A Study to Establish a Simple, Reliable and Economical Method of Evaluating Food and Nutritional Intake of Male Mineworkers Residing in a Single Accommodation Residence on a Platinum Mine in the North West Province

by

Hester Maria Bredenhann

Thesis presented in partial fulfilment of the requirements for the degree Master of Nutrition at the University of Stellenbosch

Study Leader: Ms Maritha Marais

Co-Study Leader: Ms Suna Kassier

Statistician: Prof DG Nel

Faculty of Medicine and Health Sciences

Department of Interdisciplinary Health Sciences

Division of Human Nutrition

December 2012

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Hester M Bredenhann   30 August 2012

ABSTRACT

Introduction: The study investigated the development of a simple, cost effective method to monitor food and nutritional intake of mineworkers residing in a Single Accommodation Village (SAV) by using food inventory-data.

Objectives: The aim of the study was to calculate average food and nutrient intake per mineworker using household data, assess actual food intake (individual data), determine food wastage and to compare food and nutritional intake between group and individual data.

Methodology: The study design was a cross-sectional, observational study with an analytical component. The study population consisted of male mineworkers residing in a SAV on a platinum mine in the North West Province and included mineworkers performing mainly underground tasks. A census sampling method was used to select mineworkers participating in the study, and a pilot study was done to test the proposed study process. The study was conducted over five days, which included one weekend day. Food inventory data was recorded by capturing all food quantities (weight measured in kilogram) used for food preparation on the study days. The yield of the prepared food and expected meal participation was used to calculate an average intake per mineworker according to the household record method. An observational study was done to establish the food record data. Meal as well as food item participation was recorded. Food wastage was determined by weighing the production as well as the plate wastage and this data was used to ascertain average food intake per mineworker.

Results: Approximately 700 mineworkers participated in the study**.** The study recorded a 96% meal participation measured against the planned participation figures during the main meal with 74% participating in all menu items. The values for breakfast and dinner were 95% meal participation for both meals with 87% menu item participation during breakfast and 82% during dinner. By using the t-distribution test it was recorded that limited values measured between the food inventory data and the food record data fell within the 95% confidence intervals even after correction for food wastage. However, when the planned participation used to calculate the household data was incorporated into an equation using actual participation data, the values fell within the 95% confidence interval demonstrating that with 95% certainty the planned values (when calculated according to the suggested equation) were within those values observed during the study.

Conclusion: Household data can be used as a tool to monitor average individual food and nutritional intake of mineworkers; however both planned and actual menu item participation figures should be considered, together with the total wastage per food item. This tool can be adapted to be used in industrial catering units to monitor food and nutritional intake, which will enable identification of food or nutrient deficiencies and timeous implementation of intervention strategies.

OPSOMMING

Inleiding: Die studie het ondersoek ingestel na die ontwikkeling van 'n koste-effektiewe metode om die inname van voedsel en voedingstowwe van mynwerkers wat in enkel-akkommodasiebehuising (EAB) woon met behulp van voedselinventaris data te moniteer.

Doelwitte: Die doel van die studie was om die gemiddelde voedsel en voedingstofinname per mynwerker met behulp van huishoudelike data te bereken, die werklike voedselinname (individuele data) te evalueer, voedselkwisting vas te stel en om voedsel- en voedingstofinname tussen groep en individuele data te vergelyk.

Metode: Die studie-ontwerp was 'n dwarssnitwaarnemingstudie met 'n analitiese komponent. Die populasie van die studie het bestaan uit manlike mynwerkers woonagtig in 'n EAB van 'n platinum myn in die Noordwes Provinsie en het mynwerkers wat hoofsaaklik ondergronds werksaam is ingesluit. 'n Sensussteekproefmetode is gebruik om deelnemende mynwerkers te selekteer en 'n loods studie is gedoen om die voorgestelde studie model te toets. Die studie is oor vyf dae gedoen, wat een naweekdag ingesluit het. Voedselinventarisdata is versamel deur alle voedselhoeveelhede (in kilogram gemeet) wat gebruik was vir die voedsel voorbereiding op die studiedae in ag te neem. Die opbrengs van die voorbereide voedsel is gebruik om die gemiddelde inname per mynwerker volgens die huishoudelike rekord metode te bereken. 'n Waarnemingstudie is gedoen om die voedselrekorddata vas te stel. Die voedselkwisting is bereken deur die produksie- asook bordkwisting te weeg en dan hierdie data te gebruik om die gemiddelde voedselinname per mynwerker te bereken.

Resulate: Ongeveer 700 mynwerkers het aan die studie deelgeneem. Die studie het 'n 96% maaltyddeelname opgeteken, gemeet teen die beplande deelnamesyfers tydens die hoofmaaltyd, met 74% deelname aan alle spyskaartitems. Die waardes vir ontbyt en aandete was 95% maaltyd bywoning vir beide etes, met 87% spyskaartitemdeelname tydens ontbyt en 82% tydens aandete. Die studie het beperkte waardes binne die 95% vertrouensinval tussen die voedselinventarisdata en voedselrekorddata opgeteken, selfs nadat die voedselkwistingsyfers in ag geneem is. Wanneer die beplande deelname wat gebruik is om die huishoudelike data te bereken egter in 'n vergelyking wat werklike deelnamedata gebruik, inkorporeer word, het die waardes binne die 95% vertrouensinval geval. Dit is 'n aanduiding dat daar met 95% sekerheid aangeneem kan word dat die beplande waardes (bereken volgens die voorgestelde vergelyking) vergelyk kan word met die waardes waargeneem tydens die studie.

Gevolgtrekking: Huishoudelike data kan as 'n meetinstrument dien om die gemiddelde individuele voedsel- en voedingstofinname van mynwerkers te moniteer. Beide beplande en werklike spyskaartitemdeelnamesyfers moet egter in ag geneem word, tesame met totale voedselkwisting per voedselitem. Hierdie instrument kan aangepas word vir gebruik in industriële

voedseldienseenhede om voedsel- en voedingstofinname te moniteer, wat die identifisering van voedingstoftekorte en vroegtydige implementering van intervensie strategieë moontlik sal maak.

ACKNOWLEDGEMENTS

LIST OF ABBREVIATIONS

AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Ranges
BBSEE	Broad-Based Socio-Economic Empowerment Charter
COMRO	Chamber of Mines Research Organisation
DRI	Dietary Reference Intake
EAB	Enkel-akkommodasiebehuising
ERS	Economic Research Service
FSD	Food supply data
FBS	Food balance sheets
g	gram
GDP	Gross Domestic product
IDS	Individual Dietary Surveys
JSE	Johannesburg Securities Exchange
kJ	kilojoule
lbs	pounds (1 pound = 0.454 kilogram)
µg	microgram
mg	milligram
MLL	minimum living level
MPRDA	Mineral and Petroleum Resources Development Act
MRC	Mining Regulations Committee
oz	ounce (28,4 gram)
PAL	Physical Activity Level
RDA	Recommended Dietary Allowance
SAV	Single Accommodation Village
USDA	United States Department of Agriculture
W/m^2	Watt/ meter square

LIST OF DEFINITIONS

Amaas/Nkomaas/Amazi:	a sour cultured milk product which is obtained from pasteurised milk inoculated with a culture in order for it to develop certain microbiological flora under controlled conditions.[1]
Bantu/Native:	a person belonging to, or associated with a particular place or region by birth.[2]
Hygrometer:	an instrument for measuring the humidity of the atmosphere.[2]
Lambalazi:	sour fermented maize meal porridge.[3]
Mageu/Marewu:	traditional non-dairy, non-alcoholic fermented maize meal drink.[3]
Meal Participation:	In this study this term means a person registered to participate in a meal.
Menu Item Participation:	In this study this term means a person accepting a menu item, but has not consumed it yet.
Novice: (in this study context)	a person with no prior experience of mining as a career.[4]
Psychrometer:	a hygrometer whose operation depends on two similar thermometers with the bulb of one being kept wet so that it is cooled as a result of evaporation.[2]
Strenuous work:	any work in a hot environment where the work rate exceeds 160 W/m².[4]
Thermal / Heat Stress:	the net load on the human body from the combined contributions of metabolic heat production and environmental factors.[5]
Wet-bulb temperature:	temperature indicated by a wet-bulb thermometer.[2]
Wet-bulb thermometer:	the thermometer with moistened bulb in a psychrometer.[2]
W/m²:	body's energy release rate in terms of its surface area.[5]

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CHAPTER 1.   INTRODUCTION AND PROBLEM STATEMENT

In this section background on statutory requirements of the nutritional standard for the South African Mining industry is reviewed.

1.1 Background on the Statutory Requirements of Nutritional Development in the South African Mining Industry

The South African mining sector is a major contributor to the Gross Domestic Product (GDP) of South Africa. In addition it was also a major factor in the development of other industries such as energy, water, financial and engineering services since the late 1800's. The Johannesburg Securities Exchange (JSE) was originally established to assist the mining industry with funding during the latter part of the 19th century. To this day the mining industry still accounts for a third of the market capitalisation on the JSE and is a key attraction for foreign investment.[6] The mining sector did however have an impact on the social patterns in Southern Africa as a traveller remarked in 1906 that in no single "kraal" (village) in the interior did he find more than one or two men of working age who had never made the journey to the "Rand" (goldfields). African people had one commodity for sale - their labour - and it started a pattern for migration which is still an integral part of the Industry.[7]

Since 1886, when gold mining started on the Witwatersrand, so-called "Bantu" mineworkers were housed and fed by the mining companies. The objective of feeding mineworkers at the time was short term and aimed at maintaining the working adult in a physically fit state and a "contented frame of mind". Another objective of feeding mineworkers was to ensure an adequate intake of sufficient food of good quality "approaching a balanced diet" to ensure a positive state of health of the labour force. It was reasoned that because of the inadequate knowledge of dietary requirements, the worker will not be able to meet these requirements if he had to feed himself.[3]

During 1889 a report was published to highlight the threat of severe food shortages at mining accommodation for mineworkers. An appeal was made to lift "special duties", meaning taxes on mealiemeal[i], flour, butter and tinned foods. The first regulation for feeding of "Bantu" residing in mine accommodation was promulgated during 1896 and provided for a maximum allowance of 7900 gram[ii] of mealiemeal and 910 gram[iii] of meat per mineworker per week.[8]

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[i] Mealiemeal= maize meal

[ii] 7900gram=175 lbs in the original document

[iii] 910gram= 2 lbs in the original document

During 1899, the Medical plague officer addressed a letter to the Secretary of Mines advocating measures to prevent scurvy, such as the substitution of fresh South African mealies for the dried imported mealies. He also recommended the use of vegetables, fresh meat and lime juice. The avoidance of alcohol was also promoted.[8]

Early in the 20th century the Native Affairs Department assumed control over the "Bantu" employed on the mines. Inspectors were engaged with the objective of visiting mineworker accommodation, hospitals and kitchens to enquire into all matters affecting "Native" employees. During 1903 a conference was called by the Commissioner of Native Affairs which was arranged by representatives of the Chamber of Mines and Mine Medical Doctors. This resulted in a committee of mine doctors investigating the health and the diet of the "Bantu" mineworker. Their findings were that the diet at the time lacked fat and contained too much mealiemeal (910 gram per mineworker per day) and that "nitrogen" was deficient on non-meat ration days. The practice was to provide 1360 gram[iv] of meat per week which was divided between three out of the seven days.[8] Earlier, the same medical officer blamed the diet for the high death rate; incidents as high as 90 deaths per 1000 mineworkers were reported. A memorandum published by the Chamber of Mines gave the number of deaths due to scurvy for the period November 1902 to April 1903 as double those due to accidents.[3] The medical officer used this opportunity before the Mining Regulations Committee (MRC) to recommend the introduction of fresh vegetables to the mineworkers' diet.[8]

During 1910 the medical officer for Apex Mine and Rand Collieries gave evidence before the MRC and indicated once again that fat in the diet had been underestimated and carbohydrates over estimated. He suggested that the mealiemeal allowance be reduced and replaced with items such as peas, beans and rice.[8]

The result of these findings was a "Government Standard Ration" for Bantu mineworkers gazetted under the Native Regulation Act, 1911. This regulation was revised twice up to January 1922. The most important changes over these early years were mealiemeal increased from 567 gram to 680 gram[v] per day; bread increased from 170 gram to 227 gram[vi] per day; meat increased from 1400 gram to 1700 gram[vii] per day and dried beans decreased from 114 gram to 85 gram[viii] per day. Vegetables were added to the list as 142 gram[ix] per day.

[iv] 1360 gram =3 lbs in the original document

[v]   567-680gram= 20-24 oz in the original document

[vi] 170-227 =6-8 oz in the original document

[vii] 1400-1700gram =3-3.75 lbs in the original document

[viii] 114- 85gram=4-3 oz in the original document

[ix] 142gram=5 oz in the original document

Since the formalisation of these rations for the mineworkers the incidence of nutrient deficiencies, especially scurvy and pellagra dropped from 1.461 per 1000 employed in 1936 (with a total of 430 cases and 2 deaths) to 0.159 per 1000 employed (with a total of 44 cases and no deaths) in 1948[3]. The incidence of nutritional deficiencies is no longer included in the annual health reports of mining companies.

A study conducted by Fox *et al.,* during 1940 concluded that the mineworkers' diet provided approximately 15mg ascorbic acid daily. When an additional 40mg ascorbic acid was administered in the form of an orange juice concentrate the majority of workers were "protected" against scurvy. The supplement was however too small to have a positive effect on the incidence of infections and it did not enhance physical performance.[9]

The Bantu Labour Act, Act 67 of 1964 was the last act to regulate nutrition in the mines. A regulation under this act was gazetted in 1975 and stipulated the minimum daily ration scale for Bantu employees. The Bantu Labour Act was repealed by 1988 and for a number of years no official (clarify that this is governmental) reference was made to nutrition for mineworkers. More recently the Mine Health and Safety Act of 1996,[x] made provision for a regulation on nutrition, under clause 98 (p) of the act. This clause states: "*98 (1) The Minister, after consulting the Council, by notice in the Gazette, may make regulations regarding…. standards of housing and nutrition of employees who are accommodated at the mine.*"[8] To date no regulation under this act has been passed, however a regulation under the Mineral and Petroleum Resources Development Act. (MPRDA)[xi], mentions the importance of nutrition.

During October 2002 the Mining Charter or "Broad-Based Socio-Economic Empowerment Charter" (BBSEE) for the Mining Industry was developed in consultation between the Mining and Minerals Industry, labour organisations and the South African Government.[10] The goal of the charter was to "create a mining industry that will proudly reflect the promise of a non-racial South Africa". The outcome of the negotiations was an agreement to measure the progress of Mining Companies with respect to a number of key areas as they relate to the socio-economic goals. Clause 4.5 specifically states: *"Establish measures for improving the nutrition of mine employees".*

The measures were subsequently defined in the Mining Score card, which consists of 9 elements[10] **(Addendum A).**

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[x] Act 29 of 1996

[xi] Act 28 of 2002

Element 7 addresses housing and living conditions for companies providing accommodation and the criteria for company-provided nutrition are stated as follows:

- *"Has the mine established measures for improving the nutrition of mineworkers?*
- *Indicate what has been done to improve nutrition, and*
- *Show a plan to progress the issue over time and the implementation of the plan".[10]*

There are however no criteria for the measurement of any of the indicators referring to nutrition.

As only mineworkers to whom food is provided (i.e. those staying in single accommodation also called villages) are referred to, it is necessary to develop cost effective measurement tools to monitor nutrition criteria, such as food commodities that are available and what is actually consumed.[10]

The difficulty in understanding the adequacy of nutrition was well illustrated in a Mining Charter Assessment report, published in October 2009.[11] The assessment indicated that only 29% of companies offered nutrition to employees or have established plans to improve nutrition. Inspections revealed that nutrition is typically outsourced to service providers with inadequate expertise. Furthermore this service is often supplied by former employees of the mining companies. The assessment also revealed a conspicuous absence of adequate facilities for employees to prepare their own meals.[11]

With the revision of the Mining Charter during 2010 the clause referring to nutrition was deleted **(Addendum B)**. However a similar requirement appeared in the MPRDA published in 2009 which states:

> *"Mining Companies in respect of a company providing for living conditions:*
>
> *3.1   Must ensure proper health care services for the mineworkers and their families living within and around the mining area…*
>
> *3.1. b. Sufficient proper nutrition/food and water are components of an adequate standard of living which has been linked to the productivity of mineworkers and must be provided for at an affordable, equitable and sustainable manner by the employer or necessary facilities for employees to prepare their own foods".[12]*

Clause 4 of the same act states under the monitoring and evaluation measures:

> *"4.3   In the case of establishing measures for improving the standard of living and nutrition, the mining company shall be required to indicate what it has done to improve the standard of living and nutrition and show a plan to progress the issue over time and the implementation thereof".[12]*

4

According to clause 6 of the same act, non-compliance of these standards

> *"will render the entity to be in breach with the MPRDA and subjected to section 47 of the Act".* [12]

Section 47 describes the ministers'

> *"power to suspend or cancel mining rights, -permits or -permission if no remedy of contravention, breach or failure of the act has been taken within a prescribed period".* [12]

This is an unreasonable action for breach of these vague descriptions in the Act.

The evaluation of the events highlighting the development of the nutritional standards for mineworkers throughout the years was necessary to assess the current nutritional intake of mineworkers. The development of a simple cost effective tool to measure and monitor food and nutrition intake is therefore essential in order to "*show progress*" and to implement a plan over time as described in the MPRDA.

CHAPTER 2.   LITERATURE REVIEW

In this section publications relating to food and nutritional assessment and development of a food standard for mineworkers are reviewed. However, not many recent published studies could be located on the food or nutritional standard for mineworkers

2.1   An Overview of Existing Tools to Measure Food and Nutritional Intake

Different dietary intake assessments have been investigated in order to find a suitable method to assess the nutritional intake of mineworkers. By finding a reliable method to assess nutritional intake, dietary inadequacies can be identified and intervention programmes can be developed accordingly.

According to a study conducted by Biro, dietary intake estimation encompasses the collection of information on the frequency and quantity of food eaten. By using food composition tables, the energy and macro- and micronutrient content of the food consumed can be calculated.[13] Three levels have been identified where dietary intake can be assessed, namely: at national level; at group level which includes household or institutional level; and the individual level (Table 2.1).[14]

Table 2.1   Levels where Food Intake can be Assessed[14]

Point of assessment		Method
National level		Food supply data (FSD)
Groups	Household	Household budget survey
	Institutional	Data from catering records or delivery notes
Individual	Prospective	Food diary; duplicate diet; weighed inventory; household measures
	Retrospective	Food frequency questionnaire; 24- hour recall

2.1.1   Food supply data at National level

Several countries have been conducting food supply studies for a number of years. Most of these studies have been initiated to assess household intakes, but the need has changed and recently the results of these studies have been used for marketing purposes. An example of this data is found in the United States Department of Agriculture's (USDA) first publication on availability of food for the United States civilian population which appeared in 1941 and by 1949 the USDA were able to extend the data back to 1909 for most commodities. The need for accurate food supply data was identified with the agricultural planning programmes for sustainable food supply under the Agricultural Adjustment Act of 1933. The droughts of 1934 and 1936 in the USA emphasised the need to analyse the national food supply.[15]

Food supply data (FSD), also referred to as food balance sheets (FBS), provides gross estimates of the type and amount of food available for human consumption within a country.[13] However, FSD do not measure the food actually ingested by the population or provide information on food consumption in relation to the regional, economic, demographic, seasonal, or socio-economic differences within a country. It can therefore not be used to estimate nutritional inadequacies in a particular country or region.[16]

FSD is calculated from domestic food production plus food imports (Figure 2.1). Food used for non-human purposes such as animal food and seed, as well as food used in an indirect way such as sugar for the brewing industry, is subtracted together with an estimate for wastage from the gross food supply. The result is a figure for the net amount of food available for human consumption at retail level.[16]

Box 2.1   Components of Food Supply Data[16]

Available commodity supply		Measurable non-food use		Total annual food supply of a commodity
Production + imports + beginning stocks	−	Farm inputs + exports + ending stocks	=	
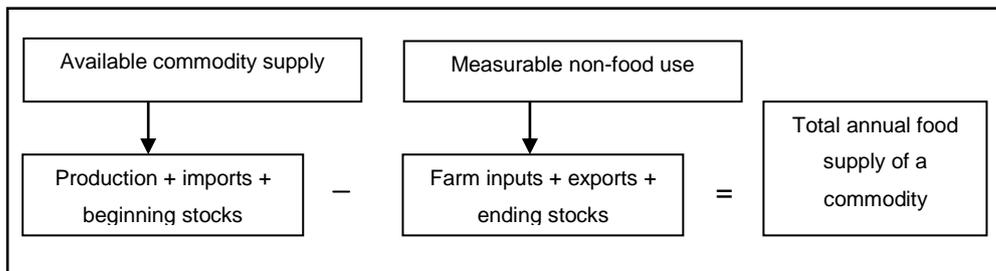
Using this data as well as an estimated population figure, it is possible to calculate the *per capita* food availability. This is expressed in terms of *grams per capita* of individual food commodities, and energy and nutrient availability per capita. Before the 1990's no deduction however was made for household food wastage or for loss of nutrients during food preparation.[16]

Food supply data is mainly used for analytical and comparative purposes. It can be used by economists to estimate effects of change in price and income as well as information on food consumption; which on the other hand provides useful information to market researchers on changes in consumption and market shares for food commodities.[15]

During the 1990's the Economic Research Service (ERS) of the USDA performed a drive to expand the usefulness of the food supply data. This data does not account for spoilage and wastage that accumulates in the marketing system or wastage which is not used at home. Therefore this data typically overestimates actual consumption. Three points of losses were identified as follows:

- Losses at primary level (farm to retail weight) ,

- Losses at retail level (this loss only takes into account losses at trade level and not at food outlets where cooked food is bought for consumption) and

- Losses at consumer level which identifies two components: (1) non-edible share of food such as bones or apple core, (2) cooking loss and uneaten food.

If the FSD data is adjusted for food loss, which includes spoilage, inedible components such as bones in meat and pips in fruit, and plate wastage as well as food used as pet food, then the food eaten by a person can be calculated over a certain period.[15] A study conducted by ERS and published in March 2008 found that the loss for fresh apples is up to 4% from farm to retail; 12% from retail to consumer and 29% at consumer level which includes spoilage, plate wastage and losses from inedible parts.[15]

2.1.2   Food Supply Data at Household Level

2.1.2.1   Household Food Consumption Surveys

Household food consumption (HFC) describes the amount of food and beverages available for consumption by the household, family group or institution and it excludes the food and drink consumed outside the home or institution, unless it is provided by the facility.[16]

Similar to FSD, HFC surveys assess food availability rather than the food eaten by an individual. However, in contrast to FSD, HFC surveys can supply information on food and nutritional intake patterns in subgroups or households and institutions. It is also possible to classify these groups into economic, demographic and other relationships, which will enable risk identification within the group.[13]

For HFC surveys to supply usefull nutritional information it must have the following data:

- *The quantitative measurement of food acquired for consumption over a given time period;*

- *A reasonable level of disaggregation of food items or groups; and*

- *Information on the number age and gender of people sharing the food.[17]*

The different methods identified for measuring HFC are:

a. **The food account method:** This consists of a daily record kept by the main respondent of all food entering the household, usually prepared by the housekeeper. This includes food which is purchased, or produced or received as gifts during a specific period- usually seven days. The respondent is usually the person responsible for food purchasing and or the preparation of food.[16,17]

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b. **The list-recall method:** A trained interviewer asks the housekeeper to recall all food used by the household on an "*as purchased*" basis over a specified time, usually seven days.[16]

c. **The food inventory method:** This method aims at recording acquisitions and changes in the food inventory of the household during the survey period. Although similar to the food account method**,** the main difference is that food store inventory is carried out at the beginning and end of the survey period.[17]

d. **The household food record method:** This method records the quantity of food consumed at each meal either by weight or household measure, before subdivision into individual servings. It therefore provides a direct measure of food available for consumption by the group and makes no assumptions about changes in food stocks.[16,17]

e. **The telephone survey method:** This method is used to collect consumer information on the purchase and use of certain food products.[16]

f. **The family food scale:** This method is used to measure complexity and diversity of food patterns of families.[16]

Two of these methods namely, the inventory and household food record methods can be adapted to measure intake of mineworkers residing in single accommodation villages. However, the procedure needs to be tested against a technique used on an individual level.

