein for albumen and for total globulin are all slightly higher than in a study of Africans from Kampala. The albumen/globulin ratios are the same for the two groups, it follows that the higher mean total protein in the Cape series is due to the higher level of both albumen and total globulin of approximately the same order. The mean gamma globulin values were considerably higher in the Kampala group, which could reasonably be attributed to the presence of tropical diseases.[96]

Anaemia and tropical disease were not seen in the Cape Town series whereas the effects of tropical parasitism are noticeable in the sera of Bushmen from South West Africa, Bantu of South West Africa and Rhodesian Natives. Differences were noted in total protein, albumen, total globulin and the albumen/globulin ratio.[96]

The serum protein fractions in non-tropical Bantu subjects are intermediate between, and significantly different from Europeans on the one hand and tropical Africans on the other hand. The differences cannot be attributed solely to tropical diseases. The question of prolonged protein malnutrition and latent liver disease is considered important.[96]

The Cape Coloureds, intermediate in the socio-economic scale, possessed a serum protein pattern intermediate between that of the Bantu and Europeans, particularly with respect to globulin values.[97] In all groups the serum albumen decreased in magnitude and the serum gamma-globulin level increased in magnitude with advancing age. The serum gamma globulin was higher in the low income group, while with the exception of the European, the serum albumen level was lower in the low income group.[97]

A highly significant association between the serum albumen and dietary protein intake was found, in that serum albumen levels increased as protein intake increased, but only up to a certain level. Above that level of protein intake no further rise in the serum albumen concentration occurred.[97]

An inverse relationship existed between the serum albumen and gamma globulin levels but evidence that factors other than dietary intake influenced the level of gamma-globulin in the serum was suggested, e.g. genetic or environmental, as a result of long continued or repeated exposure to chronic infection.[97]

In the absence of evidence of protein losses, such as proteinuria or of impaired protein synthesis, figures of serum albumen below 3.0g per 100 ml constitute very strong presumptive evidence of serious deficiency in quality or quantity of protein in the diet. The suspicion is converted to certainty when the level is raised effectively by feeding protein rich foods. The serum albumen level has been shown to be an accurate quantitative measure of the comparative efficiency of curative formulae, in kwashiorkor. (Brock)[98] The "low" serum albumen levels of the Bantu previously discussed are of importance before marginal figures in the range 3-4g per 100 ml can be regarded as sub-optimal.[98]

The problem of marginal serum albumens can aptly be compared with that of the relation of haemoglobin levels to iron deficiency. It is logical to conclude (in the absence of evidence of disturbed iron metabolism or of abnormal haemoglobin losses) that if iron therapy improves the haemoglobin levels the person was probably suffering from an iron deficiency anaemia. The same argument can be applied to marginal serum albumen levels which improve on an adequate protein diet.[98]

After mentioning the results of workers in Cape Town, Scrimshaw's findings are of considerable surprise. He found in underdeveloped areas living almost entirely on vegetable protein diets, that serum protein values were normal or even high. In Panama, whole villages had average figures of 8-9g per 100 ml. Both albumen and globulin levels were normal and a drop in serum values was seen only in severe depletion.[56] Variations in technique may account for some difference in figures from different laboratories. Marginal hypoalbuminaemia is thus difficult to define; In Cape Town it would be between 3.25 and 3.75g per 100 ml.[98]

<u>Urinary Nitrogen Partition:</u>

It is known that the 24-hour excretion of urinary urea is positively correlated with the dietary intake and that a similar but less close correlation exists between serum urea and dietary protein. Conversely, urinary creatinine shows little if any correlation with dietary protein, but appears to reflect lean body mass. Less is known about the other nitrogenous constituents of urine.[98]

Excessive amounts of riboflavin may be found excreted in the urine post operatively, in cases who were in negative nitrogen balance. The same phenomenon has been observed in diabetics who went into negative nitrogen balance after withdrawal of insulin. As nitrogen balance returned to normal, riboflavin loss in the urine became normal. In normal subjects too, riboflavin excretion is increased when they go into negative nitrogen balance. The theory behind this phenomenon is that most of the riboflavin exists in combination with protein; the association of excessive excretion of riboflavin with negative nitrogen balance implies that labile protein stores which may consist largely of flavoproteins are the first to be drawn upon in protein deficiency. The same factors would apply in conditions where protein catabolism is increased.[99]

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Amino acids and protein depletion in anaemia:

The essential (F.A.O.)[56] amino acids for rats are histidine, lysine, tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine. Histidine is not required as an essential by man.

Table 40.

	Suggested minimum intake	Value of safe intake g per day.
L.tryptophan	.25g per day	.50
L.phenylalanine	1.10 " "	2.20
L.lysine	0.80 " "	1.60
L.threonine	0.50 " "	1.00
L.methionine	1.10 " "	2.20
L.leucine	1.10 " "	2.20
L.isoleucine	0.70 " "	1.40
L.valine	0.80 " "	1.60

Safe figures are taken to be double the minimum intake. The figures above apply to man.[56] In human volunteers, a lack of amino acids caused loss of appetite, irritability, nervousness, fatigue and vomiting. These symptoms are clearly reflected in infants suffering from kwashiorkor. Valine and isoleucine lack caused symptoms particularly promptly. It was observed that nitrogen intake to allow for the synthesis of non-essential amino-acids was important.

Babies appear to require about 10 times as much (in terms of mg/kg of body weight) of the amino acids as adults do, and even more in the case of phenylalanine. The baby requires nitrogen for growth and also has a higher metabolic rate.[56]

Tryptophan seems to induce growth; leucine retards it at a level of 3% in a low protein diet. Isoleucine counters the effect of leucine. Valine also counters growth inhibition. Threonine lack seems to cause fat deposition in the liver when protein intake is below normal.[56] Tryptophan appears to be growth stimulating for normal and malignant cells in vitro.[77]

Lysine, methionine and leucine are deficient in the diets encountered in underdeveloped countries, and sunflower seed meal which has a high level of sulphur containing amino acids is helpful. (Gopalan.[56])

Amino acids have been shown to contribute to the growth of cell cultures but were unable to support life without the addition of peptides and polypeptides. The concept of essential and non-essential amino acids for the whole organism did not apply to cells growing in tissue culture.[77]

Methionine displays a significant erythropoietic potency. It increases the haemoglobin level more than the number of erythrocytes, thus causing an augmentation of the M.C.V. and the M.C.H.C. Its beneficial effects on plasma proteins, in contrast to its erythropoietic activity does not require concurrent administration of proteins or other amino acids.[62] All the amino acids which are essential for growth and weight maintenance are also indispensable for erythropoiesis.

Each anaemia induced by selective deprivation of any amino acid seems to be of the same hypochromic type as anaemia following on protein depletion. A lack of amino acid material appears to be more detrimental for the synthesis of haemoglobin than for the multiplication of erythrocytes and the formation of their stroma.[62]

Methionine is also particularly useful for leucopoiesis. Leucopenia is normally present in protein depletion. When adequate protein is supplied, simultaneously with the reticulocyte crisis, a prompt increase in the blood level of all kinds of leucocytes occurs. This phenomenon can only be explained by an accelerated maturation of these cells in the haematopoietic organs, followed by their delivery into the blood stream.[62]

Wherever a protein is adequate for growth and weight maintenance, either because of its balanced amino-acid composition or of its high levels in the diet, it is also effective on haematopoiesis. Therefore factors which change the biological value of a protein, such as cooking and other methods of processing, as well as digestibility and the time of ingestion (i.e. simultaneously or alternately with other nutrients) may also modify the haematopoietic effects of the latter. Among the vegetable proteins all of those which are deficient with respect to one or more of the essential amino-acids such as lysine (zein and gliadin) or tryptophan (zein) are inadequate for haematopoiesis.[62]

Production of blood cells and haemoglobin requires a constant supply of proteins. If this is inadequate, the needs for haematopoiesis are met from tissue proteins at the expense of other functions. The anaemia which normally is seen under these conditions is hypochromic and microcytic and is accompanied by leucopenia, eosinopenia and an atrophy of lymphoid organs.[62]

Protein depletion induces anaemia and leucopenia not only because it deprives the haematopoietic organs of amino acid constituents of blood cells and haemoglobin, but also because it prevents the production of certain vitamins, either by inhibiting their microbiological synthesis in the digestive tract (folic acid, niacin) or by suppressing the supply of their metabolic precursors, such as tryptophan for niacin.[62,78] A hormonal imbalance, particularly inactivation of the thyroid and testicles and hyperactivity of the adrenal cortex, may play a role in the development of blood disorders. Testosterone and thyroxine are particularly effective in the production of red cells.[62]

Protein constitutes a major part of the blood and blood-forming tissues, and haemoglobin forms a major part of the body proteins. The constitution of haemoglobin and the numerous enzymes and hormones concerned with erythropoiesis suggests that the requirements for essential amino-acids may be critical. B_{12} in animal foods has been mentioned and a depletion of such foods might cause effects due to the deficiency of the vitamin.[50,78]

Protein deficiency causes changes in the gastro-intestinal tract, which might lead to interference with absorption. Defective intestinal secretion might also lead to modification of the intestinal flora and affect bio-synthesis of vitamins, as mentioned above.[78]

In human subjects on a protein depleted diet, a loss of metabolically active tissue and also a reduction in the amount of haemoglobin occurs. The normal ratio of the one to the other is preserved however. In the production of specific protein depletion in adult man, factors such as selective competition for amino acids by parasites, or special tissue growth, excessive protein catabolism, metabolic competition within the body, or the effects of antimetabolites, may be of greater importance than primary dietary deficiency. The effect of the latter is likely to be complicated by the anorexia due to deficiency of essential amino acids.[78]

A critical factor in children will be whether the protein deficiency causes cessation of growth. Anaemia occurs in many cases of kwashiorkor and a correlation between haemoglobin levels of adolescents, and their protein intake has been described. The development of anaemia during the course of treatment for protein malnutrition is of interest and is probably due to a relative deficiency of protein for blood formation due to building up of other body tissues. Intramuscular iron has been shown to be of value in protein deficiency anaemia. It is possible that this is due to a failure to utilise available iron.[78]

Protein Resources:

Half the people in the world do not get enough calories. Many who get enough calories do not get enough protein. In the Far East, Near East, Central and South Africa and Central and South America, there is a general shortage of food. 17% of the world's population have more than 30g of animal protein a day - the level regarded by many as necessary. The present average British diet yields 84g of protein, of which 50g is of animal origin. 25% of the world's population have between 15 and 30g of animal protein a day, and

58% less than 15g.[100]

The most efficient way of making use of the limited number of acres at our disposal may be to eat the foods from the ground. Tastes and habit however, lead us to prefer animal foods - meat, milk and eggs, and the value of animal proteins has been mentioned. It is of interest to find:

0.1 acres of beans will produce 20 kg of protein per year.
0.27 acres of potatoes " " " " " "
0.8-1.9 acres are required for sheep.
1.0-2.5 acres are required for beef.[100]

Table 41.

Relative efficiency of farm animals as converters of calories & protein into human food.[100]

	Calories as % of calories fed.	Protein as % of protein fed.
Dairy cows	19	23
Pigs	18	12
Fowls	10	32
Beef cattle	7	10
Sheep	8	13

When the quantity of protein falls near minimum levels, the quality of the protein becomes increasingly important. 10% of protein in the diet fed to a growing child, or experimental animal, is a limiting factor in growth. The nutritional value of protein when measured under standard conditions is designated the Biological Value.

Egg protein has a biological value of					100
Soya bean flour has a	"	"	"	±	70
Meat & fish have a	"	"	"		75
Bread has a	"	"	"		50
Peas and beans have a	"	"	"		45
Peanut and presscake flour				±	56
Cottonseed				±	65
Sunflower seed					64

Biological values normally refer to fresh or undamaged foodstuffs. Ordinary cooking methods do not greatly affect the biological value of proteins, but processing damage becomes very important when preparing concentrates e.g. fish meal, and oil and seed cakes.[100] Lysine is particularly liable to damage when a protein source is subjected to heat. Autoclaving and cooking cereals under pressure and then releasing the pressure with expansion of the cereal grain, are procedures particularly likely to cause damage.[101] This point is of importance in any canteen service which provides food for its labour. Autoclaving soya bean is however advantageous, as the trypsin inhibitor is inactivated, and the product is less bitter.

Dry heating of soya beans did not harm the amino acids. Boiling for 12 hours seemed to increase the amount of amino acids which could be released by subsequent enzymatic treatment. The changes caused by heat appear to be in the way in which amino acids combine with reducing sugars at different states of humidity and temperature.[101]

The proteins of haricot bean, cottonseed meal and soyabean meal appear not to suffer by heating. If soyabean protein is overheated, inactivation of the trypsin inhibitor occurs. It is particularly important to destroy the trypsin inhibitor in soya beans when preparing feeds for children, as soya preparations tend to cause diarrhoea in infants. Soya beans have a high fat and low carbohydrate content and good protein. The lysine content is good, so mixtures of soyabean, cereal and S.M.P. (10 parts of dried milk solids) make good protein feeds for children. (Dean)[101] Cystine and methionine are low in soyabean but adequate in most cereals. Soyabean given alone has not seemed beneficial, yet it has been an acceptable food in China for 6000 years.[56]

Any attempt to increase protein resources should include: (Gopalan)[56]

(1) An increase in milk supplies.
(2) " " " Soya meal
(3) " " " fish meal
(4) " " " plant proteins generally.

In the latter category peanut meal, cottonseed flower, sunflower seeds, sesame, coroso palm and coconut protein, all have a part to play. Reference has been made to these supplements in the section on kwashiorkor, (p.257) and to Hansen's work.[40]

Peanut meal with maize cereal is not a very good combination but it makes a good additive to oatmeal and to wheat flour. In the latter, experimental results were as good as with muscle protein but the amount required was higher. When used with white flour the results were only half as good, as soyabean with white flour.[56]

Cottonseed (once the toxic factor, gossypol, is removed) is a good additive to soya meal and also to corn and sesame.[56] Sunflower is good with maize but may contain silica which may be detrimental.[56] Cocoanut protein is a good additive to yellow maize.

The value of food yeast (Torula utilis) has been mentioned in the first part of the discussion.(p.200) It has a protein content of 45% but lacks sulphur containing amino acids, cystine and methionine. Maize has a high methionine content however, and food yeast is high in lysine and tryptophan. As little as 5% is a useful additive to maize but an additional 5% of brewers yeast is better.[102] Half an ounce a day of foodyeast should be quite acceptable and not cause gastric upset. This will yield 7 or 8g of protein.[100]

In Nigeria, peanut flour has been used with success to supplement the basic diet of yams, cassava and plantain, all of which are essentially carbohydrate foods, with low protein values. This mixture is known as "Amama", and is manufactured at Apapa. It has been used with success in French West Africa, BelgianCongo and India in addition to Nigeria.[42] The peanut flour provides the bulk of the protein, milk powder and dried yeast are added but vitamin C is not included in adequate amounts.

Pro-Nutro (Hinds, Durban) has already been discussed under kwashiorkor. (p.260).

Scrimshaw and Bressani[44] working for the Institute of Nutrition of Central America and Panama (INCAP) evolved the following vegetable mixture known as INCAP No.8: dried maize masa 50%, sesame flour 35%, cottonseed flour 9%, Torula yeast 3% and kikuyu gasss leaf meal 3%. This has 25.1% protein, 13.7% fat and 503 calories per 100g. The maize provides cereal and calcium, sesame flour contains 33% fat, cottonseed provides high protein, the yeast provides B complex vitamins and the carotene-rich leaf meal is the source of vitamin A activity. In a series of 5-day balance trials, this preparation gave a nitrogen retention equivalent to milk. The results in kwashiorkor were also good except for a slightly slower regeneration of serum albumen, which applied equally to Pro-Nutro.

Difficulties in the supply of, and price of, sesame seed led to the evolvement of mixture 9B which contained 29% ground maize, 29% ground sorghum, 38% cottonseed flour, 3% food yeast, 1% calcium carbonate and 4,500 i.u. vitamin A per 100g.

Table 42. The essential amino acid composition of INCAP9B

Amino Acid	g/100g	% F.A.O. Pattern
Arginine	2.4	
Histidine	1.00	
Isoleucine	1.12	94
Leucine	2.08	154
Lysine	1.53	129
Phenylalanine	1.52	192
Threonine	.87	110
Tryptophan	.24	61
Valine	1.14	96

Results of treatment of kwashiorkor compare favourably with those of mixture 8, and the nitrogen retention when the protein intake was 2.3g/kg showed no significant difference from that when the protein supplied was milk. Acceptability is good and the product is commercially available in South America as "Incaparina". Three glasses per day give the same protein quantity and quality as an equivalent amount of milk.[44]

<u>Amino acid supplementation</u>

In place of producing mixtures of proteins, it is possible to add to the protein any deficiency in amino acids. Bread for instance, has a biological value of 50 because it has not enough of the essential amino acid lysine for tissue synthesis. If lysine is added to bread, the biological value rises to 60, where threonine becomes limiting. If threonine is added, the biological value rises to 75 when methionine becomes limiting. Add this and the biological value becomes 85. The most important additions would be lysine and methionine, the usual amino acids which are limiting in protein deficient diets.[100] Most animal diets are based on cereal where lysine is limiting. Lysine and methionine are available on the factory scale.[100]

Supplementation of proteins with amino acids is still in its infancy, but lysine supplemented bread is available in the United States, and various supplements are available for animal feeds. Reference to the supplementation of maize with lysine and tryptophan (Truswell and Brock[87] and by Hansen)[84] has been made. (P.204 & 249).

Upgrading of Proteins and maize improvement

Proteins may be upgraded by making better use of the materials available. Proteins at present used as fertilizers such as blood meal, low quality fish meal, hair and feathers, could be upgraded for animal feed. Hair and feathers need treating to make them digestible. Provided enough is known of the amino acid make-up and nutritive value of low quality proteins, then suitable blends can be made, even from very poor proteins, to provide mixtures suitable for animal food. Ruminants and to a small extent, non-ruminants, can use limited amounts of other nitrogen sources, such as urea, and ammonium sulphate for the synthesis of protein.[100]

While fertilizer grades of protein can be elevated to animal food, animal feed grades can be elevated to human food. Mention has been made of fish meal, cottonseed meal, sesame seed and others. Rice with 6% protein (biological value 60) is of special importance in that it is the staple diet of vast areas of the world, and there is a shortage. A synthetic rice made from tapioca (cassava starch) as a base, with 10% peanut flour added has been evolved, and looks and tastes like rice. Its interest lies in the fact that tuber crops yield more calories per acre than does rice.[100]

'Synthetic meat' substances have been successfully evolved from peanuts and wheat gluten. Meat extract or chicken essence has been added as a flavouring agent, and the final product appears as a chewable gel which resembles meat in texture and flavour, although not in nutritive value. These could materially assist in solving the problem referred to earlier, namely the efficiency of eating plant proteins and the absence of desire to do so.[100]

Supplementation of maize has been discussed (Brock, Truswell & Hansen)[37,39,40,84], and Scrimshaw and Bressani's[44] work in Incap has been reviewed. It is accepted that the direct distribution of milk in various forms (e.g. as S.M.P. and/or as milk enriched infant foods based on maize) to Non-European infants and young children is an effective method of preventing kwashiorkor. It also provides extra calcium and riboflavin.[103] Truswell[39] showed that subjects receiving .5g/kg per day of maize protein were in negative nitrogen balance while those receiving 1g/kg were in slight positive balance. Some uncertainty exists however in that losses of nitrogen in sweat, hair, nails and blood samples taken from subjects were not included. Possibly therefore even on 1g/kg per day there may be a negative nitrogen balance.

Apart from the fact that maize eating populations are likely to be in negative nitrogen balance, the part played by maize in causing pellagra is important. Although it cannot be said that this problem is elucidated, the body's supplies of niacin are derived from dietary tryptophan as well as from niacin and niacinamide. The niacin in wheat and maize is present mainly in a bound form which is unavailable to several different species of animals and possibly to man.[103] Experimental work overseas has suggested that niacin was not as well absorbed by children from wholemeal wheaten bread as from white bread enriched with synthetic vitamin to give the same total niacin content.[103] If the germ of the maize is removed, the level of niacin may be affected appreciably. It is possible to release the niacin by alkali treatment, but it is probably more satisfactorily provided by adding niacin or its amide artificially.[103]

The possibility that maize may contain a substance which interferes with the metabolism of niacin, and thus raises the requirement for niacin, has been raised. It is possible however, that the part played by maize can be explained merely on the basis of the non-availability of bound nicotinic acid together with a low intake of tryptophan and an imbalance of amino acids.[103]

The food balance sheet date issued by the Department of Agricultural Economics and Marketing indicates that the overall supplies of calcium, riboflavin, and possibly vitamin A available for consumption by the total population in South Africa are low by comparison with commonly recommended levels of intake. Therefore enrichment of maize with the above nutrients is perhaps justifiable. There is no evidence for the enrichment of maize with vitamin B_1 or iron in this country.

Maize enrichment should be studied, not alone, but as an aspect of the general question of finding the best conditions under which maize can be employed as a human food in South Africa. Food facilities involving the greater production and/or better distribution of supplies of certain foods may, in many instances, be found to be more satisfactory. At the present state of our knowledge, further investigations including survey work and feeding trials would be necessary before the value of the enrichment of maize with additional nutrients could be fully assessed.[103]

Conclusion:

To sum up the discussion on protein foods and the role played by protein undernutrition, it is reasonable to repeat the following hypotheses. (Brock)[98]

(1) Where a community subsists on a predominantly starchy diet of cereal or root origin, without regular supplements of protein rich foods (i.e. pulses or animal protein) kwashiorkor will be prevalent in the post weaning group.

(2) There will be many cases of pre-kwashiorkor for every case of kwashiorkor in the same age group. These may be precipitated into the full syndrome by a variety of stresses. Their prevalence can be assessed by determining the prevalence of marginal hypoalbuminaemia.

(3) At all ages in the same community protein malnutrition will manifest itself in higher morbidity and mortality and decreased life expectation compared with more privileged communities. This protein malnutrition will often, but not always, betray itself in a raised prevalence of hypoalbuminaemia.

(4) In the same community there will also be a deficiency of protective nutrients, because the protein rich foods (animal foods and pulses) are important vehicles of protective nutrients. Protein malnutrition can only be corrected by regular supplements of protein (amino acids) or protein rich foods and the provision of protective nutrients alone will not correct the position.

Protein rich foods however will go a considerable way towards correcting the deficiency of protective nutrients as well as the deficiency of protein.

(5) The community or group protein malnutrition will be associated with -

(i) overall increased morbidity and mortality and decreased life expectation.

(ii) High infant mortality rates, especially infantile gastro-enteritis.

(iii) High pre-school mortality associated with kwashiorkor and pre-kwashiorkor.

(iv) Impaired growth rates in adolescence.

(v) High maternal mortality rates.

(vi) High morbidity and mortality rates for tuberculosis and other infections.

(6) The community or group protein malnutrition and resultant morbidity cannot be corrected without improving the consumption of protein rich foodstuffs in the community or group as a whole. Provision of protective nutrients, such as vitamin C, vitamins A & D, niacin, calcium and iron may supplement the beneficial effects of protein supplementation but cannot replace it.[98]

(V) <u>The deficiency of group 6 foods (Fats)</u>

Replies concerning the use of fats in general were particularly vague. It is not clear why this should have occurred, and it is not claimed that the deficiency of fats is as real as the survey suggests. Mention of the difference in fat intake in the Bantu and Whites and the relationship to ischaemic heart disease will be discussed.

Cereal diets seem to result in a larger amount of fat being voided in the faeces. This might indicate that the digestibility of cereal fat is low and would have great importance in the diets of Africans.

Investigations by Walker and Arvidsson[104] suggest that -

(i) The maximum number of calories lost as faecal fat per diem is small and the phenomenon is therefore of limited practical importance in human nutrition.

(ii) The faecal fat is largely of non-dietary origin, thus the true digestibility of cereal fat is probably as high as that of most other edible fats.

(iii) In the African the amount of fat voided in the faeces falls to within normal limits when foodstuffs in addition to maize are present in the diet to any appreciable extent.[104]

In a survey, the diets of rural Africans were compared with White professional and clerical men in Cape Town. The former derived 18% of their calories from fat as compared with 43% by the latter.[105]

The low total fat consumption of the Bantu is comparable to that of the Japanese, Chinese, Guatemalans, Southern Italians and Yemenite Jews, amongst all of whom ischaemic heart disease is uncommon. Much of the Bantu fat is derived from maize; i.e. it has a high content of unsaturated fatty acids. The small quantity of saturated fats obtained by the Bantu come from soured milk and the rare feasts of meat.[105]

The relatively high level of unsaturated fats in the Bantu diet may be compared with the Japanese (fish) Chinese (soya bean oil) South Italians (olive oil) and Yemenite Jews (sesame oil). The fat consumption of the Bantu is in sharp contrast with that of the privileged White races which is characterised by a high content of saturated fats, both from animal sources and from artificially saturated (hydrogenated) vegetable oils, and consequently by a relatively low content of unsaturated fats. This qualitative and quantitative difference in fat consumption is the most clearly delineated exogenous factor which may account for the relative immunity of the Bantu to ischaemic heart disease. The importance of the specific effects of the high crude fibre and low animal protein intake have yet to be established.[105]

There is a close association between the serum cholesterol level and the development of ischaemic heart disease.[26,105] Several surveys have been made of the serum cholesterol levels in various African populations which show consistently low levels. The low level in the Bantu may be partly a genetic trait. By addition of saturated fats to their diets, the serum cholesterol level can be made to rise towards the level of the Whites. Other factors which may predispose to low levels are "feminisation", increased physical activity, chronic disease and, as mentioned, a diet low in fat and relatively rich in unsaturated fatty acids.[105]

A lessened coagulability of the African blood and hence of occlusive thrombosis can be only a partial explanation. Necropsy experience, however, has shown that in the Bantu severe coronary athero-sclerosis is rare and it is believed that this is the most important factor in determining the low prevalence of clinical ischaemic heart disease in this race.[105]

The incidence of cerebral thrombosis and hypertension differs little from that of the White races. A number of diseases peculiar to under-privileged races are characterised by intravascular clotting, e.g. veno-occlusive disease of the liver, tropical thrombophlebitis and endocardial thrombosis associated with myocardopathy of uncertain origin. (p.224) Comparisons of the heart in kwashiorkor and myocardopathy have been made and an interesting finding was histological changes in the heart muscle in kwashiorkor indistinguishable from those described in the adult form.[106]

In the Bantu fibrinolytic activity as measured by the clot lysis time was characteristically faster than in White controls, but in vitro tests of blood coagulability have not shown any significant differences between a group of rural Bantu men and age-matched White controls. A possible connection between the fibrinolytic activity and the Bantu diet pattern is suggested by the fact that when saturated dietary fats were eaten, fibrinolysis was inhibited, but when unsaturated fats (maize oil, arachis oil) were eaten, fibrinolytic activity was not affected.[105]

Ischaemic heart disease seen in a Western privileged group (Whites) is associated with a high morbidity and mortality. Coloureds are intermediate between the White group drawing 25% of their calories from fat, and the Bantu who are remarkably free from this condition.[26]

The correlation between the incidence of coronary heart disease in men at a given age and higher than average levels of cholesterol or lipoproteins for that age, is a valid one. The relationship has been most convincingly demonstrated for total blood cholesterol. The strongest evidence so far links the upward trend of blood cholesterol and of coronary heart disease in men with a rising fat/calorie ratio in the diet, that is with a rising percentage of total calories derived from dietary fat.[51]

Privileged high fat diets differ in many respects from primitive and under-privileged diets, e.g. cholesterol content, crude fibre content and the proportion of fat drawn respectively from animal and vegetable sources. Non-dietary factors such as exercise, cigarette smoking and emotional tension play contributory roles in the question of coronary heart disease.[45]

The reducing effect on the serum cholesterol of certain unsaturated oils is most striking, when compared with the elevating effect of certain saturated fats. This is possibly due to the fact that unsaturated oils increase the faecal and biliary cholic acid, an end product of cholesterol metabolism by up to 100%. Changes in the cholesterol fraction may be pointers only to more significant changes in other serum lipid fractions. (Brock)[45]

Neomycin has a greater effect than unsaturated oils.[105] Maize oil (rich in essential fatty acids) and menhaden oil (almost devoid of essential fatty acids) are equally efficacious in reducing human serum cholesterol levels.[105]

Work is being done on the suggestion that absorptive differences may underlie the increased lipaemia in ischaemic heart subjects. In a study on matched pairs, the lipaemia was more prolonged in the group with ischaemic heart disease, when fat was fed orally, but when it was administered intravenously, identical lipaemic curves were seen in both patient and control groups. The possibility that the disordered fat metabolism in ischaemic heart disease may be determined in the gastro-intestinal tract is therefore of interest.[107] Evidence that gastric secretory activity, at least in the basal state, was less in ischaemic heart disease patients has been produced,[108] as well as evidence for the presence of a lipase in gastric juice.[109]

Whilst the final decisions on lipaemia and ischaemic heart disease are perhaps outside the scope of this thesis, the relationship of a low fat intake of mainly unsaturated fats and a cereal diet, and the relative immunity of the Bantu to ischaemic heart disease are considered of basic significance in an Industrial setting. What is of interest in this connection is, that in the past three years there have been 10 cases of coronary infarction in Europeans in this factory (4 of which were fatal), and no cases in Africans. There are approximately four times as many Africans employed as Europeans.

