SEASONAL RURAL HOUSEHOLD FOOD INSECURITY IN ZAMBIA:

A CASE STUDY OF MUTANDA

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ABSTRACT

Sub-Saharan Africa is recognised as having a high proportion of food insecure people, most of whom live in rural areas and are dependent on subsistence agricultural production. Mutanda, a rural locality in Zambia, was studied to identify the seasonal characteristics of rural household food security. Two surveys (Food Consumption (n = 102) and Farm Systems (n = 42)) were undertaken using both objective and subjective methods.

Household food security was assessed using daily meals as a proxy indicator, supported by perception of hunger data. Both the relative size ($p < 0.001$) and frequencies ($p < 0.001$) of the daily meals were significantly lower at minimum food consumption (mid December) compared to maximum food consumption (late May). On average, the effective quantity of daily meals at minimum food consumption was reduced to 32% of the intake at maximum food consumption ($p < 0.001$). During food shortages, 63% of households considered they suffered from a degree of hunger, although no household indicated hunger was a serious issue when food is plentiful. These findings strongly support a conclusion that the Mutanda area suffers from transitory (seasonal) food insecurity.

The rationalisation of food consumption is attributed to the vulnerability of being dependent on seasonal agricultural production and the limited opportunities to augment the food supply using other sources. The primary source of food for 98% of households was from their farm/garden. Maize is the dominant crop with only 30% of farmers investing in some form of agricultural inputs. As a secondary source of food, 36% of households use income as a means of food acquisition.

The survey results highlight households using income to purchase food had a greater quantity of meals at minimum food consumption ($p < 0.001$), although the use of improved storage did not show a significant increase in food consumption during food shortages ($p = 0.227$). The results also present qualified support that seasonal variation in food consumption can be reduced through an increase in farm area, diversification of crops and the increased use of agricultural inputs.

As the study concludes that no single intervention eliminated the seasonal variation in food security, multiple strategies are presented to reduce the seasonal dependence of agricultural production. These include establishing a formalised local food market, increasing agricultural production and improving storage utilisation through education. The implications of these strategies on policy, both for governments and development organisations, are briefly discussed.

Keywords: Food security, food insecurity, daily meals, food consumption, seasonality, agricultural production, Zambia

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A. http://www.sim.org.nz

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> "Do not work for food that spoils, but food that endures to eternal life which the Son of Man will give you" *(John 6 v 27)*

> Jesus said: "I am the bread of life. He who comes to me will never be hungry and he who believes in me will never be thirsty" *(John 6 v 35)*

This is true eternal food security.

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UNITS AND ABBREVIATIONS

Units

hectare Conventional measurement of area at the farm level. One hectare (ha) is equal to 10,000 square metres.

joule The SI unit of energy. Normally given as kilojoule (kJ) = 1,000 joules or megajoule (MJ) = 1,000,000 joules

lima The common measure of land area in Zambia. One lima = ¼ hectare.

Abbreviations

BMI Body Mass Index

BMR Basal Metabolic Rate

ECZ Evangelical Church of Zambia

DER Dietary Energy Requirement

FAO Food and Agricultural Organisation of the United Nations

IFAD International Fund for Agricultural Development

IFPRI International Food Policy Research Institute

MAFF Ministry of Agriculture, Food and Fisheries (Zambia)

MARS Mutanda Agricultural Research Station

PEM Protein-Energy Malnutrition

SIM Serving In Missions

UNU United Nations University (Tokyo)

WHO World Health Organisation of the United Nations

WFP World Food Programme

Note: The notation used in Survey and Conceptual Model are given in Appendix 1

1. INTRODUCTION

1.1 AN OVERVIEW OF FOOD SECURITY

1.1.1 The Importance of Food

Food is viewed as a one of the fundamental necessities in life, not just solely in physical terms but also as a moral responsibility.

> "It cannot be stressed enough that humans have the right to sufficient food and good nutritional status" (Latham 1997, p345)

> "The right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger." World Food Summit (1996) quoted in FAO (2001a)

The importance of food is enshrined in a number of international conventions, including the 1948 Universal Declaration of Human Rights and International Covenant on Economic, Social and Cultural Rights 1966 (FAO 2001a). A reduction in food intake not only increases the chance of early death, but also reduces the physical, mental and social development of a human being, which has consequential impacts on the productivity, potential and respect for people (Latham 1997).

From the available data it is clear that the right to food is not afforded to everyone, resulting in certain areas and people groups having less, while others have more (Alexandratos 1995). Currently, according to estimates from the Food and Agriculture Organisation (FAO) of the United Nations, an estimated 815 million people are considered to be food insecure (FAO 2001c)[1].

1.1.2 Defining Food Security and Food Insecurity

The term food security (and its antonym, food insecurity) has become increasingly

1. The FAO estimates of food insecurity are frequently used in literature and have, in effect, become the default measure of food insecurity (especially comparing nations).

used since the food crisis of the early 1970's (Rahman-Osmani 2001; Antonsson-Ogle 1995) to provide an integrated study of food related issues. Food security is a complex area of study (Barrett 1999) and covers a wide range of disciplines across the broad areas of agriculture[2], health and economics (Foster 1992). Due to the complexity of food security, it is defined in broad, non-quantitative terms with Hoddinott (1999a) identifying over 250 definitions of food security. While the breath of definitions does create a variance in views, and not without some tension, most definitions are very similar in their intent, with the differences being primarily in emphasis (Carletto 1998). Maxwell (1995, p3) considers that *"most definitions of food security vary around that proposed by the World Bank".* The World Bank defines food security as the *"access by all people at all times to enough food (of good quality) for an active, healthy life"* (World Bank 1986; quoted by Carletto 1998, para.12).

However, more recently, with the work undertaken by the FAO in food security, their definition of food security is becoming increasingly relevant. Also, unlike most literature, the FAO also provides a definition of food insecurity[3].

> Food Security: "A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (FAO 2000a, p26)

> Food Insecurity: "A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity, poor conditions of health care and feeding practices are the major causes of poor nutritional status. Food insecurity may be chronic, seasonal or transitory" (FAO 2000a, p26).

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2. The term agriculture for this report includes, for simplicity, horticulture. While this study considers land based food production, this should not be inferred that aquaculture is of less importance in food production systems.

3. For this study, the definition of food security and food insecurity will be those used by the FAO. This choice is based on the significant work undertaken by the FAO in food security. For additional definitions on food security, the reader is referred to Maxwell and Frankenbeger (1992) and Clay (1997).

The measurement of food security, like its definition, is complex. There is an acceptance that a true measurement of food security is difficult to achieve, primarily due to resource constraints. Consequently, food security is typically evaluated through the use of indicators, which provide a proxy assessment to the extent and status of food insecurity.

Frequently food security indicators, especially those with a nutritional focus, tend to use an inequality framework based on the concept of sufficiency (Maxwell and Smith 1992). In the simplest form, such inequalities are based on an assessment of actual food consumption of an individual and compared to the nutritional requirement needed to maintain an adequate level of health.

1.1.3 Food Security and Agricultural Production

Agricultural production, often interchangeable with food availability, is well accepted as a foundation to food security and has historically been used as the only indicator of food security. However, more recently, there has been a trend away from agriculture to include food accessibility and utilisation. While it is true that food security is more than solely an agricultural issue (Short 2001), there are valid reasons why food security and agriculture are firmly linked.

i) Despite the blurring caused by the distraction of the market (especially in western countries), agriculture is still the only means by which humanity can obtain food (FAO 2001b; Grew 2000; Atkins 1995; Ojala 1975).
ii) It is estimated that of the people classified as food insecure, 75% reside in rural areas (IFPRI 2002, Lipton 2002). The overwhelming majority of people suffering from food insecurity obtain a high proportion of their food from subsistence agricultural production (FAO 2001b).
iii) Agriculture is a powerful mechanism by which economic growth can occur, (especially income generation), thereby increasing purchasing power for food acquisition (Mundlak 2000; Eicher and Staatz 1998; Haddad 1997).

Due to the relevance of food security to rural areas it has become *"a guiding principle for designing interventions in rural areas"* (Hoddinott 1999a, p1) - a principle adopted by various development agencies (i.e. IFAD; World Vision).

1.1.3.1 Seasonality and Agricultural Production

The majority of agricultural production systems are dependent on seasonality, primarily caused by climatic factors (Gill 1991; Sahn 1989; Chambers 1982; Chambers, Longhurst, and Pacey 1981). Consequently food availability is not constant and peaks during certain times of a year. Without the ability to smooth-out food availability, this leads to the well-documented 'hunger season' which occurs in many food insecure areas. The effect of seasonality is most acute for households that rely on food sourced from there own farm/garden production (Chambers *et.al.* 1981).

1.1.4 Food Security and Poverty

Since the 1980's, especially after the ground-breaking work by Sen (1981), the explanation of food security has moved towards a focus on economic and policy factors. Poverty is often seen as one of, if not the, underlying reason for food insecurity - *"poverty is at the root of food insecurity"* (Tabatabai 1995, p34). However, it is more likely that poverty occurs due to the same reasons why food insecurity occurs. Tweeten (1997) considers that food security and poverty are inseparable issues, hence poverty and food insecurity can be considered companion problems - the flipside of the same coin.

1.2 ASSESSMENTS OF FOOD SECURITY

Assessments of food security are dependent on spatial areas. While food security assessments are increasingly being redirected towards the household and even individual (Rahman-Osmani 2001), the predominant comparative assessments remain at the macro-scale level, typically by country. The macro-scale assessments by the FAO are commonly referred to in literature, hence form an important aspect to consider in food security discussions.

1.2.1 Global Food Security[4]

Of the 815 million people estimated to be food insecure, over 95% reside in

4. For this study, the term "western countries" will be used to denote countries that are developed (i.e. "The North" or "Industrialised Countries"), thereby preventing confusion with the term "developing countries". The term "developing countries" are used in preference to "The South" or "The Third World". The distinction between western and developing countries is based on the OEDC classification.

developing countries (Table 1.1). Since the first assessments of food security in late 1970's, the percentage of the global population suffering from food insecurity has decreased by an estimated 15% (FAO 2001), despite there being an increase in the global population of 60% over the same time. This would seem to indicate that the problem of food insecurity is diminishing. However, in reality, the success is highly regional. From the underlying data, the improvement in global food security is virtually solely due to the success of Asian continent, with only minor improvements in other regions (Figure 1.1).

Table 1.1: Assessment of Global Food Insecurity

Country Classification*	Population Estimated to Food Insecure	Percentage of Population Estimated to be Food Insecure
Developing Countries	777 Million	17
Transition Countries	27 Million	6
Western Countries	11 Million	<1
Global	815 Million	14

Source: FAO (2001c)

* *Classification based on FAO (2001c).*

Transition countries refer to those of the former USSR and Warsaw Pact countries

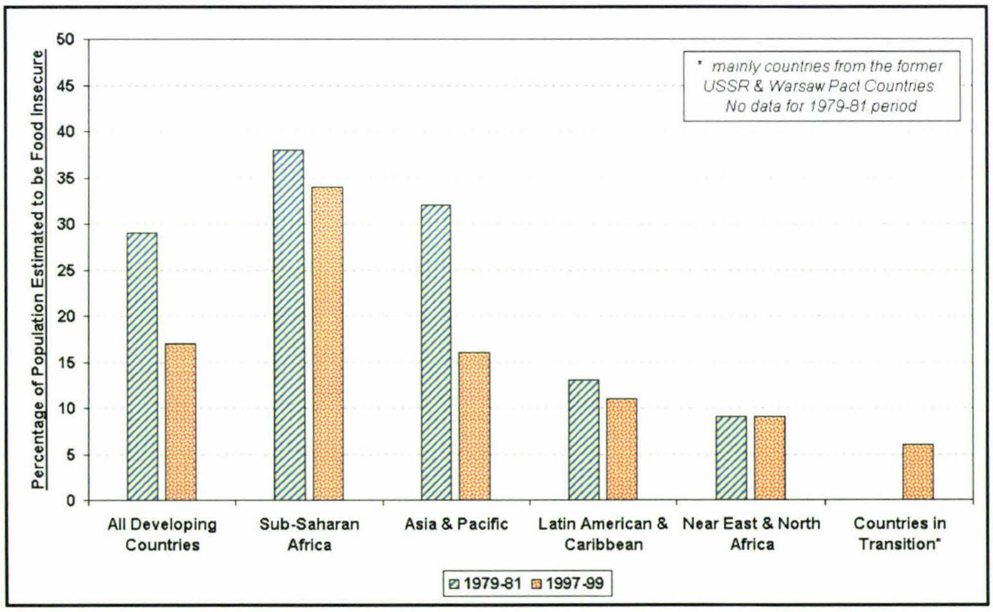

Figure 1.1: Changes in Food Security for Developing Country Regions *(Source: FAO 2001c)*

1.2.2 Sub-Saharan Africa Food Security

It is well established that sub-Saharan Africa is considered to be the most food insecure region of the world (Devereux and Maxwell 2001; Duncan 1998; Haddad

1997). This is supported by the assessment of the FAO which considers that of the 25 most food insecure countries, 19 reside in the sub-Saharan Africa region (FAO 2001c).

As with regional variations, food insecurity varies within regions. From Figure 1.1, sub-Saharan Africa has shown to have had a small improvement in food security. However, this improvement is primarily due to the West Africa sub-region, while Central, Eastern and Southern Africa all show an increased level of food insecurity (Figure 1.2) [5]. With low agricultural production growth rates and an increasing population growth, the future predications do not look overly optimistic for an improvement in food security in sub-Saharan Africa at current rates of development (Rosegrant, Paisner, Meijer and Witcover 2001; Pinstrup-Andersn and Pandya-Lorch 1997).

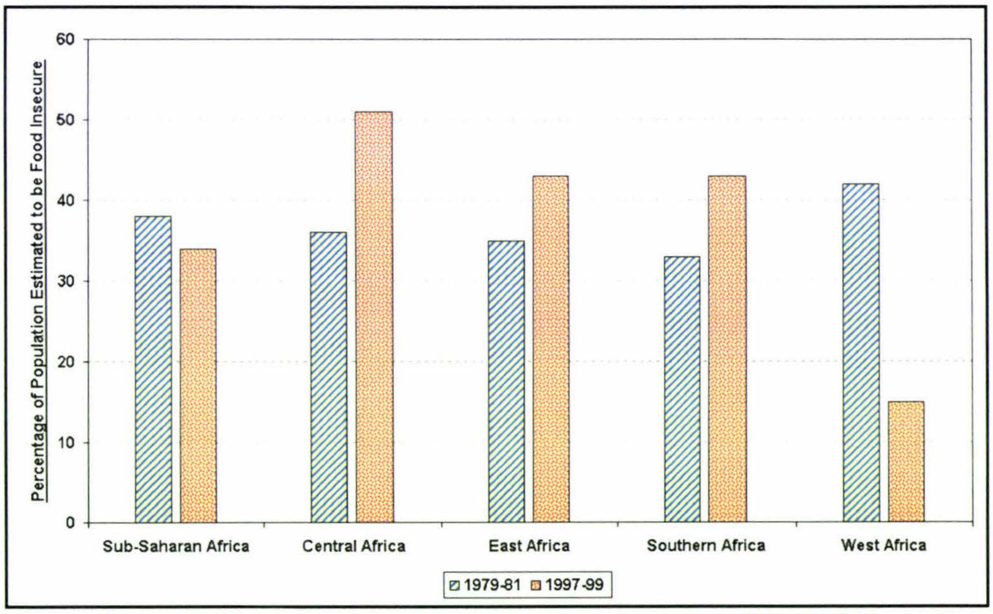

Figure 1.2: Changes in Food Security for sub-regions of sub-Saharan Africa
(Source: FAO 2001c)

1.2.3 Zambian Food Security

According to the FAO assessment, Zambia is classified as the 10th most food insecure country, with an estimated 47% of it population be classified as food insecure (FAO 2001c). In the past two decades, there has been an estimated

5. Not all the improvement in sub-Saharan Africa is due to West Africa as a few countries within the other sub-regions have also shown an improved food security status (i.e. Lesotho and Swaziland).

17% increased in people suffering from food security. This concern in food insecurity in Zambia can be graphically shown by the decreasing trend of food supply (Figure 1.3)[6]. There are various explanations given for this trend, although the leading reason for the decrease in local agricultural production is considered to be the reduction in use of agricultural inputs due to unavailability and/or high cost (MAFF 2000b).

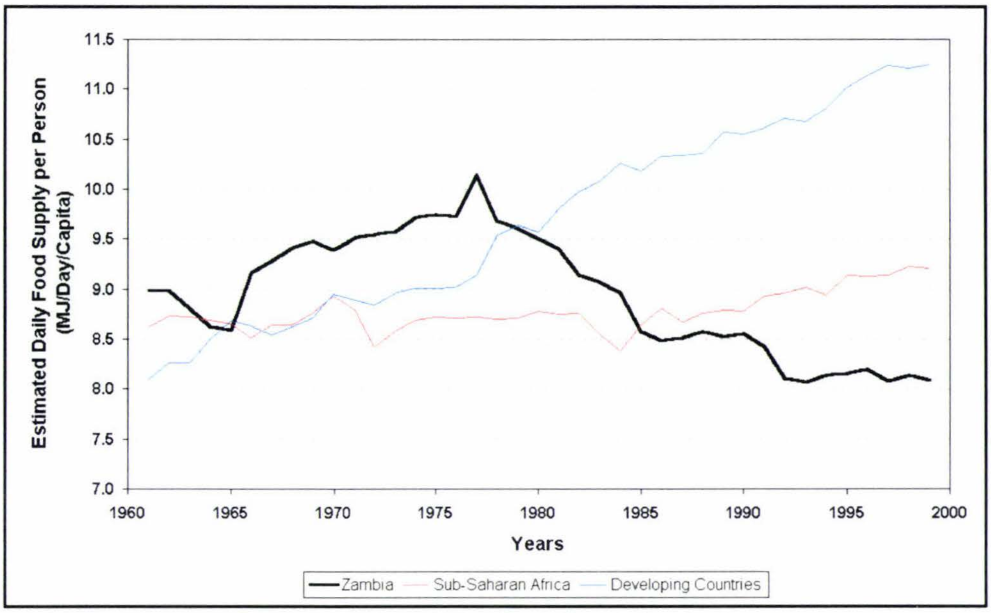

Figure 1.3: Time Series Food Supply for Zambia
Source: FAO Statistical Database (FAO 2002)
(aggregated sub-Saharan Africa and Developing Countries given for comparison)

1.3 DEFINITION OF RESEARCH PROBLEM

There are four major issues apparent in food security:

1. Food insecurity is increasing in certain areas of the world, particularly in sub-Saharan Africa.
2. Food insecurity is primarily a rural problem
3. Improving food security is still strongly dependent on agricultural production, especially at the subsistence level.
4. Due to the dependance on subsistence agricultural production, food insecurity is highly dependent on seasonality.

6. For comparison with Figure 1.3, based on standard values (James and Schofield 1990), the average Zambian adult requires about 9.0 MJ per day.

From this, the problem statement is defined as:

"Food insecurity is increasing in rural sub-Saharan Africa countries like Zambia. Understanding the characteristics of rural household food insecurity, particularly its relationship to subsistence agricultural production and the dependence on seasonality, is a vital step to develop strategies to alleviate food insecurity".

1.4 FIELD RESEARCH LOCATION

1.4.1 Zambia

Zambia is a landlocked country (752,614 km^2) with a population of 10 million (2000 est), located in central southern Africa (Figure 1.4). Depending on sources, between 70-90% of the population are estimated to live below the poverty line, most of which reside in rural areas (MAFF 2000b; Pinstrup-Andersen and Pandya-Lorch 1997). The government recognizes that food insecurity is one of the major problems facing Zambia and has developed policies to address this issue (MAFF 2000b). Due to the high level of food insecurity in rural areas, these policies have a strong emphasis on agricultural development.

Figure 1.4: Map of Zambia.
Closest Town to Research Area, Solwezi (Head of Arrow)
Source: PCL Map Collection (2001)

1.4.2 Mutanda, Zambia[7]

1.4.2.1 Geography

Mutanda (Latitude 12.24 S; Longitude 26.16 E; Altitude 1275 m) is approximately 40 kilometres southwest of Solwezi, the main administrative centre of the Solwezi District and North-Western Province (Figure 1.5). While Mutanda is a broad rural locality without administrative boundaries, it can be defined in terms of either the Mutanda Agricultural Block[8] or the Mutanda Rural Health Clinic Area (MRHC)[9].