2.1.3 Data at Individual Level

In contrast to both FBS and HFC, data on the individual level provide information on average food and nutritional intake in defined groups of individuals. Four general methods commonly used to determine dietary intakes of individuals are:

a. **The 24h dietary recall:** The respondent is asked to recall the past 24 hour's food intake. Each meal is recorded separately and all foods and beverages consumed are recorded. This technique requires skilled interviewers who are familiar with the food intake practices of the area or region where the interview is conducted. A coding system for foodstuffs and meals is usually necessary to ensure reliable results. A single 24-hour recall does not represent the usual individual intake but describes the average intake of a group reasonably well. A single 24-hour recall is therefore not suitable to analyse the association between nutrient intake and biochemical markers.[13]

b. **The dietary record:** The food intake is recorded per meal and every time food is consumed by the respondent. A record of at least three days is usually obtained, randomised to cover mid week and weekend variations as well as incorporate any seasonal deviations. The dietary record is fairly accurate with respect to the foods consumed and the weighed method is often regarded as the gold standard among dietary assessment methods. There is however a high participation burden and usual eating patterns may be disturbed by the recording process. A skilled interviewer can be accommodated for personal consultations at the beginning and the end of the reporting period to clarify entries.[13]

Variations on the dietary record method have been described by other authors which includes recording data on paper, dictaphone[18] and taking digital photographs.[19] Although these methods use technology to ensure all food stuffs consumed are recorded, portion sizes may be difficult to evaluate.[20]

c. **The food frequency questionnaire:** The frequency of food products consumed over a period is recorded. The respondents are interviewed and asked about their usual consumption frequency of foods listed in a questionnaire for a certain period. Questions to indicate the portion sizes of food consumed are also incorporated in the interview. It is important to know the population studied to ensure that foods consumed in the area are listed. The result depends on memory of food consumed as well as frequency, especially the products that are not consumed on a regular basis. The recall of portion sizes may also be difficult. However**,** this method is a useful inexpensive tool to estimate foods usually consumed.[13]

d. **The diet history:** The past and the usual diet are investigated by recording usually consumed foods, frequency of consumption and quantities consumed. It usually starts with an interview to determine usual meal pattern, which can be obtained from a 24-hour recall. Thereafter a food frequency questionnaire is completed and finally a 3 day food record is obtained. Because it is a combined method, most disadvantages of the individual methods can be alleviated and reliable information can be obtained. Unfortunately it is expensive, requires skilled staff and has a high respondent burden.[13]

Except for the dietary record, all the other methods rely on the respondents' memory. The dietary record is also fairly accurate with respect to the foods consumed as this method is done by weighing food or using household measure (i.e. cups or spoons) - this is often regarded as the "gold standard" among dietary assessment methods.[13] However the most frequently applied

method to determine dietary intake is the food frequency questionnaire, while the dietary record and recall methods are used as reference methods.[21]

Table 2.2   Advantages and Disadvantages of Data Recording[13, 21]

Method	Description	Advantages	Disadvantages
24-hour recall	Participants reports all foods and beverages consumed during the past 24 hours.	Quick method to assess intake. Suitable in populations with low literacy levels. Low respondant burden. Relatively low administration costs.	Rely on participants memory and ability to describe portion sizes. May not represent usual intake. Trained interviewers necessary.
Dietary record	The participant records/ weighs all foods and beverages consumed over a certain period.	Accurate consumption data.	High respondant burden. Intake may change to accommodate reporting.
Food frequency questionnaires	A list of determent foods to which the participant answers on the frequency and quantity of the food consumed over a certain period.	Good participant response rate. Good representation of usual dietary intake if correct foods are identified. Can be used in populations with low literacy levels.	Reduced accuracy in estimating quanitites of foods consumed. Fixed lists of food may exclude reporting of certain foods Rely on memory of the participant. Must be culturally sensitive to avoid under reporting.
Diet history	This method is a combination of the previous three methods.	Most accurate because of the combination.	High respondant burden. Trained interviewers necessary. Expensive.

When considering a method to evaluate the food and nutritional intake of mineworkers residing in single accomodation villages, the question arises as to what the quantity consumed is, as the items consumed are known. The most approriate method to apply when evaluating the intake of mineworkers will be a method which does not rely on the memory of participants as quantity is more difficult to recall and explain than recalling the item consumed.[22] A direct method where quantity can be evaluated is more desirable. It is also necessary to choose an inexpensive method, with minimum interference in daily meal pattern activities.

2.2   Comparison between Group and Individual Intake Data

According to a study by Serra-Majem *et al.*, the types of data used to understand food consumption patterns on a national level are FBS and the HBS data. Individual Dietary Surveys

(IDS) are also done on a sporadic basis.[23] In South Africa, FBS have been conducted since 1962 and studies on groups have been done by several researchers.[24]

Serra-Majem *et al.* compared the data on the different levels of information namely national, group and individual. Their findings were that data on national level (FBS) over-estimated food consumption compared with data on individual level (IDS). However, data between groups (HBS) and IDS were similar except for fish, meats, pulses and vegetables which were underestimated by HBS. Sugar, honey and cereals were over-estimated. The reasons for the discrepancies may be caused by the surveying method used, and because each method has its own advantages and disadvantages. The differences in indicators used might also be a reason for the different results (food availability, food consumption and food wastage). Another factor could be the population group analysed – FBS and HBS includes an entire population where IDS only certain target groups.[23]

For the purpose of this study on mineworkers it can then be assumed that the data measured on the household level will show a relationship to the data measured at individual level. A study which generated similar results was reported in a review on health nutrition and economic development by Strauss and Thomas. The study was conducted by Bouis and Haddad during 1992 in the Philippines. The method used by these researchers was a 24-hour recall combined with a recall from food purchases made during the study month. Their findings were that the reported daily intakes were similar. The average energy intake for an adult reported on the 24-hour food recall was 2358cal[xii] and for the purchase recall was 2439cal[xiii].[25]

The comparison of food intake at different levels is therefore worthwhile exploring. If the results prove to be associated positively, data at household level can be used as a reliable form of assessing food and nutritional intake on an individual level. For the purpose of this study it can be postulated that the data from the food entering the food service unit at the inventory level (quantity issued) will relate positively to individual consumption.

2.3 Food Wastage Record

As food wastage, and especially plate wastage, relate to the reduction of the nutritional value of the meal, all of the above assessments rely on the correct estimation of food wastage. Food wastage is the term used to describe the total food wastage after a meal has been consumed and occurs mainly at three points:

[xii] 2358cal = 9904kJ

[xiii] 2439cal = 10244kJ

- Between acquisition and preparation (preparation wastage),
- Between preparation and serving (production wastage), and
- After food serving (plate wastage).

A study done in Turkey found that the loss of energy due to food wastage from acquisition to plate wastage was 906 kJ per person per day. It was also found that the average food wastage per person per day was 318.8 gram.[26]

The three most common types of food wastage studies are recall, visual and weighed. The type of wastage study method used depends on the research question. When the accurate measurement of food and nutritional intake is to be determined, the weighed method is the preferred technique.[27]

a. **Recall Method:** The recall method is limited by the accuracy of the participants' memory as it relies on the participant to record his own plate wastage. It takes into account the plate wastage only, as a different person (the one responsible for preparation and serving) needs to recall the preparation and production wastage. If the consumer is illiterate, a trained interviewer is necessary to conduct the survey or an assessment form with pictures can be used. Participant satisfaction can be incorporated in the assessment form with additional questions such as "I liked it a lot; I liked it a little; I did not like it" or "I hated it".

b. **Visual method:** The advantage of these studies is that they are easy, inexpensive and less time-consuming. Trained observers use a rating scale to indicate consumption. These scales can describe terms such as "ate all"; "¼ remaining"; "½ remaining"; "¾ remaining" and "ate nothing."[27] The main disadvantage is that the plate wastage is mainly observed.

c. **Weighed method:** Weighing is the most accurate method as it measures the exact weight of food wastage. It is also possible to calculate the preparation wastage; the production wastage and the plate wastage per food item.[27]

A method using a mathematical model to estimate food wastage in the USA was developed by Hall *et al*. This method relies on the fact that food wastage is related to metabolic rate. A validated mathematical model was developed relating body weight to the quantity of food eaten.

$$\text{Wastage} = FA - (\bar{I}_\circ + \bar{I}\Delta)$$

where FA is the per capita food energy available as estimated by United States food balance sheets; $\bar{I}_\circ$ is the average energy intake as estimated in 1974 and $\bar{I}\Delta$ observed increase in energy intake as calculated using higher body mass.[28] This model is valuable when estimating the cost of

food energy being wasted, either as an oversupply of food or as a supply of unwanted food which goes to waste.

For the study on the assessment of food intake of mineworkers the weighed method is considered as the most appropriate method for the study. To limit participation burden, individual wastage per plate will not be considered, but rather total wastage per food item.

2.4 Development of a Food Standard for the South African Mineworker

Food shortages in mining accommodation due to drought were described for the first time in an 1889 publication of the Transvaal Chamber of Mines.[8] Since then the development of catering and feeding in the Mining Industry has been mentioned in various publications.[8] During 1896 rations were prescribed for the workforce as 7900 gram[xiv] of mealiemeal and 900 gram[xv] of meat per week. From the above it is clear that these rations were likely to result in a vitamin deficiency. However, the existence of vitamins was still unknown and scurvy was reported in 1899. By 1921 the ration scale for Bantu labourers was well defined as illustrated in table 2.3.[xvi]

Table 2.3   Ration Scale for Bantu Labourers 1921[XV]

Food product	Quantity as per the original documents	Quantity (gram)
Mealiemeal	20 - 24 oz per day	567- 680
Bread	6 - 8 oz per day	170 - 227
Meat	3 - 3.7 lbs per day	1361 - 1678
Dried beans	3 - 4 oz per day	85 - 113
Peanuts	2 oz per day	57
Sugar	1 oz per day	28
Salt	Sufficient	
Vegetables	5 oz per day	142
Coffee or cocoa	0.2 oz per day	6

A further amendment[xvii], allowed the substitution of 1 ounce[xviii] of whole mealies, samp, or approved cereal for an ounce of beans. Dr Williams of the Transvaal Mine Medical Officers Association compared this scale with others during 1941, (Table 2.4) which was only food based and no mention of influence on productivity or health was made.[3,8]

[xiv] 17½ pounds =7900 gram

[xv] 2 pounds = 900 gram

[xvi] Annexure B, the Native Labour Regulation Act, 1911 was amended by Notice No. 2241, dated 8 December 1920

[xvii] No. 37, dated 5 January 1922, Annexure B

[xviii] One ounce = 28,4 gram

Table 2.4   Comparison of the Daily Energy and Nutrient Content of Different Ration Scales[3]

Item	Unit	Ration scale 1[a]	Ration scale 2[b]	Ration scale 3[c]	Ration scale 4[d]
Protein (Total)	gram	100	126	140	189.8
Animal Protein	gram	50	78	28	51
Fat	gram	100	153	85	102,6
Carbohydrate	gram	300-500	507	652	879,6
Energy	Cal	4500	4061	3864	5433
Energy	kJ	18450	16650	15842	22275
Calcium	milligram	1000	750	338	512.7
Phosphorus	milligram	1320	1740	2012	2598
Iron	milligram	15	32	54.4	75.4
Vitamin A	International Units	4000-6000	6990	966	2905
Vitamin B	International Units	800	460	543	627
Vitamin C	milligram	30-60	88	28	80
Vitamin D	International Units	300-400	85	-	-

[a] Ration scale 1: Standard Allowance: Committee on Food and Nutrition National Research Council of U.S.A. (no date indicated)

[b] Ration scale 2: Basic Ration Scale recommended for Adult Europeans at Health Department's Institutions. (no date indicated)

[c] Ration scale 3: Government Minimum Ration Scale Native Labour regulations Act of 1911 (as amended)

[d] Ration scale 4: Standard Scale as laid down as a guide for experimental group of mineworkers (Dr Williams)

During the 1950's food wastage was investigated as food became very expensive after the Second World War. For the period 1949 to 1955 an increase of 186% in feeding cost was reported for an increase of about 2% in the labour force. The investigations at the time focused on the quality and monitoring of the raw food as well as the quality and acceptability of the end (cooked) product. The nutritional value of the food consumed or discarded was not considered.[3] During the 1960's the Chamber of Mines Research Organisation and the State Health Department recommended research into a more suitable ration scale. Dias *et al.* quoted a study by Fleming *et al.* which pointed out that the average daily intake of mineworkers was similar to the Government minimum standard. The latter authors did a comparison between the government minimum standard, the industry average and an "on demand" average. The "on demand" system was implemented at some units to minimise wastage. The findings were as follows:

Table 2.5 **Comparison of the Government Standard, Industry Average and "On Demand" Issues.[8]**

Food Items	Government minimum (g)	Industry average (g)	On demand system (g)
Maize meal	-	511	350
Total maize	682	568	266
Bread	170	156	128
Beans	85 - 114	57	34
Meat and fish	244	253	253

(Note: the values were indicated in oz[xix] in the original document)

At the general meeting of the Mine Medical Officers Association on 15 July 1971, the Gold Fields West Bantu Hospital reported on nutritional observations made on Bantu recruits on appointment. The study on 100 newly appointed mineworkers revealed that the mean value of serum ascorbic acid of the group was 0.633mg per 100ml and according to work done by Fox (1940) this was an indication of moderate to poor tissue saturation. He mentioned that at the time an investigation to add an additional 20mg of ascorbic acid to "marewu"[xx] per day was undertaken. It was assumed that together with the mineworkers' habitual intake through food, the additional intake of ascorbic acid will increase total intake of this vitamin to 70mg per person per day. It was stated that it is most important to know exactly what the nutritional state of the "Bantu" is on arrival at the mine and what effect the mine diet has on the general nutritional state of the worker.[8,9,29]

Regulation 2265 of 1975 under the Bantu Labour Act was the last to regulate nutrition in the mines. It stipulated the minimum daily ration scale for "Bantu" mineworkers as described in table 2.6.[8]

[xix] oz = 28.4gram

[xx] Marewu = mageu /mahewu

Table 2.6   **Minimum Daily Ration Scale for Bantu Mineworkers According to the Bantu Labour Act, 1975[8,30]**

	Minimum Ration Scale for Bantu Employees Schedule 44 Bantu Labour Act, 1964 Government Notice No 2265 of 28/11/75			
	Item	**Mass**	**Substitute**	**Mass**
1	Cereal, including flour or commercial powder for marewu, Bantu beer and similar liquor, mealiemeal, whole mealies, mealie rice, samp, Kaffircorn, bread meal, barley, homemade noodles macaroni, soup, thickening agents etc.	560g		
2	Bread	125g	Any item or combination under 1	85g
3	Beans	50g	Peas, lentils, soy beans, fat-free soya products	50g
4	Fresh meat: Beef, mutton, pork, chicken or venison dressed and containing not more than 25% of bone	170g	Fresh fish or meat not containing bone or fish or canned meat or fish or dried meat or fish or fat-free soy products plus oil or cereal or eggs in the shell or egg powder or cheese or fresh milk or milk powder or shelled peanuts or beans	170g 130g 130g 70g 50g 10g 25g 150g 40g 70g 700ml 70g 60g 75g
5	Offal	50g	Meat containing about 50% bone or meat specified in item 4	50g 30g
6	Fat: suet, mutton fat, lard, chicken fat and vegetable fat	15g	Vegetable oil	15g
7	Vegetables: fresh with leaves and peels, except carrot leaves (which are dangerous) and maize leaves (which are inedible	140g	Dehydrated vegetables Or canned vegetables Or frozen vegetables Or fresh fruit	15g 140g 140g 140g
8	Sugar	30g		
9	Milk: Fresh milk, whole-milk or skim-milk	50ml	Whole-milk power Or skim-milk powder	5g 5g
10	Salt	As required		
11	Herbs	As required		

The Bantu Labour Act was repealed by 1988 and since then very little research has been conducted in relation to nutrition and the Mining Industry. Mining companies began to develop their own nutrition policies – still in many cases using the old legislation as a guideline. However, food and catering became a cost driven exercise and in many instances adequate nutrition was not considered. Kitchens were closed and mineworkers given a "living-out" allowance or a food grant expected to provide for themselves. This is a problem in many cases as little support in the way of

food supply and cooking facilities exist, as well as inadequate storage facilities for food, especially for perishable foodstuffs. This phenomenon is described in the Mining Charter Assessment Report of 2009. This report mentions that the consequence of the "living–out" allowance is the increase of informal housing, due to lack of adequate accommodation.[11]

During 2002 a collective bargaining agreement between the mining industry and organised labour stated that a "*sustenance shall be provided to all underground workers*". Unfortunately the "sustenance" was never described and each site could negotiate a suitable "sustenance" with their workforce.[8] This varied from an extra plate of food at the dining room to a monetary grant for each shift worked underground - again no retail or vendor facility was provided where these workers could purchase food items.

2.5 Food Standard Development post 1988 within the Mining Company

The mining company, from which permission was obtained to conduct the study, has been following the guidelines as described in the Bantu Labour Act (Table 2.6) together with the Daily Recommended Intake (DRI's) since 1988.[xxi]

However, a formal nutrition policy and standard for workers residing in mine accommodation was developed as recently as 2008[xxii] (**Addendum D)**. In summary the policy states that the aim with reference to food and nutritional intake is to:

- Ensure optimal nutritional status,
- Ensure nutritional requirements for different workloads and special needs are met, and
- Respect people's culture and preferences.
- This will be achieved through the following principles: Commitment, competence, risk assessment, prevention and control, performance, evaluation and stakeholder engagement.

The following parameters were considered in the menu development:

2.5.1 Nutritional standards

The main nutritional aspects which were considered during the development of the nutritional standard was to ensure that food served in the Single Accommodation Village's (SAV) meet with all nutritional requirements as to enable optimum performance and well being of all workers consuming meals.

[xxi] Group Standard S&SD. Nutrition: Standard menu. Ref no: CTR-SPL-HLH-STD-001

[xxii] Group Standard S&SD. Nutrition: Standard menu. Ref no: CTR-SPL-HLH-STD-001

Where South African data on feeding workers in an "*industrial feeding*"[xxiii] context is not available, international best practice was applied in the development of the above standard.

2.5.2   Ration Scale

The ration scale of the menu is based on the minimum ration scale for Bantu Employees described in 1975. However, regular consultation with labour groups and developments in the food market, initiated changes in the food quantity served as well as in the variety of food served (Table 2.7). Products that were not described in the 1975 ration scale, which are now incorporated include dairy products especially cultured milk products such as Amaas.[xxiv]

Table 2.7   Food Ration Scale Currently Used by the said Mining Company[xxv]

Food Products	Weight (raw weight)
Breakfast	
Breakfast cereal	80g
Breakfast protein	100-120g
Bread	220g (6 slices)
Spread	30g
Beverage (tea, coffee, sugar, sweetener and creamer)	20g
Sugar	20g
Main meal	
Main meal protein	180-270g
Condiments	15g
Dried beans	30g
Maize meal	130g
Starch	80g
Vegetables	200-250g
Vegetables (salad)	80g
Oil	10ml
Fruit (4x/ week)	120-150g
Mageu (enriched with Vit C)*	800ml
Beverage (fruit drink)	300ml
Supper	
Supper protein	100-120g
Maize meal	50g
Vegetable	60g
Bread	30g
Dairy product (milk/cultured milk)	300ml

[xxiii] The meaning of industrial feeding in this context is an environment where workers are fed to ensure an intake of sufficient quantity of foodstuffs of good quality approaching a balanced diet to ensure a positive state of health in the labour employed.

[xxiv] Amaas = Nkomaas/ Nkomasi

[xxv] Group Standard S&SD. Nutrition: Standard menu. Ref no: CTR-SPL-HLH-STD-001

This ration scale exceeds the quantities in the ration scale as described by Martins (2005) for adult men performing fairly hard work according to the minimum living level (MLL).[31] According to Martins the MLL is described as the *"minimum financial requirements of members of a family to maintain their health and have acceptable standards of hygiene and sufficient clothing"*. (Table 2.8)

Table 2.8   **Minimum Living Level ≥ (MLL) Daily Food Rations for Adult Men Performing Fairly Hard Work[31]**

Food	Men (age in years)		
	19-22	23-50	51+
Milk (full cream milk powder)	40g	40g	40g
Meat, fish, eggs and Peanut Butter	73g	73g	73g
Baked beans	58g	58g	58g
Fresh vegetables	330g	330g	330g
Margarine	20g	20g	20g
Oil	20ml	20ml	20ml
Brown or whole wheat bread	280g	280g	175g
Grain products (mainly maize)	340g	340g	280g
Sugar and Jam	70g	70g	45g
Coffee and tea	7g	7g	7g
Salt	4g	4g	4g
Spices and seasoning	5g	5g	5g

Source: Martins and Maritz (2004) in Martins 2005[31]

2.5.3   Energy requirements

Although no specific data on energy requirements for mineworkers exists, the COMRO reference report 91/11 on metabolic rates of underground workers can be used as a reference to determine energy requirements for mineworkers. These rates are referred to in the guideline for Thermal Stress management and can be applied to all underground mineworkers.[4]

The COMRO report described studies done on estimated metabolic rate for underground workers and found that the metabolic rates of conventional and mechanized underground mining occupations were on average of a moderately high intensity (>130 W/m² to 180 W/m²).[32] Very hard work where the metabolic rate increases to >240 W/m² is generally of a short duration and experienced infrequently.[31]

Table 2.9   Metabolic Workload of Underground Workers[32]

Work Category	Mean Metabolic Rate (W/m²) over full working shift	Shift Duration (Min)
Stoper	160	511,5
Developing Team	163,3	545
Stope Team	163,9	551,4
Miner Assistant	164	538,1
Cleaning Team (Night Shift)	164,1	510,6
Loader Driver	170,1	545,1
Winch Driver	170,3	556,2
Driller	176,1	567,8
Drill Assistant	178	575,4

These metabolic working rates imply an energy requirement of 14000 kJ -19500 kJ for a person with a reference weight of 75kg. The metabolic rate distribution of conventional mining can be summarised according to box 2.2.

Box 2.2   Metabolic Rate Distribution over a Full Shift[31]

51,4%   is performed at a moderate rate
24,4%   represents light work and rest
19,2%   represents hard work
6%   represents very hard work

The perception that underground mining can be classified as a Physical Activity Level (PAL) of "very active" is therefore not correct. However, the study referred in the COMRO report was done at a wet-bulb temperature of 27,5°C, which is considered to be acceptable for conditions where normal routine underground work is done. Extreme environmental conditions are often experienced by mineworkers which impacts on their metabolic work rates. It is therefore compulsory that all prospective and existing underground mineworkers go through a heat tolerance screening before employed in a position for underground work. The exclusion criteria for underground work includes certain medical conditions such people with insulin dependent diabetes mellitus (DM) (these include Type 1 DM as well as Type 2 DM treated with insulin), being grossly overweight or underweight (Table 2.10).

Table 2.10   Body Dimensions as Criterion for Physical Work in Hot Environments[4]

Employee status	Criterion/standard	Interpretation and recommended course of action
Prospective ("novice")[a]	Body mass < 50kg Body mass 50-55kg BMI 15-29kg/m² BMI 30-35kg/m² BMI>35kg/m²	Unsuitable (BMI irrelevant); reject Suitable but not for "strenuous" work [b] Suitable Suitable with no medical contra-indications Unsuitable: reject
Existing	Body mass <45kg Body mass 45-50kg Body mass 45-55kg BMI<15kg/m² BMI 15-19kg/m² BMI 20-29kg/m² BMI 30-35kg/m² BMI>35 kg/m²	Unsuitable (BMI irrelevant); reject Suitable with no medical contra-indications or a history of heat disorders. No allocation to "strenuous" work(>160w/m²) Unsuitable [c] Suitable with no medical contra-indications or a history of heat disorders. Suitable Suitable with no medical contra-indications or a history of heat disorders. Unsuitable [3]

[a] Novice means a person with no prior experience of mining as a career

[b] Strenuous work means any work in hot where the work rate exceeds 160 W/m²

[c] Unsuitable implies withdrawal of certificate of fitness unless an acceptable BMI can be achieved within a reasonable time.