Fatty acids in infant feeding.

Ariztia[110] has successfully used a preparation of buttermilk enriched with fried butter and flour in the treatment of infants suffering from malnutrition.

Toleration and assimilation were excellent, and improvement rapid. He mentions a remarkable psychic improvement, and that the skin lesions heal rapidly. Skimmed milk with added sunflower oil, rich in unsaturated fatty acids has also been used successfully. Linoleic acid plays an important part in the healing of skin lesions.[110]

Linoleic acid constitutes 12% of the fat in breast milk and is responsible for 5% of the calories in the diet. In evaporated cow's milk formulas linoleic acid constitutes 1% of the calories, and in S.M.P. .1% of the calorie content.[111]

The lower the level of linoleic acid in the diet, the higher is the blood fat level, and particularly the level of trienoic acid. On the other hand, when large quantities of linoleic acid are taken, the serum levels of dienoic acid are raised. Linoleic acid plays a vital role in the diet of infants, and the authors also conclude that it has a beneficial effect on skin lesions.[111]

Conclusion.

This brief discussion of fats in the dietary may conveniently be concluded by reference to their effects on the growth of certain tumours.

The incidence of spontaneous and induced breast and skin tumours is in many cases increased with fat enriched diets, but induced leukaemia, pulmonary tumours or induced sarcomas appeared not to be affected. For induced skin tumours the tumour promoting activity was in the fatty acid fraction of the lipid. Glycerol and the non-saponifiable fraction exhibited only slight enhancement of tumour formation. Ethyl laurate was as effective as the natural fat in stimulating tumours.[77]

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The discussion on vitamins will be furthered in Chapter V.

GLOSSARY OF TERMS : DIET CHAPTER

Amasi	Soured milk.
Mfino	Spinach.
Isinkwa	Mealie Bread.
Izinkobe	Boiled whole dried mealies. "Enkobe" used by Pondos.
Phuthu or) Uphuthu)	Dry, thick porridge.
Marewu	Slightly fermented beverage.
Utshwala	Beer.
Imithombo	Basic malt used to make utshwala.
Lambalaza	A soured porridge.
Incumbe or) Nembe)	Baby food made from mealies.
Tokoloshe	Evil spirit.
Ntakati	Witchcraft.
Lobola	Payment for a bride - usually cattle.
Mcubu	A mixture of soured phuthu and marewu.
Vetkoek	Scone fried in fat.
Madumbie	Edible tuber resembling the ground Jerusalem artichoke.
Ingqanga	Lightning bird.

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CHAPTER 5

THE MEDICAL ASPECT OF THIS SURVEY

This Chapter is presented in three parts.

Part One:

This Industrial Health Study began with some observations and opinions of a general nature, and a statement of some of the known facts. This general assessment of the position led to a more specific and detailed survey of some of the social factors which are considered to be a part of the problem of Industrial Health in this study. The results of this social survey are recorded in the preceding chapters of this report, and reference is made to aspects of malnutrition. In South Africa and in many parts of the world, malnutrition is the greatest and most easily preventable occupational hazard, being a hazard of migrant labour.[1]

This report now proceeds to the discussion of the medical findings at the initial examination:

The following headings are used in the first part of the chapter:

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ANALYSIS OF FIRST MEDICAL EXAMINATIONS.

(a) Examination procedure:

The standard procedure adopted for initial medical examinations was to first record the weight (without clothes) height, measurement of chest, (normal, inspiration and expiration), R. Biceps, R. Calf and abdominal girth. The build was noted, i.e. well-built, medium or slight. The examination couch was then used while the blood pressure and pulse rate were recorded. The heart and lungs were then auscultated. Clinical evidence was sought for hepatic or splenic enlargement, the hernial orifices examined, as well as the abdominal and leg reflexes, and the reaction of the pupil to light and accommodation was noted. The genital organs were then examined. Urinary tests for albumen, sugar or other macroscopic abnormalities were carried out in accordance with accepted clinical procedure.

The skin and mucous membranes of the mouth were then examined for:

(i) Evidence of previous or present disease;
(ii) Signs of malnutrition.

The men were questioned for any history of venereal disease. Subsequently, blood samples were submitted to the Union Health Laboratory, Durban, for the Wassermann test, and the kind assistance rendered by the laboratory is gratefully acknowledged. All the results of the above medical examinations were noted on the printed medical record cards. Where indicated by clinical evidence, chest X-rays were arranged.

The salient facts revealed in this initial medical examination sketch in outline the picture of the health of the African workers who formed the test group. Comparative figures of the three residential groups which made up the sample are attached. It is submitted that these results read in conjunction with the social data compiled in this survey, present a picture of the state of health and the health needs of the African workers, from which constructive proposals can be advanced. The close association between malnutrition signs and income levels recorded in this survey appears sufficiently consistent for valid conclusions to be drawn. The results of the supplementary feeding experiment are included.

RESULTS OF MEDICAL EXAMINATIONS

In general, privileged populations are taller and heavier than under-privileged populations. There is some evidence that among developed nations there has been an increase in mean stature and weight over the last few succeeding generations.[14]

Height:	Group A.	Group B.	Group C.
Heights ranged from	5'1" to 5'11¾"	4'10¾" to 5'10¼"	5'0¾" to 6'0¼" 5'5¼"
Average heights	5'6.7"	5'5½"	5'5.4"

The test group, although not tall where the average figure is considered, are tall by comparison with the Kung Bushmen of the Okavangu strip, whose average height was 5'2½".[2]

Table 43. ANALYSIS OF AGES (As stated in Interview)

Ages years:	Under 30	30-39	40-49	50-59	60 & over
Group A.	34	40	17	9	1
Percentage	33.7%	39.7%	16.7%	8.9%	1.0%
Group B.	38	41	12	10	1
Percentage	37.3%	40.1%	11%	9.8%	1%
Group C.	30	35	25	11	4
Percentage	28.6%	33.3%	23.8%	10.5%	3.8%

The percentage of men under 40 years of age is:

Group A. (Company Compound)	73.4%
Group B. (Howick Native Village)	77.4%
Group C. (Slum areas)	61.9%

A comparison was made between men of urban origin and those born in the Reserves, Native Territories or on farms. The numbers involved are not regarded as sufficient for statistical purposes.

	Rural origin:	Urban origin:	Unknown:
Group A	92	5	4
Group B	52	36	14
Group C	90	8	7
Total Sample Group	234 76%	49 15.9%	25 8.1%
Av. height	5'6.2"	5'5"	5'5.2"
Heights ranged from	4'11¾-5'11¼"	5'0"-5'11¾"	4'10¾"-6'0¼

THE CLASSIFICATION OF BUILD WAS AS FOLLOWS:

(These distinctions are drawn on the basis of visual examination.)

Table 44.

Build:	Well built:	Medium:	Slight:
Group A	52 (51.5%)	43 (42.6%)	6 (5.9%)
Group B	33 (32.4%)	50 (49%)	19 (18.6%)
Group C	33 (31.4%)	53 (50.5%)	19 (18.1%)
Totals	118	146	44
	38.3%	47.4%	14.3%

As the comparison of the three residential groups showed such a considerable percentage in favour of the Compound Group (A) as far as the well-built individuals were concerned, these figures were further broken down into three groups - Urban, Rural Origin and those of unknown origin, and the results tabulated:

Table 45.

	Rural origin:			Urban origin:			Unknown:		
	Well-built	Medium	Slight	Well-built	Medium	Slight	Well-built	Medium	Slight
A	46	41	5	2	2	1	4	-	-
B	22	24	6	5	19	12	6	7	1
C	29	45	16	3	3	2	1	4	2
	97	110	27	10	24	15	11	11	3
	+41.4%	47.0%	11.6%	+20.4%	49.0%	30.6%	44%	44%	12%
	of 234 Rural origin.			of 49 of Urban origin.			of 25 of unknown origin.		

This table demonstrates that those of rural origin had an advantage of 21%+ over those of urban origin as far as the category "well-built" was concerned. For those who were slightly built, the rural group again exhibited a notable advantage; 11.6%, as compared with 30.6% of those in the urban group. The tribal Zulu in earlier days was known as a fine physical specimen.[3]

No doubt many factors play a part in the production of these figures. It is safe to say that in the rural areas there is a very high infant mortality rate. Thus, only the fittest survive and find their way into employment. In the urban areas (which here includes the slum belts) many infants derive the benefit of social welfare and medical services, and so reach adult life. Among the environmental factors influencing growth, the role of the endocrine glands is more important than nutrition. They seem to be the main influence through which the genotype determines weight and height and they may increase these indices even in the face of considerable undernutrition and malnutrition. Diet may, however, affect stature and weight, not only directly but also indirectly through its effects on the endocrine glands. Experimental work in animals suggests that feeding in infancy may, to some extent, determine permanently the size of the animal.[14]

Weight: The weight standard adopted in this survey is that of the "Life Extension Institute of New York", this being a set of tables based on three physical types - Heavy build, Medium build and Light build. Since these tables represent Americans, they represent people who are drawn from all the countries of Europe. Their histories, however, are not comparable with the history of S.A. Natives.

The tables were recommended by the Union Department of Nutrition and appear to correspond more closely with the build classification used in this survey than do other tables of average height, weight, age, which are in common use. The weights are, of course, based upon American experience.

In grouping the weights for the purpose of analysis, it has been accepted that less than 10% below or above standard weight may be regarded as a normal weight range. The information yielded by height and weight is limited because even in a homogeneous race a ± 10% range must be allowed around the mean on account of genetic variability. For the same reason overweight and obesity are not synonymous, nor are underweight and undernutrition. Estimation of subcutaneous fat by the manual estimation of the double skin fold, or by calliper, can be used for estimation of body fat.[4]

Variations of more than 10% either overweight or underweight have been regarded as of interest in this survey. The results of this grouping are analysed in the following table:

Table 46. Analysis of Weight.

Variation from Standard:	Group A.	Group B.	Group C.	Total.
20% or more BELOW	6	2	12	20
10% to 19% BELOW	44	50	48	142
Total underweight	50	52	60	162
% underweight	49.50%	51.00%	57.20%	52.60%
20% or more ABOVE	2	1	-	3
10% to 19% ABOVE	3	1	2	6
Total overweight	5	2	2	9
% overweight	4.95%	1.96%	1.90%	2.90%
Percentage within normal range	45.55%	47.04%	40.90%	44.49%

Weights which are below normal have not been regarded as due to undernutrition where they have occurred as isolated phenomena.

Respiratory System : Pulmonary Tuberculosis and other Chest Conditions.

The initial medical examination involved 308 men of whom 301 actually participated at the start of the investigation. The final number participating was 245. 38, or 12.4% of these men exhibited clinical signs suggestive of pulmonary tuberculosis and another 34, or 11% had signs suggestive of chronic bronchitis. All the above cases were X-rayed by the Union Health Department's mobile X-ray unit (minature chest X-rays) when it visited Howick on 4th July 1957, as well as on subsequent visits to Howick.

For the purposes of this analysis those cases which were confirmed by X-ray on the first or subsequent visits of the Mobile Unit are treated as a part of the original medical examination.

Of the original T.B. suspects (38), 3 were found to be known cases undergoing treatment, another 2 were confirmed on X-ray at the first visit and a further 6 at subsequent X-ray examination, making a total of 11 confirmed P.T.B. cases out of the 38 suspects. In addition to these cases, 2 of the suspected bronchitis cases were found on X-ray to have active T.B. at the first X-ray, whilst another 3 of these cases were confirmed as tuberculotic at subsequent X-ray investigation. In addition, 3 new cases not on the suspect list, were found. We therefore, had to consider 19 cases confirmed by X-ray examination, i.e. 6.2% of the original sample group.

Table 47.

Analysis of T.B. and other Chest Conditions.				
	Group A.	Group B	Group C.	Total
T.B. positive on X-ray	1	5	13+	19
% of Group	o.99%	4.9%	12.4%	6.2%
Cases suggestive of TB clinically	4	4	14	22
% of group	3.96%	3.92%	13.3%	7.15%
Other Chest Conditions	10	17	8	35
% of group	9.9%	16.75%	7.6%	11.35%
Total chest conditions	15	26	35	76
% of group	14.85%	25.5%	33.3%	24.7%

+ The high figure for the slum areas is again demonstrated.

The Sample Group represented 22.9% of the Africans on strength at that time. The question naturally arises as to whether the incidence of T.B. and other chronic chest conditions as reflected in the above table is typical of the Factory as a whole. At this point, all we can say is that the sample chosen represented approximately a quarter of the African labour force.

Some further indication is provided in the records of chest conditions found in new employees, who since the 22nd September 1958 have all had a full medical examination identical to that of the sample group. These records show that of the 206 Africans examined up till the 11th November 1959, 34 had chest conditions, i.e. 16,8%. Chronic cough, due probably to chronic bronchitis, was a frequent finding in the examination of the Kung Bushmen, but tuberculosis appeared to be uncommon.[2]

ABDOMINAL CONDITIONS
NOTED AT EXAMINATION

Splenomegaly: Palpation revealed no abnormalities of the spleen. In the Kung Bushmen examination, 51,8% had splenomegaly, due to malaria.[2]

Hepatomegaly: Palpable enlargement of the liver was found in 5 cases.

Group A: 2 - One with 1" enlargement, and the other enlarged about ½".

Group B: 1 - Enlarged 1".

Group C: 2 - One enlarged 1" and the other enlarged ½".

Hernia: One man in Group A had 2 small direct inguinal hernias and another in the same group had umbilical hernia, diameter 2".

Since the total number examined was 308, it can be taken that these statements are all indicative of relatively minor matters from which no general conclusions can be drawn.

EXAMINATION OF THE CENTRAL NERVOUS SYSTEM

The results recorded were non-contributory to this survey. In a number of cases, absent reflexes were associated with old injuries and none of the other cases provided any significant data, suggestive of peripheral neuritis or other neurological involvement, although it was thought that these cases might be relatively common. As we had anticipated finding neurological evidence of malnutrition, the above findings were of interest.

McCance and Dean[5] found greatly increased reflexes in one-third of a group of German civilians applying for extra rations. Treatment with 25 mgm aneurin daily for 7 days resulted in no improvement. The literature surrounding starvation and malnutrition abounds with descriptions of characteristic lesions of the peripheral and central nervous system.

Many writers have mentioned such entities as peripheral neuritis, painful feet, captivity amblyopia, central scotomata, night blindness and others. A number of careful descriptions followed the 1939-45 war particularly in prisoners of war in the hands of the Japanese (referred to in Chapter 8), German prisoners of war in the Middle East, inmates of German concentration camps and the like. In many cases no neurological findings occurred at all, apart from unduly brisk reflexes.[5]

CARDIO VASCULAR SYSTEM

Blood Pressure: The blood pressure was measured on first medical examination by a Baumanometer. Deviations from normal were classified as follows:

Table 48

	Diastolic above 95mm Mild Hypertension.	Diastolic above 100mm Moderate Hypertension.	Systolic above 180 Diastolic above 110. Marked Hypertension.
Group A	3	3	-
Group B	2	1	1
Group C	1	3	1
Total	6	7	2

A total of 15 cases of hypertension, or 4.87% of the sample group, were found. No cases were associated with renal damage, as far as could be ascertained by routine urinary and microscopic examinations of centrifuged urines.

Heart Sounds: Heart sounds were grouped into those -

(i) With indications of heart disease, of whom there were 3, (one with a diastolic murmur in 4th L interspace - Steell's murmur)[6] - one with aortic valve disease with a to and fro murmur at 2nd R cartilage, and one with systolic murmurs at all orifices and moderate hypertension;

(ii) 5 men with apical systolic murmurs, which were considered to be functional. The three men with heart disease are under observation.

GENITO-URINARY SYSTEM

There was no suggestion of the polyuria, nocturia and lowered specific gravity mentioned often in severe undernutrition.[5] Urine tests did not reveal any gross renal disease. The tabulated results of these tests which follow show a small incidence of proteinuria which in the absence of other kidney damage was considered to be either orthostatic, or due to heavy muscular exercise.[7]

Threads were found in the urine in 14 cases. Six of these cases admitted previous gonorrhoeal infection. In one case where no history of venereal infection was admitted, there were large prostatic threads, associated with backache, pains in the legs, and painful urination. A "doubtful" Wassermann reaction was found. The number exhibiting proteinuria is small by comparison with the examination of the Kung Bushmen, where the figure was over 30%.[2]

Table 49.

(a) Urine Tests	Albuminuria.	Sugar +ve	Threads.	Total.
	"Boiling test" cases produced a light cloud only.	Benedicts Test. No case produced more than a light green colour.		
Group A	7	2	-	9
Group B	3	1	6	10
Group C	4	1	8	13
Total	14	4	14	32

(b) Venereal Disease: The frequency of venereal disease is recorded from -

(1) the admitted histories of veneral infection of which there were 64 cases;

(2) the results of the Wassermann reaction. In conditions other than syphilis, in which there occurs destruction of lipoid rich cells with the

> consequent setting free of dead lipo-protein material, a false positive may occur. In these conditions a lipo-proteolytic ferment is produced which, if in sufficient quantity, will give a positive Wassermann test. Conditions in which this may be seen are: leprosy, yaws, carcinomatosis, sarcomatosis, diabetes with acidosis and in malaria during a paroxysm.[8]

Actually 5 of those with admitted histories declined to have blood taken for the Wassenmann test, as did 39 others of the Sample Group, some refusing, and others having left before the tests were done. A total of 264 men had Wassermann tests done, of which 20 were Positive and 5 were Doubtful reactions.

Fifteen of these Positives and 4 Doubtfuls were from the group who had no admitted history of V.D., thus arbitrarily accepting the "Doubtfuls" as probable cases, and adding these 19 to the 64 admitted cases, the total number of cases of V.D. was 83, or 27%. The 25 Positive and Doubtful Wassermann reactions represent 9.5% of the Wassermanns done. In 1951, Lamont[9] working at SARMCOL, in a survey on Syphilis, found 15.58% positive Wassermann reactions out of a total of 199 blood specimens submitted. They were not volunteers, but were picked at random. The lower figure found in this survey is probably due to the improved cure rate achieved by Penicillin treatment. Forty-one of the admitted histories of V.D. were cases of gonorrhoea, 22 cases of syphilis, while 1 was unspecified. No significant difference was noted in the percentage of V.D. in the three residential groups.

Results of Wassermann Tests:

(1) 64 men with admitted histories of V.D.

Table 50.

	Positive	Negative	Doubtful	W.R. not done.	Total
Group A	1	20	1	1	23
Group B	1	18	0	2	21
Group C	3	15	0	2	20
Totals	5	53	1	5	64

(2) 244 men with NO admitted histories of V.D.

Table 51.

	Positive	Negative	Doubtful	W.R. not done.	Total
Group A	4	60	1	13	78
Group B	5	61	1	14	81
Group C	6	65	2	12	85
Totals	15	186	4	39	244
Totals 1 & 2	20	239	5	44	308
Percentage:					
+ve W.R's	+7.60%	90.50%	+1.90%		
Group A	5.70%	92.00%	2.30%		
Group B	7.00%	92.00%	1.00%		
Group C	9.90%	87.90%	2.20%		

+The total percentage of positive and doubtful Wassermann reactions was 9.5%.

17% positive blood Wassermann tests were found in the Kung Bushmen: a high rate of anti-complimentary results showed positive correlation with the height of the globulin in the blood, in the examination of the Bushmen.[2]

Since the 22nd September 1958, all Non-European new employees have had complete medical examinations, including Wassermann tests. From that date to the end of November 1959, 195 new African employees, 3 Coloured and 42 Indians had W.R.'s taken. During this period a new test was introduced at the Union Health Laboratory. This test, known as the V.D.R.L. Test, is said to be more sensitive than the Wassermann test. Since its introduction, most of the blood specimens taken have been sent for both Wassermann and V.D.R.L. Tests. However, the Wassermann and V.D.R.L. Test results are recorded here in respect of the new engagements to form a standard of comparison with the Sample Groups, but only the Wassermann results are comparable, owing to the fact that the V.D.R.L. Test was not available at the time that the Sample Groups were tested.

Wassermann Test Results for New Employees:

Twenty-six of the Africans had Positive V.D.R.L. reactions coupled with negative Wassermanns, 1 had a Doubtful W.R. coupled with a Positive V.D.R.L., 3 had Positive W.R.'s coupled with Positive V.D.R.L. reactions; 1 with a Positive W.R. was coupled with a negative V.D.R.L.; 150 of the 195 had V.D.R.L. tests coupled with Wassermanns. Of the other 45 who had only the Wassermann test, 2 were Positive and 3 were Doubtful reactions.

Thus the combined Positive and Doubtful W.R.'s excluding V.D.R.L. results totalled 11 out of 195 or 5.65%, compared with 9.5% of the W.R.'s taken from the Sample Group. The only reason that can be suggested for the difference in frequency is the age factor and length of time in the urban area, most of the Sample Groups having been selected from men with some years' service in the Factory.

Table 52.

Analysis of Residential Grouping of Sample Group Positive & Doubtful W.R.'s (including all 64 men with admitted histories of V.D.

Single men (Total strength 42 men.)

	A	B	C	Total
Living at home	0	3	1	4(15.40% of 26)
Living in lodgings	0	0	2	2(12.50% of 16)
Total single cases	0	3	3	6+
" " strength	3	18	21	42

Married men (Total strength 266 men)

	A	B	C	Total
Living at home	0	19	14	33(22.20% of 149)
Living in lodgings	28	5	11	44(37.50% of 117)
Total cases of V.D.	28	24	25	77+
Total married strength	98	84	84	266

+ 83 cases in all.

SKIN DISEASES NOTED

Skin diseases were neither common nor severe. At the outset however, the feet were not examined, and when attention was directed to this aspect subsequently, it was observed that unsatisfactory conditions were prevalent. Sweating feet with dermatophytosis was frequently seen. There were cases of plantar warts, a highly contagious condition, and flat and misshapen feet were common. It was noted that footwear in a great many cases was badly fitting and unhygenic. Socks are seldom worn and where available, generally of a thin non-absorbent type and full of holes. Many of the men use pieces of cloth or sacking wrappings, instead of socks. The question of foot health amongst the African workers here is receiving further study. The following skin conditions were noted.

The results of old skin affections in 12 cases, e.g.

Keloid scars	2
Impetigo	5
Smallpox	2
Warts	2
Vitiligo	1

Seven cases of active skin disease were seen, and included:

Acne vulgaris	2
Impetigo of legs	2
Dermatophytosis	1
Varicose ulcers	1 (on the legs)
Psoriasis	1

The distribution was approximately equal between the three residential groups.

In view of the unhygenic condition of much of the clothing worn, the housing conditions and lack of washing facilities, a much higher incidence of skin infections might reasonably have been expected.

MOUTH CONDITIONS

Although examination of the mouth was mainly directed to the presence or absence of malnutrition signs, it was observed that healthy mouths were seen less often than expected. Sixty-five cases of pyorrhoea and other oral sepsis were found on examination. Gross oral sepsis was very prevalent, including many cases of dental caries, and infected roots. This is in contrast to the earlier records of writers who refer to the magnificent teeth of the Bantu.[3] A great deal of the deterioration is due to lack of proper hygiene, the reasons for which call for explanation, as the Zulu was always most fastidious about mouth hygiene. This was an essential part of good manners.[3]

The condition of the mouth in many cases must have impaired adequate mastication, and the effect on appetite of gross oral sepsis is probably contributory to a condition of general malaise and fatigue. It would be interesting to make a survey of mouth conditions of a larger cross-section of Africans.

Western diets, particularly if rich in sugar, seem to be associated with dental caries.[10]

Table 53. Analysis of Pyorrhoea & Oral Sepsis

Residential Group	Under 30	30-39	40-49	50-59	Total
Group A % of group	6 17.60%	13 32.50%	3 17.60%	4 44.50%	26 25.70%
Group B % of group	6 15.80%	7 17.00%	4 33.30%	3 30.00%	20 19.60%
Group C % of group	4 13.30%	7 20.00%	7 28.00%	1 9.30%	19 18.10%
Total number of men affected:	16	27	14	8	65
% of total sample:	15.70%	23.30%	25.90%	26.60%	21.10%

Several factors which might affect the condition of the mouths of our men occur here, e.g. the water supplies, the neglect of simple oral hygiene, nutritional deficiencies and excess of over-refined food starches and sugars.[11] The fact that a higher percentage of mouth conditions occurred in those over 30 years of age, deserves further study.

Fluorine has an anticariogenic action resulting in 30-40% protective action against caries, although the action is only manifest in young people up to the age of 16-18 years.[12] No evidence was seen of the characteristic pitted enamel associated with chronic fluorine intoxication.

Although the mouth conditions dealt with above have not been attributed to malnutrition in general, one's clinical impression is that subscorbutic states are not uncommon, and that chronic protein malnutrition with associated B complex deficiencies is common.

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The actual method of examination has already been described. In addition to this, haemoglobin estimations were done in selected cases locally. Stool examinations in certain cases were recommended. The specimens were submitted to the Government Laboratory Durban. No particular significance was attached to these estimations as it is realised that variations in the same subject may occur. Variations in haemoglobin levels are common, as are fluctuations in the erythrocyte count.[13] In repeated samples taken during the day, a variation of 12% has been described.[13] Anaemia, where parasitic infestation is absent of slight, is usually mild in cases of proteinmutrition. Mention has been made of this and it is probable that the synthesis of red cell stroma and of haemoglobin must be one of the highest priority calls on available supplies of amino acids in the body.[14]

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The medical examination procedure has aimed at detecting signs of malnutrition by simple methods not involving laboratory procedures or special instruments for which we are not equipped, or control conditions which would be difficult to achieve in a factory environment. It was recognised however, that on the basis of medical examination only, it could not be stated with any degree of certainty whether disease in any individual case was a factor in causing malnutrition, or vice versa.

In the milder stages of chronic functional disturbance the only proof of malnutritional origin is the demonstration of better function after administration of the supposedly deficient nutrient, or of a better all round diet. Brock[4] suspects that this type of sub-clinical malnutrition is a common cause of impaired vitality and growth in the economically depressed strata of all society, and perhaps almost universally in under-privileged nations. This study supports that view. In its recognition, the largely subjective and more measurable criteria of posture, stance and physical, emotional, and intellectual reactivity must be used.

Food is a fundamental necessity of life and healthy food of healthy life. In the last resort, good nutrition is indistinguishable from good health. This relationship is two-way and a breakdown at either end leads to a vicious circle of ill-health and malnutrition. This vicious circle principle is valid in every system of the body.[14] It is where good nutrition is lacking that clinical stigmata of malnutrition may appear. Their appearance, although difficult or impossible to apportion accurately, is an indication for the need of adequate nutritional supplementation and general educational methods to improve eating habits.

EVIDENCE OF MALNUTRITION

The clinical signs listed below were found on routine examination, and reflect the opinion of the examiner. ("Clinical opinion is an entity not capable of mathematical definition. Clinical grading has the drawback too that it is too inexact to be perfectly defined or reproduced, but no better system is known.") (Dean)[15] It is freely admitted that other examiners might have differed in their interpretations, both of the lesions and their causation. The examinations however, were "blind" in that the examiner did not know to which group a man belonged when he appeared for medical examination. As far as possible too, the groups were evenly represented at the medical examination, this being arranged by the Non-European Welfare

Officer. Check examinations and the final medical examinations were conducted by the same examiner, and on the same "blind" basis.

<u>Suggestive Stigmata of Malnutrition</u>:

(a) Hyperkeratosis.
(b) Xeroderma (dry skin)
(c) Stomato-glossitis
(d) Pellagroid dermatosis
(e) "Pellagrous" glossitis and gingivitis.
(f) Spongy, unhealthy gums.

All the men were actually working at the factory. There were therefore no normal controls. The signs listed above were regarded as suggestive of malnutrition, although it is recognised that it is very difficult to find departures from the normal in early deficiency states.[5,14]

Two main changes in the interpretation of malnutritional stigmata have appeared in the last decade. (Brock)[14]

(1) The important role of external physical irritants such as heat, cold, wind, dust and salt spray has been given its due recognition which was previously lacking.

(2) There is less tendency to attribute specific patterns of structural change to deficiency of individual nutrients and more recognition of the mutual interplay of several nutrients. Both these trends are an expression of the growing recognition of the importance of multiple aetiology in disease.[14]

It is clear therefore, that deficiency of a single nutrient (with the occasional exception of vitamin C) seldom occurs in man. It would therefore be surprising if structural changes in the mucous membranes and skin specific for riboflavin and niacin were to occur in nature when deficiency of these two vitamins almost always results from a diet deficient not only in the whole of the vitamin B complex, but deficient also in protein. (Brock)[14]

(a) Hyperkeratosis: also known as phrynoderma, toad skin, shark skin, giraffe skin and fish skin.[16] This was regarded as being an associated entity with follicular keratosis. The latter is normally discussed under two separate headings, i.e.