Geologically, Mutanda is situated on an extensive, fluvially dissected, plateau and is named after the predominant geographical feature of the area - the Mutanda River, a headwater tributary to the Zambezi River. As with the majority of the North-Western Province, Mutanda is located in Agro-ecological Zone Three (MAFF 2000a), with an annual rainfall over 1200mm. While there are limitations in soil quality, Chuma (2000) notes that with adequate management it can support increased agricultural development. The climate is tropical, although this is modified by the altitude. There are three main seasons:

- Dry/Cool: May to August
- Dry/Hot: September/October
- Wet/Hot: November to April

In terms of vegetation, the majority of the land can be described as either savanna woodland (>50% coverage in trees) or savanna scrubland (>50% coverage in grasses). The burning of the land, as a means for field preparation, is an annual occurrence during June-August[10]. Consequently, the majority of the trees are not mature and the tree cover is poorly developed.

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7. While the choice of Mutanda, Zambia was primarily due to the availability of a field research opportunity, this country and location fulfills the necessary conditions especially with respect to its geographical location (sub-Saharan Africa) and status of food insecurity.

8. For agricultural administration, each district is divided into agricultural blocks, which in turn are divided into agricultural camps.

9. For this study, the area in Mutanda locality is defined as that of the MRHC. While cartographically undefined, based on MRHC information, this area has an approximate area of 600 km^2.

10. It is estimated that, over a 5-year period, the whole rural area of Zambia is burnt once (Kretzschmar 2001)

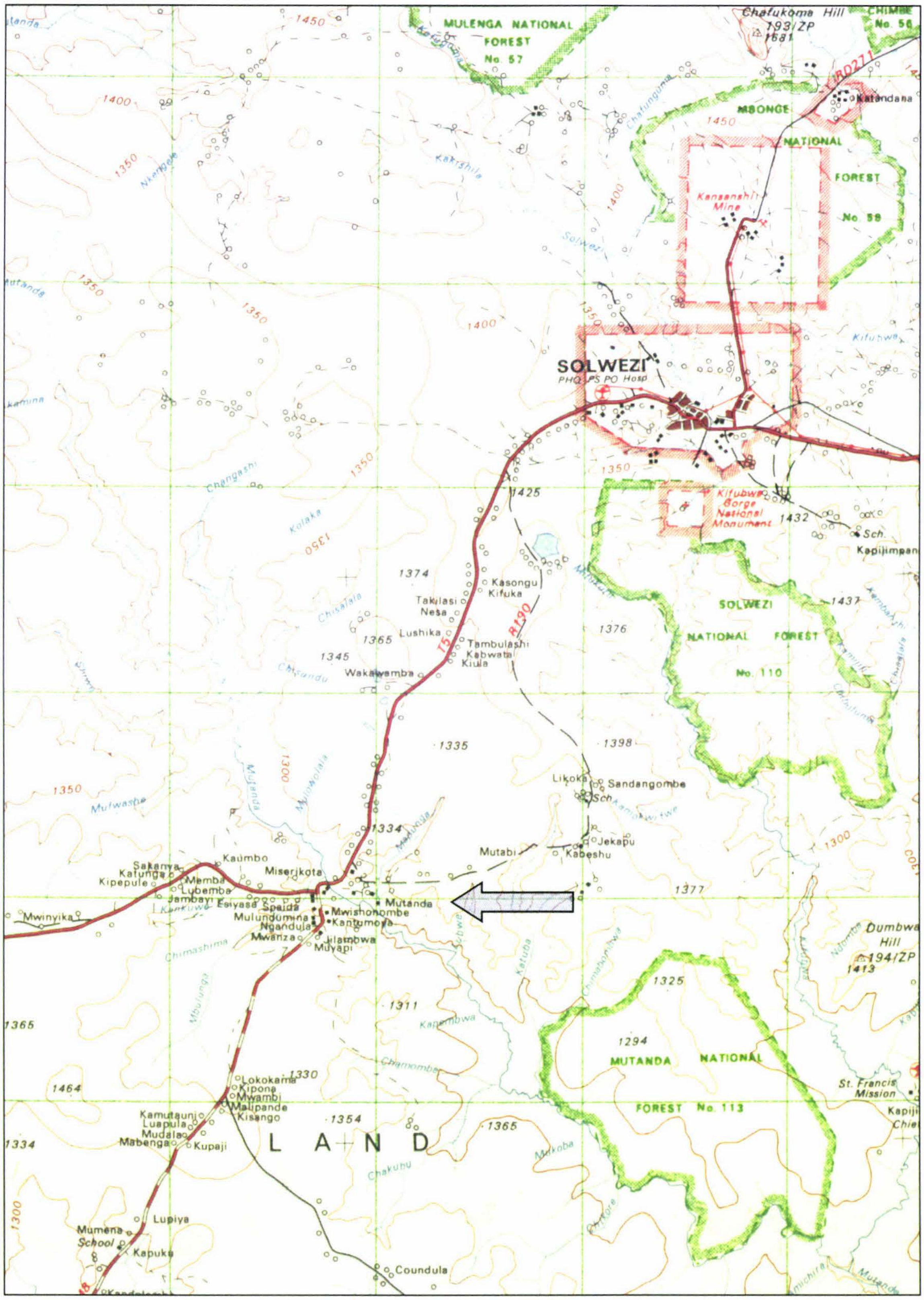

Figure 1.5: Location of Field Research. Mutanda, Solwezi District, Zambia
(Mutanda is located at head of arrow)
Scale: 34mm = 10km (approx).
Map Source: SD-35-2 Solwezi, Government of the Republic of Zambia

1.4.2.2 Population

While no official population data are available for the Mutanda area, the MRHC area has an estimated population of 10,700 (MRHC 2000). With an estimated area of 600 km^2, the population density of the Mutanda area is 17.8 person/km^2. This is significantly larger than the district average (6.7 person/km^2) and can be explained by the close proximity of the main province road [11]. Within the MRHC area, it is estimated that there are approximately 1500 households.

1.4.2.3 Agriculture

Subsistence agricultural production is the most common form of agriculture in the Mutanda area and the Solwezi District in general (Chuma 2000). According to land capability assessments, the predominant crop grown is maize which is said to suit the natural resources available.

As with the majority of rural Zambia, agriculture is poorly developed in the Mutanda area. While shifting cultivation was common in the past, there is a movement towards a more sedentary nature of agriculture and community. However, it is estimated that less than 1% of potentially adequate agricultural land is utilised in the district and 0.2% for the province (Chuma 1998a) [12].

1.4.2.4 Community

The Mutanda area can be classified as undeveloped, with notable poverty and subsistence lifestyles, limited infrastructure and services available. The area has two predominant organisations:

1. The Mutanda Agricultural Research Station (MARS), a government agricultural research station focussing on root and tuber crops. MARS is the only organisation with access to electricity and limited telecommunication services.
2. The Mutanda Centre (MC), a division of the Evangelical Church of Zambia (ECZ), is a former mission station. This centre now focuses on post-harvest processing of crops for the community (namely maize, soya beans and

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11. The majority of the district population tends to be confined to a 1km band on either side of the two main provincial roads (Solwezi Census Office, Personal Communication, 18th July 2001).

12. The majority of the agricultural land in use is close to main roads (where most of the population is located). Beyond this thin band, little land is developed for agriculture.

honey), the provision of inputs (namely seed and fertiliser) and extension to local farmers. In particular, the centre operates the only hammer mill in the area for grinding cereal (generally maize). This service reduces the backbreaking daily workload, mostly undertaken by women, of grinding maize for nshima[13]. (The next closest hammer mill is located in Solwezi). Additional to this work, the centre also operates a primary and secondary school, on behalf of the government. The Mutanda Rural Health Clinic, operated by the government, is also located on the site.

1.4.2.5 Food Insecurity in Mutanda Area

There is very little quantitative information on the level of food insecurity in the Mutanda area. However, anecdotal evidence suggests it is a frequent occurrence, in the form of a defined hunger season. Qualitative data across the Solwezi District (Phiri 1998), indicates that food insecurity is one of the major concerns currently facing rural households. Addressing food insecurity is a primary objective of organisations involved in the Mutanda area (government, non-governmental and community based), especially through interventions that promote and increase agricultural production.

1.5 RESEARCH QUESTIONS

Based on the issues raised in the literature review, and the relationship between food consumption and food security, the questions being considered are (with specific emphasis to the case study location of Mutanda, Zambia):

1. To what extent is food consumption, in terms of daily meals, impacted by seasonality?

   Hypothesis One (A)

   Rural households in the Mutanda area experience food shortages for at least some period of the year but less than half a year.

13. Nshima is the staple food in Zambia, prepared from cornmeal (known locally as mealie meal). Nshima can be best described as a thickened porridge, bordering on a cooked dough.

Hypothesis One (B)

For the average household, the food intake (based on effective daily meals) is significantly lower at minimum food consumption than maximum food consumption.

2. How does the use of income and storage impact on the level of food consumption, in terms of daily meals?

Hypothesis Two (A)

Rural households that use income for food acquisition consume a larger proportion of daily meals at minimum food consumption compared to households who do not use income.

Hypothesis Two (B)

Rural households that use ECZ silos consume a larger proportion of daily meals at minimum food consumption compared to household who use traditional forms of storage.

3. How do the characteristics of farming systems impact on food consumption?

Hypothesis Three (A)

Households with a β-ratio of less than one-third have a smaller planted crop area than households with a β-ratio greater than one-third [14].

Hypothesis Three (B)

The number of crops planted by a household effects the level of food intake during minimum food consumption

Hypothesis Three (C)

The use of agricultural inputs (aggregated use of cattle, fertiliser/certified seed) effects the level of food intake during minimum food consumption

14. Explanation of the β-ratio is given in Section 3.1.4.4

4. Based on the characteristics identified, what interventions are required to assist with the alleviation of rural household food insecurity?

The specific methods to test these hypotheses are presented in Section 3.2.7.

1.6 OBJECTIVES OF THE THESIS

The aim of the research is to recommend strategies for improving rural household food security, focussing on subsistence agricultural production. With respect to the Mutanda area, the objectives are:

1.6.1 Objective One

Examine, and critically assess, the changes in food consumption, with particular emphasis on seasonality.

1.6.2 Objective Two

Describe the relationship between agricultural production and food consumption for rural households.

1.6.3 Objective Three

Based on the relationship between food consumption and food security, recommend strategies for improving rural household food security in the Mutanda area.

1.7 IMPORTANCE OF THIS STUDY

No effective strategies to alleviate food security for an area can occur unless there is adequate knowledge as to the extent of food insecurity (Ssewanyana and Ahmadi-Esfahani 2001). While it is accepted by government officials that food insecurity occurs in the Solwezi District, there is very little quantitative information to support this assessment. Most of the information is confined to sporadic qualitative appraisals. The value of the research will be to provide assistance in identifying characteristics of rural household food security in Zambia, especially the Solwezi District, and implementing strategies to alleviate the identified problems.

1.8 BOUNDARIES AND LIMITATIONS OF STUDY

- The study is confined to the Mutanda area of the Solwezi District. As the research is a case study, extrapolation of the results outside of the study area should be treated with extreme care.
- The study will primarily focus on the food consumption aspects of food security.
- Due to the nature of food security in Mutanda, there is an emphasis on the relationship between subsistence agricultural production and food security.
- The study will assess food security at a household level

1.9 THESIS ORGANISATION

The thesis is organised into seven sections, these being:

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Conceptual Models and Methodology

Chapter 4: Results and Discussion

Chapter 5: Conclusions and Recommendations

References and Bibliography

Appendices

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2. LITERATURE REVIEW

2.1 BACKGROUND TO FOOD SECURITY

The genesis of food security studies can be traced back to the food crisis of the early 1970's (Rahman-Osmani 2001; Antonsson-Ogle 1995). Barrett (1999) identifies three stages of food security theoretical development, over this time:

1. The first stage focussed on aggregate food availability at the national level (i.e. agricultural production) to assess the level of food security.
2. The second stage, developed primarily after to the pivotal work by Sen (1981), focussed on issues related to food entitlement and access. This raised the importance of the economic issues, especially income level, and nutrition at the household and individual level.
3. The third stage, developed from the late 1980's, redirected food security assessment to more of a sociological, even psychological, perspective. In this, the behaviour of people is considered when food supply is uncertain. This approach to food security assessment is commonly described in terms 'coping strategies' (Maxwell 1995).

According to Barrett (1999, p35), food security is an *'unobservable variable with complex, multi-factorial causality'*. There is a consistent thread in literature that the concept of food security is confusing (Rahman-Osmani 2001; Hoddinott 1999a). In a review by Hoddinott (1999a), over 250 definitions of food security have been identified. A reason for the breadth of definitions, as inferred in literature, is due, at least in part, to the preferences and predisposition of organisations and/or researchers. Consequently food security definitions (and measurements) can have a considerable degree of subjectivity.

Despite this subjectivity, Carletto (1998) considers that most food security definitions contain four core concepts: access, security, sufficiency and time [15]. These concepts can be traced back to the review undertaken by Maxwell and Smith (1992), on which much subsequent food security work is referenced.

15. Variations of these core concepts occur in literature. For example, Maxwell (1995) considers that sustainability is a core concept, replacing that of time. While there is an element of time in the concept of sustainability, the context used by Maxwell (1995) is quite different based on the review of Maxwell and Smith (1992).

2.2 DIMENSIONS OF FOOD SECURITY

Hoddinott (1999a) sees that the majority of food security literature focuses on developing and testing issues, resulting in a broadening of food security theory. Implicitly, Hoddinott considers that the theoretical developments are overtaking practical food security interventions, which is crystallised in an "information constraint".

> "That is, information is often lacking on the nature of the food security and nutrition problems facing a country, or region within a country, the location of food insecure areas and the causal links between potential interventions and food security outcomes". (Hoddinott 1999a, p1)

In bridging the information constraint, food security is being increasingly described and assessed in terms of 'dimensions' (Hoddinott 1999a, Tweeten 1997). The use of dimensions can be viewed in terms of 'describing the processes' by which food security occurs rather than 'attempting to define' what food security is. The knowledge of dimensions is seen as an important foundation to alleviating food insecurity.

> "No effective food security policy can be developed without knowledge of the dimensions of the food insecurity problem". (Ssewanyana and Ahmadi-Esfahani 2001, p93)

Despite their increasing use, food security dimensions vary in literature. Von Braun, Bouis, Kumar and Pandya-Lorch (1992) discuss 'dimensions' in terms of 'measuring' food security while Hoddinott's (1999a) overview of dimensions can be considered in terms of defining the boundaries for food security assessment. Other authors (e.g. Antonsson-Ogle 1995) use dimensions as a means to classify common areas of food security.

Within the breadth of literature, food security can be described by three primary dimensions: spatial, temporal, food system (Figure 2.1). Additional to this is the interaction of the nutritional dimension which is increasingly being considered as an essential aspect of food security (Kracht and Schulz 1999).

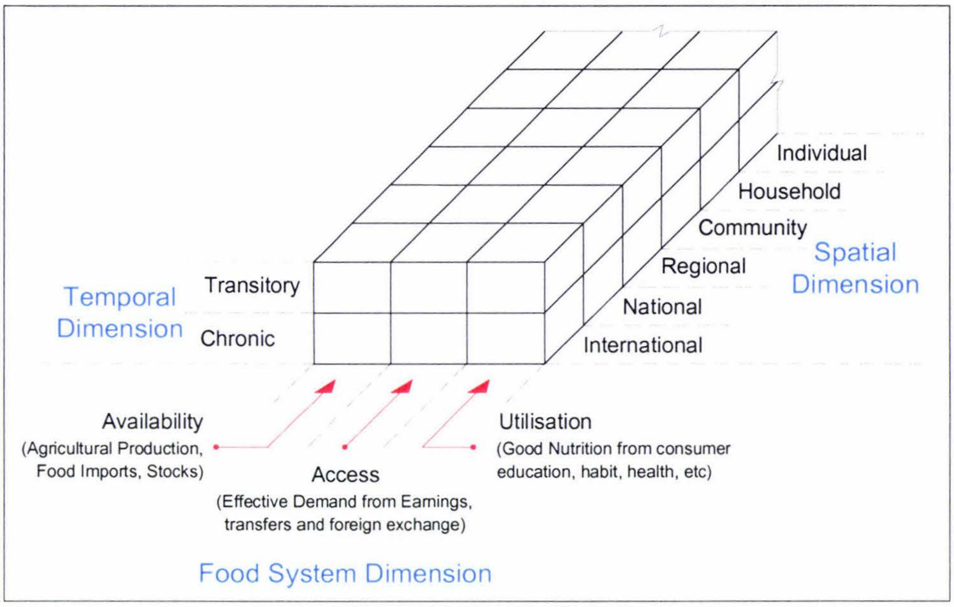

Figure 2.1: Dimensions of Food Security, and their interconnections
Source: Adapted from Tweeten (1997)

2.2.1 Spatial Dimension

According to Hoddinott (1999a, p3), the spatial dimension primary relates *"to the degree of aggregation at which the food security is being considered".* The spatial dimension occurs from the global level to the individual (Figure 2.1), although literature is varied on how this dimension is classified (Hoddinott 1999a). One potential reason for this confusion is that the spatial dimension is often considered as a single entity. However, from literature, it would seem that the spatial dimension has two components - a geographical region and 'social unit' [16] (Table 2.1). This occurrence, for example, can be observed in the FAO assessment of food security where data are aggregated at the 'country level' yet analysed for an 'average individual' (FAO 1996). Rahman-Osmani (2001) uses the terms 'macro' and 'micro' to differentiate between the geographical regions and social units respectively. At the macro-scale level, the assessment of food security is more aggregated, while the micro-scale is less aggregated (i.e. disaggregated) [17].

16. Most of the literature reviewed considers that the household and individuals can be described as spatial dimensions (i.e. Hoddinott 1999a; Tweeten 1997). Maxwell (1995) uses the term 'social unit' to describe these spatial dimensions. This term can be extended to other social units used in food security (i.e. gender and age).

17. The differentiation of macro and micro spatial dimensions can be further explained by the macro-scale level being fixed (i.e. a physical geographical region does not move), while the micro-scale level (i.e. households, individuals) can move between and within the macro-scale level (i.e. move between geographical areas).

Table 2.1: Spatial Dimension Matrix [18]
(constructed from Rahman-Osmani 2001; FAO 2000c; Hoddinott 1999a; Tweeten 1997 and Sahn 1989)

		Micro Spatial Dimension (Social Unit)			
		Individual	**Household**	**Gender**	**Age**
Macro Spatial Dimension (Geographical Region)	**Global**				
	Continental				
	Regional				
	Sub-Regional				
	Country				
	Provincial/State				
	District/County/City				
	Community				

The selection of the spatial dimension plays a critical role in food security assessment (Thomson and Metz 1997). In particular, it determines the set of boundary constraints on the food security system, especially the physical (i.e. climate), social and economic issues present (Hoddinott 1999a). Antonsson-Ogle (1995) sees the spatial dimension as being important for selecting the relevant indicators to use when measuring food security (see Section 2.3).

The social unit (micro-scale) is becoming increasingly more important in food security assessment, as it is at this level that the majority of food decisions are made (Rahman-Osmani 2001; Hoddinott 1999a; von Braun *et. al.* 1992). One of the primers for this change was the acceptance that *"adequacy at the aggregate level does not necessarily ensure adequacy at the household or individual level"*, although it has taken *"some time to redirect the discussions on food security away from the macro level towards the household, and still further towards the individual"*. (Rahman-Osmani 2001, para.11-12).

2.2.2 Temporal Dimension

Maxwell and Smith (1992, p15) consider that time is one of the core concepts in defining food security, such that food security can only occur when people have *"secure access to enough food at all times"*. Maxwell and Smith (1992) commented

18. The categories listed in the table are not exclusive and other macro or micro spatial dimensions could be defined.

that the temporal dimension has not been discussed greatly in literature, although this has changed in the intervening decade (Hoddinott 1999a).

Hoddinott (1999a, p3) refers to the temporal dimension as *"the time frame over which the food security is being considered"*, although also notes that there are various interpretations in literature. A root cause of the varying interpretations can be explained by the temporal dimension having both causal and effect components, which does not occur, at least to the same degree, with other dimensions.

The causal impacts of the temporal dimension are strongly related to climatic variability expressed in seasonality (Gill 1991; Chambers *et.al.* 1981). Such impacts are often predetermined by the selection of the spatial dimension (i.e. seasonality is intrinsically linked to a geographical area) and are manifested in the food system dimension, especially with variation to food availability.

The temporal dimension of food security assessment tends to focus on the effect component - that is, the outcomes of the causal impacts. In literature, temporal dimension is almost universally classified into two states - chronic or transitory (Hoddinott 1999a; Tweeten 1997).