An energy intake adequate for a mineworker with a BMI of 22-29 and a Physical Activity Level (PAL) of the description "low active" to "active" can therefore be used to measure adequate intake for mineworkers (PAL ≥1.4 -<1.6 and PAL ≥1.6 - <1.9).

2.5.4   Macronutrient requirements

Acceptable Macronutrient Distribution Ranges (AMDR) guidelines are used as reference for this population group of mineworkers.[33] Guidelines for athletes have also been considered.[34]

Carbohydrate: 5-7g per kg body-mass per day for moderate exercise

Protein: 1.2-1.6g per kg body-mass per day

Fat: Less than 30% of total energy intake

2.5.5   Micronutrients requirements

According to Kielblock[5] the most important nutrient turnover during work in heat is that of vitamin C. For this reason an increased intake of Vitamin C is recommended. Although increased levels are not recommended, the other micronutrients which are affected by the environmental conditions in the underground operations are Vitamin A which can affect the dark adaptation time and Vitamin D which can be affected by the lack of daylight (sunlight) exposure.[34] The Dietary Reference Intakes (DRI's)[33] is used as a reference, except for Vitamin C where a value specific for the South

African mining Industry is available. The recommendation is 250mg per person per day for underground workers.[4]

For this reason, mageu which is consumed daily is enriched with 200mg/1000ml Ascorbic acid, to ensure a higher intake of Vitamin C. The low pH of mageu ensures a suitable vehicle for the enrichment with Ascorbic acid as oxidation does not take place rapidly at this high level of acidity.[35] According to Sommano *et al.* maximal stability of Ascorbic acid is found at a pH of about 4.[36] which is also in line with results obtained from the mageu supplier to the mining company. These analyses are done on a regular basis as part of a quality control procedure **(Addendum F).**

2.6 Recommended Nutritional Value for the Menu of the said Mining Company

In order for the menu to supply adequate nutritional value to sustain health and productivity in underground conditions, the following nutritional target is considered. (Table 2.11)

Table 2.11   Nutritional Value of the Menu[xxvi]

Nutrient	Unit	Quantity/day	Energy contribution
Energy	kilojoule (kJ)	15600	
Protein	gram (g)	155	17%
Carbohydrate	gram (g)	500	54%
Fat	gram (g)	120	29%
Vitamin C	milligram (mg)	260	
Vitamin A	microgram (µg)	960	
Calcium	milligram (mg)	1250	
Iron	milligram (mg)	25	

2.7 Research Question

If there is no difference between the per capita nutrient intake of mineworkers when comparing food inventory data and that of actual food consumed measured by food record data and food wastage, then it will be possible to use the food issue data as a **"Cost effective measurement tool to monitor"** food and nutrition intake of mineworkers and strategise nutritional interventions.

2.8 Motivation for the Study

The mining Charter or "Broad-Based Socio-Economic Empowerment Charter" (BBSEE) for the Mining Industry was developed in consultation between the Mining and Minerals Industry, Labour organizations and the South African Government during October 2002.[11] The goal of the charter is

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[xxvi] Group Standard S&SD. Nutrition: Standard menu. Ref no: CTR-SPL-HLH-STD-001

to *"create a mining industry that will proudly reflect the promise of a non-racial South Africa."* The outcome of the negotiations was an agreement to measure the progress of Mining Companies with respect to a number of key areas as they relate to the socio-economic goals. Clause 4.5 specifically states: "*Establish measures for improving the nutrition of mine employees*". This is defined in the Mining Score card, which consists of 9 elements.[10]

Element number 7 addresses housing and living conditions for companies providing accommodation and sets criteria for any company-provided nutrition**.** It states the following:

 Has the mine established measures for improving the nutrition of mineworkers?

- *Indicate what has been done to improve nutrition, and*
- *Show a plan to progress the issue over time and the implementation of the plan.[10]*

There are however no criteria for the measurement of any of the indicators referring to nutrition, and as only mineworkers to whom food is issued (i.e. those staying in single accommodation) are referred to, it is necessary to develop cost effective measurement tools to monitor nutrition criteria, such as what food commodities are available and what is actually consumed. Food inventory data and a daily record (household record) of all food received and consumed in the food service unit is already available. However, limited information is available on the use of this data to determine average individual intake.

It was therefore hypothesized that inventory/household record data could be used to estimate nutritional intake of mineworkers residing in a SAV where three meals are provided by means of a cafeteria style service. Self service is not allowed, but mineworkers are allowed to make food choices on the service line. It can therefore be assumed that it is a controlled environment with limited choice. This environment enabled the researcher to explore the quantity of food consumed per mineworker and the average nutritional intake per day.

2.9 Significance of the Study

Although information on the workload (energy requirement) of mineworkers is available, information on the food and nutritional intake of this group is limited. As a result the development of a reliable and economical assessment method to determine food and nutritional intake of this group will identify possible dietary inadequacies. Intervention programmes can then be developed and implemented accordingly. The development of a cost effective measurement tool to monitor food and nutritional intake can assist with the generation of data for comparison to the relevant legislation.

No criteria or nutritional goal was mentioned in the previous Mining Charter. It only stated that measures must be established for improving nutrition of mineworkers. This has led to a lot of confusion, so much so**,** that it was recorded that the Minister of Minerals and Energy during that time, stated at a media conference that as long as the mineworkers received one plate of good food per day she would be satisfied.[xxvii]

A simple economical method to measure and monitor the food intake, of mineworkers residing in SAV's, can assist in monitoring their nutrient intake. Such a method will also assist in establishing the expected average food intake per person per day more accurately. Should an audit of food intake show deviations from the required intake, which could have an impact on the health of the worker, an intervention program can be implemented pro-actively.

Furthermore this study can assist with food procurement processes, where the evaluation of products at tender level can confirm it's suitability as a menu item.

[xxvii] Minister of Minerals and Energy at a media conference on the mining Charter 2003.

CHAPTER 3.   METHODOLOGY

3.1   Study Aim and Objectives

The aim of the study was to establish a simple, reliable and economical method for evaluating food and nutritional intake of mineworkers residing in a SAV on a mine in the North West Province.

3.1.1   The specific objectives for the study were

- To calculate the average food and nutritional intake per person (in this study, the mineworker) according to the food issue data (food inventory/household record data);
- To assess actual food intake by means of an observational study (food record data);
- To determine plate wastage at the point of consumption;
- To compare food and nutritional intake as determined by food issue data (inventory data/household record data) and actual food intake determined by measured food record data (observational study) and to determine the relationship between these variables; and
- To develop a practical, reliable and economical tool whereby food and nutritional intake can be measured in order to assist in the development of nutritional policies.

3.2   Null-Hypothesis Statement

There is no difference between the per capita nutritional intake of mineworkers when comparing food inventory data to that of actual food consumed measured by food record data and food wastage.

3.3   Study Design

A cross-sectional, observational study with an analytical component was conducted.

3.4   Sampling

3.4.1   Sampling Frame

The study population consisted of male mineworkers residing in a SAV on a Platinum Mine in the North West Province. The mining group has five operating mines in the North West and Limpopo Province. This site was selected due to easy access to the operation as well as a well established food service unit. The study group included mineworkers performing mainly underground tasks as well as a percentage performing surface work and included different work intensities (Table 3.1).

Table 3.1   **Different Work Categories of Mineworkers and the Intensity of Work Load**

Work Category	Intensity	Example
Underground	Hard work	Driller, drill assistant
Underground	Moderate hard work	Loader, driver, winch driver
Underground	Moderate work	Equipping team, Team leader, Stope team, Miner assistant, Cleaning team
Underground	Moderate light work	Electrician, Mine overseer, Loco crew
Surface	Moderate light work	Artisans
Surface	Moderate light work	Office assistants

3.4.1.1 Selection of Sample

A census sampling method was used. All respondents who complied with the inclusion criteria were included in the study (see section 3.4.3).

3.4.2   Sample Size

The number of mineworkers staying in the selected SAV ranges from between 650-700.This variation in numbers is due to the dynamics of the working environment of mineworkers. This includes transfer to a different workplace, attending a training session at a development centre, or termination of contract. According to the accommodation Human Resource records, the ages ranged between 18-54 years and academic qualifications varied between no formal schooling to a grade twelve certificate.

At the SAV where the study was conducted three meals were served per day and the habitual participation of the meals was as follows: breakfast (45 - 65%, n=315-455), main meal (75 - 95%, n=525-665) and supper (15 - 35%, n=105-245). Extended mealtimes are used (breakfast: 03h00-08h30; main meal: 11h30-18h30 and supper: 19h00-21h00) with resultant low particpation at supper. The extended mealtimes are used to accommodate those shift workers who need to travel long distances to the place of work and back. The average number of workers affected by this long distances could be as high as 80% of the underground workforce, depending on the area of work. The average shift time of work is 9½ hours. The distance from the shaft stations to the place of work could vary from 1-2½ kilometers. The means of arriving at the work place includes man carraiges (as opposed to ore carraiges) but usually workers walk to the place of work from the shaft stations. The travelling time ranges from 1-2 hours and thus could make up as much 4 hours of the total shift time.

3.4.3   Inclusion Criteria

The following inclusion criteria were used when selecting participants for the study:

- Only male mineworkers residing in the SAV were selected for this study;
- Mineworkers from all races were included;
- There was no limitation on language proficiency;
- The food intake of all mineworkers having the meal as per the menu at the selected observational days was captured. This included all qualifying mineworkers, visitors as well as special requests for overtime or late arrivals; and
- Mineworkers with special dietary needs, who were not identified, were included in the study.

3.4.4   Exclusion Criteria

The following mineworkers were excluded from the study:

- No women were considered for this study as at the time of the study no women were residing in the SAV being studied;
- Any mineworker having a meal, which is not as per the prescribed menu being monitored, was excluded from the study. If any special orders had to be made, these were also excluded; and
- The mid-shift meal (also called "sustenance" in the industry) is not issued at the food service department, but at the mine shaft to accommodate all underground workers. This contribution towards nutritional intake was excluded from all calculations.

3.5   Preparation for Data Collection

The study was discussed and explained to the head of the housing department of the mine, responsible for the SAV where the study was to be conducted. Possible data collection points were discussed and the advantages and disadvantages were considered. As the study was non invasive and no participation of any of the mineworkers was required, it was not necessary to obtain consent from them.

Informed consent (**Addendum C**) was obtained from the company's representative and the study was then discussed with the manager of the selected SAV where the data for the study was to be collected. The manager of the SAV where the pilot study was conducted was also informed. The staff structure of company employees of the housing department involved in the study is described in the organogram (Figure 3.1).

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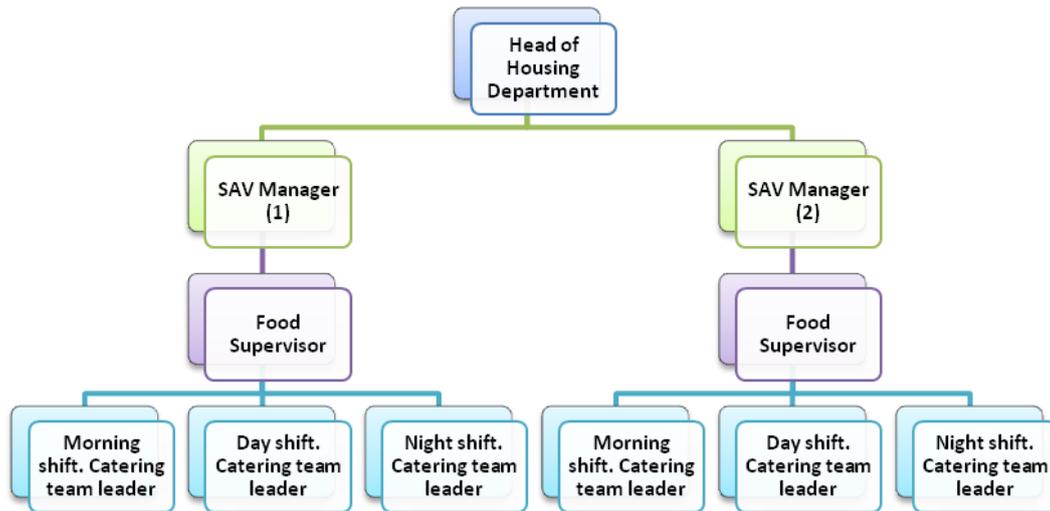
Figure 3.1   Organogram of the Mine Housing Department Personnel Involved in the Study

The study was conducted in different stages (Figure 3.2). The first action was to select the menu study days. There after the serving utensils were validated for weight and volume in relation to the type of food served; observers were trained and a pilot study was conducted at an identified SAV to test the methodology. Data was collected on the study days and results were subsequently analysed and reported.
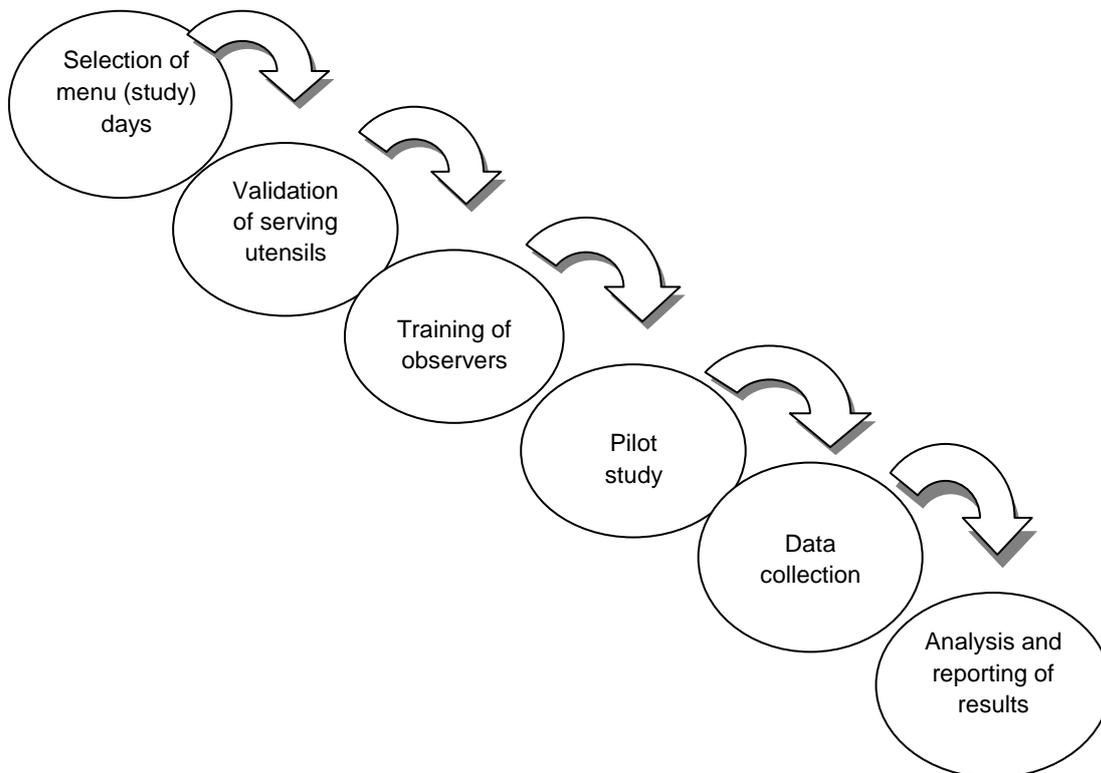
Figure 3.2   Flow Diagram to Illustrate the Sequence of Actions during the Study

3.5.1   Selection of Menu Study Days

The SAV chosen for the assessment uses a 7 day cycle menu with choices for the protein and starch dishes during the main meal. The specific days for data gathering were identified using the following criteria:

- Days on which few deliveries were received at the food service unit to ensure that interruptions were limited and that all ingredients were available;
- Days in the middle of the month were selected to ensure maximum meal participation. Through a trend analysis it was observed that meal participation dropped at the end and beginning of the month due to various reasons such as home visits, money available to purchase food at other outlets and receiving food from home; and
- At least one weekend day.

The observation days identified were Tuesday (Day 1), Wednesday (Day 2), Thursday (Day 3), Friday (Day 4) and Saturday (Day 5 weekend day).The availability of all ingredients for the selected menus (Table 3.2) was confirmed. The avocado planned as a spread for breakfast (Day 5) was not available and was substituted with margarine.

Table 3.2   Menus of the Selected Study Days

	Day 1	Day 2	Day 3	Day 4	Day 5
Breakfast	Lambalazi* Brown bread Margarine Jam Vienna with tomato and onion Tea	Sebube# Brown bread Margarine Jam Peri –peri chicken liver Coffee	Mabele Brown bread Margarine Peanut Butter Grilled beef sausage and tomato Tea	Maize meal Brown bread Margarine Jam Meatloaf Coffee	Lambalazi Brown bread Margarine Savoury mince Tea
Main Meal	Braised beef or Roast chicken Mieliepap Rich onion gravy Samp and beans Glazed carrots Apple Mageu	Beef curry or Roast chicken or fried fish Mieliepap Tomato gravy Samp and beans or rice Boiled pumpkin Coleslaw Cold drink Mageu	Braised beef or Roast chicken or Cooked tripe Mieliepap Brown gravy Samp and beans Stewed spinach Carrot salad Banana Mageu	Beef stew or Roast chicken or Grilled Russians Mieliepap Onion gravy Samp and beans or rice Stewed cabbage Apple Mageu	Roast chicken or Grilled Boerewors Mieliepap Tomato and Onion Samp and beans Boiled mixed vegetables Cold drink Mageu
Supper	Chicken stew Mieliepap Brown bread Margarine Fresh milk or Amasi Coffee	Beef stew Mieliepap Brown bread Margarine Fresh milk or Amasi Tea	Savoury mince Mieliepap Brown bread Margarine Beetroot salad Fresh milk or Amasi Coffee	Grilled beef sausage Mieliepap Brown bread Margarine Mixed salad Fresh milk or Amasi Tea	Peri-peri chicken liver Mieliepap Brown bread Margarine Carrot salad Fresh milk or Amasi Coffee

* Lambalazi: A sour maize meal based porridge

Sebube: A sour sorghum based porridge.

3.5.2   Validation of Serving Utensils to Establish Accurate Assessment of the Weight of Food Portions Served

The serving utensils used during the study was the same utensils usually used for the purpose in the dining rooms. No additional utensils were used or acquired for the study. Serving utensils are usually standardised per volume, however, for the purpose of this study it was necessary to validate the utensils for weight measured against the volume, for the different commodities. The three utensils used were a serving spade (small and large) (Figure 3.3a), ladle - 125mm (Figure 3.3b) and a heavy duty serving tong (Figure 3.3c).

(a)   **Serving Spade[37]**   **(b) Ladle[37]**   **(c) Heavy Duty Serving Tong[37]**
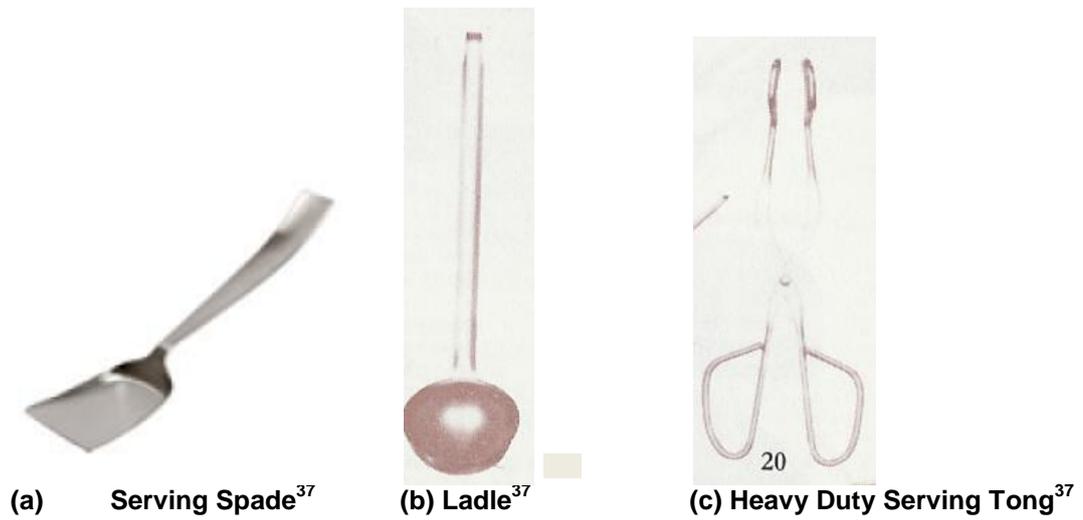
Figure 3.3   **Serving Utensils Used in Study**

To ensure accuracy, a Terraillon quarts digital (Figure 3.4) and Camry manual (Figure 3.5) scales were calibrated to 5gram accuracy using standard weights.

Figure 3.4   **Calibration of Terraillon Quarts Digital Scale using Standard Weights.[37]**

Figure 3.5   **Calibration of the Camry Manual Scale using Standard Weights.[37]**

Portion sizes were validated by weighing the portion served using the serving utensils as illustrated in figure 3.3. Ten portions of each food commodity were weighed to calculate the weight of an average portion.

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Figure 3.6   Standardisation of Food Portions using Standard Ladle and the Digital Scale.[37]

The average weight of the food products to be served using the standardised serving utensils is illustrated in Box 3.1.

Box 3.1   Type of Serving Utensil and the Weight of Food Served per Utensil

Serving Spade	
1 Serving spade pap (large)	= 340gram
1 Serving spade pap (small)	= 130gram
1 Serving spade samp	= 240gram
1 Serving spade rice	= 240gram
Ladle	
1 Ladle stew (beef or chicken)	= 350g
1 Ladle soft porridge	= 260g
1 Ladle vegetable	= 200g /190g
1 Ladle soup/gravy	= 150g
1 Ladle breakfast protein	= 120g
1 Ladle beans	= 225g
A pair of tongs	
Used to serve:	
Roast chicken, wors and sausages = 1 piece cooked chicken	
= 190gram (average cooked weight)	
Cooked wors = 185gram (average cooked weight)	
Cooked sausage = 100g (average cooked weight)	

3.5.3   Training of Observers

The observers who were identified to record the served portion sizes and to gauge the volume of food left on the plate, were the food supervisors of the food service unit and the unit leaders for the three shifts. The food supervisor was identified as the leader of the team.

The training was done by the researcher and took place before conducting the pilot study. Emphasis was placed on the evaluation of portion sizes by weighing a full portion and a half portion separately. Repeated visual portion estimation was practiced both in a closed setting as

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well as on the serving line. The closed setting consisted of pre-weighed portions being evaluated. All the observers were trained at the same session. An individual observation session for an hour at the serving line was assessed by the researcher. The observers were then brought into the same session to ensure agreement on portion evaluation, especially when half or double portions served were observed. By using the relevant symbol (Box 3.2) the observer could indicate the portion served to a mineworker. This is a non-invasive method of assessing food intake.

Box 3.2   **Symbols Used in Observation Study to Indicate Number of Portions Served**

2	= double of the portion as intended
1	= the full portion as intended
½	= half of the intended portion
0	= no portion (decline)

The workers in the dish-wash area were trained to ensure that all food wastage was separated according to the food item into the allocated bins.

3.6   Data Gathering

To enhance accuracy of captured data existing quality control measures of food preparation were adhered to. These included conforming to the prescribed menu and nutrition policy, (**Addendum D)**, of the company as well as the prescribed quantities as per the standardised recipe. All food products used conformed to the company's specifications for raw products, of which **Addendum E** is an example, and the prescribed cooking methods were executed correctly which included the correct cooking and hot holding time.