(i) "Permanent Goose-flesh" where the raised follicles are predominantly sebaceous; and

(ii) A prominent papular appearance of the pilo sebaceous follicles with a true keratin plug.

In hyperkeratosis, the skin is roughened and dry, with tiny spinous prominences which may be seen or felt. It is often associated with hyperpigmentation. It was best seen over the buttocks, but also over the thighs, calves and bony prominences, e.g. the elbows. It has been associated with:

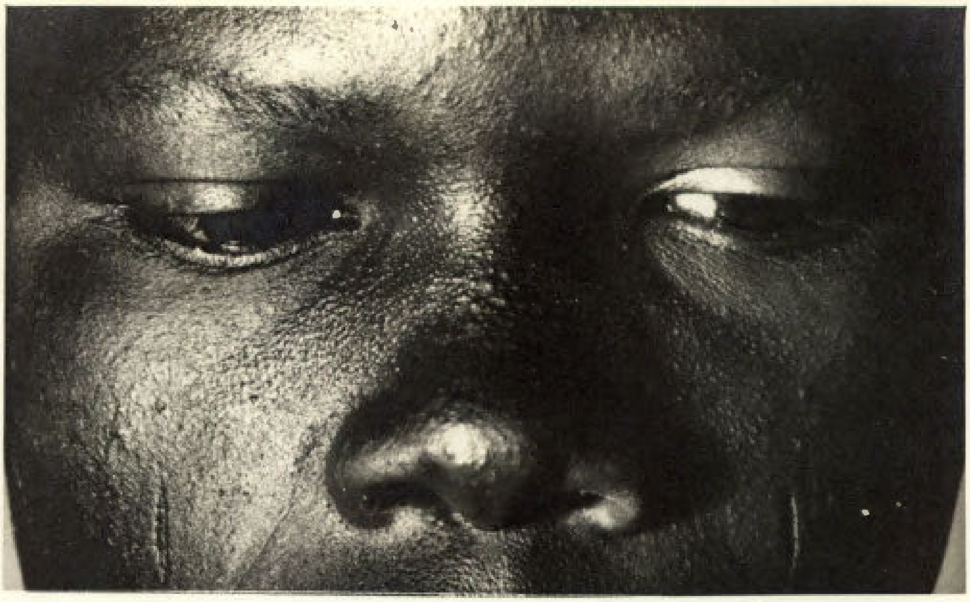
(i) Deficiencies of vitamin A, vitamin C and riboflavin.[5,16,17,18.]

(ii) Deficiency of one or more amino acids, e.g. methionine and cystine.[19]

(iii) Deficiency of fatty acids.[5,16,19.]

(iv) In persons suffering from true starvation.[5,19.]

(v) Non-nutritional causes (external physical irritants) e.g. exposure to light and heat, local pressure, repeated minor traumata, dirt and exposure to salt spray.[5,14,19.]



Prominent papular appearance of the skin.

This case resembles "permanent goose flesh".

Hyperkeratosis was found in 49 cases:

In 10 cases :	hyperkeratosis occurred as an isolated feature.
" 8 " :	hyperkeratosis occurred with suggestive signs of pellagra (raw beef tongue) and pellagroid dermatosis.(4)
" 31 " :	hyperkeratosis was associated with angular stomatitis,(4) cheilosis (14) and with spongy gums and cheilosis.(13)

Minor degrees of hyperkeratosis seem very prevalent in Africans. Vitamin A is a fat soluble vitamin, and it is known that absorption is defective in diets low in fat. The dietary survey suggested that most of the men are deficient in vitamin A. In direct contrast, the consumption of large amounts of palm oil by the inhabitants of the West Coast of Africa, ensures an adequate intake of vitamin A.

<u>Xeroderma</u>: In this condition, the skin is dry and feels like tissue paper. The skin forms fine creases and does not instantly return to its former state when pinched between the fingers. It appears to lack elasticity. Smith and Woodruff[19] and other workers suggest that many cases are due to vitamin A deficiency.[5,18,19] All our cases seen exhibited dry cracked lips; and were associated with other stigmata of malnutrition. Apart from vitamin A deficiency states, xeroderma has been associated with:

(i) Nicotinic acid deficiency.[19]

(ii) Pyridoxin deficiency.[19]

(iii) Biotin deficiency,[19] where in addition a fine scaly desquamation is described.

(iv) "Crazy pavement skin" is probably a variant of xeroderma.[5,14].

Crazy pavement dermatosis (mozaic) is a non-specific result of malnutrition. External trauma and stresses such as sun and wind, play a part in the etiology. Soap and flannel on skins unused to such refinements often play a big part in its cure.[14]

<u>Stomato-Glossitis</u>: This term is used to cover angular stomatitis, cheilosis, glossitis and pharyngitis. Smith and Woodruff associate the signs with ariboflavinosis.[19] It is probable however, that the clinical results of riboflavin deficiency are relatively trivial because of the little destruction of the vitamin in the body plus the additional source derived from biosynthesis by bacteria in the large intestine.[14]

Deficiency of the vitamin in animals results in a failure to grow and in rats a deficiency affects the skin and eyes. There is no specific sign of riboflavin deficiency in man.[14]

Classically, stomato-glossitis is linked with genital (scrotal or vulval) dermatitis. In this condition "the oro-genital syndrome" an erythema of the scrotum was described by Smith and Woodruff not involving the median raphe which, if untreated, spread extensively and became secondarily infected.[19] Weeping was common and was associated with painful cracks in the skin of the scrotum which lost its normal rugae. One case which could be labelled as the "oro-genital syndrome" appeared in the cases at SARMCOL.

Angular Stomatitis: The lesions varied from small red areas at the angle of the mouth to cases where painful fissures radiated outward to the cheek. There were 33 cases in all.

Cheilosis: The lips were invariably a little swollen, reddened and ulcerated. The ulceration seemed to commence in the centre of the lip, and spread laterally and inwards. Patches of sodden white epithelium on the lips and cheeks were frequently found. There were 65 cases in all.

Glossitis: Only one case of fully developed "Magenta tongue" was seen. The tongue in this case was swollen, glazed, painful and magenta in colour. Other cases varied from redness at the tip of the tongue to loss of the normal fur in a geographical manner, associated with a glazed, pale red tongue.

Pharyngitis: The palate and pharynx in most of the cases under discussion showed evidence of general congestion. Follicular seborrhoea on the naso-labial folds and chin was observed in several cases, but appeared to be of a minor degree. Lesions of the muco-cutaneous junctions e.g. balanitis, inflammation of the urethral meatus, anal fissures and lesions at the outer canthus of the eye described under ariboflavinosis, were not observed.

Eye Changes: Circumcorneal injection was observed in several cases, but no cases of corneal vascularisation were seen. It is difficult, where men are working in a factory, under varying conditions of heat and cold, to decide whether mild signs of photophobia and visual fatigue are to be regarded as indicating a specific deficiency, and these signs were therefore not included in the section on malnutrition.

<u>Angular Stomatitis</u>: In all, 33 cases presented with angular stomatitis; in 6, it was an isolated feature. In 17 cases, the stomatitis was associated with spongy gums. In 6 other men, hyperkeratosis of varying degrees, plus spongy gums occurred. In 4 cases there was an association between angular stomatitis and hyperkeratosis of the thighs and arms.

<u>Table 54.</u> <u>Angular Stomatitis.</u>

No. of Associated Lesions.	Nature of Lesions	Number of cases.
None	Angular stomatitis	6
One	Angular stomatitis, plus spongy gums	17
One	Angular stomatitis & hyperkeratosis	4
Two	Angular stomatitis, plus hyperkeratosis and spongy gums	6
	Total	33

The spongy gums in these cases were felt to be merely a part of the picture and exhibited no characteristic gingival pathology. The gums appeared larger and pinker than normal, did not bleed and were not ulcerated.

<u>Cheilosis</u>: Sixty-five cases of cheilosis were seen. In 6 cases it was an isolated feature. In 14 cases it occurred in association with hyperkeratosis of varying degrees. In 13 cases, cheilosis was associated with hyperkeratosis and gingivitis - (spongy gums). In 30 cases it was associated with "Spongy gums"; in one case it was associated with xeroderma and in one other

case was associated with "raw beef tongue".

Table 55. Cheilosis

No. of Associated Lesions.	Nature of Lesions	Number of cases.
None	Cheilosis	6
One	Cheilosis & hyperkeratosis	14
One	Cheilosis & "spongy gums"	30
One	Cheilosis and Xeroderma	1
Two	Cheilosis, hyperkeratosis & gingivitis (spongy gums)	13
One	Cheilosis & "raw beef tongue"	1
	Total	65

Pellagroid Dermatosis:

The difficulty of classifying deficiency lesions is well known, and pure pellagra due to nicotinic acid deficiency probably does not occur. It is now more acceptable to think in terms of certain complexes, of symptoms and signs, due to deficiency of the B vitamins which occur in association with protein deficiency.[14] The cases here described were typical of the light-sensitive dermatosis associated with pellagra and occurred on the dorsa of the hands, forearms and the front and back of the neck. The rash was symmetrical and affected the exposed portions of the body. Increased pigmentation was apparent at the edges of the rash, but on the forearms there was a rawness and sensitiveness of the skin, but no fissuring.

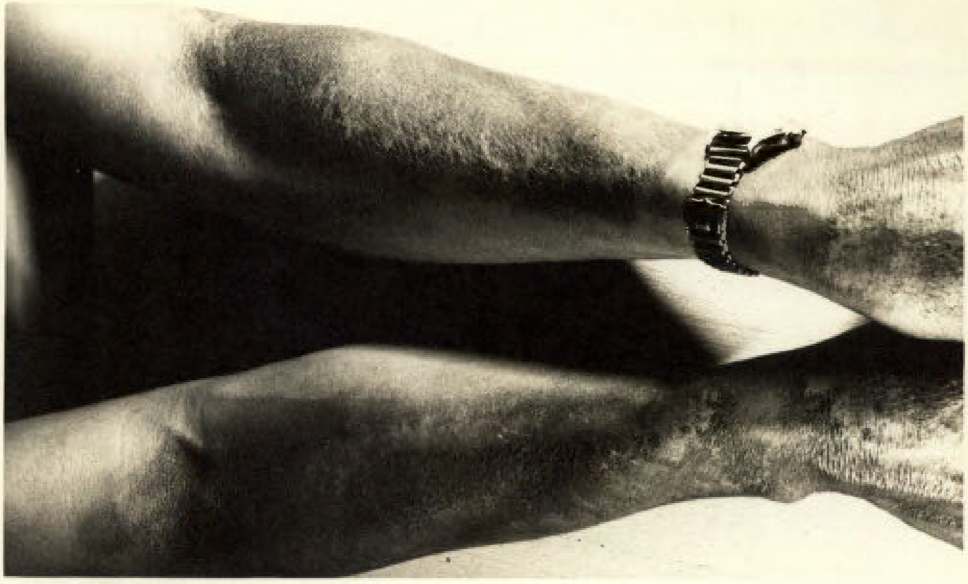
Only two cases of pellagroid dermatosis occurring as an isolated feature were reported. In six other cases, the rash was associated with buccal ulceration. It would therefore, seem that these cases were due to several deficiencies of the B vitamins. The classical description of the "three D's, dermatitis, diarrhoea and dementia" was not observed.

__Pellagrous Glossitis & Gingivitis:__

A degree of difficulty of classification occurred here, and these cases are only described under this heading because the glossitis was typified by a smooth shiny and scarlet tongue; the so-called "raw beef" tongue. When the men received their ration of skimmed milk, many complained of dyspepsia, abdominal pains and burning of the mouth.

How many of these cases could be attributed to the atrophic gastritis, achlorhydria, and stomatitis of pellagra, it is impossible to say, but it was clearly observed that if the men persevered with the ration and the tablet, the symptoms subsided in the great majority within a short period.

Superficial ulcers affecting the palate, buccal mucosa and pharynx were seen in 8 cases. In two cases, the ulcers were single; in the remainder, two or more were observed. They were shallow, small, usually infected and painful. Six cases of "raw beef tongue" were recorded, but in no case was it an isolated finding. In two cases, hyperkeratosis of the thighs and buttocks was associated. In two cases, spongy gums occurred with the glossitis. One case occurred with cheilosis, and one case with the oro-genital syndrome.



Pellagrous dermatitis affecting the dorsa of the hands and the forearms.

Pellagrous dermatitis in an old man.

It is virtually certain that more than one deficiency was present, but the pellagrous signs appeared to dominate the clinical picture. Clinically, one was unable to demonstrate the association between achlorhydria and thiamine deficiencies mentioned by Gelfand.[17]

Table 56. Pellagrous Stigmata

No. of Associated Lesions.	Nature of Lesions	Number of cases
None	Pellagroid dermatosis	2
One	Pellagroid dermatosis and buccal ulceration	2
Two	Pellagroid dermatosis, buccal ulceration and hyperkeratosis	4
One	Raw beef tongue with hyperkeratosis	2
One	Raw beef tongue and spongy gums	2
One	Raw beef tongue & cheilosis	1
Two	Raw beef tongue, stomatitis & scrotal dermatosis (Oro-genital syndrome)	1
	Total	14

Several cases of pellagroid dermatosis have been seen lately in Coloured females. The photographs of one case are attached. An interesting feature in these cases seems to be that whilst the patients claim that their diets are adequate and that they eat meat, green vegetables and maize, the light sensitive rash predominates in the clinical picture, and that they are all addicted to alcohol in various forms, usually the crude preparations brewed illicitly.

Pellagrous dermatitis in a Coloured female.

Butterfly rash affecting cheeks, eyebrows and temples.

Typical rash affecting the forearms.

<u>Spongy, unhealthy gums:</u>

This heading was used to cover many cases of uncertain gingival pathology. It is probable that many were subscorbutic states. Fully developed scurvy, with dusky swollen gums, and enlarged bleeding inter-dental papillae was not seen.

General malaise, tiredness and aching muscles are frequent complaints seen in one's private practice and in industrial work. That some of these cases are indications of latent scurvy is probable. Haemorrhage into muscles (in our experience usually involving the forearms) is not uncommon. Latent scurvy may be suspected by the fact that in the Test Group 55.00% took less than the recommended minimum of foods rich in ascorbic acid. (Group 3, foods in chapter on "Diet"). Sclerotic changes in the skin and subcutaneous tissues, resembling scleroderma have been described in cases of chronic scurvy. They develop after the haemorrhage into the muscle or dermis.[20] Spongy gums were found to occur in association with other deficiency states, and are not discussed here. In 50 cases, however, this entity occurred as an isolated phenomenon, and these cases have not been included in the number showing stigmata of malnutrition.

8 in Group A)
15 in Group B)   50
27 in Group C)

It has become apparent that many factors affect the appearance and function of the mucous membranes, particularly of the mouth. Many men are known to smoke coarse tobacco rolled in newspaper. Many too, drink rough evil alcoholic concoctions which must further devitalise tissues already suffering from an inadequate diet. In a separate study of certificates of sickness submitted to the General Manager of SARMCOL in 1959, "Gastritis" featured so prominently as the reason for absence from work, that examination of the men concerned seemed an urgent necessity. It was seen that of a total number of 146 cases of "Gastritis", 93.2% exhibited signs of pyorrhoea, and other oral sepsis. The association of atrophic gastritis, achlorhydria and vitamin deficiency states probably arises here.

Questioning leads one to the conclusion that relatively few of the African workers make any attempt at brushing their teeth. This seems to be one of the evidences of the transitional phase between the life in the Reserves and life in a settled, urbanised community. The figures above would seem to support this theory. More than 50% of the cases occur in Group C, and the lowest figure is seen in the group who are essentially rural, and therefore probably still follow the old methods of maintaining reasonable oral hygiene. (Group A).

The gums in the 50 cases under discussion exhibited essentially a picture of non-specific, hypertrophic gingivitis. The gums seemed larger than normal, were not ulcerated and in all but one case did not bleed easily. The colour varied from pale pink tobright red, but in no case was the purple scorbutic colour in evidence. In the main, infection was not a feature, but in a few cases a minor degree of pyorrhoea seemed established. Oral hygiene was definitely defective. The teeth were usually stained, and in most cases dental caries was present - often of a very marked degree.

Gorvy[21] described a condition which he ascribed to protein deficiency, where the interdental papillae were engorged, scarlet in colour, ulcerated, and fetor oris was intense.

An examination of the social and general condition of the above group revealed the following information:

6.7% were above normal weight.
93.3% were below normal weight (From 75% to 99% of normal weight).
40% had incomes above the Poverty Datum Line.
60% had incomes below the Poverty Datum Line.

Of those above the Poverty Datum Line, the variation was from 102% to 290% above the Poverty Datum Line. The percentage spent on food in this group varied from 51% to 139% of the Poverty Line minimum. Of those below the Poverty Datum Line, the variation was from 49% to 99% of the Poverty Line figure. The percentage spent on food varied from 37% to 257% of the Poverty Line standard. The high figure of 257% applied to a single man with no dependants.

The percentage below normal weight is again striking. The percentage of income spent on food is also disturbing Only 16.6% spent above the Poverty Line minimum on food.

The settled urbanised group, Group B, showed that 60% of the men here discussed had incomes above the Poverty Line. Only 25% of Group C were in that position, and 50% of Group A.

Insofar as a dietary survey conducted under the conditions which applied here may be of suggestive significance, it was further observed that the majority of the cases showed a deficiency of vitamin A, and 60% a deficiency of vitamin C in their diets. The diet analysis showed no deficiency of thiamine but niacin is probably also deficient as the staple foodstuff in general was maize.

It is felt that these entities of gingival pathology represent in many cases the results of a defective diet, and a poor socio-economic background. It is probable that many cases represent evidence of reversible dietary deficiencies.

<u>Chachaleh (Burning Feet)</u> (Gelfand)[17]

This condition was not recognised at the original examination. Interest in the subject of dietary deficiencies in Africans has brought the realisation that in minor degrees the condition is not unknown in local Africans. Checking men with certificates of sickness reflecting "Neuritis" as a cause for absence from work, one has been struck by the fact that a detailed history will sometimes reveal that the burning pains in legs, feet, back and joints are suggestive of the conditions described by Gopalan in 1946, and which he thought was due to deficiency of calciumpantothenate.[19] Anaesthesia of the stocking variety has been seen in one case, diminished reflexes have been seen in one case, and increased reflexes in 2 cases. The calf muscles were not tender, nor was the Tendo Achilles, and the positional sense of the big toe was normal. These findings are the reverse of what one would expect in thiamine deficiency states. No other deficiency signs were observed in the above four cases.

Treatment by Tab. Vitamin B. Co. containing:

Aneurin hyd	2 mg.
Riboflavin	1.5 mg.
Pyridoxin hyd	0.2 mg.
Nicotinamide	20 mg.
Calcium Pantothenate	2 mg. : 1 tablet t.i.d. has

proved of benefit where combined with dietary advice, but response is slow. Pantothenic acid alone has been shown to be disappointing in the treatment of the condition.[14]

DISCUSSION

54% of the men are between 10% and 20% below normal weight. This, coupled with the results of the dietary survey, leads one to feel that there may be a deficiency of protein foodstuffs (or this may have applied in their childhood), and also a relative deficiency of vitamins A, B Complex and C. Our investigation also suggests that there may be a deficient intake of calcium. This seems to corroborate the suggestions made in the C.S.I.R. report (No. 180, March 1961) that the overall supplies of calcium, riboflavin and possibly vitamin A for consumption by the total population in the Union are low in comparison with commonly recommended levels of intake.[22]

Vitamin A.

The provitamins are a group of carotene and carotenoid pigments occurring as yellow and orange pigments in fruit and vegetables.[14] Conversion of provitamins to vitamin A takes place in mammals in the intestine and the liver. The latter in well-fed humans stores reserves sufficient for 6-9 months[14], or possibly a little longer.[23]

In children, liver stores of vitamin A may be expected to last a shorter time than in adults, because the vitamin is required for growth. In infants, depletion may occur in 2 or 3 months.[23]

The eye remains the most sensitive indicator of human deficiency of vitamin A, but its specificity and degree of sensitiveness is still a problem.[14] Deprivation of the vitamin was associated with the following findings, in order of occurrence.[24]

(a) Rapid drop in the carotenoid content of the blood (from 150 to 12 to 40 I.U.) This occurred within the first 8 months.

(b) Plasma value for vitamin A fell slowly after 8 months of deprivation.

(c) The capacity for dark adaptation deteriorated slowly. This was measured by the rod threshold. Late effects were an increase in the time of transition from cone to rod vision. Hyperkeratosis was present at the start in certain of the volunteers, and varied during the experiment, but the variations bore no relation to the vitamin A intake. No characteristic conjunctival changes (opacity, wrinkling, thickening, xerosis, or Bitot's spots) were observed.[24] Night blindness (clinical) was not specifically admitted in any of the cases at SARMCOL, and this same observation was made by Hume & Krebs.[24]

In addition to night blindness, xeropthalmia and keratomalacia occur in vitamin A deficiency states, and these conditions may occur simultaneously.[14]

McClaren[25] feels that vitamin A deficiency has been, and probably still is, the most important nutritional disorder affecting the eyes, and that blindness often follows such a deficiency.

In malnourished communities, 4 features of this deficiency are important.[25]

(i) Highest incidence occurs in childhood - from end of the first year to about 3rd or 4th year of life.

(ii) In this group the most devastating effects, namely xeropthalmia and keratomalacia occur most frequently. Bitot's spots, which are triangular specks under the conjunctiva at the corners of the eye, may precede xeropthalmia.

(iii) Males are more susceptible to the deficiency than females.

(iv) Ocular hypovitaminosis A is one of the most frequent concomitants of protein malnutrition, or kwashiorkor.[25] This association with protein malnutrition is vitally significant.

In 1942, Brock[26] drew attention to the fact that isolated vitamin deficiencies probably never occur naturally in humans. It was also mentioned that vitamins A and C have an effect on the health of the skin, and that where synthetic vitamins are used they should be an addition to, and never a full substitute for the administration by mouth of naturally occurring vitamins.[26]

The possible relationship between vitamin A deficiency and skin changes has been briefly referred to in Chapter 3, and in the section on hyperkeratosis.

The human experiments conducted by Hume and Krebs[24] enabled the following conclusions to be drawn. (Brock)[14]

(1) That it is very difficult to produce vitamin A deficiency in a well-fed European adult.
(2) The sensivity of the eye to light can fall to about 1% of the normal without the subject being seriously nightblind.
(3) Cure is achieved by relatively small doses of vitamin A.

Night blindness is related to vitamin A deficiency. This may occur because many tissues including the rods of the retina contain structural proteins which are stabilised by combination with vitamin A or its derivative, and that these also deteriorate in the deficiency state. (Dowling & Wald). It is further suggested that vitamin A acid (which does not naturally occur in the body) is able to function as vitamin A for the extravisual functions of the vitamin, and that it can promote growth in vitamin A deficient rats, but does not cure their defective dark adaptation.[14]

The exact mode of action of vitamin A in the rest of the body is not certain. Changes however, take place in the epithelial cells of many tissues, and it is possible that there is some interference with the formation of mucopolysaccharides. There is also experimental evidence that the production of gluco-corticoid by the adrenal cortex in vitamin A deficient rats may be deficient.[14] Metaplasia of the respiratory epithelium in experimental animals occurs early. In the urinary tract in dogs, changes leading on to calculi are known.

Congenital defects:

Irregular development of the skull and vertebrae have been described, and nervous diseases were produced by Mellanby in animals where the diets were deficient in vitamin A. No changes in bone structure have been attributed to vitamin A deficiency in man.[14] Vitamin A is related to the development of the teeth; the ameloblasts which form the enamel are epithelial cells and experimental deficiency causes defective enamel formation in puppies. This has not been shown to be a factor in man.[14]

Experimental results of vitamin A deficiency:[23]

Experimentally, deficiency has led to vaginal and testicular changes. Reduced hatchability has occurred in birds. Reproductive ability fell in sows on a deficient intake, and in addition a high rate of still-borns occurred. In the young, poor growth of hair was reported. A teratogenic effect has been described recently in piglets giving eye anomalies, e.g. micropthalmia and anopthalmia. Other defects recorded were hare lip, cleft palate, horse shoe kidney and ear abnormalities.[27] Similar abnormalities were recorded in rats and in addition undescended testes, the development of a male intersex, hypospadias and abnormalities of the heart and blood vessels.[27]

In man, mongolism has been linked with deficiency of the vitamin, and also abnormality of vitamin A mentioned in diabetic mothers.[27] A recent report from a Mediterranean area suggests the possibility of a role in the production of goitre.[14]

Vitamin A in animal feeding:

From the point of view of human and animal nutrition Beta-carotene is by far the most important carotenoid. Its concentration in most common foods usually exceeds that of the other pro-vitamins, but due to its two beta-ionone rings, its vitamin A activity is at least twice as great as that of other provitamins in which non-vitamin A producing ring structures replace one of these beta ionone rings.[28]

Cryptoxanthin, another provitamin, occurs in relatively large amounts in yellow maize, and is important in animal feeding.

The contribution of milk and milk products to human vitamin A requirements is quite considerable. The actual contribution depends of course on local consumption and vitamin potency of the fat. Figures of 20% in Britain to 50% in New Zealand are given.[28] From eggs, about 10% of the vitamin A may be derived. Milk and eggs, produced under the best farming conditions each contain about the same vitamin A potency in their fat: - 50-60 I.U. per gramme.[28]

The contribution of animal foodstuffs in a privileged community is indicated by the above figures, and compares most vividly with the conventional dietary pattern of the underprivileged. Other workers have suggested that the addition of fats to a poor dietary may contribute to the relief of vitamin A deficiency, because it was shown that absorption of carotene was enhanced by the addition of 18g of olive oil per day.[14]

Serum levels - vitamin A.[23]

20-50 mcg is acceptable in adults.
10-19 is low.

Below 10 indicates a deficiency. The level at which vitamin A limits human growth is unknown.[23]

Therapeutic uses:

Vitamin A is absorbed more efficiently than carotene and is therefore preferable. In the absence of any defect of fat absorption it can be given by mouth.[14] For defective dark adaptation 1250 I.U. of vitamin A usually proved sufficient in depleted but otherwise healthy men. Ill patients may require high doses. Vitamin A is also used curatively for the other ocular results of its deficiency, and in a variety of skin conditions with very variable results.[14]

The National Research Council recommended 5,000 I.U. of vitamin A per day as the normal requirement. Requirements may be less if all are provided by vitamin A. The following ratio is suggested: 2,500 I.U. vitamin A, or 7,500 I.U. as carotene.[24]

It is recognised that one cannot assign every skin change to a specific deficiency because the evidence is invariably conflicting and uncertain, and also because skin cells have only a limited number of ways of expressing impaired function so that two or more different deficiencies may give rise to the same clinical picture.[19]

On studying the diet sheets for the men in our Test Group, one was struck by the high percentage who are possibly deficient in vitamin A, and whilst recognising the difficulty of apportioning clinical signs to this deficiency, it is felt that attempts at correcting the diet as a whole must have significant beneficial effects.

Chronic skin sepsis and vitamin A deficiency have been associated by several writers, including Smith and Woodruff.[19] Certainly skin infections are a problem in industrial workers, and whilst realising that factors such as minor traumata, minor burns and lack of washing facilities at home do all play their part, it is felt that vitamin A deficiency may also be partly responsible.

<u>Fat absorption</u>: The vitamin A tolerance test has been used as an index of fat absorption and is of use in the detection of steatorrhoea. It has also been used in studies of essential hyperlipaemia where higher levels were found than in controls. It is possible that there is a group of different metabolic disorders which have in common disturbance of lipid metabolism and coronary artery disease, and the vitamin A tolerance test may be a means of identifying those subjects who have a

disturbance of the preliminary stages of lipid metabolism. No correlation has been found with the serum cholesterol.[14]

The INCAP group has used vitamin A also for the study of fat absorption in kwashiorkor. They found that there was defective vitamin A absorption in kwashiorkor, and that this defect could be corrected by therapeutic amounts of acidified half-skimmed milk. This effect was demonstrable as early as the fifth day of treatment, and in some as early as the third day. The reason for the malabsorption of vitamin A in kwashiorkor is not clear, but may be related to defective secretion of pancreatic lipase. Poor absorption of vitamin E also occurs in kwashiorkor.[14]

The effects of excess intake of the vitamin are outside the scope of this study.

Vitamin B Complex.

The complex is readily absorbed, promptly utilised, poorly stored and rapidly excreted. Replenishment is necessary at frequent intervals.

(i) Vitamin B_1 (Aneurine; thiamine).