- *Chronic Food Insecurity:* Occurs when people live in a situation where adequate food supply is never, or rarely, available.
- *Transitory Food Insecurity:* Occurs when people have access to adequate food supplies for at least some period of the time. If conditions dictate, transitory food insecurity can take on chronic characteristics (Zellar, Schriender, Von Braun & Heidhues 1997). Typically, transitory food insecurity is divided into two sub-categories [19] (Hoddinott 1999a, FAO 2000a):
  - Temporary: Disruptions in the food supply that can be caused by a variety of factors (i.e. inconsistent income). These disruptions are generally considered to occur over a short period.
  - Seasonal: Systematic disruptions in food supply, differentiated from temporary food insecurity in that the food shortages occur at the same

19. Barrett (1999) classifies a third category - conjunctional. This is a mixture of temporary and seasonal, often caused by disasters or civil unrest. This category, however is not used by other authors reviewed.

times each year (e.g. prior to harvest, or during a regular dry spell). Such a situation is frequently termed the hunger season (Sahn 1989).

Overall, literature gives more attention to chronic food insecurity than transitory seasonal food insecurity (Hoddinott 1999a). In differentiating between these two states, Barrett (1999, p16) states that *"chronic food insecurity occurs when the subject is continuously unable to ensure access to sufficient appropriate foods".* While similar descriptions are common in literature, the term 'continuously' (and related terms) is either not quantified or very poorly defined. Accordingly the transition between chronic and transitory food insecurity is often a subjective interpretation by the researcher of the data. While literature is keen to emphasise the difference between these states, Maxwell and Smith (1992, p17) see that *'chronic and transitory food insecurity are closely linked'.* In this, such a classification maybe unnecessary as many strategies used to alleviate food insecurity are applicable to both states (Hoddinott 1999a).

Allied to the temporal dimension is the concept of vulnerability (Maxwell and Smith 1992, Maxwell 1995). In a broad context, vulnerability is related to the transition between stages of the temporal dimensions, especially moving from a food secure to food insecure situation, and to a lesser extent from a transitory to chronic phase. The vulnerability approach has a strong focus on assessing the coping strategies used by people in such situations where food supply is uncertain, for example liquidating assets to maintain purchasing power of food (Frankenbeger 1992). The use of vulnerability as a means of mapping areas of food insecurity is finding increasing favour, such as seen in the 'Food Insecurity and Vulnerability Information and Mapping Systems' (FIVIMS) developed by the FAO (FIVIMS 2002).

2.2.3 Food System Dimension

In terms of describing the processes involved in food security, a significant degree of literature focuses on the flows of food within, and between, spatial and temporal dimensions. As shown in Figure 2.1 (p18), the flow of food within the food system can be described in terms of 'food availability', 'food accessibility' and 'food utilisation'.

The use of these classifications are frequently used in literature (e.g. IFAD 2002; Elder 2000; Barrett 1999; Paterson 1999; Tweeten 1997; Haddad 1997, Diskin 1994). Elder (2000, p167) terms these classifications as the *'three core determinants'* of food security[20]. Historically, these three determinants are often related by a linear pathway (Figure 2.2), with a return feedback based the nutritional status of the individual[21].

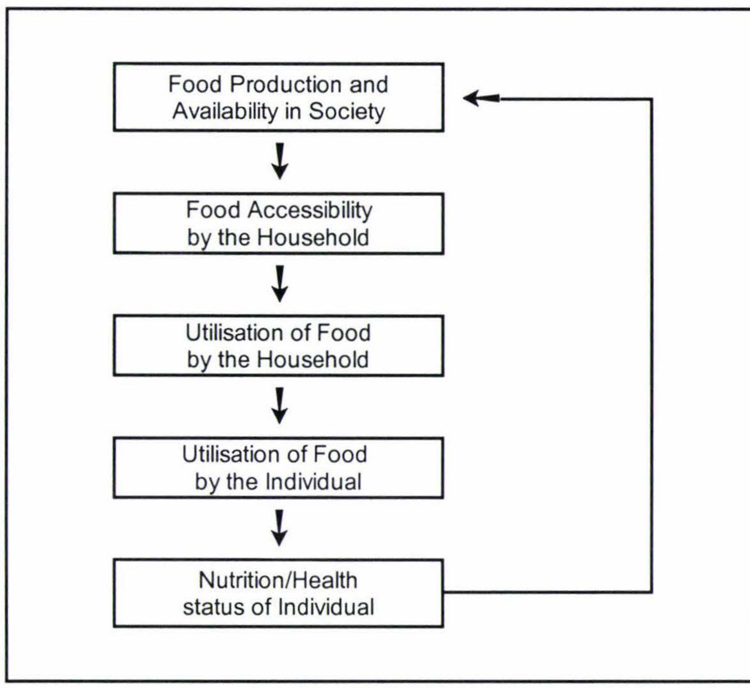

Figure 2.2: The Simplified Food System
(Adapted from Pacey and Payne 1985)

While the separation of the determinants enables the processes to be described easier, it also tends to promote a view that each determinant is mutually exclusive. However, the food systems in developing countries are not so neatly defined as the compartmentalised food systems that have evolved in western market

20. IFAD (2002) introduce a fourth determinant - 'food stability'. This determinant is explained in terms of improving crop storage, and sustainability to a lesser extent. World Vision assessments include another fourth determinant as well - 'asset creation' - which includes issues related to storage and food buffering (Abifarin and Olufowote (1998); White, Chapman, Nankam, Abifarin, and Olufowote (2000) and World Vision Canada (undated)). The issues trying to be highlighted by a 'fourth determinant' can be identified within either the availability, accessibility or utilisation determinants currently used in food security literature. While there maybe a valid argument that these issues (especially storage) are an increasingly important part of food security, and deserve to be separated into a 'fourth determinant', the current theory is not developed to an extent for this to be presented here in detail.

21. Pacey and Payne term the second stage of the system as "Food availability within the household". However, the context of Pacey and Payne's discussion, when compared with later literature, this sub-system is more related to 'food accessibility'. Pinstrup-Andersen (1981) also provides a similar conceptual model to Pacey and Payne.

economies (Atkins and Bowler 2001; Harris-White 1998). This is particularly notable in rural areas where food is acquired through multiple sources, such that the processes of food systems merge and interact to make the separation into component systems difficult. This observation is particularly relevant for food availability and accessibility where Rahman-Osmani (2001) effectively aggregates these two determinants together into the term 'food acquirement'.

2.2.3.1 Availability of Food[22]

In a broad view, food availability is linked to agriculture production and polices[23]. While there is not a unanimous agreement on what food availability means, the essence of food availability is well described by Tweeten:

> "The supply of food present from production, imports and stocks. Policies such as buffer stocks, excess production capacity and production practices (e.g. diversification, flexibility, drought-resistant varieties) are means to ensure food supply in the face of pestilence and unstable weather from year to year." (Tweeten 1997, p226)[24]

The heart of food availability rests with agricultural production. Various agricultural growth models (Ruttan 1998) and related agricultural production functions have been developed. Echevarria (1998), adapting the Solow's growth model, considers that agricultural production is dependent on labour, technology[25] and land[26]. In comparison, a cross country analysis of developing countries, Mundlak, Larson and Butzer (1997) concluded that capital and land were the primary determinants for agricultural growth. Implicitly, the use of capital can be viewed

22. Due to the breadth of the topics, the review of availability, accessibility and utilisation will be limited, in general, to that which effects rural household which have a dependence on subsistence production.

23. While there are differences between the terms 'agricultural production' and 'food production', for the purposes of this study these terms will be synonymous.

24. As a comparison, Haddad (1997 p3) considers that "food availability refers to the need to produce sufficient food in a way that generates income for small-scale producers while not depleting that natural resource base."

25. The term technology cover the broad ranges of physical and intellectual intervention. Hence, technology includes inputs (fertilisers, seed, irrigation etc) and improved management techniques.

26. While land is considered in most literature, it is potentially more correct to consider this as 'natural resources'. For example, water is considered to be a considerable and increasing constraint to agricultural production growth (Rijsberman 2002).

as an aggregation of all non-land determinants[27], as the use of capital determines which interventions occur at the farm level (i.e. use of labour and technology).

Irrespective of the models or functions used, Zellar, Lapenu, Minten, Ralison, Randrianaivo, and Randrianarisoa (1999) and Thrupp (1998) stress that agricultural growth occurs through two primary pathways: 'agricultural extensification' or 'agricultural intensification'. Hall, Dixon, Gulliver and Gibbon (2001) includes 'agricultural diversification' as an alternative strategy for growth.

Households can escape food security, and poverty, by expanding farm size. The option of expanding farm area is dependent, to a large degree, on two issues - land reform[28] and increased energy inputs, either through increased labour, animal or mechanical usage (Stout 1990). However, increasingly, agricultural extensification is losing favour as a sound option due to the expansion into marginal land areas and tropical rainforests, resulting in negative environment impact, a reduction in biodiversity and concerns regarding the sustainability of resources (Angelsen and Kaimowitz 2001; Barraclough and Ghimire 2001; Lee and Barrett 2001). While these are valid concerns, Hall *et.al.* (2001) still considers that agricultural extensification to be a relevant means to increase agricultural production, especially in part of sub-Saharan Africa.

Considerable focus on increasing production focuses on agricultural intensification, as seen through the Green Revolution (Pretty 1995; Dixon 1990). Typically, intensification is associated with increasing yields through the greater use of external inputs (especially fertiliser), high yielding crop varieties and improved livestock breeds. However, intensification can also involve sustainable use of natural resources (Pretty 1995), increased energy use (Rijk 1995; Stout 1990) and improved farm management practices (Hall *et.al.* 2001).

While agriculture growth at the farmer level can be explained by a set of variables

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27. It can be argued that land is dependent on capital as well, either through renting, leasing or ownership. However, convention in literature and agricultural production functions often considers the land issue separate to that of capital.

28. Land reform is further discussed in the following section (Section 2.2.3.2)

(such as capital, natural resources and labour), this simplifies a complex set of interactions surrounding, and between, these variables. In particular, food availability is often determined by two factors that influence on-farm interventions - macroeconomic policy (Timmer 1998) and seasonality (Gill 1991; Sahn 1989; Chambers *et.al.* 1981). These two factors are particularly influential at the smallholder level where, due to the limited market development, subsistence food production is a critical component of food security.

Macroeconomic Policy

An effective agricultural policy by national governments is seen as a critical aspect of strong food availability strategies (Elder 2000). Timmer (1998) sees that the economy and agriculture are linked into ways. Firstly, agriculture cannot grow without macroeconomic policies that stimulate the economy as a whole and secondly, agriculture contributes to growth in non-agricultural sector (Block and Timmer 1994).

Despite the importance of agricultural production in developing countries for food production, income and employment, agricultural policies are seen as inadequate to achieve these goals - and of particular concern in sub-Saharan Africa. There are various reasons presented why this occurs, of which poor governance is seen as being critically important (IFPRI 2002). However, there is an increasing trend to focus on urban policies rather than the rural sector - despite rural areas in many developing countries still having a greater proportion of both the population and the food insecure. There are concerns that political choice has a preference towards urban issues, where the voting base is stronger. Such a situation was observed in Madagascar (Pryor 1990) during the 1970's and is attributed as a reason why that country has failed to successfully develop its agricultural sector.

Readron, Barrett, Kelly and Savadogo (2001) raise an important consideration as to the pressures of adapting macroeconomic policy by external agencies. The implementation of structural adjustment policies as a condition of external finance has been a major reason why governments have cut public spending. With an urban focus, the rural sector is often the first to experience a reduction in public spending. This has a flow-on effect along the food chain. There are two areas where a reduction in public spending has a significant impact on food availability - infrastructure and agricultural research/extension. Literature strongly supports research and extension services as having a critical role in increasing agricultural production at the subsistence farmer level (Hazell and Haddad 2001; Eicher and Staatz 1998), from which a consequential mitigation of food insecurity can start to occur (Elder 2000).

Infrastructure, especially transportation, plays a crucial role in food availability and in many respects is the linkage between food availability and food accessibility. Adequate infrastructure allows for the delivery of product to markets and the provision of inputs used in agricultural production systems (Tweeten 1997; Francisco and Routray 1992). Mellor (1998) suggests that one reason why Africa and Asia have divergent successes in terms of agricultural production is due to the latter region being exposed to first generation development interventions (i.e. infrastructure, agricultural technology) while Africa received second generation interventions (i.e. poverty, environment and gender issues).

In developing countries, macroeconomic policies have focussed on adopting market economies. However, without the necessary supporting services provided by infrastructure and economic stability, prices have increased forcing subsistence farmers to move away from capital intensification of their agricultural production systems (Seshamani 1998; Haddad 1997). A poignant example of this is the reduction in fertiliser use in sub-Saharan Africa which is resulting in decreasing soil fertility, ultimately leading to a decrease yields (Haddad 1997). This has a consequential impact in food security at the subsistence level.

Seasonality

Agriculture production, by its nature, is a seasonal activity and has a fundamental impact on food insecurity and poverty (Chambers 1982; Chambers *et.al.* 1981). Seasonality is primarily dependent on one intervention - climate (Griffiths 1995, Gill 1991). As climate is a function of the geographical location, this is one of the major reasons why the spatial dimension is so important for food security, and in particular agricultural production. *"Farming activities revolve around the climate, a seasonal phenomenon over which human beings exert little control"* (Sahn 1989, p12). Climate dictates the management of farm production system globally, irrespective of technology and knowledge, and has a notable impact on the availability of food when unseasonal weather affects agriculture.

Sahn (1989) considers that there are two components of seasonality, both of which affect on food availability.

- *Intra-Annual (Cyclical) Variations:* These are deterministic variations, conventionally known as 'seasons'. They define the timing of production systems, such as determining when fields are prepared for planting crops, animals breed and products harvested. It is this variation that has the main influence on the occurrence of transitory, seasonal, food insecurity, and the existence of the 'hunger season'.
- *Inter-Annual Variations:* These are stochastic variations in climate that make the weather 'unseasonal'. While having an effect (of varying influence) on the time of food production, inter-annual variations have a greater impact on the quantity of production. These variations can be of more significant concern for food availability as they are less predicable than the relative confidence of seasonal variations. This introduces greater uncertainty and risk, which has an increased impact on chronic food insecurity, especially through the consequence of droughts and floods.

The impact of seasonality in agricultural production has increased in the recent years with the concern of climate change. While climate change is not universally accepted, there is increasing scientific evidence to support a view that climate change is occurring and this will have a consequential impact on agricultural production. Despite, various scenarios on the extent of such an impact on agriculture, there is an acceptance that climate change will have a negative impact on food availability in the future (IFPRI 2002; McCarthy, Canziani, Leary, Dokken, and White 2001).

Sahn (1989, p301) considers that *"agricultural growth and market development represent the logical long-term means of reducing seasonal food insecurity".* [29]

29. The issue of market development will be considered in the following section in relation to 'food accessibility'.

Sahn bases this view on the observation that countries with a developed agricultural sector and market have an *"almost total lack of seasonal cycles of malnutrition and food energy intakes"*. While literature offers a variety of strategies to solve seasonality, the strategies to improve food availability can be achieved through three major interventions: food production strategies, storage and processing and trade (Sahn 1989).

Production Strategies

Strategies to mitigate the effects of seasonality on production revolve around how farmers adjust their production techniques and management practices due to climatic events (Sahn 1989). This frequently involves climate modification through the uptake of technological change. For developing countries, such climate modification revolves strongly around water control and management using irrigation. With the advent of biotechnology, the use of drought-tolerant crops potentially offer an alternative form of climate modification, although the benefits of biotechnology for the poor is in contention (Persley and Lantin 2001).

However, as Sahn (1989) notes, the increase in production per se has only a limited impact on mitigating the effects of seasonality. With all things being equal, the use of high yielding varieties and/or inputs will increase production, yet most of this production will still be confined to the harvest season. The problem of seasonality is not in the quantity of production, rather the unequal temporal distribution. Hence unless there is an increase to production outside the normal growing season, such interventions can offer only a limited solution to seasonality. Sahn (1989) even notes that the use of technological inputs into farming systems is often motivated by a desire to increase production rather than smooth out production over the year.

Improving food availability during periods of low food production can occur through crop diversification (Hall *et.al.* 2001) and the planting of multiple crops over different seasons (Baldy and Stigter 1997). Although, in unimodal rainfall zones, such an option is often dependant on other technological interventions being available - especially irrigation. Diversification, however, has been observed to contribute to an increase in seasonal variation of food availability due to abandoning traditional crops and practices (Sahn 1989). Although such a situation would seem to be more of a failure in extension and technology transfer than the process of diversification itself.

Storage and Processing

The availability of effective storage infrastructure is seen as an essential requirement to manage seasonal variations in food availability (Sahn 1989). This strategy is well-accepted in developing countries, especially through the use of large coolstores and individual household refrigeration systems. However such interventions are restricted in developing countries through the lack of suitable energy supplies (FAO 2000b). The poor quality of food storage in developing countries contributes to high levels of food losses (Eade and Williams 1995). Clarke and Friedrich (2000) consider that 30% of harvested food can be lost due to poor storage, while in Zambia, local estimates consider this can be as high as 50% (Luswishi Small Scale Farmers 1997).

Trade

A consequence of seasonality being geographically dependent, food availability can be improved by importing or trading food between other geographical areas (Sahn 1989). In general, this is normally undertaken on a national scale rather than within countries where seasonal variations in agricultural production can be small. However, the applicability of trade as a means to smooth out seasonal effects is dependent on a range of supporting services and governmental polices. In particular, the effectiveness of trade to equalise agricultural production is dependent on good distribution services, especially transportation networks and services (Alexandratos 1995)

2.2.3.2 Accessibility to Food

Accessibility is primarily an issue of resources at the disposal of people through which they can obtain the available food. The heightened awareness of food accessibility can be traced back to Sen's concept of food entitlements (Sen 1981) although Maxwell and Smith (1992) consider that it was understood in a variety of forms prior to this.

The theoretical underpinning of food accessibility is strongly related to economics, including issues related to income, market development and macroeconomic policy (Tweeten 1997). However, the process of food accessibility varies depending on the mode of food acquisition. For people who purchase foods, food accessibility is strongly related to the stability of food prices and the purchasing power of income, while for subsistence farmers, food accessibility is more related to the stability of farm inputs and access to land.

Income has a powerful influence on food acquisition (Foster 1992) and is seen to have, in general, a positive influence on the food security status of a household in two primary ways [30].

1. While differences occur between spatial area, the overriding trend from research shows that as income increases so does food consumption (Foster 1992). This relationship is not linear as there is a 'diminishing food consumption with the progressive increase in income'. This condition is known as Engel's law, which in another form states that as income increases, the proportion of income spent on food decreases.
2. Income does not just affect total food consumption. As income increases, the consumption of individual foods differs (Foster 1992). Foods that have a decreased consumption as income rises (a negative elasticity) are termed 'inferior foods'. These foods tend to be starch based, such as maize and cassava. Bennett's Law states that as income increases, dependence on starch-based food reduces in favour of fats, protein and complex carbohydrates (Foster 1992). Consequently, income allows for the purchase of better quality food, thereby improving nutrition [31] (Kracht and Schulz 1999; Alderman and Garcia 1993; Foster 1992; Schiff and Valdes 1990).

Macroeconomic policies play an essential role in the accessibility of food. Arcand (2001) shows that strong macroeconomic policies which encourage growth do

30. However, increased incomes can create problems with intrahousehold allocation. In the southern Philippines, it has been observed that in spite of income generation, food security is not addressed in rural households. One of the reasons for this is the adoption of vices (including gambling, alcoholism and prostitution) mostly by men, when they sell farm production in the cities (P. Arce, Personal Communication, 18th September 2001).

31. However, as observed in developed countries, income can have a negative effect on nutrition where total food consumption is too high, especially the amount of fat. This leads to overnutrition.

reduce the level of undernutrition. While macroeconomic policy is involved at all levels of food and agriculture, it has an important role in food accessibility through the stabilisation of food prices (Barrett 1999; Timmer 1998).

Food prices, as economic theory suggests, are formed at the intersection of the food supply and demand curves (Sahn 1989). As noted previously, food supply (i.e. food availability) is not constant and varies over time, mostly due to the impact of seasonality on production systems. The consequence of this is that, assuming *ceteris paribus* conditions, food prices can be expected to rise and vary depending on the quantity supplied by seasonal production systems [32].

In a developed market economy, the utility of food purchases is supported by storage (especially refrigeration), post-harvest processing, market stability and the good distribution systems (through infrastructure). When such systems are not available other interventions are required to smooth out seasonal influences. This can be achieved through macroeconomic policy to stabilise food prices (Barrett 1999; Goodwin 1994, Sahn and Delgado 1989). The intention of such interventions is to maintain the utility of income used to purchase food.

The access to financial services is an important contributor to improving food accessibility. While there are concerns related to the use of credit, research supports the view that access to finance can assist in the improvement of household food security (Diagne 1998; Zellar *et.al.* 1997). Credit services are of particular importance for farmers as a means to mitigate the effects of seasonal production, although adequate savings schemes (i.e. banks and credit unions) can achieve a similar result. Financial services are frequently constrained in food insecure areas, often due to limited economic infrastructure, poor physical access and remoteness. The potential usefulness of credit is often limited by suitable collateral.