The gathering of data was categorised into four stages;

1)   Collection of data at inventory level;
2)   The capturing of the expected yield per food item;
3)   Collection of data on the meal observation days; and
4)   The subsequent collection of data on total food wastage.

3.6.1   Stage 1: Collection of Data at Inventory Level

The collection of data at inventory level was based on determining a realistic estimation of the expected number of mineworkers participating in a meal on the selected study days. Estimation of the planned number of mineworkers was calculated using an average participation history of the SAV over the previous three months. Figure 3.7 illustrates the meal participation pattern for a month. From the figure it is clear that participation varies; the participation during weekends is

lower, mid week participation is higher and the beginning of the month participation is much lower. Participation is therefore estimated per day and not a mean over the period.
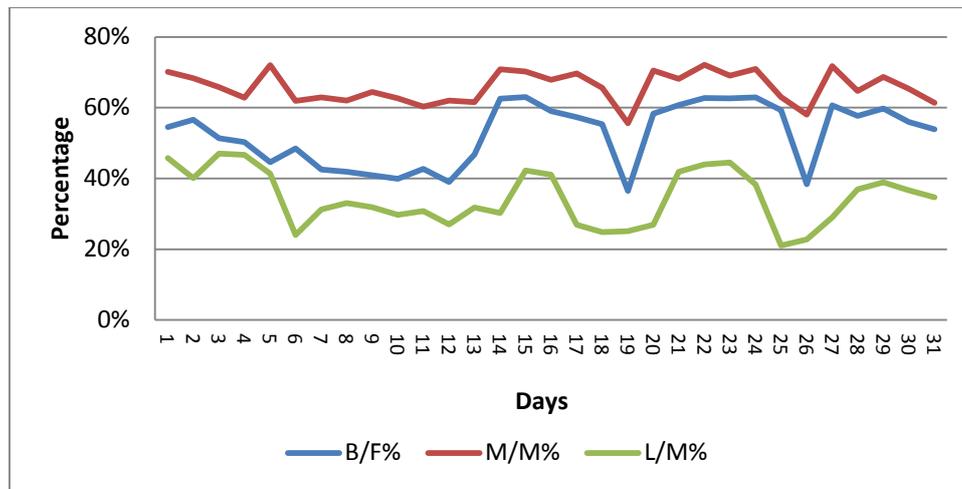
B/F = Breakfast: mean =585; max = 640; min =64

M/M =Main meal: mean =633; max=707; min=208

L/M =Dinner: mean =257; max=408; min =115

Figure 3.7 **Daily Main Meal Participation as a Percentage of Residents (n=700) Staying in the SAV**

The quantities of ingredients required per meal were calculated according to the average number of mineworkers for that specific menu day (as predicted by historical patterns), as well as the relevant recipes and the ration scale. These calculations were done on the days prior to the observation. Raw ingredients required per meal were issued accordingly and recorded on a daily issue sheet. An example of a daily issue sheet for breakfast is shown in Table 3.3 below

Table 3.3 **Example of Daily Issue Sheet**

Day:	Tuesday	Date	Strength[xxviii]	700
Meal:	Breakfast	19 October 2010	Planned participation	590
Food item		Ration Scale (kg) per person	Total (kg)	Unit
Lambalazi		0.07	40	1 bag
Sugar		0.02	12.5	1 bag
Bread		0.21	130	217 loaves
Margarine		0.015	9	Kg
Jam		0.015	9	Kg
Viennas		0.11	65	10 ½ packets
Tomato		0.02	9	Kg
Onion		0.02	9	Kg
Tea		0.021	12	1 bag

[xxviii] Strength is the term used for number of mineworkers residing in the SAV on a given day.

A data capturing sheet (Table 3.4) was used to summarise all food items issued per day (data on daily issue sheets), as well as the planned number of mineworkers participating in the meal, to enable future analysis **(Addendum G)**. The total ingredients for the study period on planned participation as well as total quantities issued for the period was recorded on the data capturing sheet.

Table 3.4   Example of Data Capturing Sheet

Main meal	Ration scale (kg) per person	Day 1	Day 2	Day 3	Day 4	Day 5 (weekend)	Total
Planned participation		*690*	*700*	*700*	*580*	*490*	*3160*
Soup powder (kg)	0.015	10kg	10kg	10kg	8kg	7kg	45kg
Beef (kg)	0.280	95kg	50kg	50kg	81kg		276kg
Chicken (kg)	0.220	75kg	75kg	75kg	64kg	54kg	343kg
Fish (kg)	0.200		35kg				35kg
Tripe (kg)				35kg			35kg
Boerewors (kg)	0.200					49kg	49kg

The total quantity issued per food item was estimated over the five menu study days together with the planned participation over the same period. This data was used to determine the 'average issue per person per day'.

3.6.2   Stage 2: Capturing of Planned Yield per Menu Item

The ration scale is specified in raw quantities, however to plan cooked food portions it is necessary to predict cooked yield. The planned total yield per food item was calculated and captured using conversion factors according to the recipes (Table 3.5).[38,39] The planned portion is calculated by dividing the expected total yield by the expected participation per meal. According to Table 3.5 the planned yield for porridge is 892kg (over the five study days) and the anticipated breakfast participation is 2790 for the same period. Therefore the planned average portion equals 892kg/2790 or 320g per person.

Table 3.5   **Planned Yield Calculated Using a Conversion Factor**

Meal Plan	Ration scale (raw)	Total quantity issued (kg)	Conversion factor	Planned yield (total) (kg)	Planned portion
Breakfast: Number of participants/meal n=2790					
Porridge	80g	233	4	892	320g
Sugar	20g	55			
Bread	6 slices	613	1	614	6 slices
Spread	30g	83	1	83.700	30g
Protein dish	100-120g	279-334	0.95-1.1	265-306*	95-110g*
Vegetable (Tomato& Onion)	10-15g	27-42			
Beverage:	300ml	65	15	837	350ml
Oil	3ml	8			
Condiments **	5g	14			
Main Meal: Number of participants/meal n=3160					
Protein dish	220-270g	695-853	0.8-0.95	556-810	218g
Gravy (soup)	15g	47	10	474	150ml
Maize meal	130g	411	2.6	1068	340g
Starch	80g	253	3.1	785	248g
Vegetable	230g	727	0.8	581	184g
Salad (2x/week)	60g	190	1	190	60g
Condiments	10g	31			
Oil	10ml	31			
Fruit (2x/week)	130 g	411	1	411	130g
Mageu	800ml	2528ℓ	1	2528ℓ	800ml
Dinner: Number of participants/meal n=1455					
Protein dish	100-120g	145-174	1.1	***160-192	121g
Soup powder	8g	12			
Maize meal	50g	73	2.6	189	130g
Condiments	5g	7			
Bread	2slices	87	1	87	2slices
Margarine	8g	12		12	8g
Vegetable or Salad	60g	87	1	87	60g
Dairy product	300ml	437ℓ	1	437ℓ	300ml

*   includes vegetable

**   condiments are issued as part of the recipes and are not reflected on its own in cooked product.

*** includes protein and soup powder as thickener

3.6.3   Stage 3: Collection of Data on Meal Observation Days

The data generated on the observation days were captured at two levels:

- Data at group level (household level): Actual yield was measured by weighing the prepared food using Bain Marie inserts as containers. The actual yield (weighed) was measured against the planned yield (calculated) as this could affect the number of portions available. The total actual yield (weighed) per menu item was captured prior to serving the food. This data was used as household food record data;

- Data at individual level: This data was collected by observing the meal and food item participation[xxix] of mineworkers participating in a food item; this was done by an independent trained observer. A data observation sheet was used for this purpose (**Addendum H**). The number of mineworkers participating in the meal was recorded. Data was recorded as 0; ½; 1 or 2 as an indication of the serving size.

- After the serving line was opened, the observer positioned himself at the end of the serving line, where the entire line was visible. The mineworkers took a serving plate, registered with a "swipe" card and proceed down the serving line. Food service unit staff members served the mineworkers. However, each mineworker could request an additional serving (except for the protein dish) or may refuse a food item.

To summarise, Figure 3.8 illustrates the sequence of events and persons responsible for actions on the observation study days.
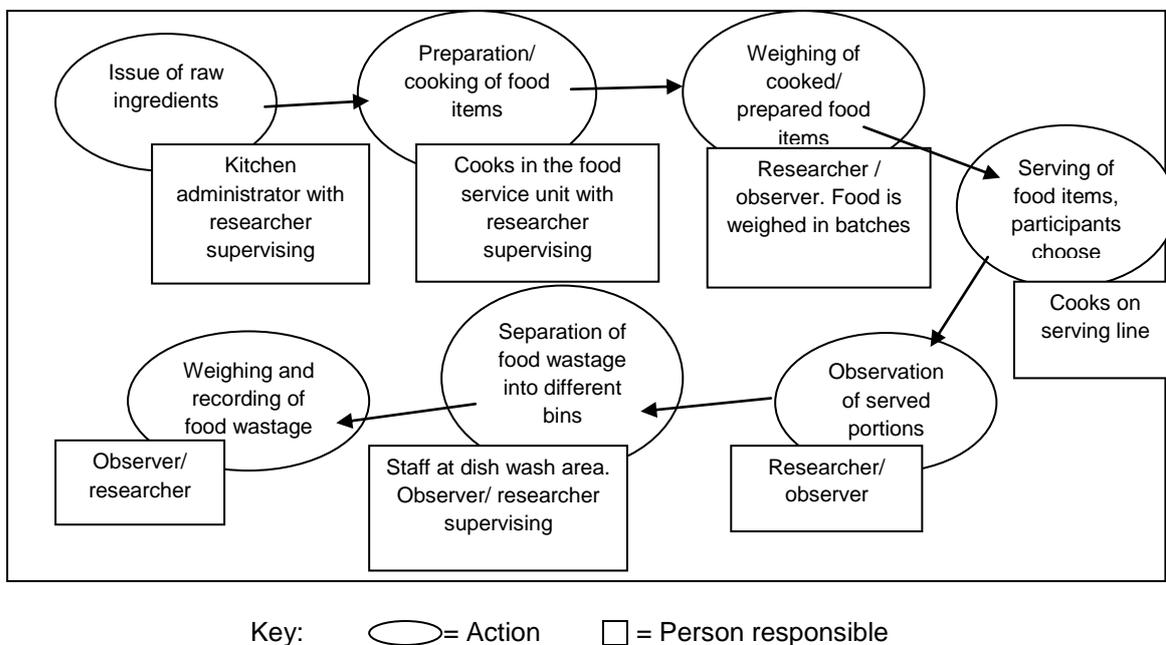
Figure 3.8   **Diagram of Sequence of Events on the Observation Days**

[xxix] Food item participation = *Food participation is the term used for mineworker accepting a certain food but not consumed yet*

3.6.4   Stage 4: Food Wastage

Collection of data on food wastage consisted of the weight of food items left after serving, described as production wastage, and the weight of leftover food after consumption by the mineworker described as plate wastage. After finishing his meal, each mineworker took his plate to the dish-wash area and handed it to a food service unit staff member who separated the food plate wastage into different bins. After completion of the meal session, food wastage per food item was weighed. The total food wastage was calculated by adding the production wastage to the plate wastage (Box 3.3). It did not include inedible wastage such as bones and peels.

Box 3.3   Formula to Determine Wastage

Total wastage = (production wastage + plate wastage)

3.7   Data Consideration for Analysis

Data obtained at the four stages of the study was analysed. Symbols were assigned to descriptions (Box 3.4) to simplify calculations and equations used for the data analysis (Box 3.5).

Box 3.4   Summary of Symbols Assigned to Specific Data Used in Equations

A: Planned portions (raw): Ration scale ingredient
B: Planned portion (cooked): Planned portion calculated by using approximate yield factors as indicated in the standardised recipes.[38] [40]
C: Planned yield (total)
D: Planned meal participation (The planned number of mineworkers participating in the meal over the study period)
E: Actual yield (total): Total cooked weight of menu items
F: Actual planned portion
G: Production wastage (Weight of individual menu items not served i.e. "left in the pot.")
H: Plate wastage (Weight of individual leftover items on the plate).
H1:   Inedible wastage (Such as bone and fruit peelings/pips)
I: Average portion served
J: Actual participation (According to electronic data - Swipe card)
K: Actual portion participated = Actual quantity served (AQS)/ actual participants (L)
M: Average Portion observed (Statistically analysed)

By using the data symbols, calculations can be simplified (Box 3.5).

Box 3.5   Summary of Equations Used for Data Analysis

B = A x conversion factor
(Where **B** is Planned portion, **A** is Ration scale as per Box 3.4)

C = B x D
(Where **C** is Planned Yield, **B** is Planned Portion and **D** is Planned Meal Participation as per Box 3.5)

F = E/D
(Where **F** is Actual Planned Portion, **E** is Total Yield and **D** is Planned Meal Participation)

AQS = E – [(G+H) + H1]
(Where **AQS** is Actual Quantity Served, **E** is Total Yield, **G** is Production Wastage, **H** is Plate Wastage and **H1** is inedible wastage)

I = AQS/J
(Where **I** is the average portion served, **AQS** is the Actual Quantity Served and **J** is the total participants according to the electronic data)

K = AQS/L
(Where **K** is the Actual Portion Consumed, **AQS** is the Actual Quantity Served and **L** is the actual participants per food item)

3.7.1   Portion Analysis

The food portions were calculated for the different stages and compared to portions obtained during the observation study.

3.7.2   Nutritional Analysis

The nutritional analysis of the data was done at the different study levels:

- Inventory data: Planned portion (B) as calculated according to raw issues using planned participation;
- Household record data: Actual planned portion (F) as calculated after actual yield was obtained and using planned participation; and
- Observed data (Food record data): Actual portion (K) consumed by the mineworkers as observed on the observation days.

Data obtained from both the planned figures (as per raw issued) as well as data from the observational study (actual consumption) was analysed for nutritional estimates, using the Food Fundi Software, based on the MRC Food Composition Data base, version 1.2. The energy intake was evaluated against the criteria described in a study done by the Chamber of Mines Research Organisation during 1991.[27] The macronutrient intake was evaluated against the Acceptable Macro

Nutrient Distribution Range (AMDR). The micronutrient intake was evaluated against the Dietary Reference Intake (DRI) values except for Vitamin C which was evaluated against the guideline for the South African Mining Industry.[4] Table 3.6 describes criteria for evaluating dietary intake.

Table 3.6   **Nutrients and Dietary References used for Evaluating Total Dietary Intake[4,28,32]**

'Nutrient	Reference Intake	Values/day
Energy	Energy intake for moderate to hard labour (COMRO) [a]	15000kJ

Macronutrient distribution:
  Protein
  Carbohydrate
  Fat
	AMDR[b]	
		
		10-35% (88-300g)
		45-65% (397-574g)
		20-35% (81-142g)

Fibre
Fat:
  PUFA
  MUFA
	AI[c]
	
	AI[c]
	AI[c]
		38gram
		
		1.6g
		17g

Micronutrients
  Vitamin A
  Vitamin C
 	
  Vitamin D
  Calcium
  Iron
	
	EAR[d]
	Recommendation for underground workers [e]
	AI[c]
	AI[c]
	RDA[f]
		
		900 µg
		
		250mg
		5µg (2000IU[g])
		1000mg
		8mg

[a] *COMRO reference report No 11 91[30]*
[b] *Acceptable Macro Nutrient Distribution Range*
[c] *Adequate Intake*
[d] *Estimated Average Requirement*
[e] *Recommendation by South African Mining Industry[4]*
[f] *Recommended Dietary Allowance[34]*
[g] *International Units*

3.8   Development of a Practical, Reliable and Economical Tool to Measure and Monitor Food and Nutritional Intake.

The hypothesis states that food inventory and household record data could be used to calculate average food and nutritional intake of mineworkers residing in a SAV where menus are controlled. However, as data at this level does not account for wastage and the possibility that mineworkers do not consume all food items, a factor to allow for these losses are necessary.

Theoretically a factor to convert raw issues to cooked food can be obtained from standardised recipes. Furthermore, the only loss should be in-edible losses as all food is pre-prepared and production losses should be negligible. However, this is not true as wastage does occur. No data on acceptable food wastage per meal was found and a factor for edible losses had to be calculated.

In-edible wastage can therefore be calculated from food specifications.

Bone loss   =   20-30% for beef

                    35-45% for poultry (chicken)

Skins   =   20-30% for fruit

Box 3.6   Equation for Calculating Food Intake per Mineworker

Food consumed/ mineworker = {Total (Raw issue x cooking/preparation factor) x (participation factor)}   – (edible + inedible wastage)

Therefore, by monitoring the food issued and wastage on a daily basis, food intake can be calculated using daily food issues.

3.9   Pilot Study

The pilot study was done on a Monday during the main meal at a unit other than where the main study was conducted using a similar menu and number of meal participants. The Monday was chosen as it was the only weekday which did not form part of the study. The pilot study was performed to test the observation sheets and assess the data collection process. Food issues for the one meal of the pilot study were calculated and the cooked food items were weighed to establish the total yield. The pilot study was also used to assess the competence of the observers trained for the study. The meals of fifty residents were observed. Subsequently no modification of the observation sheets was necessary. The researcher was satisfied that the observers understood the process and were executing their observations accurately.

3.10 Data Analysis

3.10.1   Preparation and Analysis of Data

All data on food issues, observational data and wastage data was captured electronically on Microsoft Excel (Microsoft Office 2007) by the researcher. The data was grouped according to the meal plan dividing the data into different food groups which have similar serving sizes as well as nutritional values (Table 3.7). The data was captured separately for each meal and day. The portions were captured in grams using the data in box 3.2 as reference. Nutritional analysis was done for each meal and captured. The planned portion as indicated in Table 3.5 was used as a measure to ensure the correct data was captured. Random checks were done during the study.

Table 3.7   Meal Plan and Menu Items

Meal	Meal plan	Menu items
Breakfast	Cereal	Maize meal, Lambalazi, Sebube and Mabele
	Bread	Bread
	Spread	Margarine, Jam, Peanut butter
	Sugar	Brown sugar
	Protein	Vienna's, Chicken livers, Beef sausages, Meat loaf and Mince
	Vegetables	Tomato and Onion
	Oil	Oil
	Condiments	Salt, Spices
	Beverage	Coffee, Tea
Main meal	Soup	Soup and gravy powders
	Protein	Beef, Chicken, Fish, Tripe and Boerewors
	Maize meal	Maize meal
	Starch	Samp, Beans[#], Rice
	Vegetable	Carrots, Pumpkin, Spinach, Cabbage, Mixed Vegetable
	Salad	Coleslaw, Carrot salad
	Fruit	Apple, Banana
	Mageu	Mageu
	Oil	Oil
	Condiments	Condiments*
	Beverage	Cold drink
Supper	Protein	Chicken stew, Beef stew, Mince, Beef Sausages, Chicken liver
	Maize meal	Maize meal
	Bread	Bread
	Spread	Margarine
	Salad	Mixed Salad, Beetroot salad, Carrot salad
	Dairy product	Fresh milk, Amasi
	Beverage	Coffee, Tea

\# Although beans are high in protein it is served as part of a starch item: samp and beans

* Condiments was not analysed as part of the study

3.10.2 Statistical Analysis

Data was statistically analysed with the assistance of the Department of Statistics at the University of Stellenbosch.

Descriptive statistics was used to report on the comparisons made of recommended daily allowance, nutritional intake according to inventory data and actual food intake.

Based on the observed consumed values, 95% confidence intervals were constructed for the means of different variables of interest by using the t-distribution. If the planned values fall below the lower boundary of the 95% confidence interval for the consumed values, it means that with 95% certainty the planned values were lower than those observed. If the planned means are above the upper boundary of the confidence intervals for the consumed values, it means that the planned values are too high, or that the actual observed values could not reach the planned values.

3.11   Ethics and Legal Aspects

3.11.1   Ethics

Approval for the study was granted by the Human Research Ethics Committee, Faculty of Medicine and Health Sciences, University of Stellenbosch (reference NO9/11/301).

3.11.2 Consent

Written informed consent to perform the study in the SAV of the mining company was obtained from the Company Representative, Group Properties Division (**Addendum C).**

The relevant SAV managers were informed about the study. The manager where the pilot study was conducted was also informed.

As the study was not invasive and no participation of any of the mineworkers was needed, informed consent from them was not necessary. However confidentiality was respected regarding the mining company where the study was conducted as well as to all study participants.

The food service unit workers who assisted with the study as observers and with the collection of plate wastage were identified, informed about their responsibilities and trained. Random checks on the weight of portions were done during the study.

CHAPTER 4.   RESULTS

This chapter deals with the presentation and interpretation of the data obtained during the study. For the purpose of imparting clarity the results will be presented in the form of tables, scatter grams, line or bar graphs and pie charts.

4.1   Study Population

Planned and actual meal participation varied on a daily basis and had to be considered when planning daily food issues. Figure 4.1 illustrates the difference between the planned and actual participation.
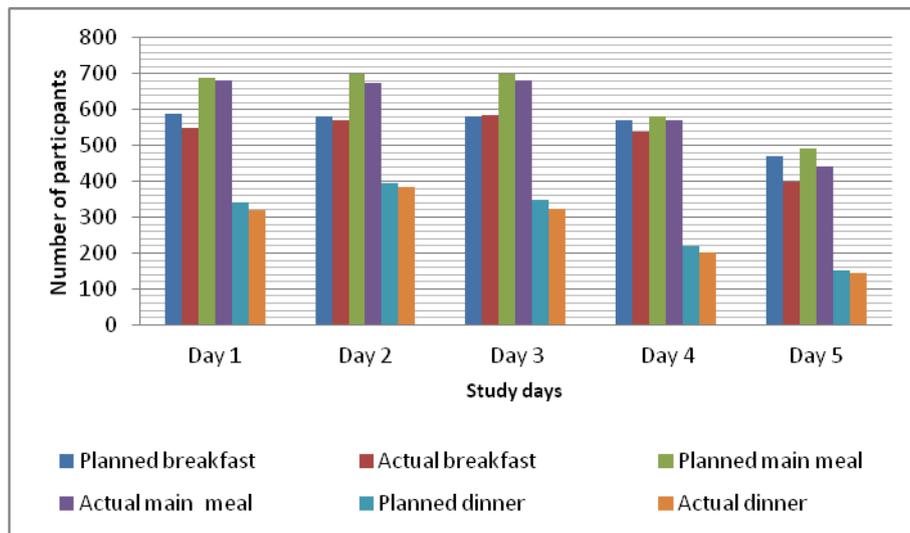
Breakfast (planned n = 2760 vs. actual n = 2625; 95%),

Main meal (planned n = 3160 vs. actual n = 3048; 96%) and

Dinner (planned n = 1450 vs. actual n = 1375; 95%).

Figure 4.1   Differences between Planned and Actual Participation

On the observation study days the process began at approximately 03h00 when breakfast service started. The majority of the mineworkers participating in the breakfast meal were dayshift workers on their way to work. Breakfast serving closed at 09h30. The main meal was served from 11h00 to 17h30 and dinner was served from 18h30 until the dining room closes at approximately 23h00. Thereafter the facilities were cleaned in preparation for the following day's food service activities. All data was collected, summarised, described and analysed according to the five objectives of the study.

4.2   Data at Household Level

4.2.1 Inventory Data

The first objective was to calculate the nutritional intake per person (in this study, the mineworker) according to the food issue data (food inventory/household record data).

The planned portion (B), per person, according to the food issue data (food inventory) was calculated using planned meal participation (D). A conversion factor was used to estimate the planned yield and by using the planned number of participants a planned portion was calculated (Table 4.1).