This vitamin is very important in the nervous and cardio vascular systems. Thiamine, as cocarboxylase takes part in the oxidation of alpha-keto acids, and when it is deficient, pyruvate accumulates, as does pyruvic aldehyde which is more toxic.[14] The requirement of thiamine is dependant on the carbohydrate content of the diet - an increase in the latter without proportional increase in the thiamine may precipitate a deficiency state.[23] Diets therefore, relatively high in carbohydrate but deficient in thiamine will increase the accumulation of pyruvate and pyruvic aldehyde and this is particularly important in cells such as nerve cells which have a predominantly carbohydrate metabolism as well as in cardiac muscle cells which use pyruvate for metabolism. Thiamine is also required for the synthesis of acetylcholine and this may result in imperfect function of nerves. In man, acute deficiency of thiamine results in vascular dilatation and minute haemorrhage characteristic of Wernicke's encephalopathy, or if the heart bears the brunt, acute cardiac beri-beri results. Both respond dramatically to therapy with thiamine.[14]

A diet which produces beri-beri also tends to produce deficiency of protein, riboflavin and nicotinic acid.[14]

Requirements:

Plasma levels of thiamine are low - 0.5-10 mcg/100 ml. Red blood cells contain 6-9 mcg/100 ml, but they do not seem to lose their thiamine even under severe deprivation.[23] Smith and Woodruff[19] felt that .4 mg thiamine per 1000 calories was the critical level before deficiency signs appeared. The Department of Nutrition in their minimum diet, recommend 1.8 mgm thiamine per day.[29] Sebrell recommends 1.0 to 1.6 mgm per day.[30]

There seems to be reasonable agreement on the figure required for thiamine intake per day. If we accept the Department of Nutrition's figure of .34 mgm thiamine per 1 lb. loaf of white bread, and .57 mgm per 8 oz. of unsifted granulated maize, we realise that theoretically the average daily diet of the men examined in this series contains adequate quantities of vitamin B_1.

Thiamine is synthesised by ruminants, and man due to the presence of specific intestinal flora. It follows that any disease e.g. inflammations of the bowel, by destroying the normal intestinal flora, will interfere with the absorption of the vitamin.

As in other deficiency states, a primary deficiency may occur if there is insufficient thiamine in the diet, and a secondary or conditioned deficiency may be expected, where intestinal diseases result in poor absorption of the vitamin and interference with its storage and utilisation.[14,17]

The blood thiamine content is not a practical procedure for establishing the diagnosis of thiamine deficiency. Urine thiamine content falls as soon as dietary intake of thiamine declines and so is of no value.[14] Arroyave[23] suggests that the 24-hour output, 1 hour excretion on fasting, and the random urine specimen for thiamine content per gram of creatinine, may prove helpful.

Blood lactic and pyruvic acid levels rise in B_1 deficiency, and are the most reliable biochemical guides and are brought out by doing the estimation after exercise and oral glucose. This biochemical abnormality must be reversed by therapeutic thiamine to make the diagnosis more certain.[14]

Thiamine requirements increase in pregnancy but it appears unlikely that deficiency produces malformation in humans.[27]

Thiamine and the heart.

Full discussion of the clinical syndromes, cardiac and neurological, is beyond the scope of this study. Deficiency of thiamine in the diet leads, after reserves of thiamine have been used up, to alteration in the electro-cardiograph and functional efficiency of the heart. If the deficiency is severe or prolonged cardio-circulatory failure supervenes. The classical picture of wet beri-beri is however, a late and complicated picture because in endemic areas (rice-eating populations) there is usually also deficiency of protein (amino-acids) and often of other nutrients.[14]

In true thiamine deficiency, a clinical and electrocardiographic picture which is characteristic occurs, particularly in the sequence of events following administration of thiamine. A sequence of changes in the S.T. segment which gives the superficial impression that the electro-cardiographic picture is becoming worse while the patient is obviously improving, has been found.[14]

Many chronic alcoholics suffer from the effects of thiamine deficiency. It is not suggested that thiamine deficiency alone is responsible for all their symptoms but the role of thiamine is established inferentially from the effects of therapy with thiamine.[14]

It is doubtful whether cases of pure thiamine deficiency occur in South Africa as they do in the Far East where white rice is used as a staple source of calories. The important causative role of thiamine deficiency in disturbance of myocardial metabolism and cardiac function is however not in question.[14]

Deficiency of other nutrients such as oxygen and glucose and even electrolyte imbalance may produce through a final common path, disturbances of myocardial metabolism which are not separable in their clinical and electrocardiographic effects. The same lack of specificity probably applies to the detailed description of T wave changes in alcoholic cardiopathy.[14]

Thiamine therapy:

Parental administration is rarely necessary in treatment. 10 mg by mouth is usually adequate, and this dose may be given 3 times daily in depleted subjects. The body content of thiamine in health is 25 mgm and if more than this is given it is merely lost in the urine. Large doses intramuscularly or intravenously are unnecessary and potentially dangerous, as anaphylactoid shock, although rare, is a reality.[14]

The most dramatic results are achieved in wet beri-beri, Wernicke's encephalopathy and infantile beri-beri. Dry beri-beri (polyneuritis) requires a long duration of treatment and may never be complete if there is long-standing paralysis.[14]

Synthesis of vitamin B complex:

Experimentally, spontaneous recovery in rats has been observed where the diet was defective in the vitamin B complex. This phenomenon, known as refection, has not yet been completely explained. It remains an open question whether it is due to intestinal absorption of vitamins synthesized by the bacteria, or to coprohagy.[14] In studies on adult subjects kept on a restricted diet for fifteen weeks, without the use of sulphonamides or antibiotics, faecal excretion of all vitamins studied, except niacin and pyridoxine, exceeded intake. The combined urinary and faecal excretion of all vitamins studied, except pyridoxin, approximated to or greatly exceeded intake on the restricted diet. It seems therefore, that many vitamins may be synthesized in the intestinal canal of man by microbial action or excreted into it through the intestinal wall.[31]

(ii) Nicotinic acid:

The practical importance of the utilization of tryptophan as a precursor of nicotinic acid is now accepted. The estimation that 60 mg of tryptophan is the dietary equivalent of 1 mg of nicotinic acid is important in that some protein which is virtually devoid of niacin can supply all the niacin equivalents necessary for optimum health.[14]

The requirements for niacin (or niacin equivalent - a term suggested by the National Research Council in 1958) are dependent upon total caloric intake either as a function of metabolism plus work, or of body size.

The requirements for niacin or tryptophan are related to calorie consumption therefore, as are the requirements for thiamine. Thiamine, pyridoxin and riboflavin are all necessary for the conversion of tryptophan to niacin.[14]

Nicotinic acid is rapidly converted in the body to its amide, nicotinamide. This in turn is an important constituent of coenzyme 2 (triphosphopyridine nucleotide T.P.N.) in human red blood cells and also occurs in coenzyme 1 (diphosphopyridine nucleotide D.P.N) found in heart muscle. The biological function of coenzymes 1 and 2 is either to donate or accept hydrogen ions in vital oxidation - reduction reactions. The conversion of lactic acid to pyruvic acid is typical of such a reaction; some require D.P.N. others T.P.N.[14]

Deficiency states:

Smith and Woodruff[19] mention an antagonism between maize and nicotinic acid, and that in maize diets far more dietary nicotinic acid is required to prevent pellagra than in any other cereal diet. The tendency to ascribe pellagra solely to a deficiency of nicotinic acid is no longer tenable. Maize, tryptophan and niacin probably all play a part in the aetiology of pellagra. It seems possible that maize contains a chemical analogue of nicotinamide which competes with it in metabolism.[14] It may also be that the nicotinic acid is bound so as to make it unavailable, coupled with the fact that maize is deficient in tryptophan and an amino imbalance results.[22]

After surgical trauma, pregnancy, lactation, thyrotoxicosis and rapid periods of growth the need for niacin is increased.[14]

Malignant carcinoid tumours may divert 60% of the body's tryptophan in order to form large amounts of 5 hydroxytryptamine.[14] Isoniazid used in the treatment of tuberculosis may induce a deficiency of nicotinic acid. Large doses of I.N.H. have been known to cause peripheral neuritis, convulsions, optic atrophy and psychosis. It seems that I.N.H. competes in some way with niacin. The peripheral neuritis caused by I.N.H. can often be reversed by giving pyridoxin. Pyridoxin is protective against the neurotoxic effects of I.N.H. but does not diminish its chemotherapeutic action.[14]

Cerebellar ataxia and pellagra occur in a hereditary metabolic condition known as Hartnup disease. This disease, seen in childhood, improves with age and the rash responds to nicotinamide. In the condition a generalised amino-aciduria of renal origin occurs, owing to a failure of reabsorption of amino acids from the glomerular filtrate. The plasma amino acids are normal.[14]

Increased requirements for niacin exist in pregnancy and there is little accumulation in the tissues. No evidence exists to link a deficiency in man with congenital abnormalities, but an association with eclampsia has been mentioned.[27]

Pellagra:

Pellagra often demonstrates the multiple aetiology of deficiency diseases which is accepted as reasonable today. In the typical picture dermatitis, stomatitis, diarrhoea and mental disturbances are seen. Manifestations of thiamine deficiency are common, e.g. neuritis, cardiac failure and oedema. Ariboflavinosis may be suggested by the cheilosis, angular stomatitis, corneal vascularisation and follicular seborrhoeic dermatosis. Other manifestations may suggest a deficiency of vitamin C or iron. In treatment it is essential to administer an adequate mixed diet which is rich in all the vitamins. In severe cases, if only one component of the B complex is administered, the accompanying deficiencies may become aggravated and lead to a fatal outcome.[32]

Where pictures of gross vitamin deficiency are seen, it is safe to assume that a much greater portion of the population must necessarily be suffering from milder degrees of deficiency not readily recognised clinically. This applies equally to kwashiorkor. It is also realistic to remember that before the grosser forms of vitamin deficiency result, the individual will have existed in a state of partial deficiency in which although organic tissue changes are not apparent, functional disturbances both mental and physical are nevertheless present.[32]

Pellagra affects the skin, buccal mucous membranes, gastro-intestinal tract and the nervous system. The skin lesion consists of a symmetrical dermatitis, usually erythematous and pigmented, desquamating or bullous, which may be pustular and ulcerated. The rash is usually seen on the dorsum of the hands, wrists, forearms and elbows. The feet are often involved, and the ankles, front and outer aspects of the lower legs and knees. Lesions on the arms were seen in our cases, as described earlier (in the section, pellagroid dermatosis), but the legs were not affected. The face often shows a typical "butterfly" lesion over the cheeks and the bridge of the nose. The forehead, chin and neck may be affected - the latter lesion often extends on to the upper sternum in a V-shaped collarette.

Facial lesions are varied and may be nodular, or give the appearance of a "mud pack". They may also be crusty or verrucous. The facial lesion frequently co-exists with a hyperkeratotic affection of the sebaceous glands which contain hard, dry, white plugs giving the skin a rough feel. The association with ariboflavinosis has been mentioned in this connection and the possibility of vitamin A deficiency may be considered.[17,32]

The buccal lesions consist of a painful glossitis, stomatitis and gingivitis. The tongue is usually bright red, smooth, swollen or atrophic. The edges of the tongue are often irregular and indented by the pressure of the teeth. This phenomenon is extremely common in Africans seen at our clinics. Ulceration is often present in the mouth, throat and tongue and the gums are often painfully swollen. Pigmented areas in the tongue are often seen, and this too is very common in Africans in our experience, although one would hesitate to label them all as deficiencies of the B complex. The lips are frequently swollen, ulcerated and fissured.[32] Diarrhoea, anorexia and indigestion are common, as is achlorhydria.[17,32]

Mental symptoms present a varied picture and may occur without any other clinical evidence of pellagra. Symptoms vary from mild mental instability and retardation, through confusion, incoherence, loss of memory, to delirium, stupor, mania and delusions. The clinical picture may resemble the picture of Wernicke's syndrome. These mental symptoms are not uncommon in elderly people and also in chronic alcoholics, or during a period of high carbohydrate diet.[32]

Treatment:

Nicotinic acid has a direct vasodilator action on blood vessels, so nicotinamide is preferred for therapy. About 500 mgm of nicotinamide per day in a mixed diet with supplementary vitamins as mentioned earlier, should be given. If vomiting is present, 800 mg a day can be given intravenously. Large doses of tryptophan may be effective under certain conditions.

A niacin deficiency anaemia occurs in dogs but has not been described in man. The anaemia seen in pellagra has been ascribed to a deficiency of folacin.[14]

Nicotinic acid has been successfully used to lower serum cholesterol. The mechanism by which this occurs has not yet been resolved. Buffered nicotinic acid 1g t.d.s. has produced the same fall in serum cholesterol as nicotinic acid itself, without the undesirable side effects.[14]

(iii) Vitamin B_{12} and Folic acid.

Our interest in these vitamins lies in their association with protein rich animal foodstuffs and the deficiency which may occur in vegetarian type diets. Straight dietary deficiency of vitamin B_{12} (i.e. not conditioned by gastro-intestinal disorder) is thought to be rare but might occur in true vegans, as opposed to ovo-lacto-vegetarians. Folic acid deficiency is quite common however in underprivileged communities subsisting on mainly vegetarian diets. A vicious circle mechanism may well operate between folic acid deficiency, gastro-intestinal function and vitamin B_{12} absorption.[14]

Assessment of the true frequency of folic acid deficiency is difficult because of uncertainty about metabolic relationships with B_{12} and because of its possible role in determining malabsorption in the intestinal tract and a resultant vicious circle. Vitamin B_{12} influences folic acid metabolism but there is no evidence at present that folic acid directly influences vitamin B_{12} metabolism. It is presently accepted that folic acid deficiency leads directly to megaloblastic anaemia; it is not yet certain that vitamin B_{12} deficiency is a direct cause of that blood disorder. The question is still open as to whether the megaloblastic anaemia which follows vitamin B_{12} deprivation is a direct result solely of such deprivation, or is partly the result of deranged folic acid metabolism caused by deficiency of vitamin B_{12}.[14]

The gastro-intestinal tract plays a conditioning role in determining deficiency of the dietary haematinic vitamin B_{12}. Addisonian pernicious anaemia is probably a syndrome of several possible etiologies, e.g.

(1) Hereditarily determined failure of intrinsic factor (B_{12}) secretion.

(2) Hereditarily determined degenerative gastric atrophy.

(3) Gastric atrophy as the end stage of superficial inflammatory gastritis.[14]

Both iron and vitamin B_{12} deficiency may cause reversible gastric atrophy, so that even the hereditarily determined cases of Addisonian anaemia may be precipitated in part by dietary deficiency.[14]

Vitamin B_{12} is not effective in coeliac disease although folic acid is very effective in the treatment of adult steatorrhoea and the associated megaloblastic anaemia. A feature of the life of poor people in the tropics is their great dependance upon vegetable protein which may lead to a deficiency of vitamin B_{12}. This type of anaemia can be improved by penicillin both by the oral and parenteral route. It is believed that the penicillin, in altering the intestinal flora, removes bacteria which compete for vitamin B_{12}, or which inhibit other bacteria that synthesize vitamin B_{12}.[14]

The association between vitamin B_{12} and growth, and the fact that a mild deficiency of the vitamin may be a factor in the production of subnormal stature and health in underprivileged communities is also of basic interest in a study involving Africans in industry.

In the absence of vitamin B_{12} zein has been shown to have a growth inhibitory effect which appears to be related to its leucine content.[38] Experimentally, in carbohydrate diets, additional vitamin B_{12} has produced better growth than in controls, and the clearance of glucose from the blood was delayed in rats.[38]

Further experimental work has shown that if the fat content of a soyabean-corn mixture was increased in chicks, an increase in the vitamin B_{12} and methionine was also demonstrated in that the effects of a high fat diet could be abolished by giving methionine, showing that methionine and vitamin B_{12} are related in the utilisation of dietary fat.[38] In newborn rats whose mothers had received a soyabean, protein diet, free of B_{12}, a uraemia was demonstrated which was reversible by injecting vitamin B_{12}.[38]

Deprivation of B_{12} in pregnant rats caused disturbances of reproduction and increased mortality. Alterations in the heart, liver, brain and spinal cord were recorded in the offspring. Hydrocephalus was prevented by administering vitamin B_{12}. In humans, the foetus fixes the vitamin at the expense of the mother; this also occurs with folic acid.[27]

Deprivation of folic acid in birds increased the mortality of embryos and caused teratogenic effects, e.g. malformations of the face, coloboma, coelosomia, ectopia of thoracic organs, abnormalities of the eyes and hydrocephalus.[27]

Vitamin B_{12} is an important dietary factor in pregnancy which is suggested by the experimental work above. The levels of B_{12} decline during pregnancy so that an adequate diet is of great importance and it is probable that a critical level is required for normal development.[33] Low levels of B_{12} have been found in cretinism and experimental thyroidectomy in rats prevents absorption of B_{12}. Low levels are also found in older people.[33]

Certain carbohydrates, D.mannitol, L.sorbose, D.xylose and particularly D.sorbitol actively enhance absorption of vitamin B_{12}.[13] Vitamin B_{12} occurs mainly in animal protein foodstuffs and is concerned with protein metabolism and mitosis. It would be surprising however, if tissues other than those concerned with blood formation were not affected by a dietary deficiency.[13]

An interesting sparing of vitamin B_{12}, niacin, pantothenic acid and riboflavin has been recorded by giving 5 mg of a broad spectrum antibiotic per pound weight in pigs. (F.A.O.)[34]

Folic acid and vitamin B_{12} play vital roles in the treatment of many megaloblastic anaemias but this is beyond the scope of the present discussion.

(iv) Riboflavin (B_2)

Ariboflavinosis[32] has been associated with follicular dermatosis or seborrhoea, in the naso-labial folds, nose, cheeks and chin. The buccal surface of the lips may be inflamed. Fissures are seen at the corners of the mouth (angular stomatitis) and on the lips (cheilosis, perleche). The glossitis is said to be specific and gives a magenta coloured tongue with flattened ("mushroom") papillae.

In the skin, phrynoderma and toad skin may occur as is described in vitamin A deficiency. Vascularisation of the cornea with the development of opacities, iritis and a type of cataract have been described.[32] McClaren[25] mentions nutritional amblyopia and corneal epithelial dystrophy in states of vitamin B complex deficiency.

Reference has been made (p.341) to the effect that clinical results of riboflavin deficiency are probably relatively trivial and that there are no specific signs of ariboflavinosis in man.[14] Riboflavin is probably present in every cell and occurs in combination with phosphoric acid to form a flavine nucleotide. This is often linked with adenylic acid to form flavine adenine dinucleotide. (F.A.D.)[14] The measurement of F.A.D. in the blood has been suggested as more reliable than the estimation of free riboflavin.[23]

On .55 mgm of riboflavin a day the red blood cell riboflavin content of an experimental group of men varied between 10.0 and 18.1 mcg/100 ml. All developed signs which were labelled as ariboflavinosis. A supplemented group receiving 2.55 to 3.55 mg/day gave red blood cell riboflavin figures of 20.2 to 27.2 mcg/100 ml.[23]

Riboflavin may be found in the urine in excessive amounts in cases in negative nitrogen balance and in diabetics as has been mentioned in Chapter 4.(p.281) The urinary measurement of riboflavin per 24 hours may be of value. For intakes between .5 mg to 1 mg a day, 9 to 14% of the ingested riboflavin is excreted daily. A single, non-timed urinary specimen may yield helpful results of riboflavin urinary excretion in field surveys.

Experimentally, a deficiency of vitamin B2 has resulted in a reduction in the hatching rate in birds. Micromelia (shortening of the limbs of the young) has been described, as has oedema, anaemia and dwarfism. In rats a deficiency appears to exert a teratogenic effect, and palatal defects, micromelia, and others are recorded.[27]

(v) <u>Pantothenic Acid</u>:

Reference has been made to the "burning feet" syndrome and that it is seen occasionally in Africans employed in this industry. It has also been described in patients taking I.N.H.[14]

Pantothenic acid is a component of co-enzyme A, and is concerned in the process of acelytation.[14] Experiments have clearly established that elaboration of adrenal steroid hormones is dependent on adequate body stores of pantothenic acid. The mechanism by which this vitamin acts to facilitate cortical hormone production has not been elucidated but its function must be identical with that of co-enzyme A, since this is the form in which most of the pantothenic acid exists in the body. Co-enzyme A serves as a carrier and activator of acyl groups and is essential for the production of various complex substances, including cholesterol and steroid hormones from acetate.[35]

No specific deficiency symptoms have been conclusively proved in man, but in human volunteers given a pantothenic acid antagonist and a diet deficient in pantothenic acid, clinical and biochemical abnormalities suggestive of adrenocortical insufficiency and peripheral neuropathy appeared. This state was not reversed by pantothenic acid alone, but was rapidly relieved by a good mixed diet with multiple vitamins.[14]

Giroud[27] found that in rats the lowest level of pantothenic acid required for normal embryonic development was 80 mgm/day. He also mentioned that a deficiency in pregnant rats caused disturbances of gestation and teratogenic effects were observed in the offspring - namely abnormal embryos, dead, or resorbed young, anopthalmia and anencephaly in severe cases.[27]

(vi) Pyridoxin (B_6)

Requirements for the vitamin are increased in a high protein diet because pyridoxin acts mainly as a co-enzyme in the decarboxylation and transamination of a number of amino acids. When it is deficient, deamination increases and urea production increases.[14] If vitamin B_6 is deficient, the normal breakdown of kynurenine into alanine and anthranilic acid does not occur. If kynurenine accumulates, it is converted into xanthurenic acid which appears in large amounts in the urine. Kynurenine is derived from tryptophan. The urinary xanthurenic acid level is a useful test for pyridoxin deficiency. Vitamin B_6 also plays a part in the enzymes concerned with the interconversion of certain fatty acids and also in normal adrenocortical function.[14]

In human volunteers on a pyridoxin free diet for up to two months, no symptoms appeared. If a pyridoxin antagonist is given however, seborrhoea like lesions occur around the eye, nose and mouth, cheilosis is seen, also glossitis, weakness, dizziness, vomiting and mild lymphocytopenia. These signs disappear in 3 days if pyridoxin is given. Peripheral neuritis may also occur and the peripheral neuritis of I.N.H. therapy responds to treatment with pyridoxin. Treatment with pyridoxin does not diminish the therapeutic effect of I.N.H.[14] It is probable however, that the best treatment for the neurological side effects of I.N.H. is systemic vitamin B complex therapy.[14]

Convulsions appear to be a critical manifestation of pyridoxin deficiency, and a certain baby food has been incriminated in this way. The convulsions and hyperirritability which occurred in about 3 out of every 1000 infants fed this formula disappeared when pyridoxin was given. It is said that these symptoms may occur on intakes of less than 0.1 mgm of vitamin B_6 a day. Vitamin B_6 appears to be the only B vitamin, deficiency of which causes epilepsy in mammals, including man.[14] The E.E.G. is normal within minutes of giving intramuscular pyridoxin.

A microcytic anaemia associated with pyridoxin deficiency has been described in dogs and pigs and it is thought that the defective heme synthesis is due to a specific biochemical defect associated with a deficient intake of pyridoxin. A case of anaemia with giant stab cells, responding to pyridoxin therapy has been reported in man.[14]

There appears to be a critical need for pyridoxin in laying hens. Its use in humans in vomiting of pregnancy suggests a need. Abortions in rats have been described in pyridoxin deficient diets.[27]

The vitamin has a wide and uniform distribution in most foodstuffs. Three biologically active forms are recognised, pyridoxin, pyridoxal and pyridoxamine.[23]

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It is not intended to discuss other elements of the B complex, e.g. inositol and para-amino-benzoic acid. Deficiencies of biotin however, have been associated with a decline in the hatchability of eggs and gross developmental abnormalities in chicks, e.g. parrot beak and limb defects. In the rat, effects of deficiency were not teratogenic, but resorption of embryos occurred and lesions of the heart, liver and veins were recorded in survivors.[27]

Vitamin C.

Holst and Fröhlich, two Norwegian scientists, stumbled on to the fact that scurvy was due to lack of a vitamin in 1909, and that the guinea pig was a valuable experimental animal. In 1932, Svent Györgi separated ascorbic acid as a crystalline substance. King and Waugh in America isolated the same substance from lemon juice about the same time and found that lemon juice was a more powerful antiscorbutic than lime juice.[36] Prof. Hopkins (later Sir Frederick Gowland Hopkins) demonstrated the value of "accessory factors of diet" as he called them, in 1912. Funk coined the name "vitamine". The final 'e' was dropped later in deference to certain accepted rules of chemical nomenclature.[36]

History and the efforts of primitive man illustrate how in preventing scurvy the association of vitamin C with fresh foods of plant or animal origin was noticed. Recognition of its almost universal occurrence in all living organisms was not established however until the vitamin had been identified and methods of measuring its content had been evolved.[37]

Early demonstrations of biosynthesis were seen in sprouting seeds which accumulated the vitamin from inactive stores. Rats too thrived on a vitamin C deficient diet, yet their tissues fed in small quantities to guinea pigs protected them from scurvy. Man, other primates, and guinea pigs appear to be unable to synthesize the vitamin.[14,37]

The result of vitamin C deficiency is scurvy. In nature, vitamin C can either be in the reduced form, L-ascorbic acid, or the reversibly oxidised form dehydroascorbic acid. The latter exists only in small amounts. Vitamin C has not yet been shown to be involved in any co-enzyme complex.[14]

Ascorbic acid is the most active reducing agent known to occur naturally in living tissues. It is a simple sugar. Certain essential steps are involved in the conversion of D-glucose to L-ascorbic acid, and work has continued on the preparation of enzyme systems capable of catalysing these changes.[14]

The work of Bartley, Krebs and O'Brien[38] has been mentioned in the introduction to Chapter 3. In subjects receiving no vitamin C, the first signs appeared after 17 weeks. Volunteers with clear-cut signs of scurvy showed a rapid response to a daily dose of 10 mg of vitamin C. It was also clear that if vitamin C is detectable in the blood, the diagnosis of scurvy is untenable.

The concentration of plasma ascorbic acid decreases rapidly with deprivation of the vitamin. A level of 0 mg/100 ml in 40 days was recorded but clinical scurvy did not appear until the 143rd day of deprivation. Two conclusions arise:[23]

(1) The ascorbic acid concentration in the blood plasma reflects recent intake of the vitamin.

(2) Its disappearance from the serum does not necessarily signify clinical scurvy, although it may be compatible with it.[23]

A better index of scurvy is the vitamin C content of the white blood cells. This does not disappear until about 4 months of dietary depletion, and the absence of it in the white blood cells makes the diagnosis of scurvy virtually certain.[14] The urinary content of ascorbic acid is not an accurate guide because small amounts of vitamin C, or some other substance reducing

2-dinitro-phenol-indophenol continues to be excreted in the urine even in the presence of obvious scurvy.[14] Arroyave[23] suggests that the urinary excretion of vitamin C in 24 hours may give an estimate of dietary intake as does the ratio of ascorbic acid to creatinine in a random single urine specimen, preferably a fasting specimen.[23] The daily urinary output of vitamin C is roughly half the intake - usually 20-30 mg in Europeans, a figure of 14.3 mgm was found in African Mine recruits.[20]

An intake of 30 mgm of vitamin C per day is considered adequate.[14] In this study where it seemed likely that subscorbutic states might be common, 45 mgm of vitamin C a day was selected as the recommended daily intake.

Deficiency of ascorbic acid results in well-known structural abnormalities, and an early sign is the petechiae resulting from abnormal capillary permeability and spongy gums. The latter sign is often absent in edentulous patients, suggesting that it is due to the combined effects of vitamin C deficiency and infection.[14] In more severe cases, haemorrhage may occur in the intermuscular septa and in or under the periosteum. In the former site, the haemorrhage often presents as lameness due to a painful swelling of the muscles of the calf or thigh.[14] In our experience similar signs are seen in the forearms of industrial workers, and respond to the administration of vitamin C, proving that the structural damage is still completely reversible.

Schulz and Swanepoel[20] describe a condition resembling scleroderma in the legs of Africans and attribute this to chronic scurvy. They maintain that the sclerotic changes in the skin and subcutaneous tissues develop secondarily to, and persist long after, the initial haemorrhage into muscle, subcutaneous tissue and dermis. They also suggest that there is a relationship between siderosis and scurvy in the Bantu, possibly because vitamin C is concerned in the transport of iron across reticulo-endothelial cells. It is possible too that absorption of vitamin C is defective, due to heavy deposits of haemosiderin in the jejunal and duodenal mucosa.[20]

Mode of action of vitamin C.