The use of income to purchase food is not afforded to everyone. This can be

32. An important consequence of this is that macroeconomic policy and seasonality are not mutually independent (Miron 1996). This is particularly notable in immature economies. Maunder (1989, 1986) provides an enlightened coverage of the consequences of climate variations, production and the economic implications.

caused by a variety of reasons, such as remoteness or simply a lack of financial resources. Consequently, functioning food markets and food price stability can be a moot issue. In such situations, food accessibility moves to land access and the stability of farm input prices, especially fertilisers and seed.

Access to adequate land resources for subsistence farmers is seen as prerequisite for food security. Numerous studies have concluded that food insecurity, and her sister, poverty, can be improved through land reform (Hall *et.al.* 2001; Chapagain 2000; Eicher and Staatz 1998; Meliczek 1995). The issue of land reform is complex. Increasingly land reform is a volatile political issue[33], as a consequence of being related, in part, to an equalisation of resources between the rich and poor. A key aspect of land reform is to allow farmers have control and freedom to determine their own destinies (Meliczek 1995). This latter point is pertinent for gender equity as, in most cases, women have less access to land than men (Meinzen-Dick 2002; Delgado 1997).

In developing areas, access to food is often more related to physical constraints. While infrastructure plays an essential role in food availability, it is also an important factor in food accessibility. Infrastructure, especially roading, plays a critical role by increasing incomes and strengthening markets (Ahmed and Donovan 1997; Wanmali and Islam1997; Amandi 1988). Consequently, there is a defendable argument that infrastructure is a feed-forward contributor to alleviating food security through improving food accessibility (Elder 2000).

2.2.3.3 Utilisation of Food

The third determinant of the food dimension is utilisation, which considers the use of the food once it has been acquired. There is a strong nutritional focus on utilisation in regards to consumer behaviour, education, health care and cultural safety [34] (Tweeten 1997). Utilisation also addresses the process of food preparation. In this, the provision of safe water and good sanitation systems are seen as important contributors to food security (IFAD 2001; Elder 2000; Haddad

33. The situation of Zimbabwe in the late 1990's and early 2000's is a case in point.

34. Well known examples include the non-applicability of beef and pork for Hindu and Jewish faiths respectively, even if the food is available and accessible.

1997). Pacey and Payne (1985) broaden utilisation to include housing and energy supplies (i.e. firewood).

Household size, as with general population growth, is seen as a contributing factor to higher food insecurity, especially when there are sudden increases through migration, birth and/or visitors. This places pressure on food allocation, especially under the constraints of limited resources. The intrahousehold allocation of food between individuals is seen as an important consideration of food security (von Braun *et.al.* 1992). In particular, various reports have noted that food utilisation by females is lower than males for the household (Kapunda 2000) although other studies have not identified, or dispute the magnitude of, any such differences (Ssewanyana and Ahmadi-Esfahani 2001, FAO 2000a)[35].

2.2.4 Nutritional Dimension

The determinants of the food system dimensions can be considered to be inputs (that is, causal explanations) of food security. It is now well accepted that food security extends beyond such causal assessments alone to also consider the nutrition (Elder 2000). The importance of nutrition can be seen in Figure 2.2 where the nutritional status of an individual will impact on the production of food (Pacey and Payne 1985) and food acquisition (Pinstrup-Andersen 1981). This feedback is particularly important in rural areas were food acquisition typically involves active manual work, such as harvesting and planting crops.

Antonsson-Ogle (1995) considers that food security assessments also include the 'Aspects of Hunger' (Table 2.2) - which can be broadly interpreted as being a 'nutrition dimension'. However, Maxwell (1995) differentiates between 'food security' and 'nutritional security', viewing food security as an assessment of inputs while nutritional security is related to the outcome effects of those inputs.

35. The issue of food utilisation difference between genders needs to be reflected against the medical assessments that women, for most nutritional aspects, require less than men. For example, it can be shown that using equations to determine energy requirements (James and Schofield 1990), an average female adult requires approximately 80% of what an average male adult needs. The issue of food consumption between males and females is, therefore, not related to quantifiable differences in food consumption per se, rather that females and males have the <u>same opportunity</u> (i.e. unbiased allocation) to the access of food.

Table 2.2: Aspects of Hunger
(Source: Adapted from Antonsson-Ogle 1995)

Hunger Unit	Indicator
Famine	Population at risk
Malnutrition	FAO Food Poverty Child Malnutrition Protein-Energy Malnutrition
Micronutrient Deficiencies	Iron Iodine Vitamin A
Nutrient Depleting Illness	Diarrhoea
Parasites	Microbiological Assays

Notwithstanding this view, there are strong reasons to accept that food security and nutrition intrinsically linked (Kracht and Schulz 1999) and the necessity to separate food and nutritional security is debatable. Campbell (1991), agrees with this view and effectively considers that food security and nutrition exist on the same continuum. This, according to Campbell, allows nutrition to provide a valid means of measuring food security, especially at the household and individual level.

2.3 MEASURING HOUSEHOLD FOOD SECURITY

2.3.1 Food Security Indicators

2.3.1.1 Introduction

Barrett (1999) and Maxwell (1995), along with other authors, consider a true measurement of food security to be effectively impossible. There are considerable conceptual and measurement problems to accurately assess and quantify the depth of food security [36]. Consequently, food security is measured indirectly through the use of indicators. In a review by Hoddinott (1999a), 450 indicators have been identified that can be used to characterise various aspects food security, mostly sourced from the work of Maxwell and Frankenbeger (1992).

36. An example of this can be seen in that the majority of indicators are 'reactive' in that there is a time lag between the onset of the food insecure situation and their measurement . This is exacerbated with a further time delay in the analysis and reporting of the information. The difficulties in measuring food security are well accepted. At the time of this study, the FAO is working on advancing the science and mathematics of food security measurement. Information on this topic can be found at http://www.fivims.net

While indicators do not represent a true measurement of food security (and it is misleading to infer as much), they are of practical value to identify situations of food insecurity (Barrett 1999). In particular, indicators play an important role in assessing the potential vulnerability of food insecurity occurring within a spatial dimension.

The selection of which indicator(s) to use is an important consideration in food security research (Frankenbeger 1992) and depends on a variety of issues, including the resources available, the spatial boundary and the objective of the study. Although, as noted by numerous authors (i.e. Barrett 1999; Babu and Pinstrup-Andersen 1994; Eele 1994), the choice of indicators is also invariably dependent on the subjective perceptions of researcher(s) involved.

Barrett (1999) considers that there is significant merit in employing multiple indicators on the principle of 'complementary redundancy', and identifies four considerations when choosing food security indicators;

i) quantitative availability of food
ii) qualitative aspects concerning the types and diversity of foods
iii) psychological dimensions (i.e. perception of hunger)
iv) social acceptability of consumption (i.e. meals, modes of food acquisition)

2.3.1.2 Macro-scale verses Micro-scale Indicators

The spatial dimension plays a fundamental role in the selection of food security indicators, especially as this often defines the objectives and boundaries of the study. Macro-scale indicators tend to be those which are dependent on a geographical constraint. Examples of such indicators include, for example, meteorological data, natural resources, agro-ecological models, geographically dependent food balance sheets. Micro-scale indicators tend to be related to social units, such as individuals and households, and often have a strong focus on nutritional adequacy.

Historically, food security has been measured using aggregated macro-scale indicators. Commonly, these included the use of agricultural production statistics and the creation of national food balance sheets. During the 1980's, interest centred on establishing a specific food security index which lead to the development of the "Aggregated Household Food Security Index" (AHFSI) by the FAO (Gurkan 1995).[37] The AHFSI has now been superseded by the current FAO undernourishment measurement (Appendix 2) used in the annual reports of global food insecurity (FAO 2001). Other indicators, such as the Depravation Index, have been proposed as an indicator of food insecurity. However, as these often include food assessment as part of the indicator, they have limited use as an acceptable measure of food security.

As previously noted (Section 2.2.1), the aggregation of data based on macro-scale spatial dimensions is slowly being accepted as not reflecting the true characteristics of household food security: *"The assumption that national average per capita food supplies is a good indicator of a country's food security, however, is frequently not justified"* (South Centre 1997, p8)[38]. Inferring micro-scale food security based on a macro-scale assessment (and, and to a lesser extent, vice versa) is open for misinterpretation (Short 2001). At the heart of this problem is the issue of aggregation and the relevance of the available data. While the data requirements may seem similar, the aggregation of the data for macro-scale assessment changes to context of the analysis that makes it problematic to dissaggregate the final assessment and infer a food security status at the micro-scale level (Thomson and Metz 1997).

Accordingly, in order to realistically describe food security at the micro-scale level, the use of appropriate frameworks and relevant indicators are now considered to be essential (Hoddinott 1999b) rather than infer assessments across a spatial boundary. However, this does not reduce the usefulness of macro-scale indicators as they can provide an excellent assessment as to the 'big picture' of food security and offer complementary information when used with micro-scale indicators.

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37. It needs to be stressed that the term "household" used in the AHFSI is highly misleading as this index has nothing to do with the "household" and is simply a macro-scale indicator.

38. Based on the context of the South Centre report, the phrase *"a country's food security"* used in this quote can be justifiably inferred to mean *"household food security"*.

2.3.1.3 Micro-Scale Indicators: Process and Outcome

At the micro-scale level (i.e. the household), Frankenbeger (1992) categories that food security indicators can be described as either process and outcome in nature (Table 2.3). Process indicators tend to reflect issues related to food availability, accessibility and utilisation. Based on Maxwell's (1995) view of food security, such process indicators can be considered to describe the inputs that establish the conditions of food security. While process indicators, are still relevant as they place into context the conditions which households and/or individuals face, there is a general move to consider that outcome indicators are more relevant to describe the characteristics of food security (Hoddinott 1999b).

Frankenbeger (1992) views outcome indicators as being a proxy for food consumption, which occur in either direct or indirect forms. In this classification, Frankenbeger considers that nutritionally related indicators are indirect measures of food security as they are consequential to the actual process of food consumption. Such a view, however, is now not consistent with the majority of literature which considers nutritional indicators to be a more relevant measurement of food security at the micro-scale level (Kracht and Schulz 1999; Morris 1999; Babu and Pinstrup-Andersen1994; Eele 1994). Therefore, in this context, it is realistic to consider outcome indicators in terms of being classified as either nutritional or pseudo-nutritional [39] rather than being direct or indirect.

Table 2.3: Types of Food Security Indicators used at the Household Level
Source: Frankenbeger (1992), with additional information from Morris (1999); Hoddinott (1999a); Tweeten (1997); and Hubbard (1995)

Indicator Category	Form	Selection of Indicators *(Examples only, and in no particular order of importance.)*
Process	---	Agricultural Production; Conflict Assessment; Coping Strategies (i.e. Risk and Loss Management, Community Inequalities); Storage Estimates; Income Use; Income Sources; Credit Access; Land Ownership/ Control; Farming Systems; Livestock; Education; Assets
Outcome	*Pseudo-Nutritional*	Food Expenditure Surveys; Budget/Income Surveys; Perception Surveys (hunger and food); Food Frequency Assessments; Daily Meal Size and Frequency; Subsistence Production Ratio
	Nutritional	Food Consumption Surveys, Malnutrition; Nutritional Status Assessment; Health Data

39. Pseudo-nutritional indicators can be defined as "indicators that offer an incompetent nutritional assessment". Such indicators often infer a nutritional status, or make specific assumptions on nutrition.

2.3.2 Nutritional Indicators

Nutritional indicators have a grounded theory in anthropometric measurements (Rutishauser 1997; Frankenbeger 1992), related to the standard body mass and height for age-gender groupings. One of the main benefits of nutritional indicators is that the data can be disaggregated, from which more accurate proportions can be determined (Frankenbeger 1992).

The use of nutritional indicators can be strongly related to the concept of sufficiency (Maxwell and Smith 1992). This concept frequently occurs in food security definitions through the use of various related terms such as 'enough', 'target', 'minimum level of food', 'basic food needs' or 'threshold'. Sufficiency is frequently assessed at the individual level, and then aggregated for the household (Maxwell and Smith 1992). The sufficiency concept leads onto food security measurements often being calculated in terms of a mathematical inequality (Foster 1992). Such inequalities require two variables:

i) the level of sufficiency for a nutrient (i.e. the threshold value), and,
ii) the level at which nutrient is consumed.

2.3.2.1 Malnutrition

Historically, nutritional indicators were confined to malnutrition, due to its ease of measurement and the low cost of data collection compared to other indicators (Frankenbeger 1992). While Foster (1992, p13) considers that *"malnutrition is difficult to define"*, Mayer (1976) identifies four types of malnutrition:

(i) Protein-Energy Malnutrition (alternatively called undernutrition).
(ii) dietary deficiency,
(iii) secondary malnutrition, and;
(iv) obesity (sometimes referred to as overnutrition)[40].

<u>Protein Energy Malnutrition (PEM)</u>

PEM is considered to be the leading nutritional issue effecting developing countries (Latham 1997). While past literature has been divided on the relative

40. While obesity (overnutrition) does occur in developing countries, it is primarily an issue of developed countries. Consequently it will not be covered here. However, it should be noted that overnutrition is the antithesis of food security, where some people have too much food than is good for them.

importance of energy and protein, it is now accepted that energy is more influential for PEM[41]:

i) It is accepted by health professionals that when adequate energy intake is achieved, other nutritional needs are usually satisfied (Maxwell and Smith 1992). A low energy intake tends to mask other health conditions, hence once energy intake is improved, other underlying conditions can be exposed and attended to as necessary (Latham 1997).

ii) There is increasing evidence to support a low energy intake as being the main reason for PEM:

> "The current view is that most PEM is the result of inadequate intake or poor utilisation of food and energy, not a deficiency of one nutrient and not usually simply a lack of dietary protein....Although termed PEM, it is now generally accepted to stem in most cases from energy deficiency, often caused by insufficient food intake. Energy deficiency is more important and more common than protein deficiency". (Latham 1997, p127-128)

Various classifications have been developed to describe the physical manifestations of PEM. PEM has an effect on anthropometric measurements, such that individuals effected will have a lower body mass and height for a specific age - based on standard body mass/height/age reference curves from the World Health Organisation (WHO) (James and Schofield 1990). PEM has three primary effects: wasting, stunting and a combination of both (Table 2.4):

Table 2.4: Effect of PEM on Anthropometric Measurement (Latham 1997)

Condition	Body Mass-for-age	Body Mass-for-height	Height-for-age	Reasons for Condition
Wasting	Low	Low	Normal	Acute current, short-duration PEM
Stunting	Low	Normal	Low	Past chronic PEM
Wasting & Stunting	Low	Low	Low	Acute and chronic or current long-duration PEM

41. Another reason, and sometimes a more compelling use of energy, is due to simplification of analysis. Food, being matter, can be converted energy (Wahlqvist 1997). The ability to aggregate food into a single value makes energy a convenient unit to use. This is not possible for protein and other nutrients.

For children, PEM is frequently deemed to occur when body mass is over two standard deviations below the WHO standard reference curve for the child's age and gender (Antonsson-Ogle 1995, James and Schofield 1990) [42]. For adolescents and adults, PEM is commonly assessed using the body mass index (BMI) (Appendix 3).

PEM has a stronger occurrence in children under five, however the effects of childhood PEM will often extend well into adult life. There are two well- identified serious forms of PEM (Latham 1997; Foster 1992; Werner 1988):

- *Kwashiorkor:* Characterised by the presence of oedema (i.e. a bloated stomach) and effects children more than adults. Traditionally, the occurrence of kwashiorkor was considered to be due not eating enough protein, however it is now accepted to be related to low energy intake (Latham 1997). Werner (1988) terms kwashiorkor as "wet malnutrition".
- *Marasmus:* Identified by severe wasting of body tissue and more prevalent than in the past. Its occurrence is due to a lack of food intake and effects a broader age range. Werner (1988) terms marasmus as "dry malnutrition".

According to Latham (1997), it is not fully understood why the two different clinical conditions appear, when the causal issues are similar. While both of these types have high levels of fatality, it is now seen that kwashiorkor and marasmus contributes to less than 5% of PEM cases. Up to 70% of children suffer from mild or moderate forms of PEM (i.e. wasting and/or stunting) based on typical growth curves (Latham 1997).

Despite its common usage, the use of PEM as an indicator of food security is not without conceptual problems (Frankenbeger 1992). In particular, PEM can occur for a variety of factors, such as poor sanitation and unclean water, hence it does not necessarily correlate to food consumption issues. PEM (like most food security indicators) is a reactive indicator in that the measurement occurs <u>after</u> food intake. However, Frankenbeger (1992) considers the changes in body condition tend to occur early in the period of food shortages and hence can still be

42. Due to the breath of reference curve data they are not presented here. For the necessary information refer to Latham (1997), WHO (1995) and WHO (1986).

a sensitive indicator of food insecurity.

Dietary Deficiency

Dietary deficiency, or more correctly micronutrient or trace element deficiency, occurs when a diet lacks certain essential nutrients. While the requirement of these nutrients is often in very small amounts, their absence or reduction in a diet will result in the accompaniment of a specific disease (Latham 1997). However, while micronutrient deficiencies are important, in terms of food security addressing PEM is considered to be the first priority (Latham 1997, Foster 1992).

Secondary Malnutrition

Secondary malnutrition is a condition or illness that prevents a person from properly ingesting or absorbing food (Foster 1992). Common causes include diarrhoea and parasites. Secondary malnutrition often accompanies and exacerbates the conditions of PEM.

2.3.2.2 Food Consumption Surveys

Food consumption surveys are seen as a direct indicator of food security outcomes (Frankenbeger 1992) and offer the most complete method of assessing food security through a variety of methods used (Cameron and van Staveren 1988). Household food consumption surveys are intensive exercises, collecting data across a broad range of variables, including (but not exclusively) food consumption (quantity, quality and types), source of foods, income usage, perception of hunger, household size and anthropometric data. While food consumption surveys are often complex and involved, they can be adapted for specific studies. In this they are flexible to focus on particular aspects of nutrition, such as protein or trace elements. Temporal assessments can be incorporated into food consumption surveys by using food calenders (World Vision 2000).

Not surprising, food consumption surveys are resource demanding, both in time and finances, hence are often impractical, except for intensive research studies

(Frankenbeger 1992).[43] Despite these constraints, food consumption surveys have a number of benefits over other indicators, including:

i) they can measure actual food intake
ii) they can take into account all sources of food and food losses.
iii) they provide a more immediate assessment of food insecurity

The general theoretical framework behind food consumption surveys is to compare the food consumed by an individual to what the individual requires to maintain good health. For household surveys, data from individual household occupants are typically aggregated for analysis [44]. The comparative nature of food consumption surveys relates well to both an inequality framework and the concept of sufficiency that underpins many food insecurity definitions (Thomson and Metz 1997, Foster 1992).

Ssewanyana and Ahmadi-Esfahani (2001) used the following food security inequality[45] in a recent study in Uganda:

$$DA_h^n \geq N_h^n \tag{2.1}$$

where:
DA = weighted actual daily food intake (see below)
N = recommended daily food intake (see below)
n = *n* th nutritional value
h = *h* th household

- *Weighted Actual Daily Food Intake:* The assessment of food intake is mostly determined by weighting the food consumed (actually the difference between pre and post consumption to account for leftover food). The determination of the nutrient level in a particular food is achieved by applying standard conversion factors (nutrient per mass of food) available in literature (USDA

43. This may, in part, explain why food consumption surveys seem to be more frequently used in western countries than in developing countries. Access and expenses can restrict multiple assessments in developing countries, hence simpler indicator (such as undernutrition) are preferred.

44. Aggregation of food consumption can occur for any micro-scale level. For example, the data can be grouped for a specific age group or gender. The later is important when assessing the issue of gender-based food security.

45. For the actual derivation of the variables in this equation refer to Ssewanyana and Ahmadi-Esfahani (2001). The equation presented here replaces an 'i' subscript with an 'h' subscript, to prevent confusion with other notation presented in this study.

2001; Holland, Welch, Unwin, Buss, Paul and Southgate 1991). In situations where no conversion factors are available, or in doubt, the nutrient value is determined by chemical assay.

- *Recommended Daily Food Intake:* Recommended food intake is based on nutritional requirements. These are typically assessed at the individual level, and then aggregated for the household. Individually, the recommended daily intakes are dependant on five human variables, these being (in order of importance) (Latham 1997; James and Schofield 1990):
  - age
  - gender
  - anthropometric factors (in particular body mass and height)
  - level of physical intensity
  - growth requirement for pregnant or lactating women

  Other influences, such as climate, can also play an important role, especially in terms of energy requirements (Latham 1997). The determination of the daily nutrient requirements is simplified by the use of equations (e.g. energy requirements - James and Schofield 1990) or standard values (Appendix 4). Due to the 'person specific' nature of nutrient requirements, the aggregation at the household level is sensitive to changes in household size through migration/immigration and/or birth/death).