Table 4.1   Conversion of the Total Raw Food Issues over 5 Observational Study Days to Planned Cooked Portion per Person

Meal Plan	Ration scale (raw weight)	Total issued (5 days)	Average gram issued per person (raw weight)	Conversion factor	Planned portion (gram per mineworker) Cooked portion (B)
Breakfast: Number of persons n=2790					
Porridge	80g	190kg	68g	4	272g
Sugar	20g	62.5kg	22g		
Bread:	6 slices	614kg	220g (6slices)	1	220g
Spread:	30g	84kg	30g	1	30g
Protein dish	100-120g	285kg	102g	0.95-1.1	94g
Vegetable (Tomato& Onion)	10-15g	92kg	33g		
Beverage:	300ml	65	23g		
Oil	3ml	12.5ℓ	4 ml		
Condiments	5g	20kg	7g	15	450ml
Main Meal: Number of persons n=3160					
Protein dish	220-270g	738kg	234g	0.8-0.95	218g
Gravy (soup)	15g	45kg	14g		142g
Maize meal	130g	410kg	130g	2.6	337g
Starch	80g	257kg	81g	3.1	241g
Vegetable	230g	725kg	229g	0.8	204g
Salad	60g (2x/week)	110kg	35g	1	35g
Condiments	10g	30kg	9g		
Oil	10ml	25ℓ	8 ml		
Fruit	130g (2x/week)	240kg	76g	1	76g
Mageu 800ml	800ml	2490ℓ	788 ml	1	788ml
Dinner: Number of persons n=1455					
Protein dish	100-120g	170kg	117g	1.1	122g
Soup powder	8g	8.2kg	6g		
Maize meal	50g	77kg	53g	2.6	131g
Condiments	5g	8kg	5g		
Bread	2 slices	88kg	60g	1	58g
Margarine	8g	11kg	8g	1	8g
Vegetable	60g	20kg	30g		39g
Salad		43kg			
Dairy product	300ml	438ℓ	301ml	1	301ml

As this study was intended to be non-invasive little attempt was made by the researcher to interfere with the day to day practice of unit of issue. The current practice is to issue per package unit. Therefore if the expected number of participants and the portion size calculated to 55 kilogram, a 60 kilogram bag was issued as it is the customary unit of issue.

4.2.2   Household food record data

The actual total weight of cooked product at the serving point before consumption was used as household food record data; since this method records the quantity of food consumed at each meal either by weight or household measure, before subdivision into individual servings. The actual yield (weight) of the food was recorded and an average portion per mineworker was calculated using the number for planned participation (Table 4.2).

Table 4.2   Expected and Actual Average Yield of the 5 Observational Study Days Calculated According to Planned Raw Ration Scale

Breakfast: Number of persons n= 2790 (D)				
Food item Ration Scale	Expected yield food inventory (kg/l) (C)	Actual total yield (kg/l) (food record) (E)	Actual planned portion (g/ml) (F) (E/D)	Average portion served per person (g/ml)
Porridge: 260g	760	730	262	227
Bread: 6 slices	614	614	6 slices	6slices
Spread: 30g	84	84	30	19
Protein dish: 120g	262	311	111	108
Beverage: 300ml	1260	1020	366	397
Main meal: Number of persons n = 3160 (D)				
Food item	Expected yield (food inventory) (kg) C	Actual total yield (kg) (food record) (E)	Actual planned portion (g/ml) (F)	Average portion served per person (g/ml)
Protein dish: 220g	689	651	206	200
Soup (gravy): 150ml	450	438	139	119
Stiff Maize meal porridge: 340g	1066	1050	332	306 208
Starch: 240g	761	763	241	
Vegetable:190g	645	626	198	181
Salad: 60g	110	110	35	69
Fruit :130g	240	240	76	122
Mageu: 800ml	2490	2490	788	533
Dinner : Number of persons n=1455 (D)				
Food item	Expected yield (food inventory) (kg) C	Actual total yield (kg) (food record) (E)	Actual planned portion (g/ml) (F)	Average portion served per person (g) (I)
Protein dish: 118g	181	174	120	113
Maize meal:130g	208	202	139	124
Bread: 2 slices	88	88	3	51
Vegetable /Salad : 60g	43	43	30g	54
Dairy product : 300ml	438	438	300	307

C= Planned yield (total); D= Planned participation; E= Actual yield (total); F= Actual planned portion;

I= Average portion served

The differences between the expected (C) yield and the actual (E) yield were noted at breakfast, namely porridge at -30kg, which calculated to a deficit of 10gram per person. The difference for the protein dish was recorded at +49kg or a surplus of 18 gram per person. (Difference between B and F) Differences noted at the main meal were the protein dish at -38kg or a deficit of 12 gram per person; soup (gravy) at -12kg or a deficit of 4 gram per person; porridge at -16kg or a deficit of 5 g per person; starch at +2kg or a surplus of 1 g per person and vegetable at -19kg or a deficit of 6g per person. At dinner the differences noted for the protein dish were -7kg or a deficit of 5g per person and maize meal at -6kg or a deficit of 4g per person.

4.2.3   Nutritional value of the household data

The nutritional analysis of the household data was compared with the ration scale. The average energy content according to the ration scale, planned portion and actual planned portion was 14790 kJ, 14803 kJ and 14862 kJ respectively (Figure 4.2). The energy value of the ration scale was lower on day 1, 2 and 3 but higher than the actual planned values on day 4 and higher than both household values on day 5.
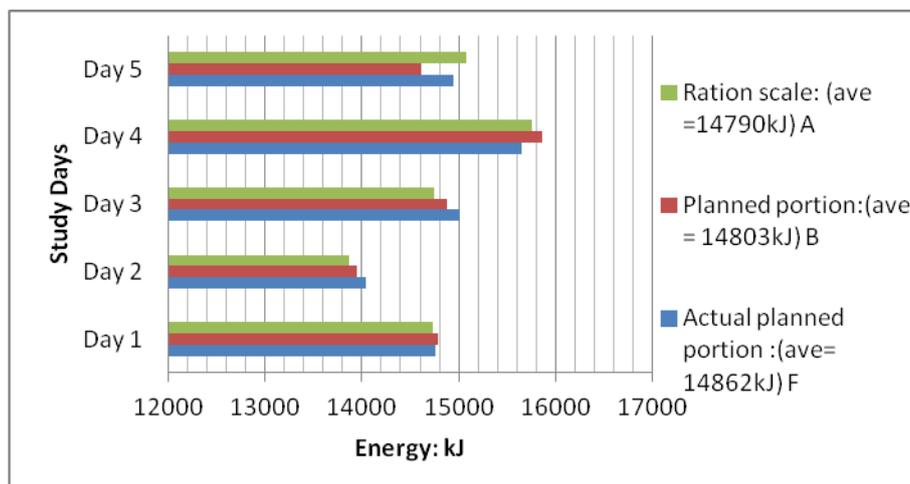
Figure 4.2   Energy Value of Data at Household Level

The same pattern was observed for fat, carbohydrate and protein values (Figure 4.3). The ration scale (A) value was lower than the household values except for day 5 where it was higher (125, 475 and 141 gram respectively) than the planned value (B) (120, 464 and 135 gram respectively) and the actual planned value (F) (124, 472 and 140 gram) respectively. On average the ration scale value was higher (142.2 gram) for the planned protein (142 gram) and lower for the actual planned value (143 gram) than the household values at planned 142 gram and actual planned 143 gram. The average carbohydrate value for the five study days was 476 gram calculated for the ration scale, 479 gram for the planned portion and 472 gram for the actual planned portion. The average value calculated for fat according to the ration scale 116.2 gram which is slightly lower than the planned value at 116.6 gram but higher than the actual planned at 114 gram. State if any of these differences were statistically significant even though one would presume not.

48
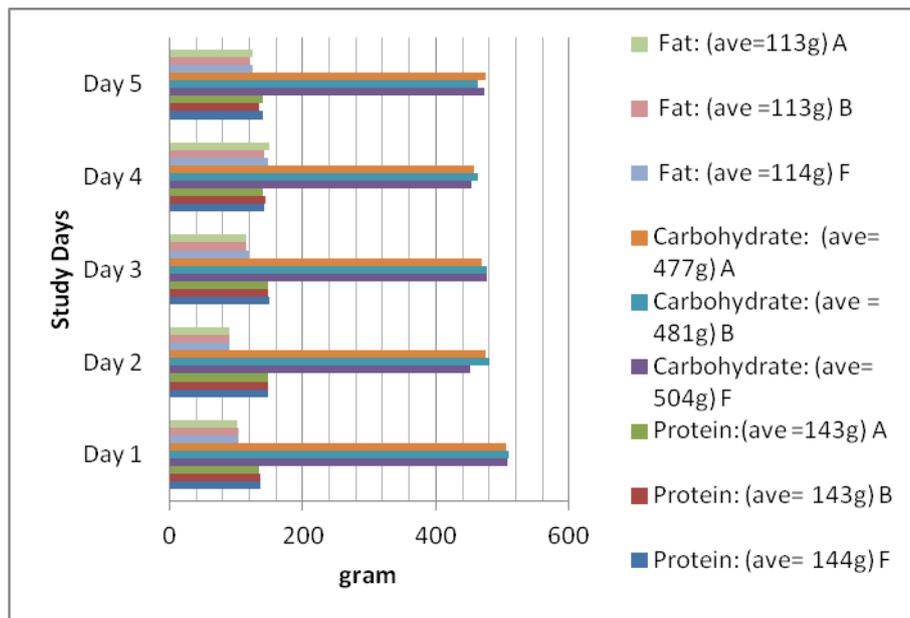
Key: A=Ration scale; B=Planned portion and F=Actual planned portion

Figure 4.3   Macro-Nutrient Value of Data at Household Level

The micronutrient value of the daily food issues was calculated and the expected intake of Vitamin C and Vitamin D was below the reference values 250mg per person per day for Vitamin C and 5µg for Vitamin D.

Table 4.3   Average Daily Micronutrient Values of Household Data

	Reference values[4,28,31]	Day 1	Day 2	Day 3	Day 4	Day 5	*Average*
Calcium mg: F	1000	1066	914.4	1118	867	1014.7	*1023*
Calcium mg: B	1000	1067	912.5	1134	868	1011.5	*1019*
Calcium mg: A	1000	1066.3	929.8	1134.4	874	1027.7	*1025*
Iron mg: F	8	19.34	24.34	22.9	18.24	23.8	*21.6*
Iron mg: B	8	19.4	24.28	22.7	18.2	23.5	*21.5*
Iron mg: A	8	19.1	25.01	22.7	18.2	24.3	*21.7*
Vitamin A: F	900	7092	2294	3427	372	4441	*3457*
Vitamin A: B	900	7179	2312	3382	371.9	4707	*3511*
Vitamin A: A	900	6845.8	2746.6	3507	372.5	4727	*3548*
Vitamin C mg: F	250	193	174	183	156	217.6	*171.2*
Vitamin C mg: B	250	191	171	133	157	218	*171*
Vitamin C mg: A	250	192.5	169.1	133	161	217.4	*171.2*
Vitamin D µg: F	5	2.6	2.7	3.5	1.9	2.6	*2.7*
Vitamin D µg: B	5	2.6	2.7	3.5	1.9	2.6	*2.6*
Vitamin D µg: A	5	2.6	2.7	3.5	1.9	2.6	*2.7*

4.3   Individual data

4.3.1   Food Record Data

The second objective was to assess actual food intake by means of an individual assessment method (food record data). A direct observation method was chosen for this purpose and was conducted by observing the practices of mineworkers participating in a menu item.

The number of mineworkers participating in a meal as well as in a menu item was noted and recorded. The observations were recorded according to the symbols mentioned in Box 2.3. The total number and type of portions served during the three meals are reflected in Table 4.4.

Table 4.4   Total Number of Portions Served during the Three Meals for the Study Days

Breakfast: Number of persons n*=2625						
	Cooked portion					
Menu item	Full portion	Half portion	Double portion	No portion	Number of persons n**	% participating in the food item
Porridge 280g	2048	115	103	359	2266	86.3
Bread: 6 slices	2400	71	148	6	2619	99.7
Margarine: 15g	2517	0	0	108	2517	95.9
Spread: *** 15g	1920	50	0	460	1970	75
Protein dish 115g	2421	64	61	79	2546	96.9
Beverage:	2473	30	25	72	2528	96.3
Main meal: Number of persons n* =3048						
	Cooked portion					
Menu item	Full portion	Half portion	Double portion	No portion	Number of persons n**	% participating in the food item
Protein dish 200g	3047	0	0	1	3047	99.9
Gravy (soup) 120ml	2326	585	62	75	2973	97.5
Maize meal pap 300g	2573	192	70	157	2835	93
Starch 180g	2587	63	164	234	2814	92.3
Vegetable 200g	2695	126	65	162	2886	94.6
Salad 60g	1089	75	69	122	1233	40.4
Fruit 120g	1930				1930	63.3
Mageu 800ml	1753	535	20	698	2308	75.7
Dinner : Number of persons n*=1375						
	Cooked portion					
Menu item	Full portion	Half portion	Double portion	No portion	Number of persons n**	% participating in the food item
Protein dish 120g	1323	5	25	22	1353	98.4
Maize meal 140g	1095	72	25	183	1192	86.6
Bread 60g	1101	50	76	146	1227	89.2
Vegetable/Salad 60g	463	14	14	34	491	35.7
Dairy product 300ml	1375	0	0	0	1375	100
Beverage 400ml	1269	5	0	88	1274	92.6

*   Number participating in the meal
**   Number participating in the food item
***   Jam or Peanut butter

As was expected, most mineworkers participated in all menu items. Meal participation was highest during the main meal with 96% of the planned number participating. Breakfast and dinner was similar with both a 95% participation rate as calculated against the planned figure (Figure 4.1).

4.3.1.1   Data on Breakfast Food Items

The menu item participation was recorded.

a.   Data on Breakfast Porridge

Breakfast porridge participation was 87%. Of the mineworkers participating in the meal over the five study days 78% (n=2049) accepted the full portion and 14% (n=366) refused the porridge (Figure 4.4).
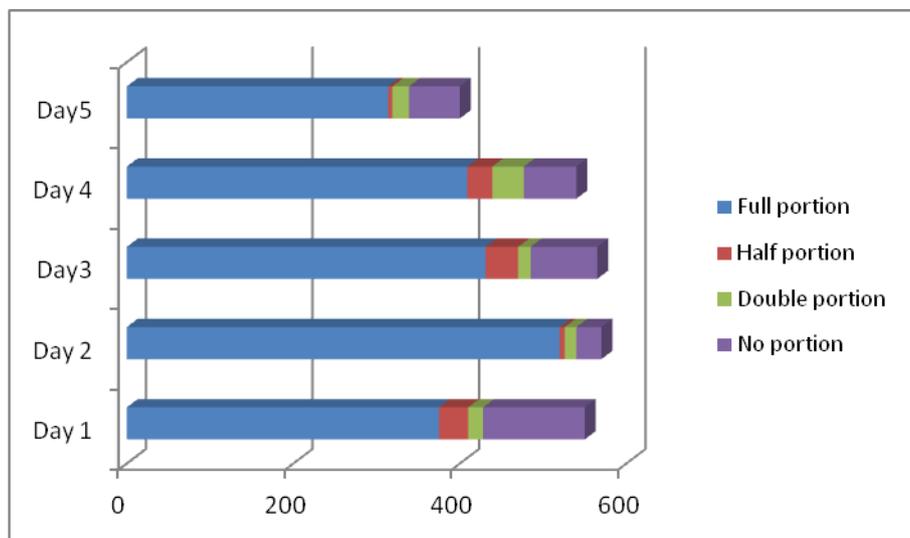
Day 1 n= 450; Day 2 n= 540; Day 3 n=485; Day 4 n=477; Day 5 n=339

Figure 4.4   Menu Item Participation Breakfast: Porridge (n=458 average)

b.   Data on Breakfast Protein

Breakfast protein was popular and most mineworkers attending breakfast accepted full portions (n=2392, 91%) Only 45 mineworkers (3%) declined the protein (Figure 4.5). The highest non participation of the protein was on day 4 with 61 (11%) not participating in the protein menu item (meat loaf). The protein served on day 3 was grilled beef sausage and only 2 (0.4%) mineworkers did not participate in the menu item. The meal participation as measured against the planned participation was 85% on day 5; there was therefore a surplus of food and 59 (14%) mineworkers had double portions of the savoury mince served.
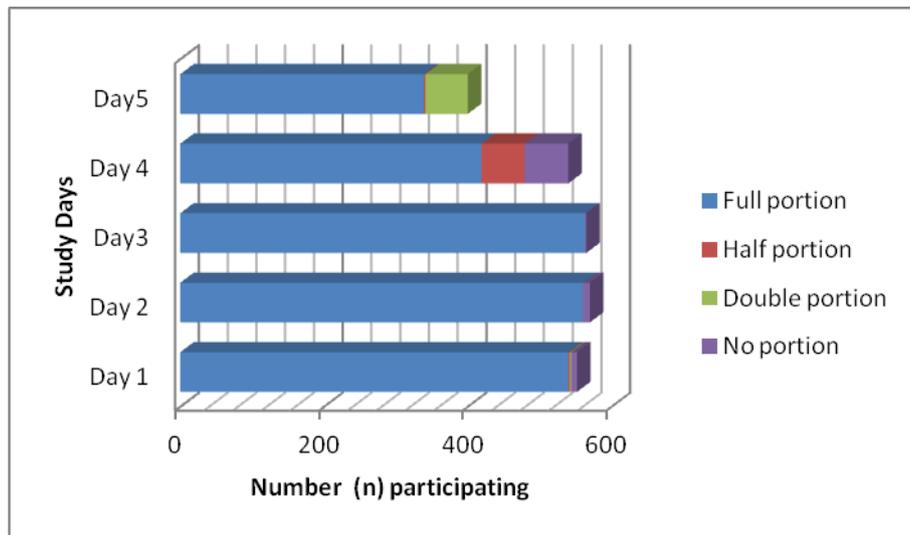
Day 1 n= 400; Day 2 n= 540; Day 3 n=567; Day 4 n=570; Day 5 n=550

Figure 4.5   **Menu Item Participation Breakfast: Protein (n=525 average)**

4.3.1.2 Data on Main Meal Food Items

During the main meal 74% of mineworkers participated in all menu items. The main meal was well attended. Due to the wider range of options, individual menu item participation was lower. A choice between two to three protein dishes was available. Maize meal porridge (stiff pap) and a starch, which could either be rice or samp and beans, were also available. Day 5 was the weekend day and as a result participation was lower for all meals.

a. Data on Main Meal Porridge and Main Meal Starch

The average participation for porridge during the five study days was 85% with the highest participation being on day 1 (91%).
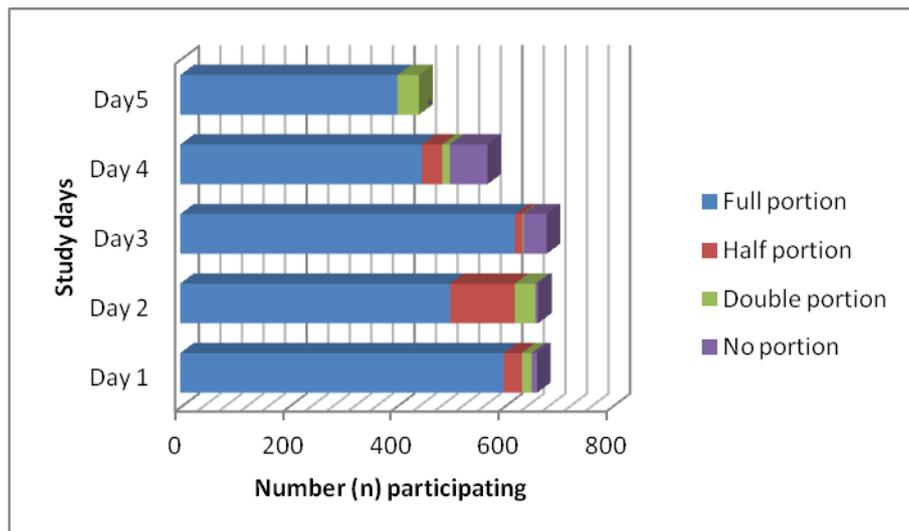
Day 1 n=616; Day 2 n=665; Day 3 n=637; Day 4 n=503; Day 5 n= 448

Figure 4.6   **Menu Item Participation Main Meal: Maize Meal Porridge (n=574 average)**

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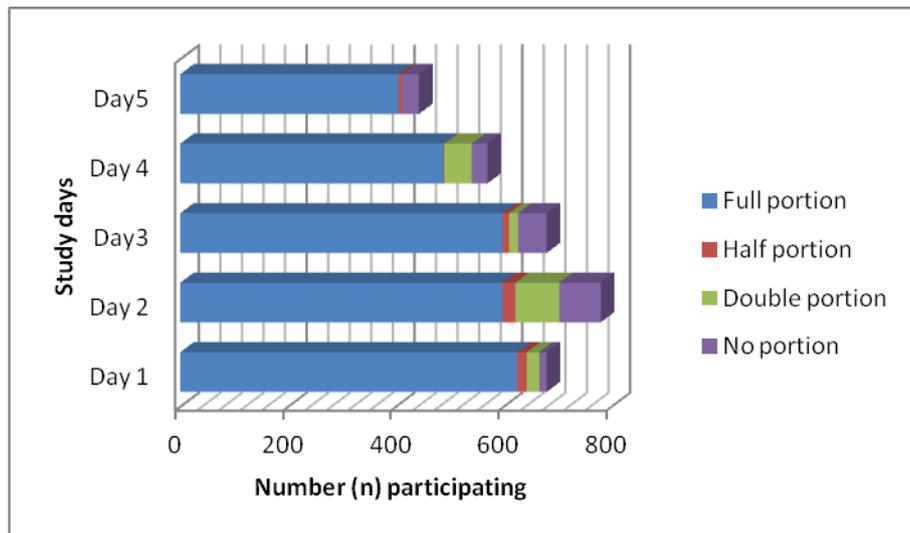
Day 1 n=666; Day 2 n=598; Day 3 n=627; Day 4 n=488; Day 5 n=412

Figure 4.7   Menu Item Participation Main Meal: Starch (n=558 average)

Because the porridge and starch are both contributors of carbohydrate it is worthwhile comparing the intake of these two commodities. (Figure 4.6 and figure 4.7) On day one, 2 mineworkers did not participate in either pap or starch (samp and beans); on day two, 3 mineworkers did not participate in either pap or starch, which was a choice between samp and beans and rice; and on day four, 5 mineworkers did not participate in either pap or starch which was samp. On day one, 2 of those who did not participate in the starch (16 in total) had a double portion of pap; on day two, 6 of those who did not participate in the starch (76) had a double portion pap and on day three, 53 mineworkers had no starch, but did not compensate with a double portion pap. On day four, 4 of those mineworkers who did not have starch (28) had a double portion of pap and on day five, 2 of the 31 mineworkers who did not participate in the starch had a double portion of pap. The pattern for the substitution for pap was therefore not the same. On day one, only 1 of the 64 mineworkers who did not have pap had a double portion of starch; on day two, 1 mineworker had a double portion of starch instead of pap; on day three no substitution took place; day four 2 mineworkers had a double portion of starch instead of pap and on day 5 no substitution for pap took place.

b. Data on Main Meal Protein

Mineworkers participating in the main meal participated in one of the protein dishes available, and all mineworkers had a full portion. Refer to the figures in the text.
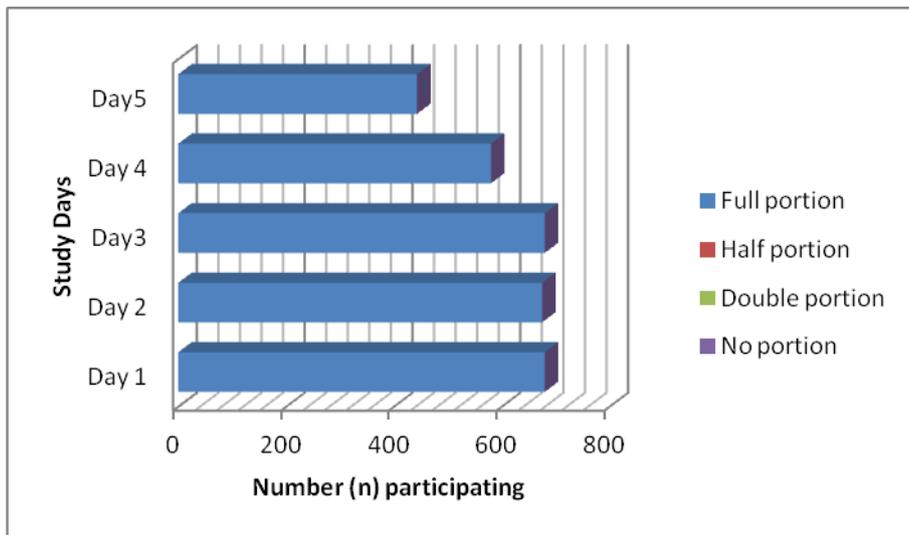
Day 1 n=662; Day 2 n=664; Day 3 n=680; Day 4 n=570; Day 5 n=443