There appears to be deficiency in collagen formation and in the function of specialised cells, the osteoblasts, odontoblasts and ameloblasts in scurvy. The essential lesion in cartilage appears to be a failure of the production and maintenance of intercellular substances. The cells of the cartilage cease to form matrix and become irregular in shape.[14]

Vitamin C plays an important part in cell physiology. A lack of phosphatase, esterase and oxidase in scorbutic tissue has been shown, as also the reduced capacity of the cells to metabolise the amino acids, tyrosine and phenylalanine. A diminished activity of many other enzymes has been described.[14] The only positive biochemical lesion that has been demonstrated in scurvy is an abnormality of tyrosine metabolism.[14]

The relationship of vitamin C to adrenal function is a controversial one, and will not be discussed here. It seems probable that ascorbic acid by its reducing properties inhibits the oxidative conversion of cholesterol to cortical hormones, and thus acts as a break in their production.[14]

The concentration of vitamin C in the adrenals is greater than in any other tissue. A variety of stress conditions will result in depletion of the vitamin in the adrenal, and in scurvy, adrenal hypertrophy occurs.[20]

Anaemia is a common finding in scurvy and it seems that vitamin C is essential for the normal maturation of the red cell.[14] The anaemia of scurvy is due thus to a fundamental metabolic derangement rather than to simple blood loss. The metabolic implications of vitamin C are extremely wide and include the utilisation of folic acid and vitamin B_{12}. The anaemia seen in scurvy is usually normocytic and normochromic, but macrocytic anaemias have been described.[13]

Ascorbic acid has a connection with many vitamins in group B, and with vitamins A and E. This connection is shown particularly by the facility with which ascorbic acid is able to replace, more or less efficiently, all the vitamins with which it is in relation, when one or other is lacking in the diet. In this way it demonstrates a protective role in certain vitamin deficiencies.[39]

Six vitamins of the B group which in some degree (at least temporarily) may be replaced by vitamin C are: thiamine, riboflavin, pantothenic acid, biotin, folic acid and B_{12}.[39] The substitutional ability of ascorbic acid with regard to vitamins is exercised with heavy doses which are out of comparison with the physiological needs for vitamins. Whilst ascorbic acid in experimental conditions can replace numerous vitamins, these also can to varying degrees replace vitamin C.[39]

It is evident that the key property of ascorbic acid is that of a redox agent. On the other hand, scurvy is not cured by non-specific redox agents such as iso-ascorbic acid. In general, iso-ascorbic acid possesses the physico-chemical properties of ascorbic acid, but a fundamental difference is that it has only one-twentieth of the anti-scorbutic power of ascorbic acid.[39]

The tissue concentration of D-ascorbic acid is less than that of L-ascorbic acid. D-ascorbic acid is non-antiscorbutic.[37]

<u>Conclusion:</u>

The role of certain vitamins has been discussed and their inter-relationship with adequate diets has been stressed. It remains to add that in the absence of organic disease in the individual who employs a diet adequate in calories in which cereals are prominent, but are supplemented with sufficient milk, eggs, meat, fruit and green and yellow vegetables, no physiological benefit will be derived from taking additional vitamins.[40] The need for an adequate, balanced diet in industrial workers is basic to this discussion.

"Food is a fundamental necessity of life, and healthy food of healthy life. In the last resort good nutrition is indistinguishable from good health. This relationship is two-way, and a breakdown at either end leads to a vicious circle of ill-health and malnutrition." (Brock)[14]

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Calcium:

The dietary survey suggested that there might be a deficient intake of calcium in many workers. As a result, a discussion on calcium follows.

Serum calcium reveals a normal adult range of 9-11 mgm per 100 ml. In Cape Town a mean adult level of 9.775 mg with a standard deviation of 0.31 in 155 subjects has been recorded. The subjects had no known disorder of metabolism.[41] Jackson[41] mentions that in a group of Bantu the mean serum level was 9.59 mg, and in a group of Europeans the level was 9.89 mg. A significant difference is apparent.

Bantu levels below 9 mg were found. It is known that albumen fractions may be lower in the Bantu, whilst total protein is normal.[42] Low calcium levels may coincide with normal serum albumen levels. Low serum calcium may be due to low intake in the Bantu, but this is difficult to substantiate.[14,41]

The intake of calcium in a poor African diet may be under 200 mgm a day. Where the diet consists of mealie meal, white bread, squash, pumpkin, sugar, salt and syrup, as little as 90 mgm of calcium may be provided. Despite this, calcium in the bones in the Bantu does not differ from that of Europeans. The Bantu have less dental caries, are not particularly prone to fractures, nor do fractures heal less rapidly. Their breast milk is identical in composition to that of Europeans, osteomalacia is unknown during their pregnancy or lactation, and osteoporosis appears to be no commoner than in Europeans. In fact, no calcium deficiency disease is known to occur in the Bantu.[41]

In 1953, the Food and Nutrition Board (U.S.A.) suggested a daily allowance of 800 mg calcium per day.[14] From evidence in this and other countries, Jackson concludes that various "official" minimum requirements varying from 700 mgm to 1g per day are totally meaningless.[41] However, in this study the figure of 800 mgm a day was used as a basis for discussion.

It would appear that the minimum intake of calcium below which the skeleton cannot be properly formed or maintained, is so low that it is exceeded by the diets of even the most underprivileged people. People who live on such low diets must be well adapted to the low calcium intake - in other words, their excretion of calcium must be low.[41]

The urinary calcium excretion in normal subjects is extraordinarily variable as between individuals (25mg to 450mg per day) but remarkably constant for the same individual on a fixed intake, and even relatively constant on vastly different calcium intakes.[14a] On a normal "civilized" intake of, say, 800mg per day in the adult, the net excretion (stools and urine, omitting the negligible amount lost in sweat etc.) equals the intake, provided the subject concerned has been on the same diet for a long period and is in a good static metabolic state.[14a]

Physiological doses of vitamin D are necessary to maintain the required intestinal absorption of calcium to fulfil the body's needs. Vitamin D appears in addition to exert a hypercalciuric and hypercalcaemic action. (Jackson)[41]

Vitamin D causes parallel rises in the serum calcium and citric acid. The actions of the parathyroid hormone and vitamin D on bone are not unrelated, as is evident from the observation that in the vitamin D deficient rat, the hormone is ineffective in mobilizing calcium. Vitamin D is further implicated in its relationship to citric acid in that the vitamin reduces the ability of the mitochondria of the rat kidney (but not liver) to oxidise citric acid.[43]

Calcium is present in the serum in 3 major components; the non-diffusible protein bound fraction, the diffusible ionic fraction and the diffusible complexes. The ionic fraction is the major component of the diffusible fraction.[43]

(1) <u>Non-Diffusible</u>.		
	Protein bound	3.3mg/100ml
(2) <u>Diffusible</u>.		
	(a) Ionic	5.3mg/100ml
	(b) Complexes	1.2mg/100ml
	Approx.	10.0mg/100ml.[43]

Vitamin D, lactose and the amino acids L.lysine and L.arginine increase the absorption of calcium. Phosphates, phytates, oxalate and fatty acids seem to hamper absorption. Vitamin D has been shown to be less effective than L.lysine in stimulating the absorption of calcium from the gut, but causes equal deposition in the femur.[43] Apart therefore, from its effect on intestinal absorption, the vitamin has actions on bone mineralisation and kidney excretion.[43] Vitamin D is necessary for the development of the foetal skeleton. Reserves can be submitted to the young, and depend upon the level of vitamin D in the mother's diet. Ossification depends upon the level of calcium, phosphorus and vitamin D.[27]

Man and animals can adapt to low levels of calcium intake by increasing the efficiency of absorption. Nicolaysen proposed an "endogenous factor" linking the stores of calcium on the one hand and the efficiency of calcium absorption as influenced by vitamin D on the other hand, and that vitamin D was necessary for its action. The endogenous factor is a concept only and there is no definite evidence to link it with a particular hormone or biochemical, but possibly the parathyroids are involved.[43]

The rate of adaptation to a low calcium intake varies and there is usually a period of negative calcium balance which may last for some weeks, or even months. Little change in urinary calcium is noted, but increased absorption and less faecal calcium excretion occurs.

In the process of adaptation to a low intake, two biological laws have been enunciated.[43] (Hegsted)

(i) The body makes more efficient utilisation of a nutrient when the body is in need.

(ii) All so-called normal adults whether they are found eating low calcium diets or high calcium diets, are in balance and show no signs of ill-health attributable directly to the level of calcium intake.

Calcium loss in sweat is higher where the humidity and temperature are higher and a figure of 484mg/day at 38° C. and a relative humidity of 68% has been recorded.[43] Iron loss in similar conditions is also high. In such conditions, special allowance might be reasonable in estimating minimum requirements. This would apply in an industry where workers are subject to conditions of fairly high temperature and high relative humidity as occurs in Howick, particularly during the summer.

The effect of pregnancy on calcium requirements lies outside the scope of this study, although it is realised that the highest calcium requirement occurs during lactation. Certain studies in the Belgian Congo would seem to suggest that many African women are in negative calcium balance for a prolonged period during their child bearing epoch, yet no skeletal disorders have been described.[14]

Fluorine causes a calcium shortage and inhibits certain enzymatic processes, particularly the activity of phosphatases. It also has an inhibitory effect on carbohydrate metabolism. The toxic effect of fluorine is related to the calcium intake and to calcium metabolism generally and calcium is administered therapeutically in fluorine intoxication.[12]

Conclusion:

A high calcium content of the diet has been inferred to have a deleterious effect upon iron absorption, and iron deficiency anaemia has been produced in mice by feeding a diet rich in calcium.[14b] (Woodruff).

The subject is complex however, for a high calcium content of the diet might be e xpected to compete with iron for phosphate and thus release iron for absorption. (Brock) If there is much calcium and little phosphate, the calcium might impair iron absorption but in a diet containing an excess of phosphate, a high calcium content could presumably assist iron absorption.[14] Calcium is important too in many tropical diets where an iron deficiency anaemia is common. In these areas iron intake is usually adequate, or greater than that accepted as minimal in Europeaand North America. Chronic diarrhoea and other infections play their part in causation, as do the bulky carbohydrate diets which although rich in iron have high phosphate and phytate and low calcium levels. Heavy infestations of hookworm aggravate the position.[14] (Nutrition Unit of W.H.O. and the Nutrition Division of F.A.O.)

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Part Two.

PROVISION OF A DIETARY SUPPLEMENT

In Chapter 3 (p.117) mention was made of the dietary supplement used in this study. The skimmed milk powder was obtained from Messrs. Hind Bros. via Lindley, Orange Free State, and the roller dried form was used. In addition, a multivitamin tablet was given to each man once a day. The tablet chosen after sample quotations was an N.H.P. (Lennon) product and was stated to contain the following vitamins:

5,000 I.U. of Synthetic Vitamin A acetate.
750 I.U. Vitamin D (Calciferol)
2.0mg Thiamine Hydrochloride (B_1)
3.0mg Riboflavin (B_2)
.5mg Pyridoxin Hydrochloride (B_6)
2.0mg Calcium d. Pantothenate
15.0mg Nicotinamide
75.0mg Vitamin C, plus standardised Brewer's yeast.

The tablet provided the daily minimum requirements of the above vitamins, apart from anything else men were receiving in their diets.

From one's reading and practical experience, it seemed advisable to provide a supplement of animal protein. This protein one hoped would be readily assimilable, and would provide valuable minerals and vitamins. No attempt was made to provide a full diet. Extensive use of skimmed milk powder in the Transkei from 1953 to 1956 in cases of kwashiorkor led us to believe that it was the most convenient form of protein to give as a supplement.

In skimmed milk the fat has been removed, but the protein content of approximately 36% is a valuable supplement in poor dietaries. Separated milk in powder form (S.M.P.) was selected because it is cheap, there are no storage problems and it is easy to handle and mix. It was hoped too that as a result of familiarisation the men would use powdered milk for their children. This, in fact, was the major factor in the decision to use S.M.P. in this study.

One pint of reconstituted skimmed milk provides approximately 20 gms of protein which is a considerable contribution to a man's daily protein requirements. In practice, we found that the powder constituted as recommended (1 lb. to 1 gallon) tended to produce abdominal distension and in some cases vomiting. It was not clear why this should have occurred, but as a degree of prejudice against the supplement was developing, adjustments were made. We found that by mixing .85 lb. of skimmed milk powder in one gallon of water, the reconstituted skimmed milk became more satisfactory. This provided approximately 17gms of protein, and 569mgm of calcium.

5,000 I.U. of vitamin A, 2.0mgm of vitamin B_1, 3.0mgm of vitamin B_2, 15mgms of niacin and 75mgm of vitamin C were provided by the multivitamin tablet. Strawberry, coffee and chocolate flavours were used to provide variety. The latter was very popular in winter. The amended mixture we found left less undissolved sediment in the can, and was generally preferred.

<u>Method of administering the supplement:</u>

A simple mechanism was adopted for the mixing, and issue of the rations. Pint mugs were purchased especially for issuing the ration and were passed through steam after being used. The tablet was given at the same time as the pint of skimmed milk. At no time was the ration varied, nor were any adjustments made in the provision of the ration. The fact that some men took less than others is the result of their own behaviour and does not reflect any attempt at influencing the amount of ration consumed.

Each volunteer in the Test Group was issued with a card. This he presented during a tea break and was issued with the supplementary ration. The cards were then sorted, counted and a check kept of the number of supplements each man received. Further observation of the men in the three groups (referred to collectively as the "Test Group") was made from time to time, and the following facts will be discussed in part 3 of this chapter.

(i) Weight changes.

(ii) Improvement in general well-being and disappearance of malnutrition signs.

(iii) Comparative sickness records.

Table 57

Analysis of Dried Skimmed Milk Powder			
Nutrient	Unit	Dried S.M.P. (per 100g) (Dean)[15]	Roller Dried S.M.P. Hind Bros.
Protein	g	35.5	36.8
Fat	g	1.1	-
Carbohydrate	g	52.2	-
Calcium	mg	1,300	1,315
Phosphorus	mg	1,035	-
Iron	mg	0.6	0.0035
Vitamin B_1	mg	0.33	-
Riboflavin	mg	2.00	-
Nicotinic acid	mg	1.1	-
Vitamin C	mg	11	-
Vitamin A or) Carotene)	I.U.	44	-
Calories		355	359

The aminogram of roller dried skimmed milk is as follows:[44] Expressed as grams of amino acid per 16 gm of nitrogen.

Table 58

		Safe intake for men gm per day.[34]
Arginine	2.6	
Histidine	2.7	
Lysine	8.0	1.60
Phenylalanine	5.1	2.20
Methionine	2.5	2.20
Leucine	9.8	2.20
Isoleucine	7.5	1.40
Valine	7.0	1.60
Glutamic acid	19.0	
Glycine	2.2	

Holt[34] suggests 67 mg of arginine and 26 mg of histidine per kg per day as minimal requirements.

The supplement used in this trial provided a portion only of the dietary protein needed, a useful amount of calcium and a small number of calories. The tablet provided certain vitamins.

The weights and general health of the men participating in the trial were checked from time to time and consolidated into tables which appear in part 3 of this chapter.

A similar table showing the percentage of men with malnutrition signs in age groups is attached.

Table 59

Analysis of Malnutrition Signs

Number of men with malnutrition signs in age groups

Group	Under 30	30-39	40-49	50-59	60 & over	Total
A	23	21	8	7	-	59
%	67.6%	52.5%	47.1%	77.9%		58.4%
B	23	26	9	7	1	66
%	60.6%	63.5%	75%	70%	100%	64.7%
C	22	25	18	6	3	74
%	73.3%	71.4%	72.1%	54.6%	75%	70.6%
Total	68	72	35	20	4	199
%	66.8%	62%	64.9%	66.6%	66.6%	64.6%

On the above figures, the distribution of malnutrition signs appears to be fairly evenly divided between the age groups. Group C however, presents the highest figure of malnutrition.

Analysing these figures into two groups, (i) those living at home and (ii) those lodging in rooms, gave inconclusive results. In Group A, the whole of the group are lodgers in the Company Compound. In Group B, 56 out of 85 living at home, or 66%, had signs of malnutrition, and 59% of the lodgers (10 out of 17) were similarly affected.

In Group C, 32 out of 53, or 60.3% of those living at home showed signs of malnutrition, compared with 80.9% (42 out of 52) of those who lodged elsewhere. The total number of lodgers showing malnutrition signs of various kinds is (65.4%) and this represents 56% of the total number who were found to have malnutrition signs. These figures were extracted in order to illustrate the extent to which living away from home, plus having to cook for themselves might contribute to the presence of malnutrition. It is not considered that the above figures are significant enough to warrant any comparative conclusions being drawn. Where a supplement such as the one used here is given for a period of a year or more, and improvement in general well-being plus improved sickness statistics follows, it is perhaps reasonable to assume that malnutrition has been at least partly responsible for the initial state of affairs.

THE MEDICAL ASPECT OF THIS SURVEY

Part Three:

This section is discussed under the following headings:

(i) Weight changes
(ii) Malnutrition Signs
(iii) Sickness Records

(i) Weight Changes:

The weights of the men in the three groups, called collectively "the test group", were compared with the weight standards in the tables of the "Life Extension Institute of New York City". Weight checks were made from time to time, and the results correlated with the amount of the supplementary ration consumed. A further subdivision of the three main groups was made, as follows:

(a) Those taking less than 41% of the total available ration, and

(b) Those taking between this ration level and the better ration scale of approximately 70%, and

(c) Those taking 71% and more of the available ration.

Table 60.

Summary of Weight Changes at end of First Year				
Group.	Ration under 41%	Ration 41%-70%	Ration over 71%	Total
A. Losses	0	5	11	16
Gains	5	6	50	61
No change	0	1	3	4
Totals	5	12	64	81
B. Losses	0	3	8	11
Gains	3	10	50	63
No change	1	0	3	4
Totals	4	13	61	78
C. Losses	0	2	11	13
Gains	4	10	51	65
No change	0	0	8	8
Combined A, B & C.				
Losses	0	10	30	40
Gains	12	26	151	189
No change	1	1	14	16
1st year	13	37	195	245

This table reveals a weight gain in the column "Ration over 71%", and a fair weight gain in the column "41%-70%".

In order that the figures may reflect a conservative estimate, gains of from 1 to 3 lbs have been regarded as normal fluctuations, not necessarily attributable to the supplementary ration, and have been bracketted with the weight losses and static weights. With this in mind, it is submitted that the weight gains shown in the preceding table offer an indication of the value of the supplementary ration to the majority of the men concerned.

The conventional method of measuring the relative value of proteins is by their effect on growth, i.e. weight gain. It is acknowledged however, that this may be misleading, as the increase may be in fat, in water or other variables. (Gopalan)[34] A better assessment would be that of nitrogen retention.

The effect of diet on a population was discussed by Suzuki.[45] He noted that the basal metabolism of most Japanese showed a decrease of approximately 10% due to food shortage in World War 11. The body size of the Japanese has increased since 1900 by approximately 1cm in stature, per decade. This was interrupted by World War 11 which resulted in a conspicuous decline in stature which was most apparent in adolescence. A few years after the war, with better food supplies, the stature again increased, and now surpasses the pre-war level.[45]

Brock[4] feels that in the milder stages of chronic functional disturbance the only proof of malnutritional origin is the demonstration of better function after administration of a supposedly deficient nutrient or of a better all-round diet. He suspects that this type of subclinical malnutrition is a common cause of impaired vitality and growth in the economically depressed strata of all society and perhaps almost universally in under privileged nations.[4] The results of the study at SARMCOL strongly supports this view. In general, it can be stated that privileged populations are taller and heavier than underprivileged ones. This is probably in part genotypical, but in part environmental.[4]

Brock[14] also states that if disease is excluded and dietary deficiency presumptively established, then improvement in any or all of the criteria as a result of test feeding can carry conviction though it does not constitute proof. This opinion is of considerable interest in this study, as the results of the dietary supplement seemed mainly favourable.

Hansen[46] feels that instead of weight gain, it might be better to think of variables which influence nitrogen retention, e.g. age, nitrogen intake, overall body stores of nitrogen, nutritive value of proteins, amino acid imbalance, calorie intake, digestibility and individual variability.

Protein efficiency rates (PER) are of considerable interest and concern the weight gain per gram of protein or nitrogen consumed. The correlation between protein efficiency and body weight gain is often so excellent that weight gain alone is sufficient to determine nutritive value.[46] Variations in PER occur with food intake, and secondly from the differential effect of diet on the protein, fat and water content of tissues. It is possible for these tissue components to vary, so that gain in weight is poorly correlated with nitrogen retention. PER for egg proteins, casein and wheat gluten may appear similar, but the nitrogen retention is in the order of egg $>$ casein $>$ gluten.[46]

Nitrogen balance is a more direct and certain measure of nitrogen retention in the estimation of the nutritive value of a dietary protein than methods based on body weight alone.[46]

In the study at SARMCOL the interest had to centre on simple measurements such as weight gain, general improvement in well-being, correlated with improvement in posture and the statements of the men forming the test group.

A table showing the position at the end of the second year is now presented:

Table 61.

Summary of Weight Changes after 2 Years Investigation

Group	Ration under 41%	Ration 41%-70%	Ration over 71%	Total
A. Losses	5	2	6	13
Gains	18	12	33	63
No change	1	1	3	5
Totals	24	15	42	81
B. Losses	4	3	6	13
Gains	23	11	28	62
No change	1	1	1	3
Totals	28	15	35	78
C. Losses	3	4	6	13
Gains	22	15	32	69
No change	1	2	1	4
Totals	26	21	39	86
Combined A, B & C.				
Losses	12	9	18	39
Gains	63	38	93	194
No change	3	4	5	12

Here again, those men who took 71% and more of the ration, offer evidence of weight gains in the vast majority of cases (93 out of 116). There is again a fair weight gain in the group who took between 41% and 70% of the ration (38 out of 51), and surprisingly an even bigger number gained weight in those who took less than 41%of the supplementary ration (63 out of 78). No adequate explanation can be offered for this latter fact, except that nutrition had been frequently discussed with all the men co-operating in the test, and possibly this fact had led to a more balanced diet being taken. In general too, it seemed that the main effect of the supplementary ration was evident at the end of the first year.

Analysis of Weight Records:

Other factors besides nutrition which may have a bearing on weight were next considered, e.g.

(1) Presence of chronic illness.

(2) Inadequate meals, resulting from a low food budget, and which the supplementary ration was insufficient to balance.

(3) Those cases where the physique and the weight were normal or above average, before starting the ration test.

Where men did not show a substantial weight gain, or where they actually lost weight, further investigations were made.

The numbers who did not gain weight are as follows:

First year of investigation.

Group A (1):	On the lower level of 41% to 70% of available ration issues	7
Group A (2):	On the better level of over 70% of available ration issues	32
	Total	39

Group B (1):	On the lower level of 41% to 70% of available ration issues	6
(2):	On the better level of over 70% of available ration issues	22
	Total	28
Group C: (1)	On the lower level of 41% to 70% of available ration issues	5
(2)	On the better level of over 70% of available ration issues	36
	Total	41

In Group A it was found that 23 men (out of 39) had normal weights at the start of the test, and 6 were below the Poverty Datum Line in their dietary scales. Pyorrhoea was further recorded in six cases; in 2 cases it was associated with diets below the Poverty Datum Line, and in 2 other cases it was associated with chronic chest disease, plus a food budget below the PDL. One case had chronic dysentery. Three+ other cases are listed below. These figures are summarised as follows:

Pyorrhoea	: 2
Pyorrhoea + sub-P.D.L. Food Budgets	: 2
Pyorrhoea + sub-P.D.L. Food Budgets + chronic chest disease	: 2
Chronic Dysentery	: 1
Sub-P.D.L. food budgets only	: 6
Initial weights in normal range	: 23
Sub-P.D.L. food budget and heart disease+	: 1
No apparent cause+	: 2
Total	: 39

In Group B, 13 (out of 28) presented with normal weights at the start of the investigation. Three cases had pulmonary tuberculosis, 2 cases had chronic bronchitis, 2 had had a recent illness shortly before being re-examined. There were 8+ other cases involved, as will be seen from the following details:

Pyorrhoea }+	:	1
Oral sepsis}+	:	1
Recent illness at time of weight check	:	2
Chronic chest disease	:	2
Pulmonary Tuberculosis	:	3
Initial weights normal	:	13
No apparent cause+	:	6
Total	:	28

In Group C only 3 cases out of 41 presented a normal weight pattern at the start of the investigation. This is perhaps of significance when it is remembered how this figure differs from the preceding two groups, and that Group C comes from the slums around Howick. Twelve cases had food budgets below the P.D.L. Five cases had gross pyorrhoea, 2 had pyorrhoea plus food budgets below the P.D.L., 3 had pyorrhoea and chronic bronchitis. One with pyorrhoea had pulmonary tuberculosis, three had chronic chest disease, and three others had pulmonary tuberculosis. Two other cases with pulmonary tuberculosis had a dietary scale below the poverty datum line. The details are summerised below:

Pyorrhoea	:	5
Pyorrhoea + Sub-P.D.L. food budget	:	2
Pyorrhoea + chronic chest disease	:	3
Pyorrhoea + pulmonary tuberculosis	:	1
Chronic chest disease only	:	3
Pulmonary tuberculosis only	:	3
Pulmonary T.B. + Sub-P.D.L. food budget	:	2
Chronic chest disease + Sub-PDL food budget	:	1
Oral sepsis	:	1
No teeth + Sub-P.D.L. food budget	:	1
Initial weights normal	:	3
Sub-P.D.L. food budgets	:	12
No recorded cause	:	4
Total	:	41

The total figures at the end of the second year of the test were:

Group A:	(1)	On lower level of 41%-70% of available ration issues	8
	(2)	On the better level of over 70% of available rations	18
		Total	26
Group B:	(1)	On lower level of 41%-70% of available ration issues	6
	(2)	On the better level of over 70% of available rations	13
		Total	19
Group C:	(1)	On lower level of 41%-70% of available ration issues	10
	(2)	On the better level of over 70% of available rations	22
		Total	32

The reasons suggested are essentially the same as those already discussed, but the summaries are appended for the sake of completeness.

Group A:	Pyorrhoea	1
	Pyorrhoea + Sub-P.D.L. food budget	3
	Pyorrhoea + chronic chest disease + sub-P.D.L. food budget	1
	Chronic chest disease	1
	Heart disease + sub-PDL food budget	1
	Initial weights normal	12
	Sub-P.D.L. food budgets	4
	No recorded cause	3
	Total	26
Group B:	Pyorrhoea	1
	Pyorrhoea + Sub-P.D.L. food budget	1
	Chronic chest disease	1
	Pulmonary tuberculosis	4
	Recent illness at time of weight check	3
	Initial weights normal	6
	No recorded cause	3
	Total	19
Group C:	Pyorrhoea	3
	Pyorrhoea + chronic chest disease	2
	Pyorrhoea + sub-PDL food budget	3
	Pyorrhoea + chronic chest disease + sub-PDL food budget	1
	Pyorrhoea + pulmonary tuberculosis	1
	Chronic chest disease	1
	Pulmonary tuberculosis	2
	Pulmonary T.B. + sub-PDL food budget	2
	Chronic chest disease + sub-PDL food budget	1
	No teeth + sub-PDL food budget	1
	Sub P.D.L. food budget only	5
	Initial weights normal	9
	No recorded cause	1
	Total	32

NOTES:

The above analysis indicates that in the first year of the test there were 108 men who failed to gain weight, or actually lost weight in spite of their taking 41% and upwards of the available supplementary ration. No adequate reason for this could be given in 12 cases. Of the remaining 96, 39 had approximately normal weights before entering the test. Dramatic weight gains were not expected in these cases, as their physical condition appeared to be normal.

In the other 57 cases, various physical conditions existed as well as low food budgets, a combination which records show is associated with low weights and the presence of malnutrition. The figure of over 70% of the supplementary ration issued was considered the minimum requirement for the optimum benefit to be derived. Obviously such an arbitrary figure cannot be strictly applied to each individual. There are however, too many factors known and unknown to attempt to individualise statistical figures of this kind, and they are submitted as generalisations.

The comparable figures for the end of the second year of the test reveal that only 7 of the 77 men taking upwards of 41% of the ration had no known factors recorded to account for their failure to register weight gains. Twenty-seven were within the normal weight range, while the remaining 43 all had records of some of the factors found to be associated with unsatisfactory physical condition.

<u>Analysis of Weight Gains (4 lbs. and over) where Ration Intake was less than 41% of Available Issues.</u>

It was found that in each of the Test Groups there were a few men who made substantial weight gains in spite of taking less than the lower level of ration issues. The level was regarded as approximately 41% of the total available ration issued.

In Group A, e.g. there were 11 men who gained from 5 to 9 lbs. whilst taking from 0 to 39% of the available supplementary ration. Nine of these men had food budgets from 107% to 171% of the poverty datum line minimum. Two had food budgets below the poverty datum line minimum. In five cases the initial weights were within the normal range. In the remaining six cases, the weights were between 82% and 90% of the standard weights applicable. The figures for the second year of the investigation are as follows:

<u>Group A</u>: (Compound)

11 men gained from 5 to 9 lbs. over their initial weights while taking from 0 to 39% of the available ration issues in the second year of the test.

9 of the above 11 had food budgets from 107% to 171% of the Poverty Datum Line minimum.

2 had food budgets below that minimum.

5 had initial weights within the normal range.

6 had initial weights between 82% and 90% of their standard weights.