It can be argued, with a degree of mathematical, biological and anthropometric robustness, that assessment derived from inequalities similar to Equation 2.1 come the closest to providing a 'true' measurement of food security. When Equation 2.1 is held to be true - that is when the actual intake of food is greater or equal to the recommended food intake - the household can be said to be food secure. Conversely, if Equation 2.1 does not hold, then food insecurity occurs.

A benefit of Equation 2.1 is that it can be conveniently related to the dimensions of food security. The right-hand side quantifies the nutritional requirements while the left-hand side, being the amount of food consumed, is effectively the result of the processes that occur through food availability, accessibility and utilisation.

2.3.3 Pseudo-Nutritional Indicators

2.3.3.1 Food Expenditure Surveys

Food expenditure surveys are a specific variant of income-based indicators. As noted in the previous chapter, income plays an important role in food acquisition such that households with higher incomes are more likely to be food secure (Foster 1992).

In such surveys, the purchased food is typically aggregated together by their energy content. While the aggregated energy can be compared to the household energy requirement, as this method does not include food sourced from the farm/garden and gifting and does not take into account food losses, such an indicator tends to underestimate food consumption, and hence will overestimate food insecurity (Frankenbeger 1992). Due to this, food expenditure surveys tend to be of limited use in remote rural areas where subsistence lifestyles are common. The use of food expenditure surveys is, however, a powerful tool to assess the changes in food consumption patterns with a change in income (i.e. elasticity of food purchases) (Foster1992).

2.3.3.2 Subsistence Potential Ratio (SPR)

For households that produce most of there own food, the 'Subsistence Potential Ratio' (SPR) is seen as a better indicator. This is a measure of the household's ability to feed itself from its own production (Frankenbeger 1992). To calculate the SPR, data on the farm size of the farm, expected crop/livestock yield and age-gender composition of the household is required. The SPR *"compares the amount of food, in terms of energy, which a household can produce over a year with the energy requirements of the entire household for the year"* (Frankenbeger 1992, p98).

2.3.3.3 Meals

An assessment of meals is typically a component of food consumption surveys (Section 2.3.2.2) but can be assessed in isolation. Meals, defined as planned eating occasions, form the predominant means of food consumption in most cultures (Derrickson, Sakai, and Anderson 2001; Swindale and Ohri-Vachaspati

1999; Castro 1997; Tabatabai (1995). Therefore, by association, meals play an important role in food security assessment.

> "the number of daily eating occasions is a proxy indicator for gauging the adequacy of household macronutrient (calories and protein) intake. An advantage in selecting this as an indicator of household food security is that data are relatively easy and inexpensive to collect" (Swindale and Ohri-Vachaspati 1999, p8).

Frankenbeger (1992) agrees with this view, despite the method being limited by its low precision. Jere and Basu (1994) contend that meals are a better measure of food security in developing countries than income based indicators.

For a meaningful proxy food security indicator using meals, two factors are required - the frequency and size (Derrickson *et. al.* 2001; Fouere, Maire, Delpeuch, Martin-Prevel, Tchibindat and Adoua-Oyila 2000; Westerterp-Plantenga 2000 and Castro 1997). These factors, combined with food composition data can provide a cost-effective measure of food security (Swindale and Ohri-Vachaspati 1999). This method is seen as particularly useful when comparing diets that have a small variation in nutritional composition.

Conventional nutrition strategies imply that access to three meals is considered to represent the ideal food security situation. In a Sri Lankan study, households considered that the inability to have three meals per day was a sign of poverty (ADB 2001). Although, as noted by Swindale and Ohri-Vachaspati (1999), the eating sociology of some cultures maybe such that it is normal for less than three meals to be consumed per day, even in food secure situations.

From literature, there is a strong emphasis that 'one-meal-per-day' is seen as the 'minimum' target in order to achieve food security (Dembele, Sissoko, Timbota, Mariko 2000)[46]. Rajuladevi (2001) considered that having less than one meal per

46. A review of literature highlights that instances of people having one meal per day or less is relatively common, especially in sub-Saharan Africa (Oxfam 2002; Corbett and Ferreira 2000; Zambian Social Investment Fund (2000) and UNDP 1999) and Central CIS-Asia (Falkingham 2000; UNDP 2000 and World Vision 1999). One meal per day or less also occurs in homeless people in developed countries (Hud User 1999).

day was a clear indicator of food insecurity. The one-meal-per-day threshold is often mentioned as a proxy indicator of food insecurity by development agencies - such as the World Food Program (Africa Online 2002). This is possibly due to meals being easily translatable across many cultures. Also, the focus on one-meal-per-day provides a practical and measurable, in not a pragmatic, target to achieve in food insecure situations.

As noted in literature, meal quantities vary throughout the year often related to seasonality of food production (UNDP 1999) or impediments to full employment (World Vision 1999)[47]. When food supply is short, households will reduce food consumption as a coping strategy through rationalising meal frequency and the portion of meal size (Ippadi 2000). Swindale and Ohri-Vachaspati (1999) note that which method of rationalising is used depends on the cultural factors that determine eating occasions. For example, cultures that have one daily meal, rationalising is undertaken through a decrease in size alone. There is an implicit view in the literature that households which rationalise meals to less than one third (i.e. from three meals at maximum food consumption to one meal at minimum food consumption) are potentially more vulnerable to suffer from food insecurity.

2.3.3.4 Perceptions of Hunger

The perception of hunger is seen as a valid indicator in food security (Frankenbeger 1992). Assessments of hunger can involve a number of different indicators, including behavioural adjustments during food shortages, coping strategies and the ranking of food satisfaction (Wolfe and Frongillo 2000; Gericke, Labadarios and Nel 2000; Frankenbeger 1992). The use of perception, however, is a subjective indicator and can be deliberately distorted for individual gain (i.e. development assistance) (Frankenbeger 1992). Consequently, the best use of perception is to place other indicators in context.

47. World Vision (1999) reported that in Azerbaijan, meal frequencies were rationalised to counter the reduction in food accessibility due to a loss in purchasing power. *"Surveys revealed that in January and February 42% of those surveyed had eaten three meals in a day, 51% had eaten two meals, while 11% reported having only one meal. The results for March and April, however, found that just 1% of families reported eating three meals in a day, 39% had eaten two meals, while 60% of families reported having eaten only one meal the previous day"* (World Vision 1999, para. 4). The reasons given for this rationalisation was due to a restriction in subsidies, pensions, limited employment opportunities along with a temporary cessation of supplementary food assistance.

2.4 FOOD SECURITY IN SOLWEZI DISTRICT

2.4.1 Introduction

Solwezi District, located in the Northwestern Province of Zambia, is predominately rural (Table 2.5). Food insecurity is commonly raised as a problem by people in the Solwezi District (Phiri 1998), a situation that occurs throughout the country (MAFF 2000b; Callens and Phiri 1998).

Table 2.5: Principal Statistics of the Solwezi District (Source: Department of Statistics 2001)

Population	204300	*persons*
Growth Rate	4	*% per year*
Rural Population	88	*%*
Area	30261	*km^2*
Density	6.75	*$persons/km^2$*

The climate of the Solwezi District is dominated by a unimodal rainfall pattern (Figure 2.3), with the rainy season falling between October and April. This determines the production seasons used by farmers, with the growing season occurring during the wet season (November to April).

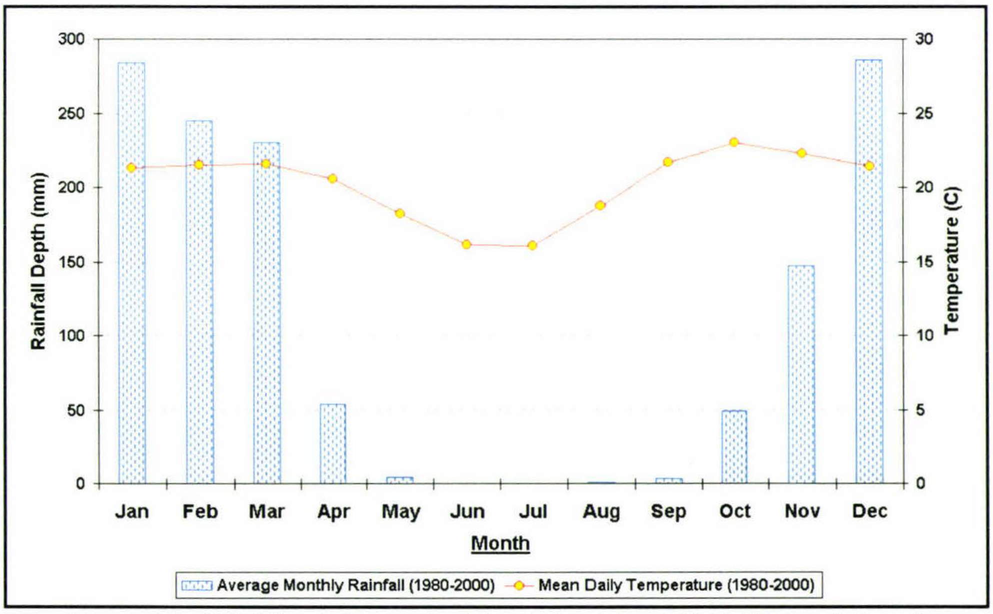

Figure 2.3: Rainfall and Temperature Trends for Solwezi District (Solwezi Airport)
Source: Zambia Meteorological Office (2001)

The assessed natural soil resources of the Solwezi District is considered to be poor (Appendix 5). However, both Munenu (1996) and Chikwekwe, Sondashi, Mukuka, Ngambi, and Chilikima (1996) consider that the land does have good potential for agricultural production. For this potential to be realised, there is a need to improve farming practices, and in particular, the development of the land is seen as being dependent on the use of inputs, especially fertilisers. The current situation, is that without fertiliser inputs, the soil resource is suffering from 'nutrient mining', consequently the quality of the soil is decreasing over time.

Agricultural production is the most important source of food, with subsistence living the primary livelihood. The Solwezi District consists of approximately 29,000 smallholder and/or resource-poor farmers, however land utilisation is low. For the Solwezi District, it is estimated that less than 1% of the potential agricultural land is in production (Chuma 2000).

2.4.2 Food Availability

Maize is the major crop grown throughout the Solwezi District, from which the staple food 'nshima' is prepared [48]. Maize is grown for household food requirements and as a cash crop, while the secondary crops (sorghum, cassava and sweet potatoes) are primarily grown for household food needs. The pattern of production in the Solwezi District fits well with the 'Maize Mixed Farming System' classified by Hall *et.al.* (2001).

Farming practice revolves around 'bush fallow' (Benneh 1996), where land rotation occurs within a fixed area of farmland. According to Chikwekwe *et.al.* (1996), no rotation pattern is followed and common practice is to keep growing crops until there are signs of a decline in yields.

Limited livestock are raised, with a production focus on cropping [49]. The main livestock raised for food are smaller livestock, especially goats and poultry. The use of cattle is restricted for draught purposes, rather than food production,

48. Nshima can also be made from other crops, including sorghum, millet and cassava.

49. The focus on cropping is related to the cultural preference, as the local people do not have a history of animal domestication and husbandry skills.

although Munenu (1996) considers that the land has good potential for livestock production. However, the limited availability and access of veterinary services is seen as a constraint for this to be realised (Munenu 1996; Chikwekwe *et.al.* 1996).

According to both Munenu and Chikwekwe *et.al.*, adequate food is grown to last most communities the whole year, however, both reports still note that food shortages occur (especially maize). The period of food shortages varies slightly within the district although normally fall between November and March (Phiri 1998; Munenu 1996; Chikwekwe *et.al.* 1996) given an average climatic year.

Concerns of decreasing production is raised in various reports (Munenu 1996; Chikwekwe *et.al.* 1996). In the report by Phiri (1998), all the agricultural blocks in the Solwezi District identified that low, and decreasing, yields were the most pressing issue facing farmers [50]. Trends from agricultural statistics for the North-Western Province indicate that maize yields are decreasing, on average, at a rate of approximately 40 kg/ha/year (MAFF 2000a) [51]. According to Chikwekwe *et.al.* (1996), the decrease in yields is related more to low input use rather than the area of land cultivated, although Phiri (1998) reports that low hectarage is of concern in most communities. Data from Munenu (1996) indicates that the yields can be decreased by as much as two-thirds when fertiliser is not used. Reasons for the low use of fertiliser is attributed to the high cost (Phiri 1998) and lateness (Chuma 1998). The usage of fertiliser and seeds is compounded, according to Chikwekwe et al (1996), by farmers not being aware of their actual farms size. This often results in an underestimation of fertiliser and/or seed requirements.

Farmers are also reluctant to use certified seed without fertilisers, and carry over seed from previous season's production. This contributes to decreasing yields, as low yielding local varieties are used instead (Phiri 1998) [52]. Due to the failure of inputs, farmers are increasingly reverting back to traditional agricultural practices

50. This was considered more important than food security and malnutrition.

51. Of the nine provinces in Zambia, all but one has a negative trend in maize production between 1987-1999. Nationally, on average, maize production is decreasing at a rate of 47 kg/ha/year.

52. Differences in maize yield between local varieties and certified seeds can be as much as 4000 kg/ha (Source: Dawako Enterprises, Personal Communication, 9th August 2001)

which are seen as being unstable for improving livelihoods.

The primary energy input for smallholder farms comes from human labour, with the use of cattle being limited to medium and large farms [53]. However, of note, while cattle numbers have increased, there has been a decrease in the number of farms using cattle (Chikwekwe *et.al.* 1996).

Phiri (1998) reports that food losses are a concern in most communities surveyed, with most households not having permanent storage structures for food (Munenu 1996). Maize is commonly stored in impermanent traditional cribs (Figure 2.4) and not shelled to reduce weevil and rodent damage. After drying, some households will transfer the shelled grains to bags, which are then stored in the house (Chikwekwe *et.al.* 1996). While no actual data are available, food losses are estimated to account for up to 30% of food supplies.

Farmers have various concerns regarding government policy, in particular focussing on the reduction in service and the inaction to improve or construct feeder roads (Munenu 1996). The improvement to agricultural production is also seen to be constrained by the limited extension services provided to farmers, mostly due to inadequate resourcing [54].

2.4.3 Food Accessibility

Food accessibility in terms of income is not frequently referred to in reports in relation to food security. This reflects the reality that income plays a secondary role to sourcing food through agricultural production. A significant reason for the limited use of income and financial services is related to remoteness, the lack of market development and poor infrastructure (Phiri 1998). The limited access to credit facilities, for example is considered to be a reason for the low use of fertiliser, leading to the consequential low crop yields (Munenu 1996).

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53. Medium sized farms are those greater than 5 hectares (MAFF, Personal Communication, 16th August 2001). Mechanised agriculture is very uncommon, being confined to the few larger farms close to urban centres.

54. An example of the reduction in extension services can be seen in the Chafukuma Farm Institute (the government extension centre in the Solwezi District) is not able to carry out activities and undertake maintenance due the restricted capital funds and labour. (Note: Local spelling variant of Chafukuma is 'Kyafukuma'). This information was sourced from a confidential report, supplied by a Key Informant.

Concerns with food accessibility amongst farmers and householders also extend to physical access issues. In particular poor roading is a common area of concern for farmers as this limits the ability to transport products to the market and obtain inputs (Phiri 1998; Munenu 1996). Transport costs are also considered to be an added constraint (Chikwekwe *et.al.* 1996).

The national land policy prevents freehold ownership (Ministry of Lands 2001)[55]. Increasingly this policy is seen as preventing the growth potential of agricultural production throughout Zambia (Smith 2001). Importantly, the policy effectively prevents land from being used as collateral, which is seen as key to further agricultural development (Kretzschmar 2001). Currently, access to land is achieved through two mechanisms:

- *leasehold:* Legally surveyed and titled, either for 14 or 99 years. Due to administration costs, outlying rural areas predominately have 14-year leaseholds as these can be prepared by local departments[56].
- *demarcation:* This is undertaken through the authority of the local chief, with the area of land often being determined by the size of the household.

2.4.4 Food Utilisation

Food security is reduced through poor sanitation and limited potable water throughout the district (Chikwekwe *et.al.* 1996). While government funded wells have been installed in most communities, these are rarely serviced with as many half not being operational (Chikwekwe *et.al.* 1996). Most wells have been constructed without groundwater protection, so contamination is of added concern.

Utilisation extends to food preferences. For example, cassava is strongly promoted as a crop to counter seasonal food insecurity due to requiring low inputs, being drought tolerant and able to be harvested throughout the year. However, as cassava requires specific processing to remove the accumulation of cyanide. As the preparation is labourious, and drying is difficult in the rainy season, this crop

55. Under Zambian law, all land is owned in perpetuity by the President of Zambia. In this, chiefs have the role of being stewards/guardians of the land with the responsibility to allocate areas of land to people.

56. The 99 year leaseholds require authorisation from the capital, Lusaka and are therefore more expensive so are not commonly used outside commercial agriculture.

is not popular with many households (Munenu 1996) and less preferred than other cereal crops (maize, sorghum and millet).

2.4.5 Nutrition

Malnutrition (in the form of PEM) is common in the Solwezi district and identified in most reports (Phiri 1998; Munenu 1996), although there is very little quantification of the extent. Data from the MRHC suggest that in period from 1998-2001, 23% of children suffered from PEM, as determined through body mass and height measurements (MRHC 2000) [57]

2.4.6 Interventions

Within the Solwezi District, the various interventions are promoted to improve food security. The most prominent of these is the 'Programme Against Malnutrition' (PAM). PAM is an umbrella organisation, involving range of non-governmental organisations, working closely with the Zambian Government and donors. Various programmes are offered by PAM to alleviate food insecurity, some of which have recently been implemented in the Mutanda area (Appendix 6).

The Mutanda Centre has developed a maize silo in an effort to reduce food losses (Figure 2.4), through the prevention of rodent access, spoilage by rain and theft. These silos can store approximately 1200 kg of maize, which is about the yield from a hectare without the use of inputs, or one lima (quarter of a hectare) with the use of inputs, especially fertiliser. The storage loss from the use of the silos is considered to be reduced to under 5% (Kajoba 2001). The cost of the silos (c.$NZ225) is partly subsided by the Centre, with the recipient households paying the balance through the an equivalent supply of maize.

The Mutanda Centre has recently initiated a cattle project. The objective of this project is to improve household food production through an increase in farm area and land utilisation. In order for farmers to be gifted two cattle (heifers), they are required to attend compulsory courses related to animal husbandry and the use of cattle for in farming operations (Kretzschmar 2001).

57. The assessment of PEM is based on the method of wasting and stunting. All children under 5 have free access to medical checkups, of which an assessment of malnutrition is included.

Figure 2.4: Traditional Storage Crib (right) compared to new ECZ Silo (left) *(Photo by Author)*

There is an awareness within Zambia that farmer cooperatives can be effective means through which poverty and food insecurity can be alleviated (Ojermark and Chabla 1994; Matoka 1985). Recently, the 'Solwezi District Farmers Cooperative Union' has been established, with a key objective to improve access to agricultural inputs for farmers, especially fertiliser. There is an interest that future development of the cooperative can include the marketing of production. Also, the cooperative structure is seen to as a means to provide a lobby through which agricultural issues affecting farmers can be presented to the government.

2.5 SUMMARY OF LITERATURE REVIEW

Food security is a complex area of study involving many interacting variables. Within these variables, food security can be described by a series of dimensions.

<u>Spatial Dimension</u>

The spatial assessment is moving from the macro-scale to the micro-scale level, with the household being seen as the focus of most food security issues. The selection of the spatial area will determine a range of variables, including physical (climatic, geographical), economic and social conditions. In this, the spatial dimension can be considered to be a 'system boundary'.

Temporal Dimension

Food security is well accepted to have a temporal dimension, typically separated into chronic or transitory forms. Seasonality in food availability and accessibility play a key role in the temporal variations of food security.

Food System Dimension

This dimension is frequently described a set of three core determinants - food availability, food accessibility and food utilisation. While food accessibility has become of increasing focus over the past 20 years (especially income use and food entitlements), food availability is still an important consideration when livelihoods are determined by subsistence agricultural production.

Nutrition Dimension

Increasingly, food security and nutrition are seen as being inseparable issues. Nutrition, and body size, is effected by the inputs from the food system dimension and hence plays an important role in measuring the effects of food security.

Measuring Household Food Security

Food security can be measured by a variety of indicators. The choice of indicators will often be predetermined by the spatial boundary and the assessment required. Increasingly, household food security is incorporating a strong emphasis on nutritional indicators. In this, the measurement of food security can be effectively developed using an inequality framework, based on the concept of sufficiency.

Food Security in the Solwezi District

The occurrence of food insecurity is well accepted in the Solwezi District. The primary means to obtain food for rural households is through subsistence agricultural production of which maize is the predominant crop. With the dependence on agricultural production, food security is highly seasonal, with a defined hunger period between November and March. Food insecurity is exacerbated by a decrease agricultural production, attributed to the reduction in agricultural input use, especially fertiliser.