Figure 4.8   Menu Item Participation Main Meal: Protein (n=604 average)

c. Data on Main Meal Vegetable
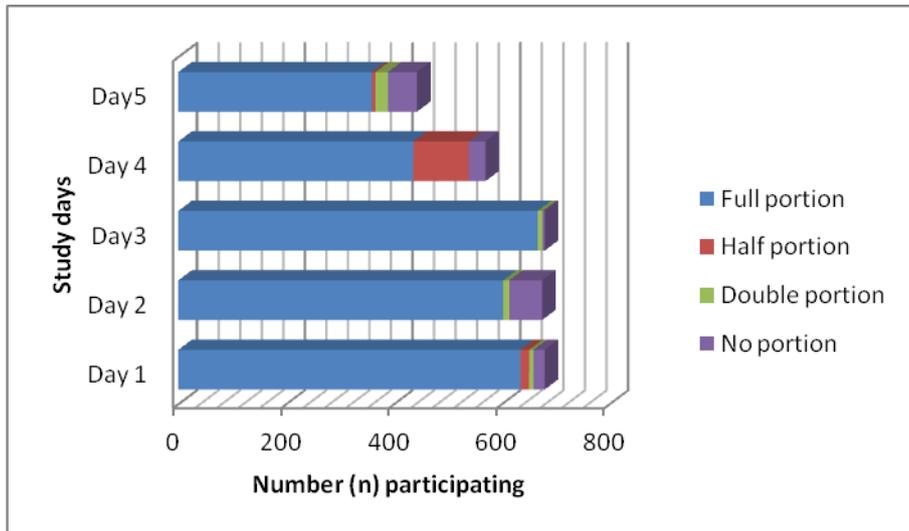
Day 1 n=659; Day 2 n=614; Day 3 n=676; Day 4 n=539; Day 5 n=389

Figure 4.9   Menu Item Participation Main Meal: Vegetable (n=575 average)

Vegetable participation was high with 97% participating on day 1; 91% on day 2; 99% on day 3; 95% on day 4 and 87% on day 5 which was the weekend day.

d. Data on Main Meal and Dinner Salad

Salad was not served daily therefore the data on the two meals were reported together.
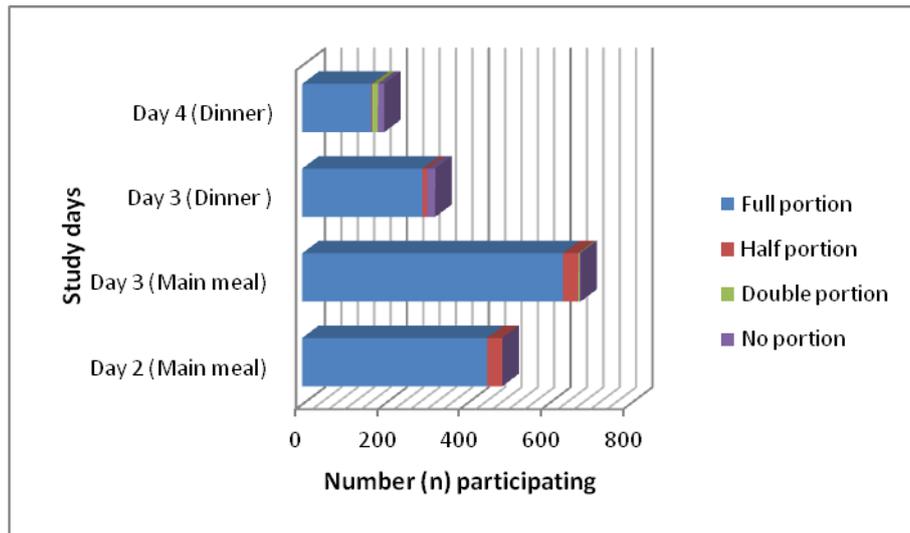
Day 2 Main meal: n=555; Day 3 Main meal: n=678; Day 3 Dinner: n=306; Day 4 Dinner: n=185

Figure 4.10 **Menu Item Participation Main Meal and Dinner: Salad (n=616 average Main meal; n=246 average Dinner)**

4.3.1.3 Data on Dinner Food Items

Dinner was not well attended (n=275 average) however, those who did participate in the meal, participated in most menu items (82% participated in all menu items). The dairy product was the most popular and was consumed by all mineworkers participating in the meal.

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a. Dinner Protein

The dinner protein participation on the full portion was 98% (n=1375) and 2% declined the protein portion (Figure 4.8). All mineworkers participating in the dinner on day 4 (n=200) or 91% of the planned participation, participated in the protein which was grilled wors[xxx]. Of those participating in the menu item, 90% (n=181) had a full portion and 10% (n=19) a double portion.
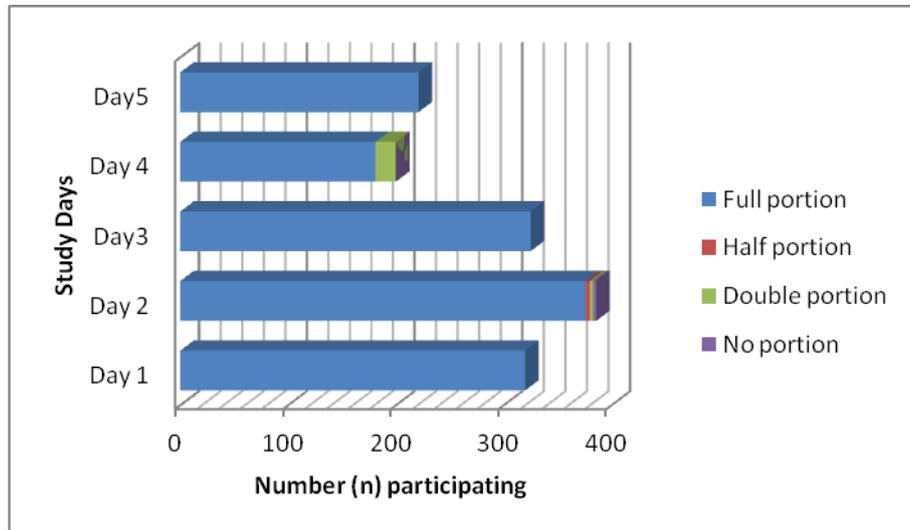
Day 1 n=320; Day 2 n=385; Day 3 n=325; Day 4 n=200; Day 5=124

Figure 4.11   Food Item Participation Dinner: Protein (n=271 average)

[xxx] Wors: A sausage manufactured from the meat of the bovine contained in an edible casing according to clause 3 of Government notice R2178 of Nov 1990 under Act no 54 of 1972.

b. Data on Dinner Maize Meal

At dinner the maize meal participation was at 85% of mineworkers accepting the full portion and 9% declining the menu item. On day 2, 18% (n=70) mineworkers declined the maize meal and 22% (n=85) declined the bread. The protein dish of the day was beef stew which has a small (5%) starch component (samp) which could be the reason for the lower starch participation.

Day 1 n=306; Day 2 n=315; Day 3 n=316; Day 4 n=149; Day 5=95   Day 1 n=280; Day 2 n=300; Day 3 n=320; Day 4 n=183; Day 5 n=144
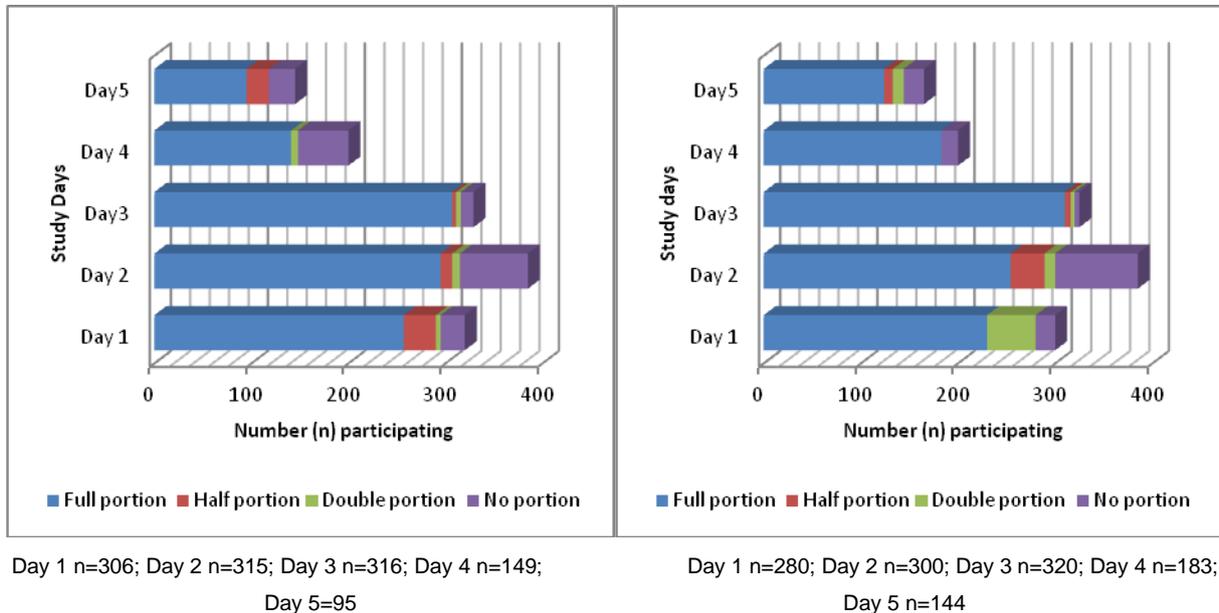
Figure 4.12   Food Participation Dinner: Maize Meal- left (n=236 average) and Bread- right (n=245 average)

4.4   Wastage Record

The third objective of the study was to determine plate wastage at the point of consumption in order to determine the actual food consumed by the mineworkers. This was done by assessing the production wastage as well as the food left on the mineworkers' plate (plate wastage).

4.4.1   Calculated (anticipated) Portion Consumed

The total wastage, which included the production wastage, was taken into consideration to calculate the actual portion served. The latter was compared to the household data which did not initially include figures on wastage. At this stage it was presumed that all residents participating in the meals consumed all food items (Table 4.5).

Table 4.5   Calculated Average Food Item Wastage per Mineworker

Meal Plan	Total quantity prepared (kg) (E)	Plate Wastage (kg) (H)	% of prepared food	Plate wastage per mineworker (kg)	Production wastage (kg) (G)	% of prepared food	Average production wastage per mineworker (kg)	Total wastage (kg)	% of prepared food	Average menu item wastage per mineworker (kg)
Breakfast: Number of persons n= 2625										
Porridge	595	50	8.4	.019	100	16	0.038	150	25	0.057
Bread:	586	16	2.7	.006	11.5*	0	0	16	2.7	0.006
Spread:	75	0.5	0.6		12*		0	0.5	0.6	0.00
Protein dish	283	7.5	2.6	.003	28	9.8	0.011	35.5	12.5	0.014
Beverage	999	26	2.6	.0010	175	17.5	.067	201	20	.077
Main meal : Number of persons n=3050										
Protein dish	632	6 **	1.5	.002	20	3.1	0.008	26	4.2	0.010
Soup (gravy)	367	19	5.1	.006	53	14	0.020	72	19.6	0.026
Maize meal	947	26	2.7	.009	44	4.6	0.017	70	7.3	0.023
Starch (Rice, samp & beans)	668	18.6	2.7	.006	84	12.5	0.032	102.6	15.3	0.034
Vegetable	551	16	2.9	.005	33	5.9	0.013	49	8.8	0.016
Salad	194	4	2	.001	7	3.6	0.002	11	5.6	0.004
Fruit	238	0 **			0			0		0.000
Mageu	1640	0			0 ***			0		0.0
Dinner : Number of persons n= 1375										
Protein dish	153	7	4.5	.005	12.8	8.3	0.009	19.8	12.9	0.014
Maize meal	171	10.5	6.1	.008	16.5	6.1	0.012	27	15	0.020
Bread	71	3.5	4.9	.003	9 *	0	.00	3.5	4.9	0.003
Vegetable/Salad	29	1.5	5.1	.001	3	10	0.002	4.5	15.5	0.003
Dairy product	421	0			0			0		0.0
Beverage	518	14	2.7	.0005	63	12	.046	70.5	13.6	.051
									6.6	.091
TOTAL	9138	187		.088	416.8		0.274	603.8	3.9	0.358

*   Not true wastage as some can be re-used.

**   In-edible wastage not considered at this point

***   Mageu is "on tap" and not issued ("on tap" means available at any time)

The total consumable quantity of food available per mineworker was calculated at 9138 gram per mineworker per day. The total wastage per mineworker calculated to an average of 357 grams per mineworker per day, of which 88 grams was plate wastage. The plate wastage represents 9% of the food items served per mineworker participating per meal.

Taking actual menu item participation into consideration, the average wastage was calculated per mineworker (Figure 4.13). Except for the beverage, the starch and maize meal menu items produced the highest wastage. The biggest contributor to the wastage was the porridge which included the soft porridge and other breakfast porridge 57 gram (25%) served during breakfast; Maize meal porridge (stiff pap) served during main meal contributed to 23 gram, (7.3%) and dinner at 20 gram, (15%). The total maize wastage calculated to an average of 100 gram (28%) per mineworker per day. The wastage of the other starch items served during the main meal was 16 gram (13%) of the portion served. The wastage of bread was low at 6gram (3%) at breakfast and 3 gram (5%) at dinner.

The wastage on protein occurred mainly during breakfast and dinner (12.5% and 12.9% respectively). Plate wastage on protein during the main meal was 4.1%.The average protein waste (10%) was 37 gram per person per day of which 27 gram was production waste (Figure 4.13).
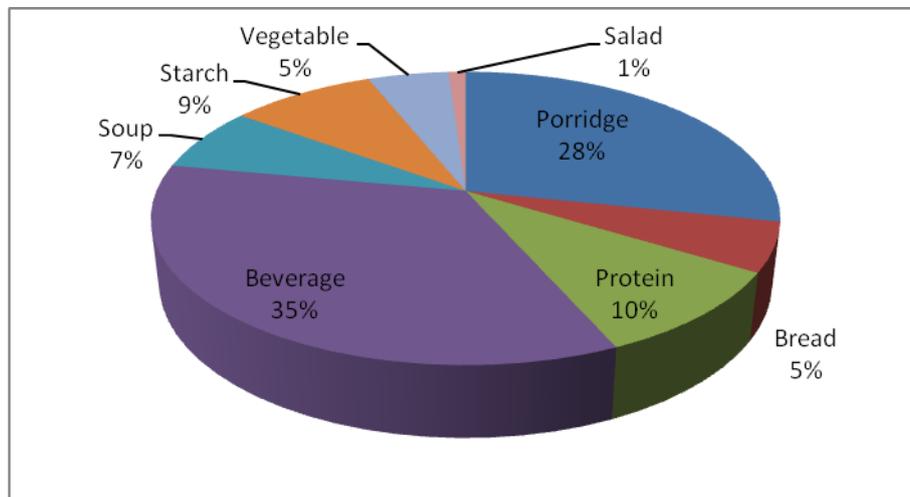
Figure 4.13 **Breakdown of Total Daily Wastage per Mineworker per Day (total average wastage = 358gram)**

The beverage component was the highest and the main reason for this was the production waste at breakfast on the beverage, which contributed 20% to the total waste.

4.5   Comparison on Food and Nutritional data

The fourth objective was to compare food and nutritional intake as determined by food issue data (inventory data/household record data) and actual food intake determined by measured food record data (observational study) and to determine the relationship between these variables.

The planned food intake was corrected by incorporating the food wastage and compared with the data obtained from the observation data.

4.5.1   Breakfast Data

When comparing the planned data versus the actual consumed data for breakfast protein and porridge it indicated that none of the planned data which was corrected for wastage fell into the upper and lower 95% confidence interval (Figures 4.14 and 4.15). When comparing the planned data versus the actual consumed data of the breakfast bread it was noted that bread planned for day three and day four fell within the 95% confidence interval (Figure 4.16).
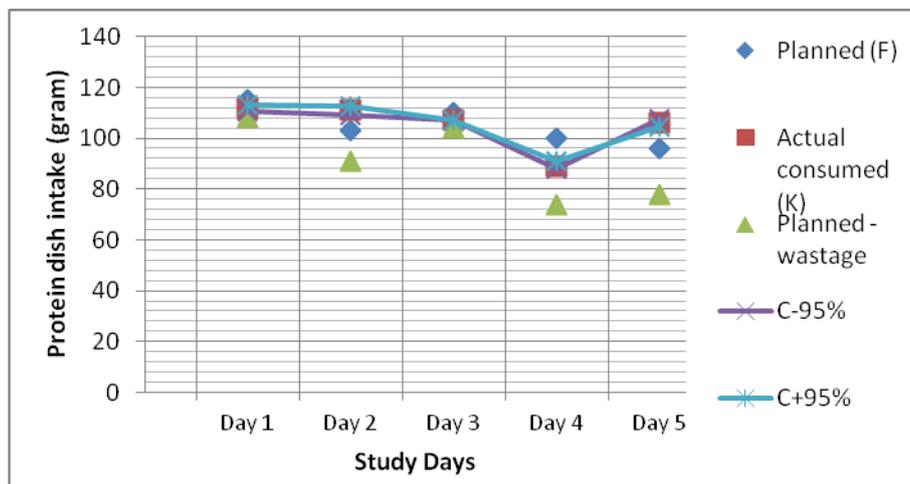
	Day 1	Day 2	Day 3	Day 4	Day 5
Planned number of participants	n=539	n=562	n=563	n=479	n=400
Actual number of participants	n=590	n=580	n=580	n=570	n=470

Figure 4.14   Comparison between Planned Values and Actual Consumed Values Breakfast: Protein
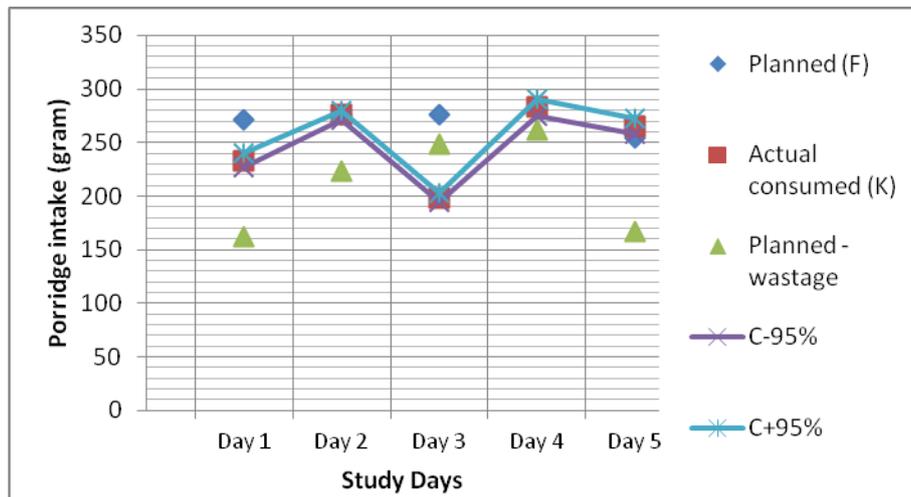
| Planned number of participants | n=428 | n=543 | n=485 | n=478 | n=400 |
| Actual number of participants | n=590 | n=580 | n=580 | n=570 | n=470 |

Figure 4.15   Comparison between Planned Values and Actual Consumed Values Breakfast: Porridge
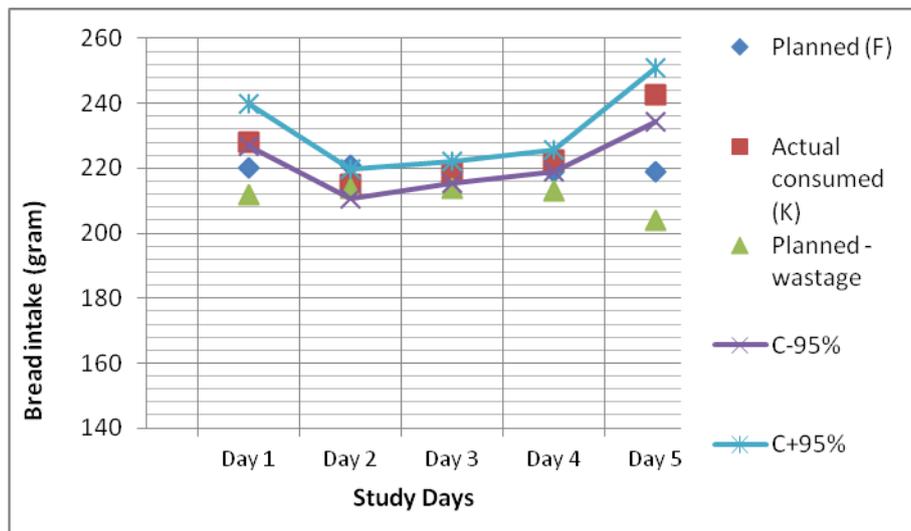
| Planned number of participants | n=428 | n=568 | n=563 | n=538 | n=400 |
| Actual number of participants | n=590 | n=580 | n=580 | n=570 | n=470 |

Figure 4.16   Comparison between Planned Values and Actual Consumed Values Breakfast: Bread

4.5.2   Data on main meal

The porridge consumed on day 2 fell within the 95% confidence interval when the planned and actual consumed data on porridge were compared (Figure 4.17). As illustrated in Figure 4.18, protein portion planned on day 1 and day 4 fell within the 95% confidence interval. Figure 4.19 illustrates that the starch portion planned on day 4 fell within the 95% confidence range. As represented in Figure 4.20 the vegetable portion planned when compared to the actual consumed data was within the 95% confidence interval on day 1, 2 and 3.
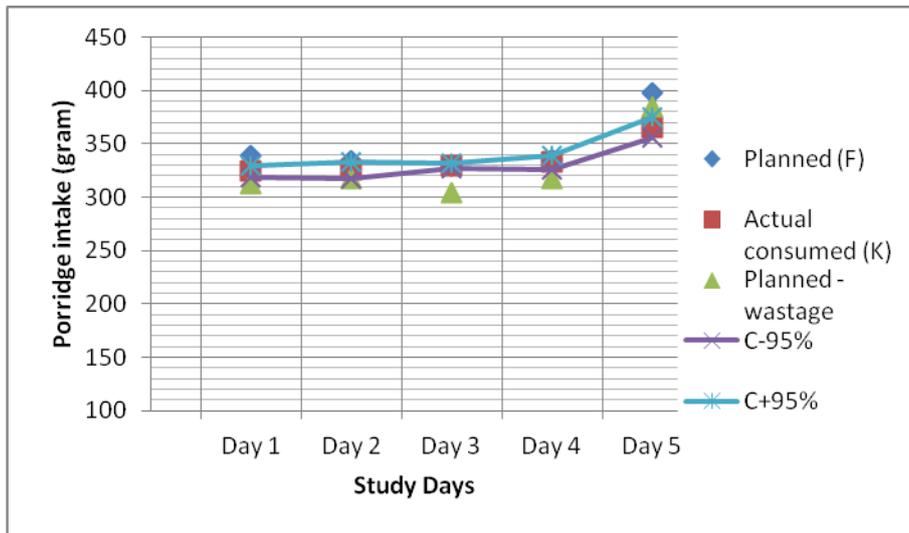
| Planned number of participants | n=690 | n=675 | n=700 | n=570 | n=490 |
| Actual number of participants | n=617 | n=665 | n=637 | n=505 | n=444 |