Only 1 of the 11 registered a substantial weight gain in the second year of the test (8 lbs). Seven of the 11 took more than 41% of the available ration issues in the first year when their major weight gains were registered.

The results in Groups B & C are summarised briefly below:

Group B: (Howick Native Village)

19 men gained from 4 lbs to 23 lbs over their initial weights, taking from 0 to 33% of the available ration issued in the second year of the test.

15 of the above had food budgets from 102%-192% of the P.D.L. minimum.

4 had food budgets from 71%-85% of that minimum.

7 had initial weights within the normal range.

12 had initial weights from 85%-90% of the standard weights.

Substantial weight gains from 7-18 lbs. were registered in only 4 of these cases in their second year.

16 of the 19 took more than 41% of the available ration issues in the first year of the test when their major weight gains were registered.

Group C: (Slum areas)

19 men in Group C gained from 4 lbs to 20 lbs over their initial weights, taking from 0-36% of the available ration issued in the second year of the test.

12 had food budgets from 77%-85% of the Poverty Line minimum.

7 had food budgets from 77%-85% of the Poverty Line minimum.

11 had initial weights within the normal range.

8 had initial weights from 72%-86% of their standard weights. All the substantial weight gains in this group of 19 men were registered in the first year of the test, when 17 out of 19 consumed over 41% of the supplementary ration.

Having regard to many of the factors which might influence a man's weight it is submitted that the analysis of weight gains in relation to the amount of the ration consumed is indicative of the value of the supplementary ration to the men taking a basically inadequate diet. At the same time, those men whose food budgets were adequate before embarking on the test did not show appreciable improvements, from which it was inferred that their nutritional state was adequate.

The weight checks, plus the examinations for the presence of malnutrition signs, were conducted by the same examiner. All the examinations were however, conducted in the "blind" manner, and it was not known what the previous weight was, or what clinical stigmata of malnutrition, if any, were present on previous examinations.

(ii) Malnutrition Signs:

Of the 245 men retained in the test group up to the end of the second year, 161 had signs of malnutrition when the study was commenced. One man presented with malnutrition signs at the end of the first year which were not present at the initial examination.

The progress is analysed in the three residential groups and collectively under the headings, i.s.q. (in status quo) Improved, Healed, Relapsed and Signs now present. It is also related to the amount of ration issues recorded as a percentage of the total issues available.

Table 62.

Group A.	First year of Test					
Percentage Ration:	i.s.q.	Improved:	Healed:	Relapsed:	Signs now present:	
Under 41%	-	-	2	-	1	
41%-70%	-	3	2	-	-	
Over 70%	-	6	34	-	-	
Total	-	9	38	-	1	
Group B:						
Under 41%	1	1	1	-	-	
41%-70%	1	-	8	-	-	
Over 70%	-	9	30	-	-	
Total	2	10	39	-	-	
Group C:						
Under 41%	-	-	3	-	-	
41%-70%	-	2	8	-		
Over 70%	1	7	41	-	-	
Total	1	9	52	-	-	
A, B & C:						Total
Under 41%	1	1	6	-	1	9
41%-70%	1	5	18	-	-	24
Over 70%	1	22	105	-	-	128
Total	3	28	129	-	1	161

One other in Group C took 70% in the first year, but was not re-examined for malnutrition signs. He had, however, gained 8 lbs. in weight. The second year he gained a further one pound, taking only 2% of the ration.

The figures for the second year of the test are also appended.

Table 63.

Group A.			Second year of test			
Percentage Ration:	i.s.q.	Im-proved	Healed.	Relaps-ed.	Signs now present.	Total
Under 41%	1	-	12	2	-	15
41%-70%	-	-	1o	-	-	10
Over 70%	-	2	21	-	-	23
Total	1	2	43	2	-	48
Group B.						
Under 41%	-	-	17	3	-	20
41%-70%	-	-	9	2	1	12
Over 70%	-	-	20	-	-	20
Total	-	-	46	5	-	51
Group C.						
Under 41%	1	-	17	-	-	18
41%-70%	-	-	14	1	-	15
Over 70%	-	-	28	-	-	28
Total	1	1	59	1	-	62
A, B & C.						
Under 41%	2	1	46	5	-	54
41%-70%	-	-	33	3	-	36
Over 70%	-	2	69	-	-	71
Total	2	3	148	8	-	161

It will be noted that many cases are reported as "healed" in the under 41% ration group. It is known that many men in this ration group in the second year took considerably more than 41% in the first year of the test. As a result, the malnutrition signs had either improved or healed before the second year of the test was under way.

The overall impression was that most of the men benefitted by taking the supplement, and they confirmed this by admitting to a better general state of health and activity. The posture in many improved noticeably.

The results of these weight checks plus the improvement noted in the majority who exhibited stigmata of malnutrition, supports Brock's view[14] that where dietary deficiencies were presumptively established and improvement occurred as a result of test feeding, this might reasonably be considered to carry conviction, although it does not constitute proof.

(iii) Comparative Sickness Records:

The problem of the worker who regards his two weeks sick pay as a vacation to be claimed as a right, is familiar in this and other industries where sick pay is provided. However, it was felt that the question of sickness amongst the Non-Europeans, particularly Africans, was closely bound up with the housing shortage, involving as it often does, separation from family life and over-crowding, either with or without families, in unhygienic, self-constructed dwellings with a total absence of any sanitation. In these conditions of squalor and lack of family life or social amenities, shebeens flourish. The harmful effects of a weekend spent at shebeens is known to be an important factor in absenteeism. The side-effects of lowered resistance and increased susceptibility to infections cannot be ignored.

The Company's records of the cost in terms of sick-claims paid out in certain years, are as follows:

<u>In 1955</u>: SARMCOL paid out £6,418 for Sick Pay representing over 104,280 hours of working time lost, or approximately 2.5% of the possible working time. Non-Europeans lost 95,570 hours.

<u>1956</u>: The Company paid out £5,817 for Sick Pay involving 85,435 hours of working time lost, or approximately 2.1% of the possible working time. Non-Europeans lost 80,466 hours.

<u>In 1957</u>: The Company paid £8,016 in Sick Pay for a loss of 122,872 working hours, or 2.8% of possible working time. Non-Europeans lost 105,704 hours.

Records showed that in 1955, 50% of the employees receiving sick pay were claiming the full amount of sick pay to which they were entitled under the provisions of the Wage Determination Act, that is, full pay for two weeks in each 12-month cycle of employment. The records of sickness only cover periods of absence for which sick pay claims, supported by the requisite medical certificates were submitted.

<u>Absence from work due to sickness: Experience in Britain</u>.

It is interesting that Government experience in Britain has shown that the introduction of a sick pay scheme not only increases absence from work, but that it also increases the differential absence between time and piece rate workers.[47] In the steel industry in Britain, there is no sick pay scheme, and there are wide differences in the level of pay. It was found in this industry that the number of shifts lost per 100 men per year, tended to increase with wages.[47] Family responsibilities and social background were also found to influence the picture, and absence tended to be higher for single men and to fall as the number of dependants increases up to two. Men with more than two dependants tend to be away from work more. In the latter case as the total family load rises, the family takes priority even over attendance at work.[47]

Experience in Britain has shown too that men tend to stay away if they dislike their work, and also if they are well paid during periods of absence - in short, they will stay away if they can afford to do so. It appeared too, that there is no sharp division between medical and non-medical reasons for absence, one imperceptibly shades into the other.[47]

A factor commented on by Browne[47] which is supported by our own experience at SARMCOL, is that in general time off tends to be taken in periods of a whole week. We have observed too that a week is often taken in the first half of the year, followed by a second week in the latter half of the year - this period often coincides with the local ploughing season.

London Transport showed that time lost from short absences of one, two or three days tends to fall with the age of the workpeople, but that time lost from absences of four or more days tends to rise with age. As men grow older they become immune to the short term infections and are away for fewer short spells, but as the pattern of illness alters with age, the length of time taken off at each spell of sickness increases up to retirement.[47]

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At the outset of this Study no statistics were available upon which to base any conclusion as to whether our experiance of the incidence of sickness was high, average or better-than-average. Since then, however, in January 1958 an article was published in "The Manufacturer" entitled "Absenteeism in Industry" by Dr. Gerald Machanik (page 9), Senior Medical Officer of the Office of the Workmen's Compensation Commissioner, Pretoria, giving facts and figures prepared from a questionnaire which had been completed by 61 firms, representing 16 different types of industry in the Union. The figures given are for total days lost in each of the types of industry concerned, for -

(a) sickness, other than compensable accidents;
(b) compensable accidents, and
(c) other causes.

These are summarised by tables of the total Sample Survey of the 61 firms with figures of the average days lost per employee in the different racial groups employed, for the year ended 30th June 1955.

For comparative purposes, the figures for Sarmcol have been converted from hours lost to days, and are embodied in the following table. (Table 17 published in "The Manufacturer" detailed the racial groups separately and also included female workers. For our purposes, the figures for Non-Europeans have been consolidated into one column and figures of females excluded, as we have no comparable record.)

Table 64(a)

Comparative Table of Total Sample Survey (61 Firms) & SARMCOL, of days lost for the year ended 30.6.55.

Cause of Absence:	Non-Europeans Sample Survey: No. of employees.	Non-Europeans Sarmcol: No. of employees.
	17347	1694
(a) Sickness, other than compensable accidents	41738	8035
(b) Compensable accidents	9560	545
(c) Other causes	51125	6251
Total days lost	102423	14831

Average Days Lost for Year Ended 30th June 1955

Table 64(b)

Cause of Absence:	Non-Europeans Sample Survey:	Non-Europeans Sarmcol:
(a) Sickness other than compensable accidents	2.4	4.7
(b) Compensable accidents	0.55	0.3
(c) Other causes	2.9	3.7
Average days lost from all three causes	5.9	8.75

The different types of industry represented in the Sample Survey are as follows:

Footwear (10 firms), Tanning (1 firm), Textiles(5 firms), Electrical(2), Motor Assembly(4), Cement products(2), Milling(7), Tyres(2), Building(2), Soap and Candles(1), Tobacco(2), Timber(3), Printing(17), Chemical(1), Aluminium(1), Confectionery(1).

It would appear from the above table of average number of days lost that the figures are appreciably higher for SARMCOL in respect of (a) Sickness and (c) other causes, than the figures for the Sample Survey.

No information is available about the siting of the 61 industries of the Sample Survey, nor is it stated whether the industries concerned fell under Wage Act Agreements which stipulated that sick pay must be paid. It is noted however, that the figures for sickness in respect of the Building Industry are the lowest in the Survey. It is understood that Sick Pay is not paid in that Industry. On the other hand, the Printing Industry in common with Motor Assembly and Tobacco are highest, followed by Tanning and Tyres. Climatic factors may have some bearing on certain types of sickness, making comparisons of widely spread groups difficult and possibly misleading.

The article quoted in the January number of "The Manufacturer" was concluded in the February issue. The following paragraph is relevant:

"In Tables Nos. 19 and 20 below, the average days lost for that year are given where casual absences of less than 3 days were not paid for, and where they were paid for respectively. As will be seen, sickness absence decreased where they were not paid for."

Average days lost where casual absences of less than 3 days are NOT paid for, for all races (males) amounted to 4.4 days. Average days lost where casual absences of less than 3 days ARE paid for, for all races (males) was 6.46 days.

It was noted that the racial composition of the Sample Survey was different from that of SARMCOL, but the figures do not indicate that this composition accounts for the higher rate of absenteeism - quite the reverse, in fact. The ratio of the racial groups in the Sample Group and SARMCOL was as follows:

	Sample Group	Sarmcol
Coloured	14.8%	3.0%
Asiatic	6.4%	13.9%
Natives	48.6%	77.0%

Among possible causes for the high rate of sickness, it was believed that the Natives would show the highest incidence because of their generally lower living standards, with Coloured, Asiatic and Europeans following in that order. In actual fact, the numbers of sick claims related to the numerical strength of each group were in inverse ratio to this expectation, with Europeans highest with a figure of 57%, Asiatics 53%, Coloured 50% and Natives 40%.

It was observed that this order reflected the average levels of education and possibly intelligence of the respective groups, indicating (possibly) that the ratio of sick claims might be in proportion to their perception of the sick pay benefits available. An additional factor which could not be excluded, might be the sense of security felt by the different racial groups and that whilst Europeans felt relatively secure in their jobs, Natives might fear loss of employment if they were absent too often. This however, was pure conjecture and what appeared to be an equally valid argument was that Europeans were less ready to risk dismissal and therefore produced medical certificates to cover all absences, even for the most trivial complaints. However, this suggestion may be disregarded in the light of the figures for (c) i.e. "Other causes than sickness or compensable accidents" which show a higher rate of absence for Europeans than for Non-Europeans. It is undoubtedly true that Natives frequently treat themselves with their own herbal remedies, or consult herbalists and witch-doctors - "inyangas" or "sangomas" as they are called. In such cases, they are naturally not in a position to furnish medical certificates, although a document from an inyanga was on one occasion produced in support of a sick claim.

Analysis of the records of absence due to sickness among Natives revealed a comparatively high rate of sickness among Natives housed in the Company's Compound, and a relatively low rate for those housed in the Howick Native Village. Natives living in the slum areas had a high incidence of sickness.

It was very strongly felt that housing and nutrition were the two principal underlying factors in the problem of industrial health and that the high rate of absence through sickness in the Compound and slum groups was a concrete illustration of the probability of this theory. In the case of the Compound Group, the men are separated from their families and generally obliged to cook for themselves. The slum groups were known to be existing in overcrowded and badly ventilated structures, made generally of insubstantial material, subject to dampness, leaks and probably verminous.

A brief discussion on comparative lines follows with particular regard to the Asian Influenza Epidemic:

Asian Influenza Epidemic (24.7.57 to 7.9.57).

The known cases of Asian Influenza (covered by sick claims) of Africans employed at SARMCOL, and a group of Africans employed by S.A.R. Tunnel Company, Cedara, Natal, are compared. Both groups were under our control.

Table 65.

	Sarmcol	S.A.R.Company
No. of cases	492	120
% affected	37.7%	20%
Time Lost(average)	406 lost 40.6 working hours. 86 lost 73.3 hours.	103 lost 38 hours. 17 were not booked off duty).
Complications	55 (11.2%)	2 (1.67%)
Mortality	Nil	Nil

The difference in the time lost and the percentage of complications recorded are in favour of the S.A.R. Company. Both groups of Africans in general shared similar living conditions. The type of work performed again did not favour the S.A.R. group, who were working underground in damp conditions. The latter group, however, were fed a balanced ration scale and all food was provided. This scale was mentioned in the chapter on diet.

It is of some interest to mention here that the Factory Test Group as a whole had an incidence of 31.9% affected, as compared with the remainder of the factory Africans, called the Non-Test Group, who gave a figure of 39.4% affected. The value of nutrition in these figures is suggestive.

Consolidated record of sick claims.

After the figures for the Asian Influenza Epidemic had been completed, a record of all sick pay claims in respect of the Company's African employees was compiled for the years ended 30.6.1958 and 30.6.1959. The statistical record was broken down into the three main residential groups, these being again sub-divided into the test and non-test groups. Sick pay claims in respect of injuries were excluded from the record.

Table 66.

Percentage of Group submitting Sick Claims during period		
Residential Group:	Year ended 30.6.58.	Year ended 30.6.59.
Compound: Non-test	75%	68%
" Test Group A	83%	73%
Howick Bantu Village: Non-Test	78%	76%
" " " Test Group B	81%	57%
Other areas: Non-test	94%	85%
" " Test Group C	82%	73%
Total: Non-test	87%	79%
Test Groups	82%	68%

The above figures were broken down in respect of the Test Groups into further sub-divisions, viz. those who took from 70% and more of the available supplementary ration, and those taking less than this. The full benefit of the supplement might be expected to apply to those men who took 70% or more of the supplement - in other words, those who used the supplement on seven out of 10 working days. Men who took over 70% of the ration were labelled the "effective" group.

Though the total sickness rate of the Test Groups as a whole is still lower than that of the Non-test employees, the percentage is weighted by the inclusion of those who took less than 70% of the available ration, and who would therefore be regarded as non-effective or only partially effective.

Table 67. Sickness Rates.

Comparison of "Effective" and "Non-Effective" Participants in Ration Scheme Test.		
	Year ended 30.6.58.	Year ended 30.6.59.
Group A: Effective	81%	73%
Non-Effective	89%	73%
Group B: Effective	79%	50%
Non-Effective	100%	72%
Group C: Effective	81%	75%
Non-Effective	87%	68%
Total Test Groups:		
Effective	79%	68%
Non-Effective	92%	69%
Non-Test Group	87%	79%

The above figures refer to the actual numbers of men who had one or more cases of sickness during the periods recorded, and for which sick claims were submitted. The actual number of periods of illness varied from 1 to 7 in Non-test group and 1 to 4 in the Test groups in the year ended 30.6.58. These cases of illness involved from 1 to 9 claims for Sick Pay in the former group and 1 to 6 claims per man in the Test groups.

In the non-test group 10.5% in 1957/58 and
11.5% in 1958/59

submitted sick claims in respect of injuries(not I.O.D). The Test Groups had a rate of:

7.4% in 1957/58 and
10.4% in 1958/59.

Comparison of the above rates of sickness with the Sickness Morbidity Rates recorded by Williams[48] in his feeding experiment, show a striking difference in favour of the Mines' sickness rates, compared with those of this Factory. The rates per 1,000 per annum for the Mining Industry were:

	1938	287	
	1939	253	
	1940	268	compared with
Sarmcol	1958	865	
	1959	780	or an average on the

Mines of 270 against this Factory's experience of 822. There appear to be several contributory factors operating:

(1) The medical requirements for fitness for the Mine "red ticket";

(2) The fact that the Mine workers are entirely housed and fed by the Mine;

(3) The Mine Medical Officer alone is responsible for all Medical certificates, necessitating absence from work, hospitalisation, medicine and duty, etc.

At Sarmcol certificates are accepted from all medical practitioners in the area.

(4) Mine Natives housed in Compounds are under tighter discipline and, generally, are far from their homes, and consequently less prone to the results of weekend sprees than are the workers in other industries.

(5) Sick pay is on an entirely different basis from this Industry. On the Mines a man is hospitalised or given light duty. He is not paid during hospitalisation unless this is for a long period, when he receives an ex-gratia payment which equals about 50% of his normal pay. Payment for convalescence or light duty is 2/- per day. Convalescents are put on to light duty, such as tending gardens.

It is of interest that Williams found significant decreases in the sickness and accident morbidity rates of his Experimental Group, as compared with the men receiving standard Mine rations, the difference in favour of the Experimental Group being 6.1%, 12.2% and 11.4% for the years 1938, 1939 and 1940 respectively.

In the experiment at SARMCOL, only a protein supplement of skimmed milk, plus a multivitamin tablet was given each day. Despite the relative smallness of the supplement offered, the test group in the year ended 30.6.58 showed that 82% had submitted sick claims as opposed to 87% in the non-test group.

In 1959 the figures were: Test group	68%
Non-test "	79%
In the Effective group (30.6.58)	79%
In the Non-effective " (30.6.58)	92%
In 1959 the figures were:	
Effective group	68%
Non-effective "	69%
The Non-test group figures were 1958	87%
1959	79%

The difference in the figures, although not striking, is suggestive of the value of the nutritional supplement, and this is in keeping with Williams' experience.[48] It is not possible to assess the part played by all the factors causing absence, although reference to several factors has been made in the text.

Conclusion:

The impression gained in this study was that the provision of a supplement was of benefit to the majority of the men concerned. It is not suggested that the supplement used is the only, or even the best approach, to the problem of malnutrition affecting Bantu workers in industry. It would probably be better to provide a balanced cooked meal once a day. Brock feels that the provision of such a meal is the most important step in any programme of rehabilitation of the undernourished.[49] This will be discussed further in chapter seven, which deals briefly with the present canteen arrangements at SARMCOL.

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The next chapter will discuss the poverty datum line as it applied to our people.

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CHAPTER 6

THE POVERTY DATUM LINE

The general idea contained in the expression "The Poverty Datum Line" is readily acceptable to most people. The subject can become controversial however, when an analysis is attempted of the items which make up the total. For the purpose of this article, it is hoped to define in some detail what is included in the figures. The figures are not intended to be read as general standards. They apply specifically to the men concerned in this study.

By clearly defining what has been done, it is hoped to avoid criticism that items have been included which should not be included, or that items have been excluded which should have been included.

The Poverty Datum Line has been defined as "the income which an individual household would require if it is to attain a defined minimum level of health and decency. This includes only food, housing, transportation, clothing, fuel and lighting and cleaning materials. It does not allow for amusements, sport, medicine, education, saving, holidays or for any comforts or luxuries."

This standard was devised by Prof. Edward Batson[1] of the University of Cape Town whose social survey aimed at establishing a basis upon which the social worker could measure not only whether a family is poor, but also the degree of poverty. (The relative literature surveyed is listed at the end of the chapter under 1.)

THE EFFECTIVE MINIMUM LEVEL

According to Wollheim[2], "If a family attains these levels, it is said to be on the Poverty Datum Level, but that effective living demands more than merely keeping alive. For this reason the calculation makes provision for another level called the Effective Minimum Level, which is about 50 per cent above the Poverty Datum. It is only from this Effective Minimum Level upwards that life becomes tolerable or consistent with the minimum requirements of urban environment. Poverty, therefore, begins when a family falls below the effective minimum level and increases in severity until the family reaches the Poverty Datum Level, below which the family immediately becomes a grave problem to the community by virtue of the additional services which it requires in extra police, charity, clinics and hospitals, feeding schemes, assisted housing, subsidised transport and the like."

THE POVERTY DATUM LINE[1]

Where living conditions vary considerably it has been found necessary to take account of different individual and group circumstances to an extent which even our sub-division of the Test Group into three residential groups does not entirely accomplish.

Apart from the obvious factors, such as marital status and number in the household, which have a bearing on the economic level, other considerations which apply are:

(1) Distance of home from place of work.

(2) Whether living at home.

(3) Number of homes supported.

(4) Whether polygamous.

(5) Whether family lives in a reserve, on a farm or in a township.

(6) Amount of contributions to dependants each of which considerations represents a different subdivision of the residential groups previously defined as Test Groups A, B and C.

(7) The question of debt.

Surveys carried out from time to time by various authoritative investigators have produced standards for Poverty Datum Lines in some of the larger centres, e.g. Durban, Johannesburg, Cape Town and Pretoria, and amongst the different racial groups of the population, including Africans. These are not necessarily related to the factors found in a small township like Howick. It would be unrealistic to apply the same values in this area as are applicable to larger centres where a greater degree of urbanisation of Africans has taken place.

This urbanisation is interesting, and a notable characteristic of the population of this country is the extent of the urbanisation that has taken place. Official statistics reveal quite clearly that the urbanisation rate of the Bantu has outstripped that of any other race. The scale of the Natives' movement to the towns is best seen in the actual numbers involved. Where in 1911 there were approximately half a million Natives in the urban areas, the number had increased to some 3.1/3 million by 1960. Where 50 years ago but one in every eight Bantu resided in the metropolitan areas, today 3 in every 10 do so. During the last inter-censal period (1951-1960) there was a bigger increase in the urban Bantu population than in any similar period in the past. A sample survey just completed by the Council of Scientific and Industrial Research reveals that 70% of urban Natives are industrialised workers who have never reverted to rural work. (Horwood)[3]

There are factors which at present make it possible for Africans to maintain an adequate nutritional level in conjunction with a lower economic level than that of the European. One reason for this is that the African palate is not yet conditioned to reject some of the more wholesome traditional Bantu foods whichEuropeans often find unappetising or even revolting; furthermore, monotony of diet does not appear to concern the African, provided sufficient quantities of food are available.

Though it is true at the present time that living conditions amongst the different groups studied vary considerably, it should be noted that future development as far as industry is concerned lies in the direction of native townships on similar lines to the Howick Native Village, which will tend to produce a stabilised urban

African population living in more or less uniform conditions. The development of Kwa Mashu outside Durban is a recent example. For this reason, it seems that the significant figure for our Poverty Datum Line would be the income which an African family in the Howick Native Village would require as a minimum for the standard defined in the early part of this chapter.

There are certain unavoidable expenses which, though possibly not essential to maintain life, are at the same time so essential that where these have been incurred, a smaller amount is available for the necessities - grouped under the Poverty Datum Line.

When the costs of rent, transportation and taxes, which are the first charges against income, have been deducted, the amount available for food, clothing, fuel, lighting and cleaning materials can be determined.

Rent forms a considerable burden to the urbanised African, and it is of interest that Herman Schwabe, director of the Berlin statistical bureau in 1868, propounded his well known law that "the poorer anyone is, the greater the amount relative to income that he must spend for housing." This is equally true today and is complicated by the fact that two conventions relating to housing seem to have arisen in South Africa. The one is that 20% of income is a fair and reasonable rental on residential property, the other, that an income of £15 a month is the rightful dividing line for payment of "economic" and sub-economic" (subsidised) rentals by African families.[3]

Food is a very special item and its enormous importance in the family budget is at once apparent. The famous empirical law of consumption - that "the poorer a family, the greater the proportion of its total expenditure that must be devoted to the provision of food" is as valid for the urban African in South Africa today, as it was for Germany at the time it was first formulated by the famous Prussian investigator, Engel, in 1857.[3] A survey in Pretoria involving Africans, revealed that the average sized household (6 persons) required from £12 to £12.10.4. i.e. nearly half its income to purchase sufficient food for its needs.[4]

The fact that the aggregate family income may equal or exceed the standard accepted as the Poverty Datum Line for that particular family unit, does not necessarily imply that the members of such a family do actually attain the defined minimum level of health and decency which their income is capable of providing. On a marginal income this is only possible by rigid economy in the use of resources and if these are diverted for other purposes, whether for luxuries, comforts, unavoidable expenses or simply squandered, there must be a corresponding reduction in the budget for food, clothing or other necessities.

Austerity living is unattractive, and in every level of society there are those who aspire to better living standards than are warranted by their financial resources. However, this natural aspiration apart, there is a distinct gap between the poverty line and an effective minimum level which would allow for the normal contingencies, social obligations and educational and cultural needs of modern community living, as well as an adequate level of nutrition and health.

In the chapter on Diet, in which the cost of a minimum standard of nutrition was considered, the costs of other more adequate diet standards were presented. As the scope of this Industrial Health Survey is primarily related to the health of the African worker, the stated or assessed expenditure on the worker's own food has been bracketed against each individual analysis of income and expenditure, in the working sheets used. This figure will reflect how many of the group spend less on food than the defined minimum of the Poverty Line. Examples appear in the Food Analysis sheets, found at the end of the thesis.

The assessment of income, other than the worker's own earnings is problematic and one of the difficulties is that of obtaining dependable figures about the earnings of members of the household who contribute to the family budget. Many of the women and children earn small amounts of money for casual or permanent work; e.g. one has a secondhand clothes shop and others earn undisclosed amounts from illicit liquor dealing or brewing.

The amount contributed by an unmarried son or younger brother to the head of the house is often held in trust for the provision of lobola, an obligation which devolves upon the head of the family. This obligation is in fact recognised as the joint responsibility of all members of the family; cattle owned in the name of the kraal-head or other members of the family being recognised as the possession of the family unit for the ceremonial and ritual purposes of native custom and law.

The anomaly of families living below the Poverty Line, whilst possessing livestock often representing a quite considerable cash value, is thus at least partly explained. Income in cash or kind derived from crops produced has been assessed on the basis of average production of the Reserves.

In estimating incomes derived from agriculture and stock an average production figure of 6 bags of grain per family has been accepted. This figure was assessed by the Department of Native Affairs Chief Agricultural Officer, and was the same as our own assessment made from observation and enquiry at Impendle. It was estimated that 4½ bags of grain reaped were maize and 1½ bags kaffircorn. Valued at 36/2d. per bag for maize and 47/6d per bag for kaffircorn, these represent an income equivalent to £1.2.4d per month. These prices are millers' selling prices. No other crops, such as beans, potatoes and cabbage have been taken into account as production is irregular.

The Native Affairs Department assessment of income derived from stock is £2.10.0. per cattle unit, 5 small stock being equal to 1 cattle unit. This figure has been accepted for the purposes of this survey.

Where other members of the family contributed their earnings but no actual figure was stated or known, a figure of £3 per month has been assessed.

In determining a poverty line it is apparent that the term is relative. In the case of diet, it depends on a minimum standard of nutrition. Where clothing and cleaning materials are considered, the standard must be related to the social environment, essential protection from the elements and the level of general hygiene.

Transport presents a problem in assessing the degree of necessity. The procedure adopted has been to sub-divide the test group as far as practicable into homogeneous units for the assessment of minimum standards in respect of transport, fuel and light, cleaning materials and clothing. The basis adopted for food costs is the minimum diet for a Bantu manual worker, his wife and two children. (Diet 1, discussed in the chapter on Diet). Current local retail prices were used.