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3. CONCEPTUAL MODEL AND METHODOLOGY

3.1 CONCEPTUAL MODEL

3.1.1 Introduction

The literature review highlighted the complexity of defining and measuring food security. Within this, the concept of sufficiency was raised as one of the important characteristics that define food security. However, unlike other concepts used to define food security, sufficiency can also be related to the measurement of food security, especially through an inequality framework. Consequently, the concept of sufficiency provides a commonality by which food security can be both defined and measured.

3.1.2 Food Security Inequality

Food security inequalities can be developed for a variety of parameters, however, it is most common (and theoretically robust) to develop an inequality using a nutritional perspective. Such an inequality relates well to the tension between food consumption and the nutritional requirements for maintenance of health. While such assessments can be undertaken at the individual level, they are typically aggregated at the household level. The household is increasing being seen as providing the best means to assess food security, from which effective strategies to counter food insecurity can be developed.

As presented in the literature review, Ssewanyana and Ahmadi-Esfahani (2001) present an effective food security inequality (Equation 3.1), where food security is assessed to occur when actual daily food intake is greater than the recommended daily intake.

$$DA_h^n \geq N_h^n \tag{3.1}$$

where:
DA = weighted actual daily food intake
N = recommended daily food intake
n = *n* th nutritional value
h = *h* th household

Logically, the inequality of Equation 3.1 can be rearranged in terms of a ratio (Equation 3.2), such that when $\Lambda_h \geq 1$, the household can be considered food secure.

$$\Lambda_h = \frac{DA_h^n}{N_h^n} \tag{3.2}$$

where:
Λ_h = index of household food security.

3.1.3 Food Security and Temporal Variation

It is well accepted, that as part of the vulnerability of food insecurity faced by households, actual food intake (DA) will vary with time (Dostie, Haggblade and Randriamamonjy 2000; Sahn 1989). The reasons for this variance include a reduction in food availability, restriction to food accessibility and poor food utilisation. To a lesser extent, there is a variation in the recommended daily intake (N) over time as well, especially energy (Sahn 1989). Therefore, and more correctly, Equation 3.1 could be rewritten as:

$$\Lambda_h(t) = \frac{DA_h^n(t)}{N_h^n(t)} \tag{3.3}$$

where:
$\Lambda_h(t)$ = index of household security, dependent on time
t = time (typically in days)[58]

By plotting Λ_h over a period of time (t), various 'food security curves' can be developed. From literature, the most common food security curve associated with a seasonal (or annual) timeframe, is one with a single maxima [$\Lambda_h(t)_{max}$] and minima [$\Lambda_h(t)_{min}$] (Figure 3.1)[59]. Such a characteristic is often related to the climatic conditions that determine seasonal food production.

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58. By convention, actual and recommended daily nutrient intakes are assessed on a 'per day' basis. The FAO/WHO/UNU (1985, p12-13) report states: *"As a matter of convention and convenience they are expressed as daily rates (of intakes). However, there is no implication that these amounts must be consumed each day."* While this is in the context of energy requirements, a similar view is held for most nutrients. It can be taken from this that daily intake values can be taken as to infer 'a daily average intake over a period such that the health of the person is not adversely affected during that period.'

59. From Equation 3.3 and Figure 3.1, $\Lambda_h(t)_{max}$ and $\Lambda_h(t)_{min}$ are the respective maximum and minimum values of the continuous function, $\Lambda_h(t)$, between the time interval of [α, ω], where α = start time and ω = end time. For convention, the time interval is set to an annual year.

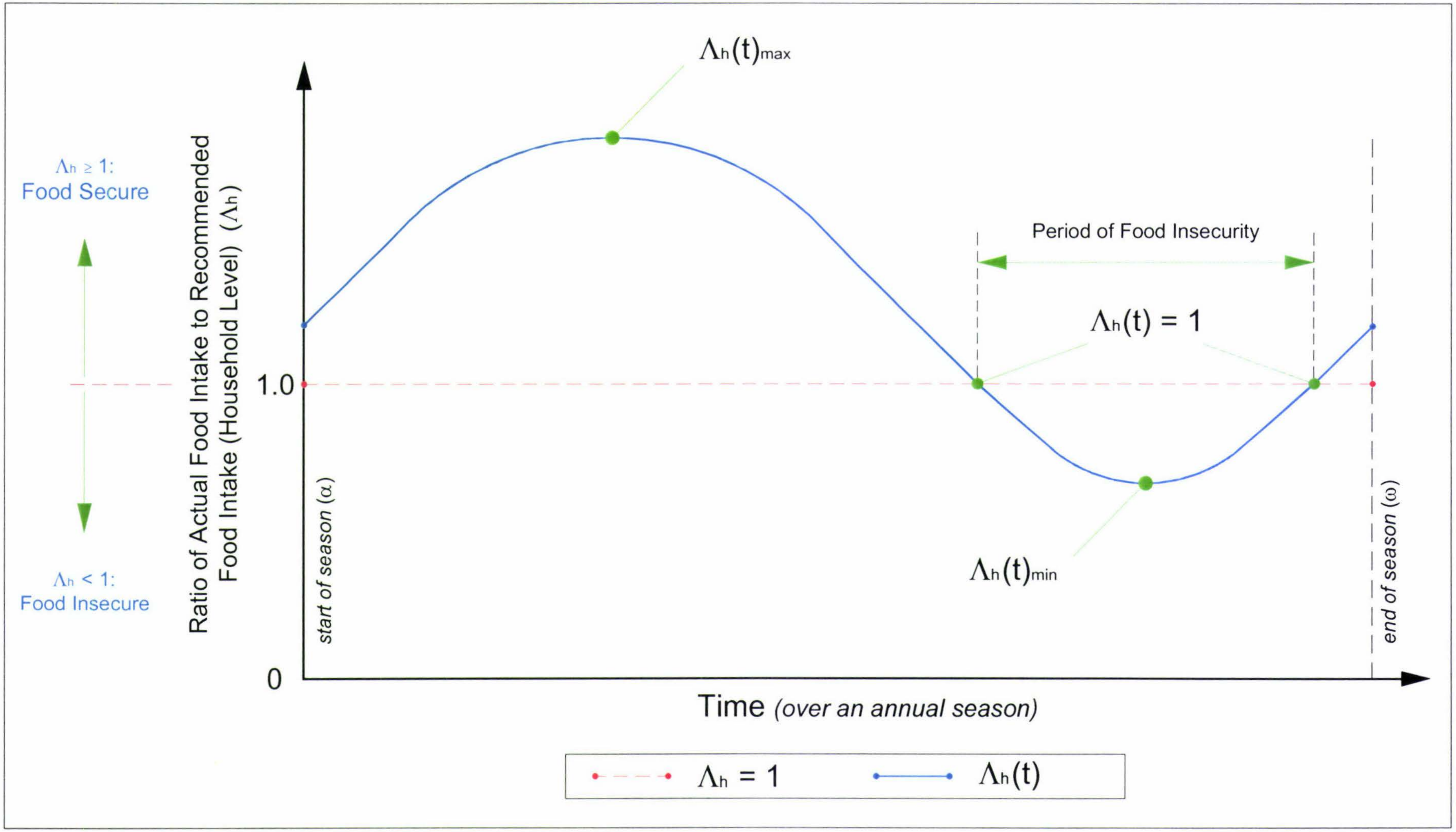

Figure 3.1: Conceptual Model of Seasonal Food Security in Rural Households of Developing Countries

Such a curve as that presented in Figure 3.1 is most likely to replicate the food security situation in Mutanda, where there is a defined period of maximum and minimum food consumption during the year[60]. This situation seems to be primarily due to the following conditions:

i) the food source is strongly dependent on subsistence agricultural production, which in turn is highly seasonal due to climatic conditions. Therefore, there is a single peak and single trough in the food consumption trend over a season. This creates the well-documented 'hunger season'.
ii) there is limited food storage, and what storage is available is generally of poor quality.

3.1.4 Adaptions to the Conceptual Model due to Resource Constraints

3.1.4.1 Rationale for Adapting the Conceptual Model

Based on the literature reviewed, the conceptual model presented in Figure 3.1 would adequately measure variations in food security. In order to validate this model, there would be the need to obtain information on actual and recommended food intakes, so that values for Λ_h could be derived. This would require a detailed food consumption survey to be carried out, throughout the years, which would have necessitated in access to extensive resources.

Due to the limitations in resources, especially finances, multiple field visits were not possible for this study. To counter this constraint, the conceptual model is adapted for use in a single field study. This is achieved by focussing on food consumption and using the changes in daily meals as the primary indicator. This adaption still preserves the objectives of this study (Section 1.6) to consider the seasonal variation in food security.

3.1.4.2 Food Security and Food Consumption

As noted in Section 3.1.2, food security can be defined in terms of a ratio between actual and recommended food intakes (Equation 3.2). While it is accepted that both these functions vary with time (Section 3.1.3), the predominant variation in

60. The author is particularly thankful for the information provided by a key informant, who visited the Mutanda in the year prior to the field research for preliminary information to construct this model.

food insecure situations tends to occur through food intake rather than the recommended level of food intake (Latham 1997):

- Most of the recommended level of nutrients are standard values, so there is no temporal variation (Appendix 4).
- The nutrient with the most temporal variation is energy, which varies due to a number of factors including increased physical exercise and growth (James and Schofield 1990). However, for an average individual the variation can be controlled by either:
  - using average values for physical intensity and keeping growth requirements constant over the period of assessment. This method is used in other indicators of food security, such as the FAO method of food inadequacy (FAO 2000) or,
  - using standard values (e.g. Appendix 4)

Therefore, by making the food requirement (N) constant, all the variation in $\Lambda_h(t)$ will occur through the variation in actual food intake (DA).

3.1.4.3 Food Consumption Using Daily Meals

As noted in Section 2.3.3.3, daily meals offer a cost-effective and adequate proxy indicator for food security studies. Making the assumption that the primary means of food intake occurs through the consumption of meals (an assumption supported by key informants from the MRHC), food intake can be approximated as a function of meal consumption.

$$DA_h^n(t) \approx eM(t) \qquad (3.4)$$

where:
eM(t) = effective quantity of meals consumed, dependent on time

Consequently, the variation in actual household food intake [$\lambda_h(t)$], can be defined as a ratio of the intake at maximum food consumption[61] (eM_x), such that:

61. It could be equally valid to consider the variation from minimum food consumption. However, the convention in literature tends to contextualise food insecurity as a movement away from a state of food security. This context can be seen in the increasing use of 'vulnerability' to determine regions prone to food insecurity (FIVIMS 2002).

$$\lambda_h(t) = \frac{DA_h^n(t)}{DA_{h\,max}^n} \approx \frac{eM(t)}{eM_x} \qquad (3.5)$$

where:
$\lambda_h(t)$ = ratio of actual food intake to maximum food intake, dependent on time
eM_x = effective daily meals at maximum food consumption

By plotting $\lambda_h(t)$ over time, the variation in food intake can be described (Figure 3.2) by a "food consumption curve". Following the seasonal characteristics identified for food security curve (Section 3.1.3), and due to assumption given in Section 3.1.4.2 (stating that the primary variation in food security is due to food intake), the shape of the respective curves in Figures 3.1 and 3.2 will be similar in that there is one maxima and one minima occurring between the start and end of the season.

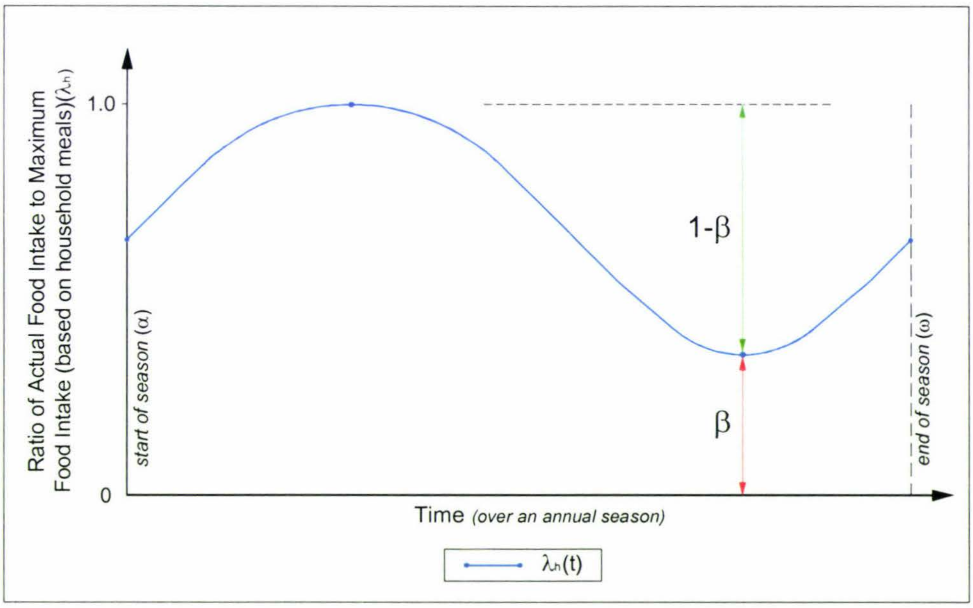

Figure 3.2: Adapted Conceptual Model, focussing on the Variation in Seasonal Food Consumption

3.1.4.4 Definition of the β-Ratio

Derived from Equation 3.5, the β-ratio is defined as the variation in food consumption between the times of maximum and minimum food consumption, such that:

$$\beta = \frac{eM_n}{eM_x} \qquad (3.6)$$

where: eM_n = effective daily meals at minimum food consumption
eM_x = effective daily meals at maximum food consumption

It follows from the above assumptions, that the β-ratio can also approximate the variation between maximum and minimum levels of food security as given in Figure 3.1, such that:

$$\beta = \frac{eM_n}{eM_x} \approx \frac{\Lambda_h(t)_{min}}{\Lambda_h(t)_{max}} \qquad (3.7)$$

The β-ratio is used in preference to an absolute meal value between maximum and minimum food consumption, due primarily to:

- As noted by Swindale and Ohri-Vachaspati (1999), households have differing practice of eating occasions and may vary size instead of frequency. The β-ratio takes into account both the variation caused through a reduction in meal frequency and size (Section 3.2.3). Consequently, the β-ratio provides for a better estimate as to the relative variation in food consumption than can be achieved using absolute value of meal frequencies alone.
- The β-ratio can approximate to the seasonal variation between maximum and minimum level of food security (Equation 3.7).

3.1.4.5 Complementary Redundancy

Alone, the β-ratio does not indicate the existence of food insecurity (which is defined by Equation 3.3). It is possible, for example, that someone could already be food insecure at maximum food consumption and hence, with a β-ratio less than one, would simply be more food insecure at minimum food consumption. (This would be an example of chronic food insecurity).

The β-ratio, however, does provide a strong indication in the variation of food consumption during the year, based on the above assumptions. To offer a qualified approximation to the occurrence of food insecurity, other indicators will be used to provide "complementary redundancy" (Section 2.3.1). Such indicators will include:

- the perception of hunger
- the occurrence of food shortages
- qualitative information from households and key informants

3.2 RESEARCH METHODOLOGY

3.2.1 Research Approach and Methods

3.2.1.1 Research Process

The approach to undertaking the research involved three distinct processes. The initial approach involved a literature review of the topic, which included Internet searches. Supporting this review was the use of official statistics/reports and discussions with development organisations and personnel. From this, the research objectives for the study were developed and the requirements of the field work established. The field research component consisted of quantitative surveys, qualitative interviews and observations. Post field research processes involved data analysis and compilation of the final report.

3.2.1.2 Methodological Approach

Based on the work of Tashakkori & Teddlie (1998), this research can be classified as a "Multiple Applications Within Stage of Study". In this, the quantitative approach is dominant, supported by qualitative data collection.

1. Type of Inquiry — QUANTITATIVE & qualitative
2. Data Collection/Operations — QUANTITATIVE & qualitative
3. Analysis/Inferences — QUANTITATIVE & qualitative

3.2.1.3 Field Research

The field research was undertaken between 16th July - 16th August 2001. While the field research was undertaken during the dry season and when food is considered plentiful - two potential biases noted by Chambers (1983) in rural development research - the timing of the field research was independent of such considerations [62].

3.2.2 Field Survey Design

3.2.2.1 Quantitative Surveys

Two quantitative surveys, a food consumption survey and farm systems survey were undertaken. The objectives and design of these surveys are as follows:

FOOD CONSUMPTION SURVEY

Objectives

- assessing the variation in food consumption during the year
- identifying the modes of food acquisition, including the role of storage
- determining the types of food consumed
- determining the household size

Survey Design

The questionnaire used for the food consumption surveys is given in Appendix 7. The design of the survey to accomplish the objectives include:

i) Modified Food Calender

Respondents selected the typical (i.e. average) months when:

- their household consumed the most and least food
- food shortages started and ended for their household.

There was no constraint to the number of months that could be selected. The month selected could be defined to one month, hence a data precision of ±½ month. For data analysis, months were ascribed their "month number" (i.e. Jan = 1, Feb = 2.....Dec = 12). If multiple months were selected, the median month was used for data analysis (i.e. if May and June were selected, the month number was recorded as 5.5).

62. The primary determinants for the timing of the field research were based on commitments and requirements for the completion of the thesis and to attend an international food security conference after the field research.

ii) Daily Meals

Respondents were asked:

- the number of daily meals at maximum food consumption (M_x)
- the number of daily meals at minimum food consumption (M_n)
- the relative size of daily meals at minimum food consumption (S_n), compared to the size of daily meals at maximum food consumption (S_x). For the survey, S_x was fixed at 'one', hence S_n is a ratio of S_x.

Meal frequency could be defined to ½ meal accuracy, hence the precision of the data was ±¼ meal. Relative size data had an accuracy of ¼, hence the precision of the data was ±⅛.

iii) Perception of Hunger

Respondents were asked to rank their level of food satisfaction at maximum and minimum food consumption on a scale of one to seven. The perception of hunger is seen as a valid means of providing 'complementary redundancy' in support of other food security data (Barrett 1999).

iv) Household Size

Respondents were asked to identify the age-gender groupings of their household. From this information, the aggregate household size was determined.

v) Types of Food Consumed

The types of food consumed in each household was recorded. If the food was grown on their farm, the area of crops were recorded [63].

vi) Modes of food acquisition

To assess the relative importance of subsistence production and the usage of income in food acquisition.

63. In rural Zambia, the most common measurement of area is the "lima". One lima is equivalent to ¼ ha. Areas of crops were listed when equal or greater than ¼ lima (0.0625 ha). At areas less than this, the crop was recorded but not the area. For this study all areas will be analysed in hectares.

vii) Types of storage systems used

To assess the impact of different types of storage on the level of food consumption.

FARM SYSTEM SURVEY

Objectives

- determine land tenure arrangements and size
- assess the role, and constraints, of agricultural inputs.

Survey Design

The questionnaire used for the farm system survey is given in Appendix 8. The farm system survey is undertaken to characterise the farming system, and provide support to the household survey and qualitative survey. The design of the survey to accomplish the objectives include: [64]

i) Land Size and Tenure

Respondents were asked to whether they had leasehold or demarcated land. Also, the size of the total farm area was asked to compare to the planted crop area.

ii) Use of Agricultural Inputs

Respondents were asked to identify inputs used in their farm, in particular fertiliser, certified seed and energy (machinery, cattle and labour).

iii) Supporting Questions:

Additional questions were included to determine

- livestock production
- the interest in crop diversification
- the amount of maize sold [65]

64. An oversight in survey design accounted for crop production not being included as a question in the farm system survey. Some information on production (in terms of maize) was obtained from the key informant interviews.

65. Maize is used due to its importance in agricultural production and food consumption in the Solwezi District.

3.2.2.2 Qualitative Interviews

Additional qualitative methods were used to provide a more complete picture of the issues involved in food security. These interviews were generally unstructured and brief (Appendix 9), following the guidelines from Broughton and Hampshire (1997). Supporting these interviews was information from field notes and observations. The qualitative process was primarily used to describe:

- the usage of income in the house
- the constraints to growth in agricultural production
- the operation of subsistence agricultural production systems

3.2.3 Relationship between Survey Data and Adapted Conceptual Model

The effective daily meals (eM) (Equation 3.4) can be defined as a function of meal frequency and meal size (Section 2.3.3.3), such that, over time;

$$eM(t) = f(M, S)(t) \quad (3.8)$$

where:
M = frequency of meals per day
S = size (quantity) of meal

To determine the β-ratio (Equation 3.6) from the survey data, the effective daily meals at maximum and minimum food consumption are respectively calculated as follows:

$$eM_x = M_x \cdot S_x \quad \text{and} \quad eM_n = M_n \cdot S_n \quad (3.9a \ \& \ b)$$

where:
eM_x = effective daily meals at maximum food consumption
- M_x = frequency of daily meals at maximum food consumption
- S_x = 1 (Note: As $S_x = 1$, then $eM_x \equiv M_x$)

eM_n = effective daily meals at minimum food consumption
- M_n = frequency of daily meals at minimum food consumption
- S_n = relative size of daily meals at minimum food consumption compared to the size of daily meals at minimum food consumption (S_x). S_n is a ratio of S_x.