Figure 4.17   Comparison between Planned Values and Actual Consumed Values Main Meal: Porridge
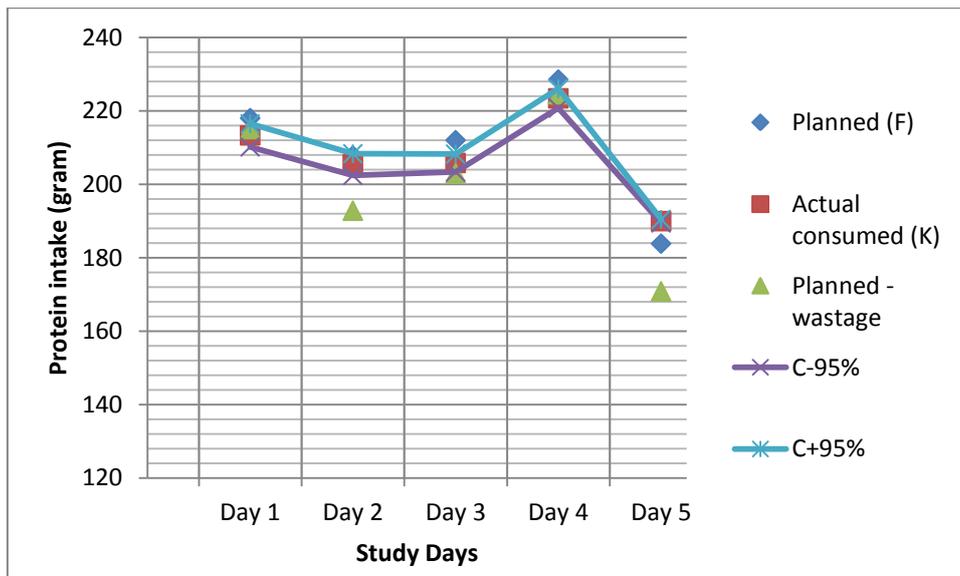
| Planned number of participants | n=690 | n=675 | n=700 | n=570 | n=490 |
| Actual number of participants | n=680 | n=675 | n=680 | n=570 | n=444 |

Figure 4.18   Comparison between Planned Values and Actual Consumed Values on Main Meal: Protein
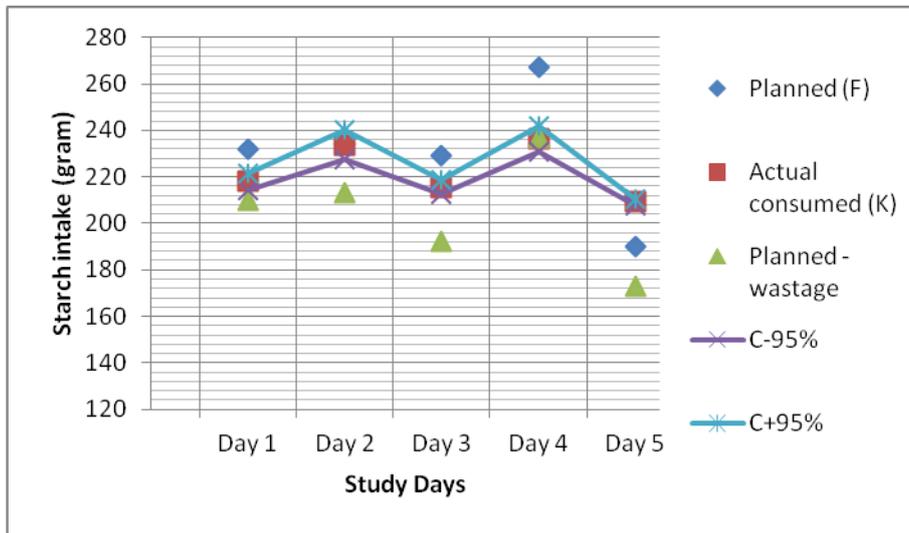
Planned number of participants   n=690   n=675   n=700   n=570   n=490
Actual number of participants   n=662   n=600   n=625   n=540   n=413

Figure 4.19   Comparison between Planned Values and Actual Consumed Values on Main Meal: Starch
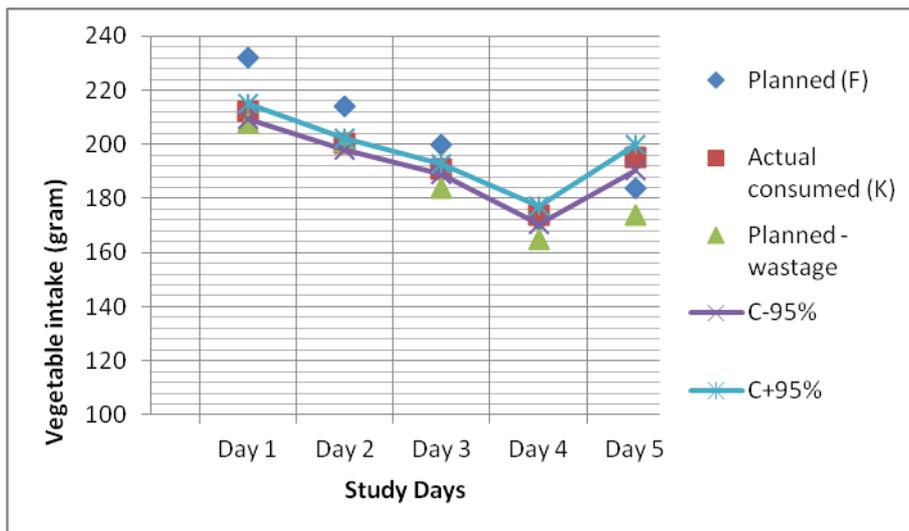
Planned number of participants :   n=690   n=675   n=700   n=570   n=490
Actual number of participants   n=665   n=615   n=676   n=540   n=391

Figure 4.20   Comparison between Planned Values and Actual Consumed Values Main Meal: Vegetable

4.5.3   Data on Dinner

Figure 4.21 illustrates that the protein planned for day 2 fell within the 95% confidence interval. As illustrated in Figure 4.22 no planned figures fell within the 95% confidence interval for dinner maize meal.
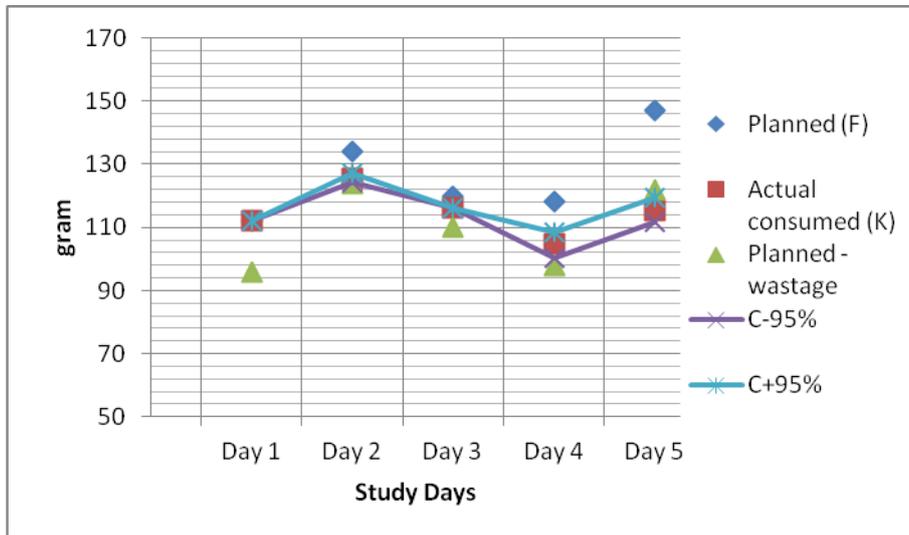
| Planned number of participants | n=340 | n=395 | n=350 | n=219 | n=169 |
| Actual number of participants | n=320 | n=383 | n=325 | n=200 | n=125 |

Figure 4.21   **Comparison between Planned Values and Actual Consumed Values Dinner: Protein**
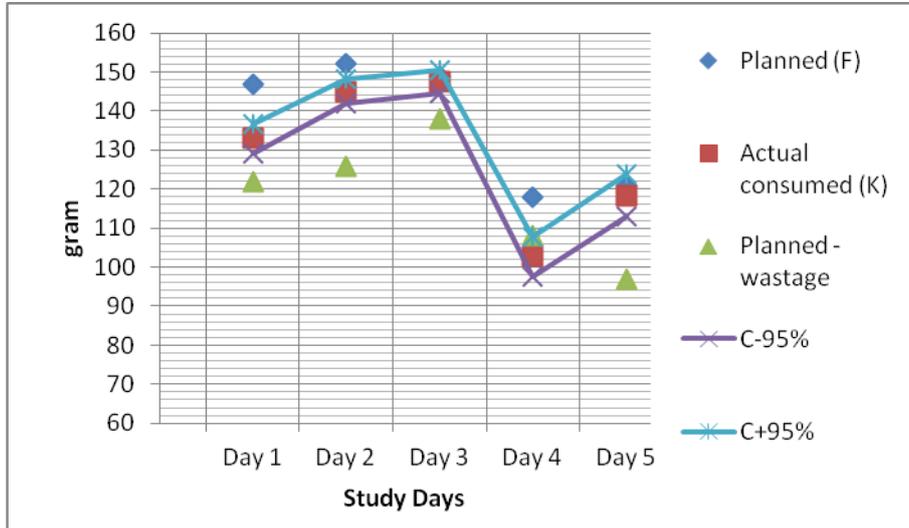
| Planned number of participants: | n=340 | n=395 | n=350 | n=219 | n=169 |
| Actual number of participants: | n=306 | n=315 | n=318 | n=149 | n=118 |

**Figure 4.22**   **Comparison between Planned Values and Actual Consumed Values on Dinner: Maize Meal**

4.6   Comparison of Nutritional Values

The fourth objective was to compare food and nutritional intake as determined by food issue data (inventory data/household record data) and actual food intake determined by measured food record data (observational study) and to determine the relationship between these variables

The nutritional values of the corrected planned value for wastage, and consumed data were compared and measured for 95% confidence interval levels as can be seen in the following table 4.6a – 4.6f representing each study day.

The consumed data represents the actual menu item participation as opposed to the planned data which represents the planned number of participants per meal, as if all mineworkers participated in all menu items.

The average consumed energy, 14242 kJ, was lower than the reference value; however, on day 4 and 5 the intake exceeded the reference value of 15000 kJ. The consumed carbohydrate, 459 gram, was within the reference value of 397-574 gram on all five study days. The average protein consumed was 140 gram per person per day with day 1 being the lowest at 129 gram per person. The reason for the lower consumption on day 1 is that the ration for protein on day 1 was 135 gram per person as opposed to the average of the study days at 143 gram per person per day. The average total fat intake of 111 gram per person per day, was within the reference value of 81-142 gram, however the monounsaturated fatty acids, (MUFA) as well as the poly-unsaturated fatty acids (PUFA) is above the reference values at 40.6 and 23.5 gram respectively. The average fibre (37.4mg per person per day) intake is slightly below the reference value of 38mg per person per day. The iron intake of 20.7mg per person per day is more than double the reference value of 8mg per person per day, due to the protein intake. The highest intake of iron was on day 5 at 24.1mg per person per day. Calcium intake was at 981mg per person per day, slightly lower than the reference value of 1000mg per person per day. Vitamin A intake is higher than the reference value mainly because of the chicken liver, spinach and pumpkin consumption. Vitamin C intake is lower than the reference value because the consumption of mageu, which is enriched with Vitamin C (20mg/100ml), is on average 450ml as opposed to the 800ml planned. This accounts for a deficit of 70mg Vitamin C per person per day. The low Vitamin D intake can be explained by incomplete information on the data base used for the nutritional analysis.

Based on the observed consumed values, 95% confidence intervals were constructed for the means of different variables of interest by using the t-distribution. If the planned values fall below the lower boundary of the 95% confidence interval for the consumed values, it means that with 95% certainty the planned values were lower than those observed. If the planned means are above the upper boundary of the confidence intervals for the consumed values, it means that the planned

values are too high, or that the actual observed values could not reach the planned values. Most of the planned values did not fall within the 95% confidence interval, however, when corrected for wastage some of the values did fall within this 95% confidence interval.

On day 1, the value for energy being 13712kJ was within the 95% confidence interval (13540-13786kJ); carbohydrate at 462 gram (451-462 gram); protein at 129 gram (127-130 gram); fat at 99 gram (99-100 gram); MUFA at 36.74 gram (35.99-36.75 gram); PUFA at 18.55 gram (18.09-18.71 gram) and Vitamin A at 6378mg (6323-6611mg). The other nutrients, iron, calcium, Vitamin C, Vitamin D and fibre fell beyond the 95% confidence interval. The data on the average nutritional intake over the five study days illustrated that fat at 109 gram (109-113 gram); MUFA at 39.70 gram (38.8-42.3 gram); PUFA at 22.9 gram (22-24.8 gram); fibre at 37mg (36-38.9mg); iron 19.5mg (19.3-22.1mg) and Vitamin D at 2.4mg (1.72-3.9mg) fell within the 95% confidence interval.

Table 4.6   **Comparison of Energy and Nutritional Values**

Table 4.6a   **Comparison of Energy and Nutritional Values for Study Day 1**

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (g)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration scale (A)	14734	505	135	102	38	19	42	19	1066	6846	193	2.6
Planned Portion (B) n=1620	14788	510	137	103	38.24	19.25	43	19.34	1067	7179	191	2.6
Planned – wastage	13741	465	130	99	36.74	18.55	40	18.34	1024	6465	189	2.3
Actual Planned n=1620 (F)	14759	508	137	103	38.24	19.25	42	19.34	1066	7092	193	2.6
Actual planned – wastage (I)	13712	462	129	99	36.74	18.55	39	18.34	1022.6	6378	191.4	2.3
Consumed n=1550	13663	457	129	100	37.31	18.85	41	17.83	930.43	6466	120	2.5
+95%	13786	462	130	101	36.75	18.71	41.42	18.12	934.16	6611	120	2.5
-95%	13540	451	127	99	35.99	18.09	40.32	17.55	926.7	6323	119	2.5

Table 4.6b   Comparison of Energy and Nutritional Values for Study Day 2

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (mg)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration scale (A)	13863	475	147	89	28	22	41	25	929	2747	169	2.7
Planned Portion (B) n=1650	13945	481	147	89	28.56	22.33	42.7	24.28	912.47	2312	171	2.7
Planned – wastage	13064.5	451	124	84	27	20.63	39.6	21.98	875	1666	168	2.5
Actual Planned (F) n=1650	14045	451	147	89	28.8	22.4	42.83	24.34	914.4	2294	174	2.7
Actual planned – wastage (I)	13165	421	136	84	27.4	20.9	40.5	22.34	877	1652	170	2.5
Consumed n=1630	13420	460	141	87	28.15	21.3	39	23.14	931.7	2126	166	2.6
+95%	13556	466	142	88	28.56	21.5	39.69	23.47	830.5	2148	166	2.652
-95%	13284	454	140	86	27.75	21.06	37.9	22.82	823.38	2105	165	2.628

Table 4.6c   Comparison of Energy and Nutritional Values for Study Day 3

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (mg)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration Scale (A)	14743	469	147	115	41.9	26	39	22.6	1134	3507	133	3.5
Planned Portion (B) n=1630	14879	476	147	115	41.9	26.47	39	22.7	1145	3382	133	3.5
Planned – wastage	14023	445	138	110	40	25.87	36.6	21.4	1073	3329	128	3.1
Actual Planned (F) n=1630	15017	476	149	119	43.39	26.67	39	22.9	1118	3427	183	3.5
Actual planned – wastage (I)	14161	445	141	115	41.59	26.1	36.6	21.6	1045	3374	178	3.1
Consumed n=1570	14254	452	142	113	40.61	25.82	37	21.7	1118	3444	130	3.4
+95%	14362	456	143	114	40.94	26	38	21.9	1128	3454	130	3.5
-95%	14148	447	140	112	40.29	25.59	37	21.5	1109	3444	130	2.77

Table 4.6d   Comparison of Energy and Nutritional Values for Study Day 4

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (mg)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration Scale (A)	15753	457	201	150	58.7	28.5	35	18.2	874	372.5	161	1.9
Planned Portion (B) n=1359	15862	464	144	149	58.6	27.82	29	18.2	868	371.9	157	1.9
Planned – wastage	14576	435	133	133	51.4	26.42	27.3	16.8	807	347.1	153.7	1.4
Actual Planned (F) n=1359	15654	454	143	148	58.5	27.68	34	18.2	867	372.1	156	1.9
Actual planned – wastage (I)	14368	425	132	132	51.3	26.28	32.3	16.8	806	347.3	152.7	1.4
Consumed n=1305	15249	439	140	146	57.67	27.6	33.35	17.5	770.6	372	155	1.9
+95%	15443	446	142	148	58.95	28.06	33.81	17.89	865	375	156	1.9
-95%	15055	432	119	143	56.38	27.22	32.95	17.19	860	369	155	1.9

Table 4.6e   Comparison of Energy and Nutritional Values for Study Day 5

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (mg)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration Scale	15082	475	141	125	44	25.85	35	24.3	1027.7	4727	217.4	2.6
Planned Portion (B) n=1129	14609	464	135	120	43.9	25.25	34	23.5	1011.5	4707	218	2.6
Planned-wastage	13166	413	116	113	41.7	23.95	30	19.6	933.9	3386	211	2.1
Actual Planned (F) n=1129	14943	472	140	124	45	25.05	35	23.8	1014.7	4441	217.6	2.6
Actual planned – wastage (I)	13500	421	121	117	42.8	23.75	31	19.9	937.1	3120	210.8	2.1
Consumed n=858	15131	473	144	125	45	25.29	35	24.7	1030	4846	215	2.6
+95%	15361	482	147	129	47	26	35.5	25.3	1061	5052	217	2.6
-95%	12174	465	141	123	44	24.9	34.5	24.1	989.5	4650	214	2.6

Table 4.6f   Comparison of Average Energy and Nutritional Values

	Energy (kilojoule)	Carbohydrate (gram)	Protein (gram)	Fat (gram)	MUFA (gram)	PUFA (gram)	Fibre (mg)	Iron (mg)	Calcium (mg)	Vitamin A (mg)	Vitamin C (mg)	Vitamin D (µg)
Reference value[4,28,31]	15000	397-574	88-300	81-142	17	1.6	38	8	1000	900	250	5
Ration Scale	14790	477	143	113	41	23.49	38.9	21.7	1025	3548	171.2	2.7
Planned Portion (B) n=1478	14803	481	143	113	41.3	23.8	38	21.5	1019	3511	171	2.6
Planned-wastage	13776	444	130	108	39.7	22.9	35.8	19.3	971	2799	165	2.3
Actual Planned (F) n=1478	14862	504	144	114	41.39	23.8	39.2	21.6	1023	3457	171.2	2.7
Actual planned – wastage (I)	13835	467	131	109	39.79	22.9	37	19.5	975	2745	165	2.4
Consumed n=1383	14242	457	140	111	40.6	23.5	37.4	20.7	981	3317	151.6	2.59
+95%	14327	459	141	113	42.3	24.8	38.9	22.1	986	3464	154.1	3.9
-95%	14187	454	137	109	38.8	22	36	19.3	976.6	3170	149	1.72

4.7 Development of a Practical, Reliable and Economical Tool of Food and Nutritional Intake

Objective five was to develop a practical, reliable and economical tool whereby food and nutritional intake can be measured in order to assist in the development of nutritional policies. For this purpose the following equation was proposed:

Food consumed/ mineworker =

{(Raw issue x cooking or preparation factor) x participation factor)} – (edible + inedible wastage) OR **K= B x participation factor – (G+H+H1)** (Box 3.5)

The participation factor is obtained by dividing the planned participation by the actual menu item participation.

Box 4.1 presents an excerpt of data to illustrate the validity of the equation. Nutritional values were calculated using portions calculated according to the following equations:

Box 4.1   Excerpt of Data to Illustrate the Use of the Proposed Equation

Day 2: Main meal - maize meal:
Portion consumed   = (130 x 2.6 x (765/665)) - 18
                                    =325 (95% confidence = 317.4- 333.25)
Day 2: Main meal - protein:
Portion consumed   = (260 x .85x (650/650) - 15
                                    = 206 (95% confidence = 202.41-208.306)

Day 4: Main meal – starch:
Portion consumed   = (80 x 3.1 x (570/540)) - 30
                                    =232.88 (95% confidence = 230.8-241.8)

From the above data it is evident that raw values **in addition to** a conversion factor for preparation and participation can be used to calculate food and nutritional intake of mineworkers.

The results described above proved to be informative and the implication thereof will be discussed in Chapter 5.

CHAPTER 5.   DISCUSSION

5.1   Discussion

According to the MPRDA, Mining Companies, in respect of a company providing for living conditions, such companies must provide for adequate nutrition and food to mineworkers. However, no measurement or assessment tool was described to evaluate indicators referring to nutrition. Adequate nutrition of mineworkers is necessary to meet the physical and cognitive demands of mining tasks; not meeting the nutritional requirements may lead to unsafe work practices and adverse health effects.[8]

Calculation of the average food and nutritional intake per person according to the food issue data (food inventory/household record data)

By considering household food data as a means of assessing food and nutritional intake, this study confirmed results obtained by other studies that inventory methods provide information on the mean daily intake of the whole group as it does not account for losses or individual intake.[40] The measurement of individual food intake using an observational method provided more detailed information and it was evident that the planned and the average actual portion consumed did not correspond.

According to a study by Sera-Majem[23] household budget data and individual data were similar except for fish, meats, pulses and vegetables. In this study a similar relationship was recorded as no definite trend was observed: protein fell within the 95% confidence range on two days, and vegetable on three days and porridge and starch one day each, which suggest that another means of calculating intake is required.

Assessment of actual food intake by means of an observational study (food record data)

Observation studies have previously been done to assess food intake of children[41] and older adults.[41,42] Both studies by Ball *et al.* and Shantestein *et al.* reported a strong positive correlation between weighed and estimated values as obtained from the visual observations. However no published data whereby the observed data was compared to the household food record data was found. By using an observation study such as the one conducted at the SAV in this study, it was possible to compare household data with individual data.

Meal participation was highest during the main meal with 96% of the planned number participating. Breakfast and supper participation were both 95%. The highest menu item participation was during

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breakfast with 87% of those participating in the meal, consuming all menu items (porridge, bread and protein dish). This is in contrast to the study by Dias *et al.*[8] done on mineworkers where a breakfast participation of 73% was reported. The same study reported a participation of 55% for two meals breakfast and lunch, and a participation of 26% for all three meals. This could be an indication that food served in the SAV's is more acceptable than at the time of the study done by Dias *et al.*, as well as that reliable statistical measures are necessary to predict actual participation.

Determination of the actual food consumption by the mineworkers

All food served is not necessarily consumed and therefore there are always varying amounts of wastage. In this study, the food wastage was assessed on two levels namely the production and plate wastage. Production wastage was the wastage which was not served of which some was not considered as wastage as it could be re-used, this included bread and spread.

Furthermore it was observed that the main contributor to wastage of cooked items was production wastage. The reason could be that the planned yield and the actual yield did not always correspond. One of the factors influencing the actual yield is the cooking method. An example is the maize meal porridge which is cooked in a "Capdan" cooker and reduces the cooking time considerably as it agitates the product thereby increasing its volume while cooking. The consequence is that a lot of air is incorporated into the product, which increases the volume of the product. The aerated product is not popular with all the mineworkers and a settling time of at least 30 minutes is necessary after cooking, thereby reducing volume. Cooking method and time is therefore important when a standard for assessing food and nutritional intake is developed as the difference in volume could impact on the food wastage.