As so many workers were extremely vague about the ages of their children, no attempt has been made to estimate their food requirements, according to nutrition tables for different ages and an average figure has been taken for children of all ages. The standard adopted is £2.10.9. for a man, £2.7.9. for a woman inmate of the household, and £1.16.11. for each child - per month - for food. It is felt that contributions to dependants who are not members of the household are an obligation recognised as essential by most Africans. The amount so contributed varies considerably.

The question of debt has not been exhaustively investigated, though some of the men stated that they were in debt. Hire purchase agreements are a regular feature of urban African living. It is a common feature in industrial communities in all parts of the world.

The whole question of debt can be likened to "one of the holes in the net" in this study. One was conscious at the time that the men were questioned that the whole story was not being divulged. Debt however, is a thorny problem and men are naturally reluctant to discuss it fully.

Hire purchase transactions are easily entered into but equally dangerous in their implications. The time may well come when legislation to curb this aspect may be required, as occurred in the "credit squeeze" in Britain recently. In Britain, the problem assumed such proportions that it became a matter of national emergency demanding government action.

It is easily understood that on a limited income with hire purchase obligations superimposed, restriction of essentials, e.g. food, housing or clothing may be required.

In the absence of a complete economic survey it has been necessary to accept the estimates based on the replies to questions, after due assessment of these replies in relation to known facts and probability.

The basis adopted for the Poverty Datum Line has been related to the different standards of living obtaining in different environments. For example, the standard of dress in the Reserves which would represent a norm of respectability there, would almost certainly be considered below the accepted standard in the Howick Bantu Village. Similar differences occur in standards of cleanliness. In the Reserves, washing facilities are less convenient, housing conditions less conducive to cleanliness and items such as shoe polish unnecessary because few of the people wear shoes regularly, if at all.

It is conceded that the poverty line adopted in this survey is extremely low by comparison with surveys in other centres. To some extent it is reasonable to assume that living in this semi-rural area should be cheaper, but apart from this fact lower basic standards have been adopted purposely, to avoid over-drawing the picture and partly to offset the reticence encountered in revealing the earnings of the other members of the family income. It is felt that most families have earnings other than the wages of the householder, and that family incomes are probably higher in many cases than the amounts disclosed.

The following figures are submitted as a dietary basis for the Poverty Datum Line:

Table 68

Daily Quantities	Man 3,400 Calories	Woman 2,300 Calories	Each Child 1,750 Calories
Meat	2 oz.	2 oz.	2 oz.
Milk : Whole	½ pt.	½ pt.	¾ pt.
Skim	½ pt.	½ pt.	½ pt.
Dried beans	2 oz.	2 oz.	1 oz.
Mealie meal	8 oz.	6 oz.	4½ oz.
Samp or mealie rice	8 oz.	4 oz.	2 oz.
Brown bread	8 oz.	8 oz.	5½ oz.
Vegetables	8 oz.	8 oz.	4 oz.
Potatoes	2 oz.	2 oz.	2 oz.
Sugar	3 oz.	2 oz.	1½ oz.
Margarine	½ oz.	½ oz.	¾ oz.
Fat	1 oz.	1 oz.	¾ oz.
Coffee	½ oz.	½ oz.	½ oz.
Salt	½ oz.	½ oz.	¼ oz.
Representing a monthly cost of:	£2.10.9.	£2.7.9.	£1.16.11.

In a footnote to the above diet, the Department recommends the addition of fresh fruit or canned fruit juice 2-3 times a week. It is also pointed out that whilst the amounts of foods indicated in the ration form a balanced diet, the palatability of any diet should not be lost sight of. For instance, the amount of meat in the ration is less than would be welcomed by any African. These figures are thought to compare favourably with a diet discussed in a Cape Town study.[5]

Rent:

Rent reflects the figure for a 2-bedroomed house, with combined diningroom/kitchen, pantry and bathroom and follows the accepted scale as laid down in the location by-laws. This applies to the Howick Native Village. The figure is £2.9.0. per month.

Transport to work is not an item in the budget of residents in the present Howick Bantu Village who work at the Factory. The projected Location which will eventually replace this Village is, however, some miles away and transport costs will then be incurred.

The basis accepted for fuel and light is somewhat higher in the above estimate than that accepted in the 1958 Durban Survey. TheDurban figure has been accepted however in the summaries of our survey, that is 9/5d per month. This allows for 2 bags of firewood, 5 bottles paraffin, 10 candles and 5 boxes matches. The reason this extremely low figure is accepted is that wood can still be obtained free, or virtually free by those who are willing to fetch it, and many Africans do so. It is submitted that where real necessity exists, such wood as can be had for the taking will be taken even at the cost of some inconvenience in having to fetch it. Lighting is by paraffin lamps and candles. In the Pretoria survey the average Bantu family spent 7% of its income on fuel and light.[4]

Cleaning materials in Howick Native Village would include soap and polish. Here, the figure adopted is

2/5d per person per month in our survey, compared with 3/8d per month in Durban. This somewhat arbitrary figure is based upon observable standards of cleanliness here as compared with urban conditions.

As a standard for clothing the Durban assessment for men was adopted with slightly lower figures for women, and an average figure for children of all ages. These figures are £1.2.1. per month for a man, 17/5d for a woman, and 11/1d for children.

The average sized Bantu household (6) in Pretoria spends 41% of its income on food, 10% on clothing and 11% on housing.[4] Our figures show considerable differences, as will be seen.+

Clothing items represented by this budget are:

Man:	1 pr. shoes per year @ £2	£ 2. 0. 0.
	1 suit in 5 years @ £10	£ 2. 0. 0.
	1 jacket in 3 years @ £4	£ 1. 6. 8.
	1 pr. trousers per year @ £3	£ 3. 0. 0.
	3 shirts per year @ £1	£ 3. 0. 0.
	1 pullover in 3 years @ £2	13. 4.
	2 vests in 2 years @ 7/6d	7. 6.
	2 prs. socks per year @ 2/6d	5. 0.
	1 tie per year @ 4/6	4. 6.
	1 belt in 3 years @ 10/-	3. 4.
	3 handkerchiefs per year @ 4/6d	4. 6.
	(£1.2.1. per month)	£13. 4.10.

Woman:	1 pr. shoes per year @ 14/11d	14.11.
	2 dresses per year, 1 @ £3, 1 @ £1.10.0.	£ 4.10. 0.
	1 blouse per year @ 14/11d	14.11
	1 skirt in 3 years @ 29/6d	9. 6.
	2 petticoats per year @ 12/11d	£ 1. 5.10.
	3 bloomers in 2 years @ 5/6d	8. 3.
	3 vests in 2 years @ 4/3d	6. 4.
	1 cardigan in 3 years @ £1.10.0.	10. 0.
	1 coat in 5 years @ £5.19.6d.	£ 1. 3.11.
	Sundries, including doek and handkerchiefs	5. 4.
	(17/5d. per month)	£10. 9. 0.

The amount accepted for children is approximately 50% of the figure for a man's clothing. The insistence on school uniforms makes the provision of better clothing for children an essential in the Village.

Examples:

(1) A man, his wife and three children require a minimum income of £17.15.10d. per month to live in the Howick Bantu Village. (These figures for the P.D.L. were completed in June 1959).

This figure is made up of:

			+Pretoria
1. Food	£10. 9. 3.	58.8%	41%
2. Rent	£ 2. 9. 0.	13.8%	11%
3. Taxes	3. 4.	0.9%	
4. Fuel & light	9. 5.	2.6%	7%
5. Cleaning materials	12. 1.	3.4%	
6. Clothing	£3.12. 9.	20.5%	10%
	£17.15.10.		

+Considerable differences are seen from the figures presented in the Pretoria survey.[4]

A man lodging in the SARMCOL Native Compound with his home at Impendle, would have the responsibility of providing for his wife and family in the rural area. His own expenditure would be as follows:

Food	£2.10. 9.	16.8%
Rent	8. 0.	2.6%
Transport to Impendle twice a month	£2. 0. 0.	13.2%
Taxes	3. 8.	1.2%
Cleaning materials	2. 0.	0.7%
Clothing	£1. 2. 1.	7.3%
(1)	£6. 6. 6.	

Fuel and light are supplied free by the Company to the Compound.

For the support of his wife and three children living at Impendle (provided he has the average number of stock and income from crops in cash or in kind) the same man would require £8.16.5d. This is calculated as follows:

Food	£5.18.10.	39.2%
Fuel and light	9. 5.	3.1%
Cleaning materials	8. 0.	2.6%
Clothing	£2. 0. 2.	13.3%
(2)	£8.16. 5.	

or a total minimum wage (1 & 2) of £15.2.11d. The figure for food is calculated on the basis that his crops would produce £1.19.8d. If he did not have crops, the figure for food would be £7.18.6d.

In the above assessment lower estimates have been accepted for cleaning materials and soap, the difference being the amount allowed for shoe polish. The amount for clothing is approximately 25% lower than for the Howick Bantu Village.

The minimum living costs of a man living at Howick West would not be very different from his requirements if he lived in the Howick Bantu Village. His rent would average £1.3.8d. per month, which would be partly offset by transport costs which vary from 10/- per month to £1.10.0. if his family used public transport to school or to the township.

It is emphasised that the living standards possible are on the most frugal scale and include no extras beyond the essentials of food, clothing, shelter and necessary transport. No provision is made for medical expenses, recreation, luxuries or savings.

<u>Discussion:</u>

Production and markets being essential to industry, it follows that the reward paid to the worker must be related to his productivity. When a man's productivity is centred entirely on his own physical effort, that productivity may be increased by increased skill arising from his own development or by training which directs and speeds his own development. Machine evolution in industry tends to replace men's own physical effort but in spite of this the majority of working people in this country still earn their livings by physical effort. In Horwood's survey[3], three-fifths of all working men were classed as labourers; 2% were in the professional class, 4% were office workers and 8% were drivers.

Physical efficiency depends to a considerable extent upon the health of the worker. This is influenced by a number of factors. Living conditions in a broad sense are of obvious importance. In a more limited field, habits of feeding through childhood and in adult life are of the highest importance, and these have been discussed in the previous chapters.

In this study we concern ourselves with this latter factor. The changes in feeding habits which were spread over two or three hundred years in the development of European industry are taking place in this country in a very much shorter time. The results are very imperfect. In saying this, we may well remember that feeding habits in Europe are still far from being perfect. The means to obtain adequate food requirements are ahead of the knowledge of what these requirements are.

Unfortunately the worker's income level does not necessarily determine how he lives in relation to the accepted poverty line. "Man does not live by bread alone", and the way he lives is strongly affected by the habits and behaviour of the people amongst whom he lives. This is not a reaction peculiar to African workers. The consideration of a Poverty Datum Line however, is a theoretical conception which is essential to a study of this kind. The practical meaning of poverty is a comparative one. In the case of an individual there is ample evidence that its practical meaning is determined in a large measure by the elements of society amongst which he wishes to stand as an equal.

To live on the Poverty Datum Line certainly means to live and to go on living. But at that level there is no chance of relaxation from the struggle to continue living. Many people are living on this level in undeveloped or underdeveloped countries. In some degree this condition may be corrected or adjusted by widespread famine or disease. That is a form of adjustment from which all men shrink. The other way to adjust the situation is by a more effective exploitation of natural resources. This can take many forms - by increasing the efficiency of agriculture in terms of both crops and animals, by exploiting natures mineral wealth which may be available in many forms, and by developing manufacturing industries which rely upon the capacities and skills of the population. We are concerned of course, by this latter process. And the rewards which a man receives who works in industry are in the form of wages - money. The more productive a man's efforts, the more money he is likely to receive.

Money is an infinitely flexible buying medium. It can buy the essentials for the life of a family or it can buy non-essentials which may be attractive, interesting, desirable, but which make no contribution to the physical well-being of a family. First things do not necessarily come first even in a relatively educated household. The chance of an African worker making a wise choice of expenditure in an industrial community is very small indeed. There is so much to attract him and to compete for his money, that even though his income may bewell ahead of the Poverty Datum

Line, he and his family may suffer the evils of malnutrition. In developing a manufacturing industry there is a need for sustained effort in the men engaged in it. Malnutrition of its workers is one of the severe handicaps in the development of an effective labour force in industry.

In what has been said, it should be clear that whilst the need for an adequate income level is inescapable if a satisfactory state of nutrition is to be achieved, there is also great need for education on how money should be used, particularly in providing food for those who are, or will be committed to a life in industry.

It would be a strange state of affairs if African workers could live beside European workers without being stirred by an intense desire to have in their lives some of the amenities which they see Europeans enjoying. It has been claimed repeatedly that South Africa's cheap native labour is, in fact, the most expensive labour in the world, because of the low capacity of the worker. The productivity of African labour is generally on a distinctly low level, and there is a universal problem in this country on methods by which productivity of African labour can be increased. Any attempt to break the rotation in which living standards, productivity and wages revolve in endless succession should logically begin with the objective of improving the capacity of the worker, since without that the mere act of raising wages only results in spiralling prices which lower the real value of wages.

A programme of training and educating the worker, not only in the techniques and skills of his occupation - a field in which this Company is well to the fore - but also in correct diet and hygiene, is a first requisite in improving capacity.

Preventive medicine which includes adequate nutrition may well start with the worker in the factory. At the same time, the full effects of such measures cannot be felt immediately, especially in the reserve of labour represented by the workers' families, whose status can only be expected to improve gradually in proportion to the extent to which living standards are raised.

In the work recorded here, our efforts were almost exclusively focussed on the men working in the factory. It is recognised however that this is not enough for a long range project. The next stage should be a programme of enlightenment about nutrition aimed directly at the workers' families, together with realistic and progressive wage revisions and education about the use of money and the encouragement of thrift. The wage increases which were effected after these P.D.L. figures were evolved are shown at the end of this chapter, and reflect the interest of the Management in this matter. The results should become apparent in time, in the supply of labour which is represented by the children of workers presently employed, so that future intakes may start their careers in industry with advantages which many present employees lack - the possession of good physiques, good health and the stamina and intelligence required in factory work. This social aspect of the problem calls for attention if a supply of labour having a reasonable productive potential is to be developed and maintained for the requirements of industry.

In South Africa a great deal of work has been done on the nutrition of Native workers. Various feeding experiments have been conducted, notably on the Mines.[6] This was mentioned in chapter five. These reveal significant reductions of absenteeism due to sickness as well as lowered accident rates, where an adequate diet is provided. These results are side-effects of the state of improved wellbeing which they indicate. Apart from the improvement in productivity arising from less lost time, there is the additional factor of greater capacity and efficiency, which the lowered accident rate seems to confirm and which might reasonably be expected to flow from improved physical wellbeing.

This work is of great basic significance in the results it has produced, but it lacks one extremely important feature which becomes essential in industrial life on the European pattern. When a man is under constant discipline, he behaves more or less exactly as that discipline demands. Feeding is part of the discipline and he must eat what is put before him. This situation may be entirely to his satisfaction, but it certainly contributes very little - probably nothing - to his capacity to judge what he or his family should eat. In other words, the experience has no educational content. It is our very strong conviction that the European pattern of industry which places a man under discipline only during the working hours spent in the factory, leaves African workers in a great need of a form of education on feeding habits which can be carried into their own homes and families. The steps taken in this direction can be taken only very slowly and they demand the most careful judgement. The first effective point at which this effort can commence is the works canteen. This is a small and remote point in relation to the final long term objective, but correct nutrition provided in the canteen itself can offer immediate benefits to the men working in the factory, and we hope to make it the foundation for practical nutritional education of the worker which will extend through him to his family. This is discussed in chapter seven.

The summaries which follow indicate the relationship between wages and food budgets, whilst the chapter on the medical aspect of this survey attempted to show more particularly to what extent malnutrition signs and sub-standard weights are related to income and expenditure on food, in the cases studied. An analysis of the medical and weight checks carried out over a period of about two years, in connection with the supplementary feeding experiment was included in that chapter.

For the purpose of making a broad comparison between the three residential groups represented in the survey the foregoing analyses are briefly summarised as follows:

Table 69.

Below the Poverty Datum Line:	A	B	C
1. No. of family units with incomes below P.D.L.	55	40	67
2. As above, but including dependants not residing with wage-earner. (Average No. of persons)	9.5	8.3	8.8
3. % of family units with incomes below P.D.L.	68%	51%	78%
4. Av. PDL per family unit with incomes below PDL	£24.15. 0.	£23.15.7.	£24.2.4.
5. Av. income per family unit with incomes below P.D.L.	£19.14.11.	£17.11.8.	£17.3.1.
6. Av. figure for 3 groups		£18. 3. 3.	

Table 70.

Above the Poverty Datum Line:	A	B	C
1. No. family units with incomes above P.D.L.	26	38	19
2. As above, with dependants not residing with wage-earner. (Average number of persons).	6.8	5.6	4.9
3. % of family units with incomes above P.D.L.	32%	49%	22%
4. Av. PDL per family unit with incomes above PDL	£18.15.2.	£17.16.9.	£15.16.5.
5. Av. income per family with incomes above PDL	£23.12.9.	£23.11.8.	£21.15.5.
6. Av. figure for 3 groups		£22. 19. 1.	

It is clear from the foregoing figures that in all three residential groups the average size of family unit living below the Poverty Line was appreciably larger than that of those families whose incomes were above the Poverty Datum Line. It is also evident that the average income is in inverse ratio to the size of the family units.

The average income for groups A, B and C in those below the P.D.L. is £18.3.3., and in those above the P.D.L., the figure is £22.19.11. Horwood[3] suggests a minimum of £26.0.0. for a family of 5 in those living in the Durban-Pietermaritzburg complex. He arrives at this figure in the following way.

1. Food	£14. 1. 7.
2. Clothing, fuel, light, cleansing, transport and taxation	£ 6. 1. 4.
3. Rent	£ 3. 5. 0.
4. Furniture, medicine, education, tobacco and liquor	£ 2.12. 1.
	£26. 0. 0.

He adds that even allowing for a generous supplementing of wage incomes by other legitimate sources of revenue, it is safe to say that not one half of the African families in the above area could afford such a standard of living.[3]

In the Pretoria[4] survey the following income figures are given:

Professional classes	£28. 8. 9.
Semi-skilled classes	£22. 1. 2.
Clerical workers	£25. 1. 4.
Unskilled workers	£14. 3. 8.

66.4% of the heads of families were unskilled workers, 17.8% were semi-skilled and 7.8% were in professional, managerial, administrative and clerical and skilled jobs.[4]

Local Regulations:

The smaller households found in the Howick Bantu Village are partly the result of the application of Location Regulations by the Howick Town Board, limiting the dependants who may live with the householder to his immediate family. This compulsory reduction of the number of encumbrances has possibly been beneficial to the men concerned, though a certain number do have obligations to dependants not living with them which in some cases are fulfilled.

Such social reconstruction is necessary because the urbanisation of the Bantu has practically destroyed the existing social structure and the process has gone too far for a return to the old standards which in any case have no place in this modern industrial age.

A Review of Salary Scales:

The fact that this Company is deeply concerned about the welfare of the Non-European workers is clearly evidenced by the nature of this investigation. It remains to add a few pertinent facts concerning salaries and a ratio of the groups employed. A comparison follows of the average gross earnings (including bonus and overtime) per week:

Table 71.

	August 1939	1945	July 1959	Jan/Feb. 1961	Jan. 1962.
African	£1.0. 8.	£1.19.3.	£3.17. 6.	£4.11.11.	£5. 3.3.
Coloured	£1.3. 8.	£2. 7.3.	£4.12. 8.	£5. 1.11.	£5.14.8.
Asiatic	£1.2.11.	£2. 3.6.	£5. 3.11.	£5.12. 6.	£6. 7.2.

Table 72.

Ratio of average Gross Earnings taking August 1939 as 100.

	August 1939	1945	July 1959	Jan/Feb. 1961	Jan. 1962.
African	100	190	375	446	499
Coloured	100	200	393	432	488
Asiatic	100	190	454	492	555

A noticeable change in the ratio of Non-European to European employees is shown in the following table. The figure for Europeans represents those essentially concerned with production, and does not include office staff.

Table 73.

	Comparison of No. of Factory Employees over the past 22 years.				
No. of employees.	August 1939	1945	July 1959	Jan/Feb 1961	Oct. 1962
African	277	596	1,150	1,267	1,344
Coloured	36	46	40	46	51
Asiatic	81	149	238	286	310
European	140	126	155	165	192
No.of N/E per one European male	2.8	6.3	9.2	9.7	8.8

Comparative figures for various race groups are shown here for the sake of interest.

The wage rates were controlled in April 1945 when minimum wages were fixed by the Wage Board under Wage Determination No. 125. No major changes were made until 1953. In January 1953, the basic rates for all Non-Europeans were increased above the Wage Determination level. In October 1959, the c.o.l.a. was consolidated with wages for Non-Europeans, and the figures adjusted so that the lower paid employees received substantial increases, and the higher paid smaller increases. As from June 1960, a further increase of 5/- per week was made in all rates, and various jobs were up-graded, which resulted in further increases. The most recent wage increase in January 1962 is shown. This involved an increase of 12.4% for Africans, 12.26% for Coloureds and 13.1% for Indians. The figures show clearly that this Company recognises the need for independent action, and is well to the fore in its general treatment of all employees. The wage structure is still receiving very careful consideration from the management.

Conclusion:

The present wage structure greatly alters the concept of the poverty datum line as shown in this chapter, when it is realised that the figure of £17.15.10. represented the P.D.L. for a family of five in the Howick Bantu Village in June 1959. The present average monthly salary for Africans would be not less than £20.13.0. Whilst this figure does not yet agree with Horwood's[8] suggestion of £26.0.0., it is maintained that living costs in Howick, as mentioned in the text, are lower than in the larger metropolitan areas.

The Company's attempts at providing nutrition education through its canteen, plus other educative methods are discussed briefly in chapter 7.

The sterling monetary system has been retained as the figures were originally calculated in this system.

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CHAPTER 7

THE PRESENT CANTEEN SERVICES PROVIDED BY SARMCOL

Introduction:

When this study was commenced, the factory canteen served tea, bread and a soup. (Chapter 2, p.39). An immediate purpose of this investigation was to discover whether malnutrition played a part in the health of the men concerned, and if so, to take steps to remedy the position. (Chapter 3, p.58)

The canteen was felt to be an ideal starting point in any programme of nutrition education. (Chapter 6, p.455). When this investigation revealed that malnutrition was prevalent, the management of the Company decided to improve the canteen services. It is proposed to review briefly the steps taken to date. The programme is not static, and changes will be made as they become desirable.

(1) Canteen Committee:

A committee was formed under the Chairmanship of the Secretary of the Company. Seven other Europeans representing various departments, e.g. the Non-European Labour Manager, Non-European Welfare Officer, Accident Prevention Officer, 3 foremen of main departments and the Medical Officer, all serve to contribute their special knowledge. In addition six Africans, including the Social Welfare worker, were selected. These selections were made because of their status, long service with the Company, general influence with the main body of workers, and their interest in the subject.

The first committee meeting was held on the 11th February 1960, and monthly meetings have been held since that date. At the initial meeting the Chairman made it clear that "the target was to increase the use of the canteen and, through providing correct diet, to direct the feeding habits of the workers for their own benefit, and ultimately for the benefit of their families."

The Chairman of the Leyland & Birmingham Rubber Company, England (parent company of SARMCOL), the Chairman of SARMCOL, and the General Manager of SARMCOL, are all actively interested in the working of the committee and help to direct its efforts.

On the 24th February 1960 the Chairman of the Canteen Committee advised that he had been authorised to obtain the necessary staff to run the canteen efficiently.

(2) <u>Canteen staff</u>:

A European Canteen Manager was appointed and assumed duty on 1st May 1960. A Non-European assistant and 2 African cooks were also appointed. Adequate deep metal plates and spoons were ordered to enable the canteen to serve a meal.

On the 8th June 1960 the first midday meal was served. This consisted of a beef and vegetable stew with a thick slice of bread, and was sold at 6d. per plate. 239 meals were sold on that day.

The policy of the management is that as far as possible the Canteen Manager shall recover only the cost of the food served. All overheads, including staff wages, are subsidised by the Company.

At the last meeting of the committee on 11th October 1962, the Canteen Manager was able to report that a total of 10,626 meals, or a daily average of 559, had been served since the beginning of 1962.

The canteen is now well patronised, and in addition to a stew serves mahewu, tea, bread and jam, samp and beans, phuthu and amasi (sour milk), and fried fish. Recently meat and sausage sandwiches have been offered on a small scale.

(3) Food available:

(a) Beef and vegetable stew. This consists of good quality beef plus vegetables in season. Usually potatoes, cabbage, onions and tomatoes are provided with pea flour to thicken the gravy. The taste is sometimes varied by the addition of curry powder. The beef and onions are braised initially in marrow fat and the vegetables are added subsequently.

A Crypto Rotopan cooker has recently been installed. The cooking in this apparatus is accomplished by steam percolation, and this retains the form and flavour of the vegetables. At present vegetables are being prepared in this way, and added to the stew when it is served. The stew now provides a well-balanced meal and is available at 5d. a plate - i.e. a reduction of 1d. a plate has been made. Many men take a slice of bread in addition, which is sold at cost. (1d).

The meal comprises approximately 2.8 oz. of beef, 2 oz. potatoes, 1.9 oz. cabbage, .4 oz. onions, .4 oz. tomatoes, plus pea flour and a small quantity of fat (from the marrow fat) per man. This yields approximately[1]

13.3 gm animal protein } or 15.6 gm of total
2.3 gm vegetable protein } protein foodstuffs.

33 mgm calcium.

4.8 mgm iron

391 I.U. vitamin A

0.2 mgm vitamin B_1

0.07 mgm vitamin B_2

4.15 mgm niacin

2.8 mgm vitamin C

Calories 1538.

Considered as one meal in a day this stew provides at a very nominal cost a reasonable supplement of protein, useful vitamins, plus a small quantity of calcium, and approximately one-third of the total daily calorie requirements. An optional addition is available, and is mentioned later.

(b) <u>Fried Fish - (Hake)</u>

Approximately 4 oz. are provided at 6d. a slice. This yields:[1]

20.4 gm protein
24 mgm calcium
0.4 mgm iron
160 I.U. vitamin A
0.04 mgm vitamin B_1
0.04 mgm vitamin B_2
4.4 mgm niacin
0.8 mgm vitamin C
88 calories.

This has proved a popular alternative to the stew, and provides very useful animal protein, plus small quantities of vitamins. Many men buy fish and take it home for their families. This has been encouraged, and each piece of fish is sold wrapped in grease-proof paper.

(c) Samp and beans:

This dish was very popular when first served, but has now gone out of favour - probably because of the warm weather. The approximate average serving (cooked weight 20 oz.) yields:[1]

15.7 gm vegetable protein
63.0 mgm calcium
6.3 mgm iron
0.6 mgm vitamin B_1
0.1 mgm vitamin B_2
0.8 mgm niacin
476 calories.

Each serving costs 5d. and consists of approximately 1 oz. beans (raw) and 4 oz. samp (raw).

(d) Phuthu & Amasi:

The average serving consists of 14½ oz. phuthu and 1 pint amasi. This yields:

<u>Phuthu</u>[2] 19.5 gm vegetable protein
37 mg calcium
6.8 mg iron
0.5 mg vitamin B_1
0.2 mg vitamin B_2
2.4 mg niacin

<u>Amasi</u>[2] 21.4 gm animal protein
720.0 mgm calcium
0.4 mgm iron
966 I.U. vitamin A
0.2 mgm vitamin B_1
1.0 mgm vitamin B_2
0.6 niacin

The total food analysis is as follows:

40.9 gm protein
757 mgm calcium
7.3 mgm iron
966 I.U. vitamin A
0.7 mgm vitamin B_1
1.2 mgm vitamin B_2
3.0 mgm niacin
1158 calories.

This is a very popular dish and is sold at 7d. The protein value is helpful in a poor dietary and the calcium and vitamin contributions cannot be ignored.

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The bread is sliced so that 10 slices are obtained from each 2 pound loaf and both brown and white bread are popular. Tea is sold with milk and sugar at 1d a pint, and mahewu is also available at 1d. a pint.

It will be seen that a fairly varied fare is available at a very reasonable price. The experience gained so far leads us to believe that the variety of dishes is appreciated.

Optional addition to the stew:

If desired, men may ask for a scoopful of phuthu to be added to the stew. This is approximately one half of the amount served when phuthu and amasi are ordered. When added to the stew, no extra charge is made. This increases the nutritive value of the stew by approximately 370 calories, 9 gm vegetable protein, 18 mg calcium and small amounts of the B vitamins. Strangely enough, this addition is not as popular as one would imagine. One reason given is that it alters the taste of the stew. Other men state that they prefer to eat their phuthu dry.