3.2.4 Survey Sampling

3.2.4.1 Quantitative Survey Sampling

The survey methods were based on based on Cluster Sampling, as explained in Broughton and Hampshire (1997).

> "This involves first selecting clusters or groups of people you want to interview, e.g. a number of villages or farmers groups within the project area (rather than individuals), and then once in the field, interviewing people in these locations as you find time. The groups may thus be chosen at random by using random selection techniques, but the individuals for the interview are then selected by moving from one house to the next until the sample quota is reached." Broughton and Hampshire (1997, p76).

The only difference with the field approach, is that households selected within each village were undertaken randomly rather than moving from house-to-house. This was achieved using a random number generator on the field calculator (Hewlett Packard 21S).

For the quantitative surveys, respondent answering the survey were restricted to either the male or female head of the household present at the time of the interview. All respondents were asked to consider the questions from the household perspective and not their individual situation. All surveys were undertaken face to face, with the assistance of a local interpreter.

Pilot Survey *(both surveys) (14 Respondents)* [66]

Participants were randomly selected from a list of farmers (n = 32) that attended extension courses run by the Mutanda Centre (Appendix 10).

Subsequent to the pilot survey, some of the questions were slightly reworded. One question was added to the farm system survey, regarding the use of fertiliser and certified seed. Based on the pilot survey, and advice from local key

66. The results from the pilot survey were included as part of the survey data.

informants, it was decided that the targets would be 100 household surveys and 50 farm system surveys [67].

Household Survey *(Target: 100 Respondents; Actual: 102 Respondents)*

Five villages were randomly selected from the Mutanda area, as defined by the Mutanda Rural Health Clinic (MRHC). Villages are broad and not well defined entities, although according to the MRHC, there are "about ten" village localities in the area. According to key informants, there is little agri-socio-economic difference between the villages - with the possible exception that the villages close to the river are more likely to undertake fishing. The aim was to interview 20 households in each of the villages. Interviews were conducted in two parts:

- Mill Interviews.

  From key informants, it was suggested to interview households at the Mill. However, due to the potential of bias, this was not considered optimal but discussing the issues with the mill manager, the level of bias was considered to be limited and manageable within the research methodology [68]. The key reasons interviewing at the mill were:

  - The hammer mill is considered one of the most frequented place in the community, with over 100 people visiting each day.
  - Interviewees would still only be interviewed if they were based in one of the villages, as selected above.
  - Interviews where undertaken randomly, with interviewees selected by ballot.
  - As most people visit the mill on the same day of the week, interviews were undertaken on three different days over a period of three weeks. The selection of days was determined in consultation with the Mill manager.

67. The pilot survey indicated that the variation in responses was very small for the farm system survey, from which a field decision was taken to use a smaller sample size due to limited resources (TOPNZ 1994). However, in hindsight, the intention to survey 100 farmers should have been retained (or even increased) due to the small variation. This oversight, has resulted in a smaller dataset, and consequentially impacted on the confidence the survey can provide.

68. The two primary bias' introduced by the mill interviews were: i) the requirement for people to be physically present at the mill. However, this is not considered to be a serious limitation as most people walk or use bicycles. This would prevent people with health issues (illness/disability/age). However, as the survey was for a 'household' rather than an 'individual' it was possible the household could be represented by another household members. ii) there is a potential bias towards females as they are typically tasked with having the maize ground at the mill. The implications of these bias' on the results are discussed is Appendix 11. Overall, the use of the mill for interviews, probably falls between what Broughton and Hampshire (1997) call 'Cluster Sampling' and 'Quota sampling'.

- Village Interviews
  - The villages were interviewed on four days over a three-week period.
  - Villages tend to be elongated along the road running through the community. Using a random number function of the calculator, if an odd number was selected, the 'interview transect'[69] was started at the far end of the village (as approached from the Mutanda Centre). Conversely, if an even number was selected, the interview transect began at the near end of the village and the transect walked to the other end of the village[70].
  - Selection for each household was determined from a random number generated by the field calculator (Appendix 10).

Farm System Survey *(Target: 50 Respondents; Actual: 42 Respondents)*[71]
Every second household, which indicated in the household survey that the primary source of food was from the farm, was selected for the survey.

3.2.4.2 Qualitative Sampling Selection

Households used for the qualitative interviews were selected from respondents surveyed for both the household food security and smallholder farm production surveys. Interviews were carried out for every fifth farm system survey, such that eight interviews were undertaken.

3.2.4.3 Key Informants

Additional to the selected farmers, the qualitative approach also involved key informants. These were selected from organisations based on their role in food security and/or agricultural production. Personnel from the following organisations were interviewed:

- Ministry of Agriculture, Food and Fisheries (Provincial and District Office)
- Mutanda Centre Staff
- Solwezi Farmers Cooperative Union
- Fertiliser and Seed Companies

69. The 'interview transect' was the main road running through the middle of the village.

70. Village 'boundaries' were determined by key informants, namely the village headmen.

71. Due to a set of circumstances, combined with transportation constraints, eight farmers could not be visited. Consequently, the total number of farm systems surveys was restricted to 42.

3.2.4.5 Survey Administration

For the food consumption and farming system survey, the data collected was recorded in specifically designed field survey notebooks containing the survey forms. Interviews from key informants were recorded in a separate notebook. Immediately after the survey and interviews, a backup copy of the data was transferred to a second set of field notebooks. All notebooks were books being securely stored, with the backup copies stored in a separate building to the primary copy. Immediately after the field research was completed, the data was transferred to a computer (Microsoft Excel Spreadsheet) ready for data analysis.

3.2.5 Ethical Considerations

While the research methodology was not considered to have significant ethical problems, the Massey University research ethics guidelines were followed throughout the survey and interviews process (MUHEC 2000). Of particular note, the following points were stressed before all interviews were undertaken:

1. *Informed Consent:* Interviewees were advised the survey was voluntary, could refuse to answer any question, withdraw from the interview at any time; ask any questions about the study, and request a summary of the research findings. At all times, the interviewees were truthfully informed of the objectives for the research.
2. *Confidentiality and Anonymity:* The food consumption and farming system survey were anonymous [72]. Key informants were advised that their involvement was confidential to the research.

3.2.6 Data Analysis

3.2.6.1 Quantitative Data Analysis

Non-Proportional Data

Analysis of datasets was primarily univariate in nature. Due to variability in the distribution of the data, both parametric and non-parametric descriptive statistics are used to describe the data.

72. Some respondents were insistent on having their names recorded. In such cases, the names have been kept confidential.

A set of hypotheses were developed, relating characteristics from the survey data to the conceptual model (β-ratio). Hypothesis testing from datasets obtained from the food consumption surveys was undertaken using the 't-test of means', with 'χ^2-tests' to determine differences in proportions for bivariate analysis (Johnson and Bhattacharyya 2001). Due to the small sample size for the Farming Systems Survey, the Mann-Whitney tests was used to determine significance where necessary (Hollander and Wolfe 1999; Sprent1993). For all tests, the significant level was set at 5% [73].

Proportional Data

Proportional data was analysed using the normal approximation method (Johnson and Bhattacharyya 2001), with a significant level of 5%.

Analysis Software

The quantitative analysis was undertaken using Microsoft Excel 2000 (for data entry), with statistical analysis performed using Analyse-it (Analysis-it Software 2001) [74]. Additional analysis was undertaken using Mathcad Version 6 [75]. A HP-21S Hewlett Packard statistical calculator was used for field calculations.

3.2.6.2 Qualitative Data Analysis

The use of the qualitative information is primarily used to support the survey data, in terms of context. In this regards, there is limited analysis of data beyond classification into appropriate categories. The method of classification, follows that prescribed by Dey (1993).

3.2.7 Hypotheses

3.2.7.1 Question One

To what extent is food consumption, in terms of daily meals, impacted by seasonality?

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73. The choice of a 5% significant level was made, in part, with consideration to the level of reliability of the data obtained. Under these conditions, a 1% significant level could not be justified.

74. http://www.analyse-it.com/

75. http://www.mathcad.com/

Hypothesis One (A)

Rural households in the Mutanda area experience food shortages for at least some period of the year but less than half a year.

- Method: 95% Confidence Limits of Mean
  - Null hypothesis: H_0: $\mu > \mu_1$
  - Alternative Hypothesis: H_A: $\mu_0 \leq \mu \leq \mu_1$

  where: μ = mean number of months with food shortages

  μ_0 = 0

  μ_1 = 6

Hypothesis One (B)

For the average household, the food intake (based on effective daily meals) is significantly lower at minimum food consumption than maximum food consumption.

- Method: t-test of mean @ 5% significance level *(Lower one-tail)*
  - Null hypothesis: H_0: $\mu = \mu_0$
  - Alternative Hypothesis: H_A: $\mu < \mu_0$

  where: μ = mean of β-ratio for all households

  μ_0 = 1 *(i.e. there is no difference between maximum and minimum food consumption)*

3.2.7.2 Question Two

How does the use of income and storage impact on the level of food consumption, in terms of daily meals?

Hypothesis Two (A)

Rural households that use income for food acquisition consume a larger proportion of daily meals at minimum food consumption compared to households who do not use income.

- Method: t-test of means @ 5% significance level *(Upper One-Tail)*
  - Null hypothesis: H_0: $\mu = \mu_0$
  - Alternative Hypothesis: H_A: $\mu > \mu_0$

  where: μ_0 = 0 *(i.e. no difference in β-ratio)*

  $\mu = \mu_a - \mu_b$

μ_a = mean β-ratio of households who use income for food purchases

μ_b = mean β-ratio of households who do not use income for food purchases

Hypothesis Two (B)

Rural households that use ECZ silos consume a larger proportion of daily meals at minimum food consumption compared to household who use traditional forms of storage.

- Method: t-test of means @ 5% significance level *(Upper One-Tail)*
  - Null hypothesis: H_0: $\mu = \mu_0$
  - Alternative Hypothesis: H_A: $\mu > \mu_0$

    where: μ_0 = 0 *(i.e. no difference in β-ratio)*

    $\mu = \mu_a - \mu_b$

    μ_a = mean β-ratio of household using an ECZ Silo

    μ_b = mean β-ratio of household using traditional storage cribs

3.2.7.3 Question Three

How do the characteristics of farming systems impact on food consumption?

For the following hypotheses, the β-ratio is collapsed into two groups (i) $\beta < 0.333$ and (ii) $\beta \geq 0.333$. The threshold was set at $\beta = 0.333$ as when meals are used as an indicator of food security, there is an implicit view in literature that when households rationalise meals to less than one third of maximum, they could be potentially more vulnerable to suffer from food insecurity (Section 2.3.3.3).

Hypothesis Three (A)

Households with a β-ratio of less than one-third have a smaller planted crop area than households with a β-ratio greater than one-third.

- Method: t-test of means @ 5% significance level *(Lower One-Tail)*
  - Null hypothesis: H_0: $\mu = \mu_0$
  - Alternative Hypothesis: H_A: $\mu < \mu_0$

    where: μ_0 = 0 *(i.e. no difference in planted crop area)*

    $\mu = \mu_a - \mu_b$

μ_a = mean planted crop area of households with β-ratio < 0.333

μ_b = mean planted crop area of households with β-ratio ≥ 0.333

Hypothesis Three (B)

The number of crops planted by a household effects the level of food intake during minimum food consumption

- Method: χ^2 -test @ 5% significance level
  - Null hypothesis (H_0): The distribution of planted crops is independent of the household β-ratio
  - Alternative Hypothesis (H_A): The distribution of planted crops is associated with the household β-ratio

Hypothesis Three (C)

The use of agricultural inputs (aggregated use of cattle, fertiliser/certified seed) effects the level of food intake during minimum food consumption

- Method: χ^2 -test @ 5% significance level
  - Null hypothesis (H_0): The use of agricultural inputs is independent of the household β-ratio
  - Alternative Hypothesis (H_A): The use of agricultural input is associated with the household β-ratio

3.2.7.4 Question Four

Based on the characteristics identified (and the established relationship between food consumption and food security), what interventions are required to assist with the alleviation of rural household food insecurity?

This question will be answered through discussing the results of the survey and identifying which interventions have shown to improve food consumption (based on the previous hypotheses). Additional to this, strategies presented in literature will be considered based on their applicability to be successfully implemented in the Mutanda area.

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4. RESULTS AND DISCUSSION

4.1 RESULTS

This chapter presents the results obtained from the quantitative and qualitative surveys. The first part of the results' section provides an overview of the data collected. This is followed by the section considering the specific hypothesis raised in terms of the research objectives. The discussion of these results occurs in the following chapter.

4.1.1 Characteristics of Household Food Consumption

4.1.1.1 Sources of Food

98% (n = 102; FCS)[76] of the respondents stated that their main source of food was from their own farms (Table 4.1). The remaining 2% used income as the main source of acquiring food. 48% of the respondents indicated that they had a secondary source of food acquisition; consisting of 36% using income, 10% sourcing food through free collection (hunting and gathering, with fishing the most common activity) and 2% farm production[77]. Of the 36% who use income, 52% obtained the majority of their income through the sale of on-farm products.

Table 4.1: Sources of Food for Households (n = 102)

	Primary Source	Secondary Source	Total
Farm/Garden	98%	2%	**100%**
Income Use	2%	36%	**38%**
Free Collection*	---	10%	**10%**
Total	**100%**	**48%**	

* *also referred to as hunting and gathering*

Available income is generally used to purchase non-food items over food, such as housing, school fees, clothing and household items. The use of income for food is confined, in general, to the non-grown foods such as milk, sugar and salt. A common view expressed is that: *"we don't spend much money on food as we can*

76. The abbreviation of FCS refers to 'Food Consumption Survey', while FSS refers to 'Farming System Survey'

77. Four respondents mentioned that a small amount of food was acquired through bartering, but this was seen as an infrequent from of food acquisition.

grow it in the garden". [78] The proportion of income spent on food was seen as being *"very little"*, and when prompted, this was indicated to be *"much less than one quarter"* of the food consumed was purchased.

In discussing reasons why food was not purchased, respondents indicated that being far away from shops was the major reason why they did not (or could not) purchase more food, including the cost of transport being a constraint. Most food purchased was undertaken at the small local Mutanda centre shop and through informal local markets. Respondents did suggest that more income is spent on staple foods, such as maize flour (locally known as 'mealie meal'), during food shortages once stored food has been consumed but this was not quantified.

4.1.1.2 Types of Food

The staple food consumed by households in the Mutanda region is maize, which is grounded into a flour to prepare nshima. From the survey data, maize accounts for 73% of food grown (on an energy basis) by household farms. Nshima can also be prepared through cassava and other cereals, such as sorghum and millet, although it is more common for these cereals to be used to prepare a local fermented drink. The remaining food consists of sweet potato, Irish potato, relish (consisting of cabbage, onions and tomatoes), beans, groundnuts and soya beans. Chicken and fish provide the main sources of meat but the consumption is very small. While red meat consumption is rare, goat meat is more common than beef.

4.1.1.3 Household Size

The median (and also mode) of household size is seven people, consisting of four males and three females (Table 4.2).

Table 4.2: Age and Gender Composition of Median* Household

Age	< 10	10 ≤ 17	18+
Male	2	1	1
Female	1	1	1

* *also the modal values*

78. Most of the quotes were translated into English. Inevitably, some paraphrasing may have occurred in translation but emphasis and intention of the respondents answers was not altered.

4.1.1.4 Food Storage

In the Mutanda area, 26% (n = 102; FCS) of the households use the ECZ silo for maize storage, with the remainder using traditional storage cribs (74%). Of the households using storage cribs, 87% transfer the maize into bags after shelling to be stored in the house.

4.1.1.5 Food Shortages

The occurrence of food shortages during the year was mentioned by 95% of households. For the Mutanda area, food shortages, on average, occur between mid-November and mid-March. However, the start and end of food shortages can vary up to a month for individual households (Table 4.3).

Table 4.3: Start and End of Food Shortages

Food Shortages....	Mean Month*	1st Quartile	3rd Quartile
...Start (T_s)	Mid-November	Mid-October	Early December
...End (T_e)	Mid-March	Early March	Late March

* *also equivalent to the median month*

4.1.1.6 Occurrence of Maximum and Minimum Food Consumption

On average, maximum and minimum food consumption occurs at the end of May and December respectively (Table 4.4).

Table 4.4: Months of Maximum and Minimum Food Consumption

Food Consumption	Mean Month*	1st Quartile	3rd Quartile
Maximum (T_x)	Late May	Late April	Late June
Minimum (T_n)	Late December	Late November	Late January

* *also equivalent to the median month*

4.1.1.7 Food Satisfaction (Perceptions of Hunger)

All respondents indicated they had at least an average satisfaction during maximum food consumption, with the clear majority of households considering themselves to be 'always well fed'. This compares to 63% of households indicating they suffered from hunger (ranking of less than four) during minimum food consumption (Figure 4.1).

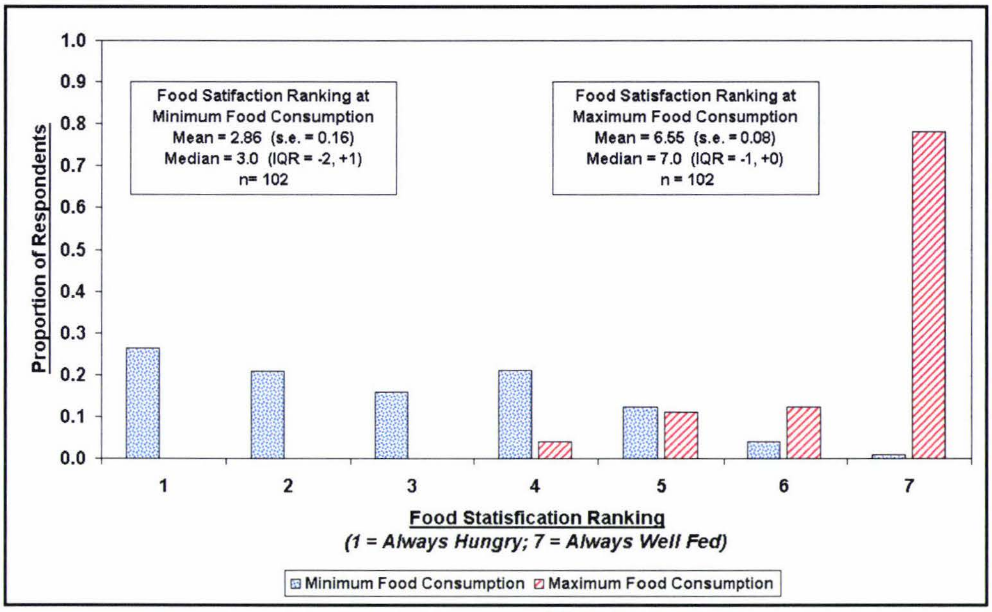

Figure 4.1: Comparison of Food Satisfaction Rankings at Maximum and Minimum Food Consumption

4.1.1.8 Meals

At maximum food consumption, the most common frequency (mode) of daily meals is three, which reduces to one daily meal during minimum food consumption (Table 4.5a). Although, at least half of the households consume three meals every two days (i.e. one and half meals per day) during minimum food consumption.

On average, the size of meal at minimum food consumption s was only 51% of the size consumed at maximum food consumption. Combined with a reduction in meal frequency of 46%, on average households consumed only 32% of food at minimum food consumption compared to maximum food consumption (β-ratio).

Table 4.5a: Surveyed and Derived Meal Statistics (n = 102)

Dataset	eM_x*	M_n	S_n	eM_n	β-Ratio
Product of....	*raw data*	*raw data*	*raw data*	$M_n \cdot S_n$	eM_n/eM_x
Mean	2.63	1.45	0.51	0.84	**0.32**
SE	0.05	0.07	0.02	0.07	0.03
Median	3	1.5	0.5	0.5	0.25
Mode	3	1	0.5	0.5	0.33

* As $eM_x = M_x \cdot S_x$, where $S_x = 1$, then $eM_x \equiv M_x$

In terms of effective daily meals (that is, the product of frequency and size), 60% of households have three meals or greater at maximum food consumption with 39% having two meals. During minimum food consumption, 61% of households consume less than one effective meal per day. At this time, only 5% of the households retained having three effective meals per day (Table 4.5b).