The documented total wastage (plate wastage plus production wastage) at breakfast was the highest at 156 gram per mineworker. The wastage recorded at main meal was 110 gram and at dinner 92 gram. However, the total average plate wastage accounted for, was 82 gram per mineworker per day. This is lower than the data reported by Pekcan[26] on food wastage in Turkey which was an average total wastage of 318.8 grams per person per day. The above author reported a higher wastage between food preparation and food service than between food acquisition and preparation. The plate wastage recorded in the Pekcan study was an average of 111.8 grams per person. The reason for the difference between the Pekcan study and this study was that food intake in this study is controlled in the SAV and no other food choices such as food from home are available. There is also limited preparation wastage in this study as raw food used for cooking is pre-prepared and no vegetable preparation wastage is recorded. The food wastage in this study contributed to a loss of +/- 1000kJ per mineworker per day, of which +/- 78% was

recorded as production wastage. The production wastage in this study was mainly because of the difference in planned and actual menu item participation.

The relationship between food and nutritional intake as determined by food issue data (inventory data/household record data) and actual food intake determined by measured food record data (observational study).

The nutritional values for the household data and the individual data fell within the 95% confidence interval only on day 1. As the total wastage was taken into account for calculating the data, another contributor to the discrepancy had to be found.

The discrepancy proved to be the participation figures. When calculating the data for the household figure, actual participation is not known and assumed figures had to be used. When individual data is collected actual participation figures are used. As a result the factor denoting the difference between these two figures is therefore of utmost importance. Although the nutritional data between the household and the individual data corresponds for day 1, the participation factor was calculated to be 1.05. This is more than the 1.01 which was calculated for day 2 where the values did not fall within 95% confidence interval. When the raw data for day 2, however is calculated using the menu item participation factor, it differs from the data from the household study, as can be seen in box 4.1 but it falls within the 95% confidence range. It is therefore clear that food and nutritional intake should not be calculated on planned figures but can only be calculated when the actual menu item participation and the total food item wastage is known.

The average nutritional intake over the five study days proved to be adequate for carbohydrate, protein, fat, calcium and fibre. The energy intake was slightly below the reference value, however the "sustenance feed" issued at the shaft or place of work, was not considered in this study. The energy intake for underground workers therefore may be adequate. The vitamin C intake is below the reference value of 250mg per person per day for underground workers, however this may be supplemented by the "sustenance feed", which is enriched with Vitamin C and the daily intake may therefore be adequate. The high iron content of the menus is mainly because of the meat intake. Similarly the high Vitamin A content is due to the chicken livers (98% participation on day 2) and the spinach (99% participation on day 3).

The consequence of the nutritional intake measured in this study is that when a supplement is considered for mineworkers it is important to assess the habitual intake first as some of the nutrients such as iron and Vitamin A in this study, are in oversupply. Adding unnecessary nutrients to the diet of mineworkers may therefore do more harm than good. One of the nutrients which

deserves further investigation is Vitamin D. Mineworkers performing underground tasks have limited exposure to sunlight and their Vitamin D levels may therefore be compromised. Vitamin D deficiency has been linked to several disorders other than those associated with skeletal tissue. It has been documented that Vitamin D contributes to decreasing the risk of various chronic illnesses, including cancer, auto-immune -, infectious - and cardiovascular disease.[43]

Development of a practical, reliable and economical tool whereby food and nutritional intake can be measured in order to assist in the development of nutritional policies.

The aim of the study was to compare an assessment method at household level with an assessment method at individual level in order to develop a practical tool to assess food and nutritional intake at individual level. Combining the various sets of data, the following equation was used to calculate food intake: *Food consumed/mineworker = {(Raw issue x cooking/preparation factor) x participation factor)} – (edible + inedible wastage)*. The proposed equation was found to be an acceptable and cost effective (in terms of human resources required) method of evaluating food and nutritional intake. The statistical analysis was done based on the observed consumed values and 95% confidence intervals were constructed for the means of different variables of interest by using the t-distribution.

Therefore the null-hypothesis as proposed for this study cannot be accepted as there is a difference between the per capita nutritional intake of mineworkers when comparing food inventory data to that of actual food consumed measured by food record data and food wastage. The actual participation factor per menu item has to be considered and not only the planned participation for the meal as illustrated in this study.

CHAPTER 6.   SUMMARY

6.1   Conclusion

The main aim of this study was to develop a tool to assess food and nutritional intake of a group of mineworkers. The focus of this study was not particularly to assess the adequacy of nutritional intake, however the nutritional intake was considered to determine the practicality and merit of the tool.

As it is difficult to assess the food and nutritional intake of groups, this tool whereby intake can be monitored can be helpful. The ration scale and food inventory data can be used as information to monitor average nutritional intake, however it must be site and food specific. This data can be used to identify inadequacies in the diet and intervention programmes can be explored and implemented without additional cost.

When the study was completed and the data analysed it was apparent that the following equation can be adopted to calculate food intake:

Food consumed/ mineworker =
{(Raw issue x cooking/preparation factor) x participation factor)}   –
(edible + inedible wastage)

6.2   Recommendations

The tool developed in this study can assist with the assessment of food and nutritional intake of groups, however, the following recommendations should be considered to ensure accurate data analysis:

- A cooking or preparation factor should be considered for each food item and this should be verified with the cooking equipment available as well as the cooking method;
- The participation factor should be considered per food item and not per meal participant and
- Food wastage should be kept to a minimum and should be monitored. Although inedible wastage is not considered to be true wastage, care should be taken to limit bone and other inedible wastage losses, as it can impact on the actual edible portion available.
- The study should be repeated in a smaller unit, or a unit with shorter meal period to enable a more reliable observing practice without adding more observers.

6.3   Study Limitations

A major limitation of the study was that it was not repeated in different seasons. The quality of ingredients, especially dry products, can have an effect on the cooked product's water holding capacity. In the dry season, when the moisture levels in dry products such as samp and maize meal are low, the water holding capacity differs to when the moisture levels are higher.

In practice, it is very difficult to obtain exactly the same yield consistently. Although care was taken to adhere to cooking methods, variations may have taken place. The maize meal porridge (pap) was cooked in a Capdan cooker which has an agitator. This result in air mixed into the product. A settling time is then necessary to allow the air to escape as an aerated porridge is not acceptable to the mineworkers (participants) in this study. The holding time of the product has an effect on the volume.

Because the cooked product was evaluated, the incorporation of ingredients which could have an effect on especially micronutrient intake, such as sodium, is difficult. The database specifies a "stew" with salt added – to add additional salt which was part of the ingredient list may distort the data.

The extended meal period could have contributed to observer fatigue. This can be prevented by training and standardising more observers who can then rotate during mealtimes.

Other limitations of the study include:

- The assessment of inventory data was done for the five study days only;
- Cultural and gender differences were not explored.

6.4. Further Areas of Research

This study field could be further investigated to implement this equation in other institutions where food is prepared and served to residents or clients enjoying meal privileges. It is recommended that the study be repeated in a smaller unit or a unit with shorter meal periods to enable a more reliable observing practice. The equation may also be useful in long term care facilities catering for vulnerable groups e.g. older persons or psychiatric patients. Other areas of research which can be investigated is the nutritional requirements of underground mineworkers, the need and required nutritional composition of a midshift meal, the impact of high iron intake and the impact of the work environment on the Vitamin C requirement. The impact of different cultural food preferences on food intake will also be an interesting topic for investigation.

The influence of working for extended periods of time in areas without access to direct sunlight should be investigated to assess the influence on Vitamin D availability.

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APPENDICES

Addendum A   Scorecard for the Broad- Based Socio- Economic Empowerment Charter for the South African Mining Industry

Notes	Description	5 year target	10 year target	
	Human Resource Development			
1	Has the company offered every employee the opportunity to be functionally literate and numerate by the year 2005 and are employees being trained?	Yes	No	
	Has the company implemented career paths for HDSA employees including skills development plans?	Yes	No	
2	Has the company developed systems through which empowerment groups can be monitored?	Yes	No	
	Employment Equity			
	Has the company published its employment equity plan and reported on its annual progress in meeting that plan?	Yes	No	
3	Has the company established a plan to achieve a target for HDSA participation in management of 40% within five years and its implementing the plan.	Yes	No	
	Has the company identified a talent pool and is it fast tracking it?	Yes	No	
4	Has the company established a plan to achieve the target for women participating in mining of 10% within the five years and is implementing the plan?	Yes	No	
	Migrant Labour			
5	Has the company subscribed to government and industry agreements to ensure non-discrimination against foreign migrant labour?			
	Mine community and rural development.			
	Has the company co-operated in the formulation of integrated development plans and is the company co-operating with government in the implementation of these plans for communities where mining takes place and for major labour sending areas? Has there been effort on the side of the company to engage the local mine community and major labour sending area communities? (Companies will be required to cite a pattern of consultation, indicate money expenditures and show a plan)	Yes	No	
	Housing and living Conditions			
6	For company provided housing has the mine, in consultation with stakeholders established measures for improving the standard of housing, including the upgrading of the hostels, conversion of hostels to family units and promoted home ownership for mine employees? Companies will be required to indicate what they have done to improve housing and show a plan to progress the issue over time and is implementing the plan?	Yes	No	

7	For company provided nutrition has the mine established measures for improving the nutrition of mine employees? Companies will be required to indicate what they have done to improve nutrition and show a plan to progress the issue over time and is implementing the plan?	Yes	No	
	Procurement			
8	Has the mining company given HDSA's the preferred supplier status?	Yes	No	
	Has the mining company identified current level of procurement from HDSA companies in terms of capital goods, consumables and services?	Yes	No	
	Has the mining company indicated a commitment to a progression of procurement from HDSA companies over a 3-5 year time frame in terms of capital goods, consumables and services and to what extent has the commitment been implemented?	Yes	No	
	Ownership and Joint Ventures			
9	Has then mining company achieved HDSA participation in terms of ownership for equity or attribute units of production of 15 percent in HDSA hands within 5- years and 26 percent in 10 years?	15%	26%	
	Benefication			
	Has the mining company identified its current level of benefication?	Yes	No	
10	Has the mining company established its baseline level of benefication and indicated the extent that this will have to be grown in order to qualify for an offset?	Yes	No	
	Reporting			
	Has the company reported on an annual basis its progress towards achieving its commitments in its annual report?	Yes	No	

Source: South African Government Department Mineral Resources. 2003

Addendum B   Scorecard for the Broad- Based Socio- Economic Empowerment Charter for the South African Mining Industry. 2010

No	Element	Description	Measure	Compliance Target by 2014	Progress achieved by					Weighting
					2010	2011	2012	2013	2014	
1	Reporting	Has the company reported the level of compliance with the Charter for the Calendar year?	Documentary proof of receipt from the department	Annually	March 2011	March 2012	March 2013	March 2014	March 2015	Y/N
2	Ownership	Minimum target for effective HDSA ownership	Meaningful economic participation	26%	15%			→→→		26%	Y/N
			Full shareholder rights	26%	15%			→→→		26%	
3	Housing and living conditions	Conversion and upgrading of hostels to attain the occupancy rate of one person per room	Percentage reduction of occupancy rate towards 2014	Occupancy rate of one person per room	Base-line	25%	50%	75%	100%	
		Conversion and upgrading of hostels into family units	Percentage conversion of hostels into family units	Family units established	Base-line	25%	50%	75%	100%	Y/N
4	Procurement & Enterprise Development	Procurement spent from BEE entity	Capital goods	40%	5%	10%	20%	30%	40%	5%
			Services	70%	30%	40%	50%	60%	70%	2%
			Consumable goods	50%	10%	15%	25%	40%	50%	3%
		Multinational suppliers contribution to social fund	Annual spend on procurement from national suppliers	0.5% of procurement value	0.5%	0.5%	0.5%	0.5%	0.5%	3%
5	Employment equity	Diversification of the workplace to reflect the country's demographics to attain competitiveness	Top management (Board)	40%	20%	25%	30%	35%	40%	3%
			Senior management (Exco)	40%	20%	25%	30%	35%	40%	4%
			Middle management	40%	30%	35%	40%	40%	40%	3%
			Junior management	40%	40%	40%	40%	40%	40%	1%
			Core Skills	40%	15%	20%	30%	35%	40%	5%
6	Human Resource Development	Development of requisite skills, incl support for South African based research and development initiatives intended to develop solutions in exploration, mining, processing, technology efficiency (energy and water use in mining), benefication as well as environmental conservation and rehabilitation	HRD expenditure as percentage of total annual payroll (excl mandatory skills development levy)	5%	3%	3.5%	4%	4.5%	5%	25%

7	Mine community development	Conduct ethnographic community consultative and collaborative processes to delineate community needs analysis	Implement approved community projects	Up-to-date project implementation	Implementation of projects will serve to enhance relationships amongst stakeholders leading to communities owing patronage to projects	15%
8		Improvement if the industry's mine health and safety performance	Implementation of the tripartite action plan on health and safety	100%	Annual progress achieved against commitments in the tripartite action plan on health and safety.	12%
		Utilisation of South African bases research facilities for analysis of samples across the mining value chain	Percentage of samples in South African facilities	100%		5%
9	Beneficiation	Contribution of a mining company towards beneficiation (this measure is effective from 2012)	Additional production volume contributory to local value addition beyond the base-line	Section 26 of the MPRDA (percentage above the base-line)	The beneficiation strategy and its modalities of implementation outline the beneficiation requirements per commodity extracted in South Africa	
	TOTAL SCORE					100%

Source: South African Government Department Minerals and Energy Sep 2010

Addendum C   Letter to Mining Company – Permission for Study in the Food Service Department

Esme Bredenhann
DIETITIAN   Pr. No 8400741

The Company representative

August 2009

Re: Permission for a study in the Food Service Department
I am currently studying toward a Masters in Nutrition at the University of Stellenbosch; Department of Human Nutrition in the Faculty of Health Sciences. As part of the study my intention is to verify and evaluate the food and nutritional intake of the residents residing in the Single Accommodation Villages.

Project Title:
A study to establish a simple, reliable and economical method of evaluating food and nutritional intake of mineworkers residing in a single accommodation residence on a Platinum mine in the North West Province.
The aim of the above mentioned study is to establish a simple, reliable and economical method of evaluating food and nutritional intake of mine employees residing in high- density accommodation.

The information collected will be treated as confidential, it will be included in a thesis, a publication in a professional journal, and be presented on national conferences, without disclosing the identity of any person or the institution.
An observational study to observe the portion sizes and the food waste generated will also be done. Very little impact on the work processes and workforce in the unit is envisaged as it will be an observational process only. Other than myself no people for outside the company will enter the premises as the catering training officer will assist with the study.

The study has been approved by the Health Research Ethics Committee Faculty of Health Sciences, Stellenbosch University and will be conducted according to the ethical guidelines and principles of the Medical Research Council (MRC) Ethical Guidelines for Research

The benefit for the Company will be that a reliable and verified tool will be available to measure food and nutritional intake of Mineworkers residing in the Single Accommodation Villages.

Permission is therefore requested to use the Townlands Food Services department for this research and that any information on procurement or other food related issues be made available.

Your kind consideration and approval of this project will be appreciated.

Signed

Esmé Bredenhann

Principal Investigator   Date :   30 September 2010

Permission granted:

Company representative: Date: 01 October 2010

P.O. BOX 6972   WESTGATE 1734   EMAIL: esmebre@iafrica.com
TEL: 011 954 0560   FAX: 011 954 3568   CELL: 082 651 7633

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Addendum D   Mining Company - Nutrition Policy

NUTRITION POLICY

The company, as the worlds leading primary producer of platinum group metals, commits itself to supply safe, wholesome and nutritious food to all employees.

AIMS:

In order to give practical expression to our commitment and to measure compliance and progress, we have the following aims:

Food Safety:
- Prevent food-related infections or -poisoning outbreaks
- Contribute to safe food handling practices in surrounding communities.

Food and Nutritional Intake:
- Ensure optimal nutritional status.
- Ensure nutritional requirements for different work loads and special needs are met.
- Respect peoples culture and preferences.

MANAGEMENT PRINCIPLES:
All our food service units are required to adhere to the following principles in a systematic and comprehensive fashion, and actively encourage by business partners. Further all contractors are obliged to comply with provisions of this policy.

1. **Commitment:** Hold senior personnel within each unit responsible for the ordering, storage, preparation and serving of safe wholesome food. Adequate financial and human resources are allocated to ensure optimum performance.

2. **Competence:** Ensure workforce competence and responsibility at all levels through selection, retention, education, training and awareness in all aspects of food handling.

3. **Risk Assessment:** Identify, assess and prioritize the hazards and risks associated with all our activities.

4. **Prevention and Control**: Prevent, minimize or control priority risks through planning, design, investment, management and workplace procedures. Where incidents do occur, take prompt corrective action, investigate root causes and take remedial action.

5. **Performance:** Set appropriate goals, objectives and performance indicators for all food service units. Meet applicable laws and regulations as a minimum, and where applicable apply international best practice.

6. **Evaluation:** Monitor review and confirm the effectiveness of management and workplace performance against company standards, objectives, targets and applicable legal requirements. Key to this process is a system of appropriate audits and progress reports to senior management.

7. **Stakeholder Engagement:** Promote and maintain open and constructive dialogue and good working relationships with employees, regulatory agencies, and food suppliers to increase knowledge and enhance mutual understanding in matters of common concern.

8. **Continual Improvement:** Support research and development into nutrition and performance, food innovations and promote the implementation of international best practice and technologies where appropriate.

Addendum E   Food Specifications

SPECIFICATION	FOOD COMMODITY SPECIFICATION
NUMBER : 159	Ref: HM Bredenhann
CODE NO. : 811.51.1025	DATE : 2009-11-22 revised Amendment 3

PRODUCT NAME : BEEF PORTIONS : BRAISING				
DEFINITION : The meat shall be cut from Class C1, 2 or 3 of the Bovine into 270 - 300 gram portions, 15 - 20mm thickness. The portion shall be cut from chuck, neck, loin, blade and rumpbone.				
SHELF LIFE AND STORAGE REQUIREMENTS : The beef portions shall be frozen and kept at -12° Celsius.				
PRODUCT INGREDIENTS : Fresh, good and wholesome beef, derived from healthy animals.	**SOURCE**	**NUTRITIONAL ANALYSIS :**		**SOURCE**
CHEMICAL ANALYSIS : Fat 4,1 - 5,2% Bone <23%	**SOURCE**	**MICROBIOLOGICAL/BACTERIOLOGICAL REQUIREMENTS :** Standard Plate Count 1 000 000 Staph Aureus 10 Salmonella Absent Vibrio Cholera Absent Clostridia of Foodpoisoning Absent Coliform Organisms 100 Feacal Coliform Bacteria Absent in 10 gram Listeria Monocytogenese Absent in 10 gram		**SOURCE** SABS guideline
PACKAGING AND LABELLING : The product shall be packed in suitable plastic bags into a suitable solid white crate. The plastic bag shall be securely tightened. The nett weight of a plastic bag shall be 10 kilogram (2 x 10 kilogram per crate). The following shall appear on the label : - Name and address of the manufacturer; - Date of processing; - Nett mass of the contents; - Name of the product.				
GENERAL: The product shall be cut from fresh healthy animals conforming to the Company specification for the raw product				
TRANSPORT AND DELIVERY The product shall be transported and delivered in accordance to the Company specification for Transport and Delivery of frozen product				

Addendum F   FoodCorp – Certificate of Analysis

CERTIFICATE OF ANALYSIS

Expiry date: 10 JUNE 2011

PRODUCT: MAGEU NUMBER ONE CREAM 500ML SACHETS

DESCRIPTION: Non alcoholic, non dairy, fermented maize based beverage

INGREDIENTS: Water, maize meal, lactic acid producing culture, sugar, artificial flavourant, vitamin C, preservative: potassium sorbate, non-nutritive sweetener: aspartame*
*contains phenylalanine

Test	MNO Result	MNO Specification	Result
Temperature (°C)	24	Room temperature	Complies
pH	3.43	3.3 to 3.8	Complies
Total solids (%)	7.27	7 to 9	Complies
Vitamin C (mg)	282	200 – 250 mg	Complies

We declare to the best of our knowledge and technical ability that there are no foreign materials present in our products

Signature: _Ncgapelo_____   Date: _18 04 2011_____
QA MANAGER p.p

Addendum G   Tables of Raw Food Issues for Breakfast, Main Meal and Supper

Table G1: Raw Food Issues for Breakfast (in kilogram)

Breakfast	Ration scale raw portion/person (kilogram)	Day 1	Day 2	Day 3	Day 4	Day 5 weekend
Planned participation		590	580	580	570	470
Lambalazi	0.070	40				30
Sebube	0.070		40			
Maize meal	0.070				40	
Mabele	0.070			40		
Sugar	0.020	12.5	12.5	12.5	12.5	12.5
Brown Bread	0.210	130	128	128	125	103
Viennas	0.110	65				
Chicken livers	0.100		60			
Beef sausage	0.100			65		
Meat Loaf	0.100				50	
Mince	0.100					45
Tomato	0.020	12	12	12		10
Onion	0.020	12	12	12		10
Soup powder (thickener)	0.010	5	5	5		5
Margarine	0.015	9	9	9	8	7
Jam	0.015	9	9		8	
Peanut Butter	0.015			9		7
Oil	0.005	2.5	2.5	2.5	2,5	2.5
Tea- mix *	0.021	12		12		12
Coffee-mix **	0.021		12		12	

* Tea- mix consists of tea leaves, sugar and sweetener and tea creamer

** Coffee-mix consists of coffee, sugar and sweetener and coffee creamer.

Table G2: Raw Food Issues for Main Meal (in kilogram)

Main meal	Ration scale raw portion/person (kilogram)	Day 1	Day 2	Day 3	Day 4	Day 5 weekend
Planned participation		690	700	700	580	490
Soup powder *	0.015	10	10	10	8	7
Beef	0.280	95	50	50	81	
Chicken	0.220	75	75	75	64	54
Fish	0.200		35			
Tripe	0.200			35		
Boerewors	0.200					49
Maize meal	0.130	90	90	90	75	65
Rice	0.080		30			
Samp	0.060	40	20	40	50	30
Beans	0.020	15	7	15		10
Carrots	0.230	160				
Pumpkin	0.250		175			
Spinach	0.180			130		110
Cabbage	0.180				100	
Onion	0.020			15		10
Potato	0.020			15		10
Oil	0.010	5	5	5	5	5
Salt	0.005	3	3	3	3	3
Condiments	0.005	3	3	3	3	3
Coleslaw	0.080		55			
Carrot salad	0.080			55		
Juice (powder)	0.015		10			5
Apple	0.120	85			70	
Banana	0.120			85		
Mageu ml	0.800	550	550	550	460	380

* Soup powder instead of gravy powder is used.

Table G3: Total Raw Food Issues for Supper (in kilogram)

Supper	Ration scale raw portion/person (kilogram)	Day 1	Day 2	Day 3	Day 4	Day 5 weekend
Planned participation		340	395	350	220	150
Chicken stew***	0.120	40				
Beef stew****	0.120		50			
Mince	0.100			35		
Wors	0.100				25	
Chicken liver	0.120					20
Salt	0.005	2	2	2	1	1
Condiments	0.005	2	2	2	1	1
Soup powder (Thickeners)	0.005	2	2	2	1.2	1
Onion	0.020			7		3
Tomato	0.020			7		3
Maize meal	0.050	20	20	20	10	7
Brown Bread	0.060	20	25	21	13	9
Margarine	0.015	5			4	2
Fresh milk ml	0.300		120			45
Amasi ml	0.300	102		105	66	
Beetroot salad	0.060			20		
Carrot salad	0.060					10
Mixed salad	0.060				13	
Tea- mix *	0.021	7		7		7
Coffee-mix **	0.021		7		7	

*** A pre-prepared chicken stew consisting of: 50g chicken pieces, vegetables and spices

**** A pre-prepared beef stew consisting of:50g beef stewing pieces, vegetables and spices.

Addendum H   Observation Sheet

Participants	Observation sheet		Date:			Meal				Observer	
	1		2		3		4		5		6
	Food Item		Food Item		Food Item		Food Item		Food Item		Food Item
	Portion size		Portion size		Portion size		Portion size		Portion size		Portion size
	Utensil		Utensil		Utensil		Utensil		Utensil		Utensil
	Total yield		Total yield		Total yield		Total yield		Total yield		Total yield
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