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Brock[3] mentions that in the meals provided by the Witwatersrand Mining industry adequate calories are provided in the form of mealie meal, and a degree of variety is provided by a stew containing meat and vegetables. He feels that provision of a cooked meal once a day is most necessary in industries where manual labour is provided by the Bantu. The meal should preferably be provided free, because the Bantu is suspicious of any compulsory charge, even for a meal. It is felt that the employer would be amply rewarded by increased efficiency.[3]

Conclusion:

The decisions of the management are beyond the scope of this study, but it is felt that this Company has made a positive and valuable contribution to the welfare of their Non-European workers by providing an excellent canteen service. This service seeks to provide variety and balanced meals at an exceedingly low cost. The educational value of this service should contribute materially to the wellbeing of the men concerned, and of their families. The fact that the men pay for their meals might enhance the educational value of this service.

A series of lectures covering the essentials of nutrition, general hygiene measures, and the care of children, are being given. It is hoped to extend this feature to the wives of the men and to enlarge for their benefit on methods of preparation of food and how to use available income to the best advantage.

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CHAPTER 8

ANALYSIS AND CONCLUSIONS

Group A (81) - Men living in the factory compound.
Group B (78) - Men living in the Howick Native Village.
Group C (86) - Men living in the slum areas.

Total - 245 men.

As a preliminary to this analysis we can state again that the men's own declarations on diet form the basis of information used in estimating deficiencies. On questioning men in detail about their eating habits, the first tendency was to enlarge. This was countered by a careful explanation of the purpose of the work, and by judgement. It is believed that the information ultimately gained was reasonably nearly correct.

As another preliminary to the analysis it seems reasonable to pick out two basic assumptions and for convenience to repeat them here. In the first place it is considered advisable that an adequate diet for a male adult industrial worker should contain the following items:

Animal protein	30 gm
Vegetable protein	40 gm
Calcium	800 mgm
Iron	12 mgm
Vit. A. (I.U.)	4,000
Vit. B_1	2.0 mgm
Vit. B_2	1.5 mgm
Niacin	15.0 mgm
Vit. C	45.0 mgm
Calories	4,500

These quantities of the various nutritional elements are taken as reasonable standards and deficiencies are measured against them.

In the second place, a simple supplementary diet had to be determined which was likely to correct the deficiencies. This inevitably had to involve an element of guesswork.

The time factor in the work made it necessary to decide upon a supplement which could be maintained as a constant over a considerable period. This had to be done on the basis of general knowledge drawn from many sources and reinforced by an earlier experience gained by working amongst the men employed in the factory.

The decision was to supply a supplementary ration consisting of -

1 pint of reconstituted skimmed milk daily,
plus a multivitamin tablet (N.H.P.)

The milk ration was flavoured in various ways, the most popular flavour being chocolate. The tablets contained an adequate daily ration of vitamins, and were unlikely to deteriorate in any way.

In terms of food values the supplement contributed:

Animal protein	17.2 gm
Calcium	569 mgm
Vitamin A. (I.U.)	5,000
Vit. B_1	2.0 mgm
Vit. B_2	3.0 mgm
Niacin	15.0 mgm
Vit. C	75.0 mgm

This was adopted as a daily ration. It was made available to the men by issuing to them cards which could be exchanged in the factory canteen for the ration. The cards were returned daily to the medical department and formed the basis by which it was determined what proportion of the total ration had been taken by the men. For various reasons and at different times men were absent from the factory, and on these occasions of course, the ration was missed. The following figures derived from the record sheets give an indication of how absence affected the total intake of the supplementary ration.

Table 74.

Percentage of ration taken.	Total No.	Numbers in Groups.	
Above 95%	39	13	A
		12	B
		14	C
80 - 94%	115	38	A
		33	B
		44	C
60 - 79%	55	18	A
		21	B
		16	C
Below 60%	36	12	A
		12	B
		12	C
	245	245	

The supplementary ration was designed to improve the intake of animal protein in particular and to provide certain vitamins. In this way it was hoped that it would help to produce a generally balanced state of nutrition. In itself it contains no elements capable of making any notable contribution to a man's weight, except that the correlation between protein efficiency and body weight gain alone may be sufficient to determine nutritive value. (Hansen J.D.L. Nitrogen Metabolism in Kwashiorkor. M.D. Thesis. Cape Town 1960).

The actual weight changes during the course of the work appear in the following table:

Table 75.

Final gains in weight.	Total No.	Numbers in Groups.	
Negative	40	14 13 13	A B C
Nil	12	5 3 4	A B C
Up to 5 lbs.	94	29 26 39	A B C
From 5-10 lbs.	66	26 22 18	A B C
Above 10 lbs.	33	7 14 12	A B C
	245	245	

We attach no great significance to these figures either in total or in the group. All that might have been expected was evidence of rather small gains which would be related to improvements in general health. The only figure which seems to justify a mild comment is the figure of 39 men in the C group who gained up to 5 lbs in weight.

DEFICIENCIES

In examining the incidence of defects of diet, single items show the following results.

(a) Carbohydrates and calories:

Having some lengthy general knowledge of the feeding habits of the men, it was not anticipated that deficiencies in carbohydrates would be important or numerous. This is substantially confirmed by the analysis. In the total of 245 men, there were 168 cases which did not show a deficiency.

The total theoretical intake of 4,500 calories was deliberately adopted as a high figure and, on the whole, the deficiencies were not unduly numerous or excessively high. It will be noticed that group C tends to throw up a rather higher figure than the A & B groups, and this is affected mainly by the figure showing deficiencies in excess of 1,000 cal. per day.

A table showing the standard requirements compared with the actual intake follows:

Table 76.

Deficiencies - Carbohydrates Standard requirements (4,500 calories) compared with actual intake (calories)			
Men showing deficiencies (calories)	Total No.	Numbers in groups.	
None	168	67 45 56	A B C
200 cal. or less	16	2 7 7	A B C
400 cal. to 199	11	2 4 5	A B C
600 cal. to 399	9	3 2 4	A B C
800 cal. to 599	8	1 5 2	A B C
1000 cal. to 799	10	- 9 1	A B C
Above 1000 cal.	23	6 6 11	A B C
	245		

(b) (i) Animal protein:

Since animal proteins contain the important range of amino acids and are rich sources of certain vitamins, little emphasis was placed on the vegetable proteins. The discussion in the chapter on diet however, has drawn attention to the value of vegetable proteins and the need to supplement amino acid deficiencies.

It is widely accepted that the animal protein content of the diet of urbanised Africans is deficient. Table 19 suggested that 35% of the men showed a dietary deficiency of group 1 foods (animal proteins and legumes) and 58% a deficiency of group 2 foods (milk products). Exercising judgement and a conservative attitude, it is suggested that the following figures interpret the present position.

The relationship between protein malnutrition and vitamin deficiencies has been mentioned however, and malnutrition signs were clearly observed in the men studied. It is considered that many men are able to improve their intake of animal protein considerably when they find employment in the factory, and this fact is probably reflected in the figures which follow.

The supplementary ration provided approximately 17g of extra animal protein per day, and although this work is incapable of evolving positive evidence, there is a strong personal feeling that this additional protein intake was of value to the majority of the men concerned.

Table 77.

Deficiencies : Animal Proteins. (Requirement 30g a day)			
Men showing deficiencies (animal protein)	Total No.	Numbers in groups.	
None	201	68 70 63	A B C
Between 10g and zero	37	10 7 20	A B C
Between 20g and 10g	5	3 1 1	A B C
Between 20g and 30g	2	- - 2	A B C
	245	245	

(b) (ii) Vegetable Proteins:

With few exceptions, the intake appears adequate.

Table 78. Vegetable Protein

Men showing deficiencies (vegetable protein)	Total No.	Numbers in Groups.	
None	236	77 76 83	A B C
10g and less	5	3 1 1	A B C
20g and less	2	- - 2	A B C
30g and less	1	1 - -	A B C
Above 30g	1	- 1 -	A B C
	245		

(c) Calcium:

Bearing in mind the limited value of any dietary survey as an indication per se, of dietary deficiencies, there appeared to be a deficiency of calcium in 84% of the men studied. The deficiency is spread through the 3 groups fairly evenly.

Calcium is supplied mainly through milk and milk products and our investigation suggested a too meagre use of these foods. For the purposes of this investigation we have no specific knowledge of the position of children on this matter of calcium intake. Mention has been made of the fact that adaptation to a low calcium intake occurs, but generally there appears to be a shortage of calcium in the years of growth in the underprivileged.

Table 79. Deficiency : Calcium

Men showing deficiency in Calcium	Total No.	Numbers in groups	
None	161	57 40 64	A B C
Above zero, less than 200 mg	37	11 16 10	A B C
201mg - 400mg	24	4 14 6	A B C
401mg - 600mg	19	9 6 4	A B C
601mg - 800mg	4	- 2 2	A B C
	245		

(2) Vitamins:

Insofar as a dietary survey of this nature may be indicative, 2 outstanding deficiencies of vitamins appeared. These could be anticipated from the general knowledge of feeding habits in industrialised communities. Fatty foods are not very commonly or generously used - butter, cheese, milk etc. The same can be said of the fruit and vegetable foods containing vitamin C. It seems likely that the cooking methods employed will notably diminish what vitamin C is available in the vegetables commonly used.

It was considered necessary to include vitamin A and vitamin C in the supplementary ration and this was done by adding appropriate amounts of the vitamins in tablet form.

(1) Vitamin A.

The analysis shows the following figures. It may be judged remarkable that the proportion of men taking half or less than half of the nominal requirement is so high. It amounts to 228 men and again there is no clear distinction to be drawn between the groups. This appears to be a general deficiency of some importance.

Table 80 Deficiency : Vitamin A

Deficiency Vitamin A. (I.U.)	Total No.	Numbers in groups.	
None	4	- 4 -	A B C
Up to 1000	1	- 1 -	A B C
1001 - 2000	12	6 3 3	A B C
2001 - 3000	65	34 14 17	A B C
Above 3000	163	41 56 66	A B C
	245		

(2) Vitamin C.

The analysis shows the following figures. In this case 172 men are taking half or less than half of the suggested amount required, and again there are no notable distinctions between the groups. The deficiency appears to be widespread and important.

Table 81. Deficiency : Vitamin C

Deficiency Vitamin C (mg)	Total No.	Numbers in groups	
None	5	1 1 3	A B C
0 - 10	23	10 5 8	A B C
11 - 20	45	13 19 13	A B C
21 - 30	40	10 17 13	A B C
31 - 40	49	15 17 17	A B C
Above 40	83	32 19 32	A B C
	245		

As far as the food analysis figures could be judged accurate, there appeared to be relatively little deficiency of vitamins of the B complex. This was not supported by actual clinical examination. The figures are appended.

Deficiency of B_1	18 (4A, 6B, 8C)
Deficiency of B_2	21 (3A, 6B,12C)
Deficiency of niacin	8 (2A, 5B, 1C)

In the supplementary ration, the tablets should have corrected any deficiencies, but no firm conclusions can be drawn about how this affected the main outline of the work.

(3) Iron:

The deficiencies of the various trace elements could not be apportioned in the broad outline of this kind of study. As far as the mineral iron was concerned, only 4 cases were found where the intake of iron might have been considered deficient. In view of the generally accepted fact that iron intake is usually excessive in African diets, no importance was attached to the above figures, and it will be noted that the supplementary ration takes no account of iron deficiencies.

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In dealing with deficiencies, it will have been noticed that the characteristics are common throughout the groups. No group can be selected which shows a marked advantage or a marked disadvantage compared with the others. This is a matter of some importance, and will be referred to in the final summing up.

On the Influence of Income Levels

In considering the relationship of the level of income with the P.D.L., allowance was made for a man's responsibilities towards dependants. The spread is shown in the following table. It seems very necessary to point out that this situation is not necessarily exposed unless a man's responsibilities towards dependants are discovered in detailsand taken into account.

This figure is obscured if the figure taken is a mean figure taken from a mass of observations. It is also stressed that this is the history of a situation which existed in 1959.

The policy of the Company is to adjust wage levels to remedy this condition. This was referred to in chapter six. The Company policy will spread over a period, but the first step was taken soon after this position was recognised, and further steps have been taken since that time. Still further developments are being considered.

Table 82. Income Levels

Income as percentage of P.D.L.	No. of men	Numbers in groups.	
150%	22	4 11 7	A B C
125-149%	17	6 6 5	A B C
100-124%	45	17 21 7	A B C
In excess of 100%	84	27 38 19	A B C

Table 83.

Income as percentage of P.D.L.	Total No.	Numbers in groups	
90-99%	32	13 9 10	A B C
80-89%	30	11 8 11	A B C
70-79%	27	14 5 8	A B C
60-69%	31	7 7 17	A B C
Below 60%	41	9 11 21	A B C
Below 100%	161	54 40 67	A B C

We shall relate this evidence to clinical conditions discovered in the first examination of the men. These showed the following results.

Table 84.

Clinical Evidence : First Examination			
Malnutrition Evidence	Total No.	Numbers in groups.	
Present +	160	46 51 63	A + B C ++
Present in a minor degree	1	1 - -	A B C
Absent	84	34 27 23	A + B C ++

These figures show the most favourable state of health amongst the men living in the factory compound, whilst the men drawn from the slum areas show the worst condition. This is indicated by the asterisks. There must be many conditions which contribute to this result. The men in the compound have a freedom which is not shared by men living in households, whilst the men living in the slum areas lack almost all the facilities which make a healthy life reasonably possible.

Almost every case of the 245 men dealt with in this study showed a food deficiency on the basis of their declarations. Lest there be misunderstanding on this point, we refer again to the statement made at the beginning of this summary. The information we obtained was given in good faith and we accepted it only after probing and examination, together with explanations of our purpose. What appears significant is that 161 of these men showed clinical evidence of malnutrition.

Table 85.

Income Level related to the P.D.L.	Total No.	No. showing evidence of malnutrition	%	Numbers in groups.	
150%	22	11	50	2 6 3	A B C
125-149%	17	9	53	3 4 2	A B C
100-124%	45	28	62	7 15 6	A B C
90-99%	32	22	69	8 6 8	A B C
80-89%	30	19	63	7 6 6	A B C
70-79%	27	20	74	12 2 6	A B C
60-69%	31	22	71	4 4 14	A B C
Below 60%	41	30	73	4 8 18	A B C
	245	161			

The figures shown in the foregoing table are probably the most important in the whole record. In relation to the groups of people with whom we have dealt, these figures produce substantial evidence on two important matters.

In the first place, there is a steady and notable increase in malnutrition as incomes diminish. The figures are high and the progression is steady. Their meaning is inescapable. There has been much discussion and controversy based on the supposition that to pay higher wages to Africans will not necessarily improve their standards of living. We interpret our results as being quite destructive to this argument.

But in the second place we take notice of the fact that although a proportion of the men dealt with have incomes above the Poverty Datum Line, malnutrition amongst them appeared to be present in high proportion.

The figures in this table indicate very clearly that nutritional defects discovered through clinical examinations, are not inevitably the result of sheer poverty. The P.D.L.'s used in the income estimates are adjusted so that family responsibilities are included in the figure. A man is not necessarily pushed into poverty by having to maintain a family since allowance to deal with that situation is included in the figure for the P.D.L. applied in any particular case.

It is clear that income alone does not determine the nutritional standard displayed under clinical examination. We consider this to be a fact of basic importance which we intend to consider in our final summing up. At this point we can state shortly that our opinion is that this aspect of the situation is due in many cases to ignorance.

Weights at 1st Clinical Examination

Our thoughts on the problems of child health were influenced by the weights of men determined at the first clinical examination.

Table 86

% of appropriate standard weight	Total No.	Numbers in groups.	
Above 100%	18	7 6 5	A B C
95 - 99%	50	17 15 18	A B C
90 - 94%	60	20 22 18	A B C
80 - 89%	102	32 33 37	A B C
Below 80%	15	5 2 8	A B C

The standard adopted for these comparisons is taken from tables of the "Life Extension Institute of New York City". These relate weight, height and build.

Perhaps their main merit for our purpose lies in the fact that they offer standards against which comparisons can be made. Those standards generally are well in excess of the weights recorded in our examinations but it seems reasonable to assume a proportionality which still would indicate some important failure or defect in development.

Since we are dealing with adult men, we consider that this condition of being underweight is largely determined by the conditions of nutrition in childhood. A comment on this aspect will be made later.

A few more figures remain to be presented. The results of the first clinical examination are presented in a table on page 486.

At the end of approximately one year a second chinical examination was carried out with the following results:

Table 87. Clinical Examination 2

Malnutrition evidence	Total No.	Numbers in groups.	
Present	3	1 1 1	A B C
Present in a minor degree	4	3 1 -	A B C
Improved	26	8 9 9	A B C
Absent	210	69 66 75	A B C
Not checked 1B, 1C.			

At the end of the second year the figures were as shown below:

Table 88. Clinical Examination 3.

Malnutrition evidence	Total No.	Numbers in groups.	
Present	11	2 5 4	A B C
Present in a minor degree	5	5 - -	A B C
Improved	2	1 - 1	A B C
Absent	226	73 73 80	A B C
Not checked 1C			

On these figures two broad conclusions were drawn:

(1) that the supplementary ration satisfied the general need.

(2) that one year's treatment on this supplementary ration is sufficient to deal with the great majority of the signs of malnutrition.

At the end of the second year changes were made in the men originally involved in this work. The work continues, and has extended but the results now are not comparable with what has gone before, and therefore cannot be included in this analysis.

GENERAL SUMMARY

In considering the results of this work we cannot claim that a new situation has been revealed. Malnutrition on an extensive scale has been recognised for a long time amongst African workers. This is a condition completely antagonistic to an efficient industrial performance and since we believe that South Africa has a great industrial future, remedies for this condition should be sought and applied. The experience gained in pursuing this work enables us to state some of the essential basic needs in seeking solutions to the various problems involved.

Throughout the work we have found no substantial evidence that conditions of shelter - housing conditions - have had much effect on conditions of nutrition. There is substantial evidence of a rather complete ignorance on what are the essentials of nutrition. It seems likely that as that ignorance is removed, conditions of shelter will become of increasing importance in affording means for the preparation and the storing of foods which at present find no place in the African's diet.

There has been much controversy on wage levels in industry - on the use of money by people unfamiliar with the social habits of Europeans. The controversy has ranged far and wide and we have no wish to enter into it. The need for sufficient money to provide for adequate nourishment requires no arguing - it is obvious.

The income situation of workers in industry in general scarcely falls within the range of this work. It is a situation of great complexity but the needs can be summed up very simply in the light of this present experience. Men must earn as a minimum, sufficient money to satisfy the basic needs of their households, and, they and their womenfolk must be taught how to use that money in satisfying those basic needs.

It is realised of course that even when the necessary money is available, men and their families may live in a state of malnutrition. This condition occurs so frequently that the only possible conclusion is that it arises through ignorance. Many of the items commonly used by people of European background seem so attractive that the essentials are forgotten. "Forgotten" is probably the wrong word, because the essentials - particularly adequate food - were never really known. There is a state of ignorance which would justify the most intense efforts for its correction, and particularly in the field of nutrition. In those industries where a complete and continuous discipline is imposed on its workers, this need cannot be very evident. In the wider industrial field where men are relatively free, and must judge how they will provide for themselves and their families, the need is great and urgent.

To deal with the problem involves many complications and much detail. The need for a sufficient income is obvious but this alone will not remove the ignorance which overshadows all. A vigorous and skilful education programme is needed and if this were directed upon nutritional needs the rewards could be very great.

In placing an emphatic accent on the need for education in feeding habits, we consider that in this work we can draw certain conclusions on family life in industrialised African communities. The men we have dealt with are, generally, underweight. Many have relatively small frames and although they are reasonably proportioned, they are underweight - they are small men. We take this as an indication that as children they were probably the victims of under-nutrition. With a reasonable experience in dealing with sick African children we know that that condition continues almost unaltered. A background of ill feeding in childhood is poor preparation for a working life in industry.

The results of a meagre and inadequate diet in childhood seem to follow a man through his adult life. In stating our confidence in the future of industry in Africa, we must call attention to the need for a far view of the future. The children and the young people of today and tomorrow must become the workers of five or ten years ahead. Their physique at that time will be greatly dependent on what happens to them as children. There is a great urgency attached to this problem which should be recognised and acted upon. To deal with the nutritional problems of men working in a factory reveals much, but it only touches the wider problems. There is a tremendous need for adult education in the homes of the workers and the primary need is to teach how children should be fed.

The most important conclusions to be drawn from a study of this sort may be few and simple, but they would involve enormous effort to act upon them effectively. It is relatively simple for industrial organisations to correct nutritional deficiencies and to reduce the consequent diseases of deficiency under the conditions which have applied in this work, but this is not nearly enough. The general physical structure of a man is so greatly influenced by conditions of nutrition which occur during childhood and during the years of development that it is in this field that enormous effort is needed. European experience has passed through this stage, perhaps more easily than we can expect to pass through it in South Africa. In spite of this, it is doubtful whether any country in Europe made any big impact on child health in less than thirty to forty years.

We believe that a good background of physical development in childhood is essential to ultimate success in industry of the kind which we believe to be desirable and possible. The problem of how this is to be achieved cannot be left in the hands of industry. It is a national problem to be tackled on a national scale.

Enlightened industrialists could make a considerable contribution by way of advice and general support but effective action it seems should lie in a government department which should have a very exact function in child welfare work. The speed of growth and activity of such a department might be phenomenal. The need is both vital and urgent.

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Conclusion:

It seems remarkable that in the last sixty years effective use of animal experimentation has brought to light the approximate number and the chemical nature of most of the elements and organic compounds which are the primary nutrients for all living things, except those capable of photo-synthesis which can synthesize them all.

The discovery that each essential nutrient when in deficient supply causes a specific and unique type of metabolic disturbance by the symptoms of which it may be recognised in man or animals, and the nature and occurrence in the nature of each nutrient, provided the means of prevention and cure of several diseases not hitherto recognised as being referable to dietary errors. One thinks of beri-beri, rickets, pellagra, endemic goitre, pernicious anaemia, kwashiorkor, and scurvy in bottle-fed infants.

The application of the knowledge gained in the last sixty years is one of the greatest achievements in the history of preventive medicine. Dietetics today, ranks with immunisation against contagious diseases, sanitation and quarantine, as a vital health measure. (From "The History of Nutrition". Prof. E.V. McCollum. World Review of Nutrition and Dietetics. Vol. 1. Pitman Medical Publishing Co. Ltd. London 1959).

Any study involving Africans brings the realisation that the Bantu comes from a rural pastoral background in which the cultural and dietetic pattern is vastly different from that of the European. Relatively few of the Bantu have been urbanised for more than a generation and the great majority are migrant labourers, returning to their homes after a period in the towns.

These migrant labourers retain to a very large extent the cultural and dietetic background of their home environment, while their urbanised brethren - a minority as yet - are slowly trending towards the European pattern. During his stay in the towns the African migrant labourer may, in this age, present with florid scurvy, the very disease which led the Dutch East Indies Company in 1652 to establish a revictualling station for their commercial navy on the site which has now become the City of Cape Town. (From "Recent Advances in Human Nutrition". Prof. J.F. Brock, J. & A. Churchill Ltd. London 1961.)

This s tudy has attempted to deal with this and other reactions of the Bantu to urbanised living, particularly as they affect industry.

Food Analysis Sheets are attached, which show the method employed in calculating each man's diet. The original sheets are retained at SARMCOL

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Amasi
Beans, dried
Beef
Bread, enriched brown
Bread, white
Cabbage
Carrots
Marewu
Milk
Mealie Meal
Potatoes
Samp
Sugar

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Cheese
Condensed milk
Eggs
Mealie rice
Onions
Rice
Tomatoes

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No. 8098/195 with family

FOOD ANALYSIS

L. Backhouse, P.M.B.—36704—70

	Food Summary	Weekly Total		Calories	PROTEIN Animal Gm	PROTEIN Veg. Gm	PROTEIN Total Gm	MINERALS Ca Mgm	MINERALS Fe Mgm	VITAMINS A I.U.	VITAMINS B 1 Mgm	VITAMINS B 2 Mgm	VITAMINS Niacin Mgm	VITAMINS C Mgm
Factory Morning	Bread(white)	2 lbs	Food Budget: £2.5.6. per month.	1960	-	56.0	56.0	182	9.0	-	0.68	0.30	6.0	-
	Jam	4 oz		316	-	0.45	0.45	13	1.12	-	-	-	-	-
	Milk	¾ pt		312	16.05	-	16.05	540	0.33	725	0.154	0.78	0.513	6.75
	Sugar	4 oz		437	-	-	-	-	-	-	-	-	-	-
Home Midday	M/Rice	1 lb	Weight: 85% of normal.	1607	-	40.3	40.3	59	8.2	-	0.23	0.09	0.9	-
	Meat	2 lb		1528	138.4	-	138.4	80	20.6	-	0.60	1.22	33.2	-
	Cabbage	2 lb	Malnutrition Signs: Present.	160	-	9.2	9.2	304	3.4	540	0.40	0.34	2.0	110.0
	Beans	½ lb		768	-	48.6	48.6	370	15.65	-	1.53	0.52	4.95	1.33
	Potatoes	2 lbs		636	-	15.2	15.2	84	5.2	140	0.8	0.28	8.8	44.0
	Phuthu	9 lbs		14724	-	387.0	387.0	738	138.6	-	10.26	4.86	48.6	-
Home Evening			Income: 58% of P.D.L.											
Other	Utshwala	3 gals		6000	-	7.5	7.5	-	-	-	10.92	4.62	2.64	-
ESTIMATED WEEKLY INTAKE				28448	154.45	564.25	718.7	2370	202.10	1405	25.574	13.01	107.603	162.08
ESTIMATED AVERAGE DAILY INTAKE				5689.6	30.89	112.85	143.74	474	40.42	281	5.1148	2.602	21.5206	32.416
RECOMMENDED DAILY INTAKE				4,500	30	40	70	800	12.0	4,000	2.0	1.5	15.0	45
DEFICIENCY BETWEEN RECOMMENDED DAILY INTAKE and ESTIMATED				-	-	-	-	326	-	3719	-	-	-	12.584
SUPPLEMENTARY NUTRIENT AVAILABLE				173.4	17.2		17.2	569	—	5,000	2.0	3.0	15.0	75.0
SUPPLEMENTARY NUTRIENT TAKEN			96%	166.5	16.5		16.5	546		4800	1.9	2.9	14.4	72.0

No. 6033/74

FOOD ANALYSIS

L. Backhouse, P.M.B.—36704—70

	Food Summary	Weekly Total		Calories	PROTEIN Animal Gm	PROTEIN Veg. Gm	PROTEIN Total Gm	MINERALS Ca Mgm	MINERALS Fe Mgm	VITAMINS A I.U.	VITAMINS B 1 Mgm	VITAMINS B 2 Mgm	VITAMINS Niacin Mgm	VITAMINS C Mgm
Compound Morning	Milk	½ pt		208	10.7	-	10.7	360	0.22	483	0.103	0.52	0.342	4.5
	Sugar	4 oz	Food Budget:	437	-	-	-	-	-	-	-	-	-	-
	Scones	1¼ lbs	£2.3.4. p.m.	1225	-	35.0	35.0	114	5.6	-	0.42	0.187	3.75	-
	Phuthu	10 lbs		16360	-	430.0	430.0	820	154.0	-	11.40	5.40	54.0	-
Compound Midday	Dumpling	1¼ lbs	Weight: 86% of normal.	1225	-	35.0	35.0	114	5.6	-	0.42	0.187	3.75	-
	Cabbage	2 lbs		160	-	9.2	9.2	304	3.4	540	0.40	0.34	2.0	110.0
	Potatoes	2 lbs	Malnutrition Signs:	636	-	15.2	15.2	84	5.2	140	0.8	0.28	8.8	44.0
	Tomatoes	1 lb	Nil.	98	-	4.5	4.5	45	1.8	4500	0.23	0.14	2.3	30.3
	Meat	1¼ lbs		955	86.5	-	86.5	50	12.875	-	0.375	0.762	20.75	-
Compound Evening	Amasi	2½ pts	Income: 137% of P.D.L.	1040	53.5	-	53.5	1800	1.10	2415	0.515	2.62	1.712	-
	Marewu	10 pts.		2360	-	60.1	60.1	-	-	-	1.1	1.0	13.9	-
Other	Utshwala	5 gals		10,000	-	12.5	12.5	-	-	-	18.20	7.70	4.4	-
ESTIMATED WEEKLY INTAKE				34704	150.7	601.5	752.2	3691	189.795	8078	33.963	19.136	115.704	188.8
ESTIMATED AVERAGE DAILY INTAKE				6940.8	30.14	120.3	150.44	738.2	37.959	1615.6	6.7926	3.8272	23.1408	37.76
RECOMMENDED DAILY INTAKE				4,500	30	40	70	800	12.0	4,000	2.0	1.5	15.0	45
DEFICIENCY BETWEEN RECOMMENDED DAILY INTAKE and ESTIMATED								61.8	-	2384.4	-	-	-	7.24
SUPPLEMENTARY NUTRIENT AVAILABLE				173.4	17.2		17.2	569	-	5,000	2.0	3.0	15.0	75.0
SUPPLEMENTARY NUTRIENT TAKEN			70%	121.4	12.0		12.0	398		3500	1.4	2.1	10.5	52.5