Table 4.5b: Effective Daily Meals Consumed at Maximum and Minimum Food Consumption (Percentage of Respondents)

Percentage of Households at....	Effective Daily Meals (eM)			
	$eM < 1$	$1 \leq eM < 2$	$2 \leq eM < 3$	$eM \geq 3$
Maximum Food Consumption (eM_x)	0	1	39.2	59.8
Minimum Food Consumption (eM_n)	60.7	27.5	6.9	4.9

The predominant means of meal rationalisation was through both a reduction in frequency and size of daily meals (Table 4.5c). The rationalisation of meals is linked to the start of food shortages. From discussions with the respondents, food shortages were considered to start when the frequency of daily meals was reduced from the desired household level, which, for most households, occurred where meals were reduced from three to two meals per day. The adjustment in the meal size occurred prior to start of food shortages (that is, a reduction in meal frequency). However, such rationalisation in size was small with most size reduction occurring within the period of food shortages, along with further rationalisation in meal frequencies (if required).

Table 4.5c: Methods of Rationalising Daily Meals (Percentage of respondents; n = 102)

Frequency Rationalised?	Relative Size Rationalised?		
	Yes	No	Total
Yes	79.4	8.8	88.2
No	6.9	4.9	11.8
Total	86.3	12.7	100

4.1.2 Characteristic of Farming Systems

4.1.2.1 Land Area

Total farm area of households is highly variable, ranging one to 100 ha (n = 42; FSS). The distribution of total farm area is highly positively skewed, with a median of 4.0 ha and mean of 11.5 ha (Table 4.6). In comparison, the actual planted crop area has a median of 1.5 ha, with a mean of 1.7 ha [79].

Table 4.6: Comparison between Total Farm and Planted Crop Area

Parameter	Total Farm Area (ha)	Planted Crop Area (ha)
n	42	102
Median	4	1.5
IQR	-1.5, +5.0	±0.5
Mean	11.5	1.71
SE	3.9	0.11
Geometric Mean	5.15	1.46

Of the respondents, 24% (n = 42; FSS) had a leasehold on their farm, all of which were for fourteen years. The remaining land is not owned by the householder, but demarcated through the authority of the local chief. Comparison between leasehold and demarcated farmland shows that leaseholders have a significantly larger total farm area, with the difference in the planted crop area only marginally non-significant at the 5% level (Table 4.7a & b).

Table 4.7a: Comparison between Farm Tenure: Total Farm Area

	n	Median Total Area (ha)	Mann-Whitney U Statistic	p-level *(Upper-Tail)*
Demarcated	26	4	177.5	0.011
Leasehold	9	10		

Table 4.7b: Comparison between Farm Tenure: Planted Crop Area

	n	Median Planted Crop Area (ha)	Mann-Whitney U Statistic	p-level *(Upper-tail)*
Demarcated	32	1.8	215	0.05
Leasehold	10	2.6		

79. The planted crop area has a distribution that fits well to the log-normal distribution, hence the inclusion of the geometric mean in Table 4.6.

4.1.2.2 Crops

The growing season occurs from October through to June, during the rainy season. Most harvesting, especially maize, occurs from March through to June, although some crops (i.e. pumpkins) are harvested from late January. Sorghum and millet tend to be harvested after maize, which can extent into August. Root and tuber crops have a wide harvest season, and for cassava this can extend throughout the year.

Cropping production is dominated by maize, highlighted by the following results:

- All households grow maize, with the next main crops being sorghum, millet and sweet potato (Figure 4.2). The median farmer grows four crops[80], one of which will be maize.
- Maize is the largest crop grown by 93% (n = 102; FCS) of the farmers, with a geometric mean of 0.82 ha[81] (Figure 4.3). Over the Mutanda region, in terms of area, maize accounts for 60% of all crops grown. The next largest crop, sorghum, accounts for 13% of planted area.
- For 75% of farmers, maize accounts for over half of the planted crop area. In terms of food energy, maize accounts for 73% of crops grown.

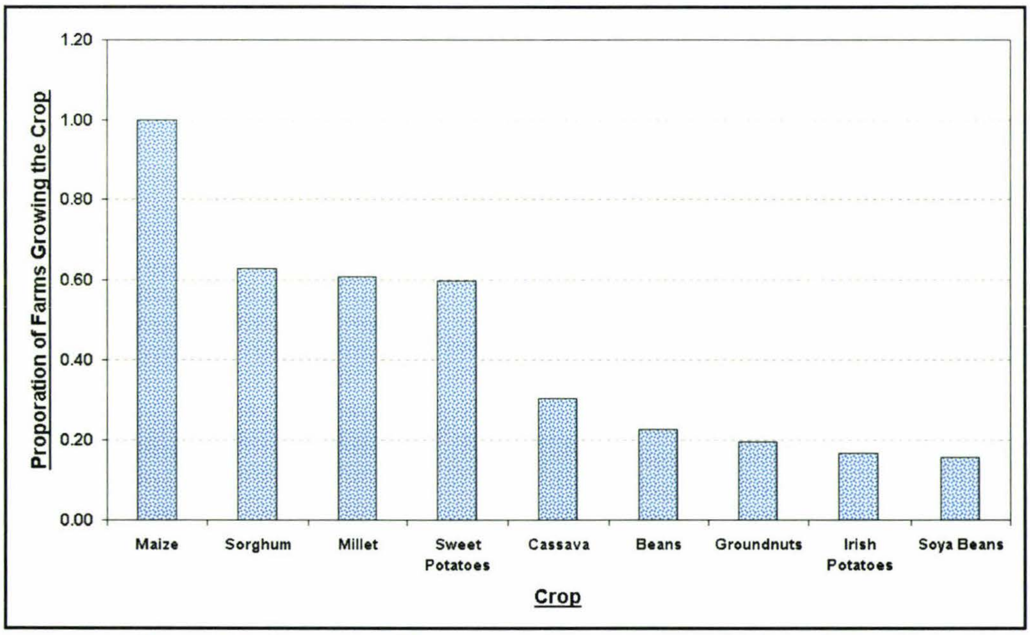

Figure 4.2: Proportion of farmers growing certain crops in Mutanda Area

80. Due to the small area used (< 0.0625 ha), all vegetables are classed as one crop.

81. See Footnote 79. As a comparison, median = 0.75 ha and mean = 1.02 ha (se = 0.08).

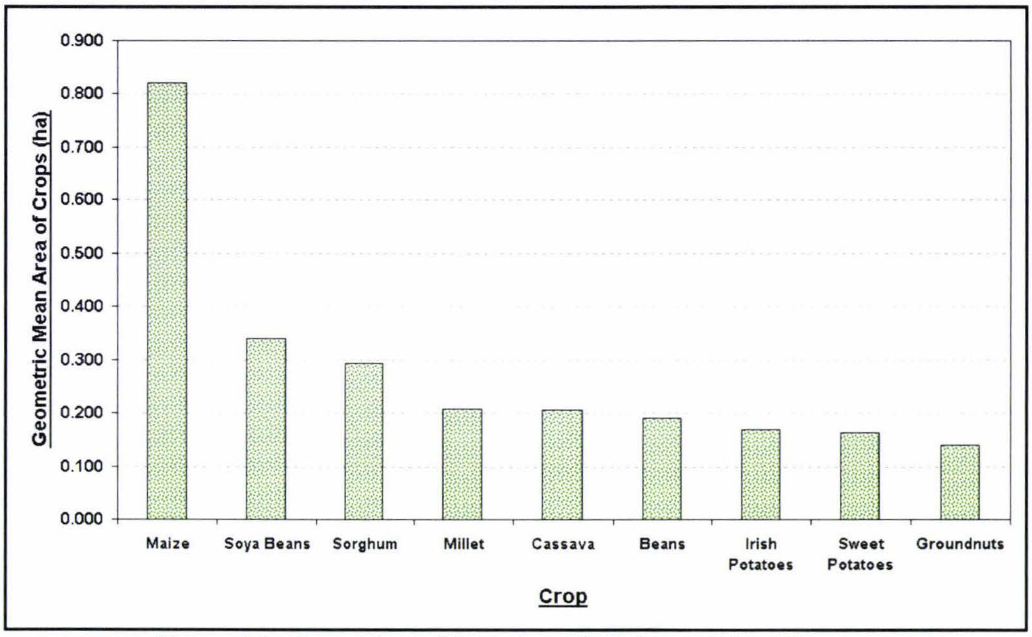

Figure 4.3: Comparison of Crop Area Planted by Individual Farmers

4.1.2.3 Farm Production

According to respondents [82], production is highly variable due to climatic effects. Maize production [83] ranges between ten to twenty 90kg bags per hectare (900-1800 kg/ha) for poor and good growing seasons respectively. Yields of fourteen to fifteen 90 kg bags per hectare (1170-1350 kg/ha) are seen as acceptable in average growing seasons. While information on production is not recorded by farmers, there is an awareness that maize production is decreasing.

The sale of crops is highly dependent on the success of the growing season, with household requirement coming first before trade. During poor seasons little of the crop is sold, while over half can be sold in good seasons. In a typical year, approximately 29% of the maize crop is sold (n = 22; FSS) [84].

82. Levels of production were asked at the farmer interviews (n=8), with additional information from key informants. For a variety of reasons a production question was not included in the farming system survey, which, in hindsight, should have been included.

83. Due to profound importance of maize, only maize production is considered here. There are valid reasons for this. Firstly, it is the only crop grown by all farmers and secondly it is often used as an indicator crop for agricultural performance within Zambia.

84. Of the 42 respondents, eight mentioned that they did not sell crops while the remainder (12) could not identify the amount of maize sold.

4.1.2.4 Livestock

Of the respondents, 76% (n = 42; FSS) owned livestock of some form, with chickens and goats being the main livestock species owned (Table 4.8). Livestock are primarily raised as an intermittent source of meat. Cattle, however, are primarily used for draught purposes and are rarely used for meat by the household, although sometimes they are sold as a means of income generation.

Table 4.8: Livestock Ownership in Mutanda (n = 42; FSS)

Livestock	Goats	Chickens	Cattle	Pigs	Others*
Percentage of Farms	31	67.7	19	11.9	4.8
Median Number	6	>10	2	2	---

* *Includes Sheep, Pigeons and other fowl species*

4.1.2.5 Farm Inputs

Agricultural inputs were used by 30% of the farmers in some form. Fertiliser was used by 23% (n = 42; FSS), with these same farmers also using certified seeds. No farmers used certified seed without fertiliser. Animal draught power is used by 21% (n = 42; FSS) of the farmers, with all but one of these farmers owning their cattle. The use of machinery (of any type) is virtually non- existent in the area, with only one farmer irregularly hiring a tractor.

The main form of energy input is through human activity, using hoes and axes. For typical farming operations, the median labour force is 3.0 people per farm (n = 42; FSS), although this is dependent on farm size. Weighted against the planted crop area, the average labour density of 1.9 people/ha.

Despite the small sample, the comparison of the primary inputs used (cattle and fertiliser/seed) highlights that farms with cattle use have a significantly larger planted crop area (Table 4.9).

Table 4.9: Impact of Inputs on Planted Crop Area

Input	Use	n	Median Area (ha)	Mann-Whitney U-Statistic	p-level *(Upper-Tail)*
Cattle	*No*	33	1.6	209	**0.032**
	Yes	9	2.6		
Fertiliser & Certified Seed	*No*	34	1.9	130.5	**0.57**
	Yes	8	1.6		

4.1.2.6 Development

There is a keen interest shown by farmers to develop their agricultural production system. All farmers that did not currently use cattle showed a strong desire to own cattle for use in their farming operation. If a tractor was available, 93% (n = 41; FSS) of the farmers showed a keenness to hire one. The median "willingness to pay" price for the use of a tractor was K50,000[85] (n = 24; FSS). Notably, 29% of the respondents who would like to hire a tractor mentioned that their willingness to pay was *"dependent on who owned the tractor"*, while 8% would like to hire a tractor but could not afford to.

All but two respondents (n = 42; FSS) indicated they were very interested in growing new crops, especially soya beans. The diversification to cassava, however, did not seem to be favoured by farmers not growing it already.

4.1.2.7 Constraint Assessment

The assessment of constraints by farmers strongly emphasises the low input systems of farming, and difficulties related to infrastructure and the market.

Fertiliser and Seed

The use of fertiliser is limited for two universal reasons. Firstly, farmers consider that fertiliser is too expensive to justify its use[86]: *"I would like to use fertiliser but it is too expensive."* It can be shown that the use of fertilisers, accounts for over 60% of the input costs for the current present farming systems. Including certified seed use, which is often congruent with fertiliser use, this increases to 70% (Table 4.10).

Secondly, while farmers need to apply fertiliser during field preparation prior to crop planting (October/November), a constant constraint identified by farmers was that fertiliser rarely arrives when it is required: *"Fertiliser always late. I need it when preparing the ground but it arrives in January."*

85. This price excluded fuel and but included the driver payment. At the time of the surveys, 50,000 kwacha equates to $NZ33.46 or $US13.87.

86. At August 2001, fertiliser costs were K72,000 per 50kg bag of both urea and Compound D ($NZ48.19, $US19.97) in Mutanda. The general use of fertiliser requires two 50kg bags per lima, with one basal dressing and one top dressing.

Table 4.10: Approximate Inputs Costs for Annual Maize Production, per lima (Data from Key Informants)

Input	Cost per Lima*	Percentage of per Lima
Ploughing, planting and preparation	40000	**16.7**
Weeding	20000	**8.4**
Harvesting	15000	**6.3**
Fertiliser	144000	**60.3**
Certified Seed	20000	**8.4**
Total Cost of Maize Production	**239000**	**100**

* *Costs in Kwacha. At time of survey (August 2001), $NZ1 = 1494 Kwacha*

The constraints in fertiliser use impacts on the usage of certified seed as farmers are reluctant to use the latter without the former: *"I do not use certified seeds as I do not use fertiliser."* This is an extensive belief throughout the farming community, confirmed by key informants.

Energy

Farmers identify the shortage of energy inputs, either as cattle or machinery was a significant constraint: (1) *"We do too much manual work. We cut down trees, walk five km, we have no machines and not many cattle. It makes living very hard."* and (2) *"Using hand power, we can cultivate two hectares of land and don't have enough to eat. With animal power we could use ten hectares, increase food to eat and sell more crops."*

The cost of cattle is a considerable constraint, costing around one million Kwacha (c.$NZ670). As noted by respondents this is out of reach of most households. According to key informants, the use of cattle is also constrained by the culture of the people in that they do not have a history of cattle husbandry which has to be learnt.

Roading

Transportation was regularly identified as a constraint to increasing agricultural production: (1) *"It is difficult to transport crops when farmers are spread out. It is too costly."* and (2) *"I would like to grow other crops but I cannot sell my current crops as transport is poor and expensive. Farmers closer to the towns and cities* *are better off. It is easier for them".* From personal observation, the conditions of feeder roads can be justifiably classed as being in very poor condition.

Technology Transfer

Key informants commented that agricultural practices are not improving and noted that many farmers are *"returning to the old ways due to lack of inputs".* Two farmers (key informants) were very assertive that many farmers are still unaware of basic agricultural practices and critical that necessary extension services were not available: *"We don't have all the information required to change [our farming practices]. We need to be taught how to do new things."*

Land Tenure

The issue of land ownership was not highlighted as major concern by farmers, with other issues being considered more pressing (i.e. fertiliser). However, key informants considered this to be an underlying issue related to poor agricultural growth. One key informant considered that land reform was the most important issue facing farmers stating that *"development cannot occur unless it is linked to the land".* The context of this statement was that for agricultural development to occur, as desired by the government, farmers needed to have the freedom in land ownership.

4.1.3 Hypotheses Testing

4.1.3.1 Question One

To what extent is food consumption, in terms of daily meals, impacted by seasonality?

Hypothesis One (A)

- Rural households in the Mutanda area experience food shortages for at least some period of the year but less than half a year.

While there are variations in the start and end of food shortages for individual households, on average the food shortages last for 4.0 months[87] of the year. With a small variation (se = 0.16), the hypothesis can be supported (Table 4.11) that the Mutanda area is effected by food shortages, but they not extended beyond half a year. From the survey data, proportionally Mutanda experiences food shortages for ⅓ of the year.

Table 4.11: Analysis of Hypothesis One (A)

Months with Food Shortages	n	Mean	SE	95% Confidence Limits	
				Lower	*Upper*
	102	4	0.16	3.7	4.3

Result
As the lower CL (u_0) is greater than zero and the upper CL (u_1) is less than six, the null hypothesis is rejected at the 5% significance level and the alterative hypothesis is accepted. Thus, food shortages occur in Mutanda but do not extend beyond half a year.

Hypothesis One (B)

- For the average household, the food intake (based on effective daily meals) is significantly lower at minimum food consumption than maximum food consumption.

With a β-ratio of 0.32 at minimum food consumption, households on average consume 32% of the food they do at maximum food consumption (in terms of effective meals). Consequently, there is a significant difference in the quantity of food consumed between maximum and minimum food consumption (Table 4.12a).

Table 4.12a: Analysis of Hypothesis One (B)

β-Ratio	n	Mean	SE	Difference*	t-stat	p-level
	102	0.32	0.03	-0.68	-26.9	<0.001

Result
As the p-level (<0.001) is less than the significance level (0.05), the null hypothesis is rejected and the alternative hypothesis accepted. The amount of food consumed (in terms of effective daily meals) during minimum food consumption is significantly different from that consumed during maximum food consumption.

* *Hypothesised Mean = 1 (i.e. no difference in ratio)*

87. There are four months between mid-November and mid-March: i) mid-November to mid-December, ii) mid-December to mid-January, iii) mid-January to mid-February and iv) mid-February to mid-March

This difference in food consumption can be supported by a χ^2 test, between the effective daily meals at maximum and minimum food consumption (Table 4.12b). This results shows that the distribution of effective meals between these two times, is significantly different ($p < 0.001$). The change in the distribution occurs through a rationalisation of both the frequency and relative size of daily meals during minimum food consumption (Table 4.12c).

Table 4.12b: Comparison of Effective Daily Meals at Maximum & Minimum Food Consumption

Percentage of Households at....		Number of Effective Daily Meals (eM) eM < 1	1 ≤ eM < 2	2 ≤ eM < 3	eM ≥ 3	Total
Maximum Food Consumption (eM_x)	*Observed*	**0**	**1**	**40**	**61**	**102**
	Expected	-31	-14.5	-23.5	-33	
Minimum Food Consumption (eM_n)	*Observed*	**62**	**28**	**7**	**5**	**102**
	Expected	-31	-14.5	-23.5	-33	
	Total	**62**	**29**	**47**	**66**	**204**

χ^2 statistic = 157.82
p-level < 0.001

Table 4.12c: Changes to Frequency and Size of Daily Meals (n = 102)

Daily Meals	Maximum Food Consumption *Mean*	*SE*	Minimum Food Consumption *Mean*	*SE*	Difference	t-stat	p-level* *(Lower Tail)*
Frequency (M)	2.6	0.05	1.45	0.07	-1.15	-17.1	<0.001
Relative Size (S)	1.0	0.00	0.51	0.02	-0.49	-20.6	<0.001
Effective (eM)	2.6	0.05	0.84	0.07	-1.76	-23.5	<0.001

* *using paired t-test*

4.1.3.2 Question Two

How does the use of income and storage impact on the level of food consumption and hunger?

<u>Hypothesis Two (A): Income</u>

- Rural households that use income for food acquisition consume a larger proportion of daily meals at minimum food consumption compared to households who do not use income.

Comparing respondents who use income for food purchases to those who do not, supports the hypothesis that households using income have a greater consumption of food at minimum food consumption. On average these households using income to purchase food, consume 68% more food (in terms of daily meals) at minimum food consumption compared to households who do not use income (Table 4.13a).

Table 4.13a: Analysis of Hypothesis Two (A)

Income Use for Food Purchases	n	Mean	SE	Difference between Means	t-statistic	p-level
		β-Ratio				
Yes	39	0.42	0.048	0.17	3.37	<0.001
No	63	0.25	0.026			

Result

As the p-level (<0.001) is less than the significance level (0.05), the null hypothesis is rejected and the alternative hypothesis accepted. Consequently, household which use income to purchase food consume a greater proportion of food at minimum food consumption than household who do not use income to purchase food.

In terms of complementary redundancy, the use of income to purchase food also produces a significant difference in the level of food satisfaction at minimum food consumption (Table 4.13b).

Table 4.13b: Effect on the level of Food Satisfaction at Minimum Food Consumption due to Income Use

Income Use for Food Purchases	n	Mean	SE	Difference between Means	t-statistic	p-level
		Food Satisfaction Ranking (R_n)				
Yes	39	3.3	0.28	0.7	2.16	0.016
No	63	2.6	0.18			

Hypothesis Two (B): Storage

- Rural households that use ECZ silos consume a larger proportion of daily meals at minimum food consumption compared to household who use traditional forms of storage.

Comparing households using ECZ silos to households with traditional storage cribs does not support the stated hypothesis. While there is a slight improvement in the β-ratio at minimum food consumption for households using the ECZ silo, this improvement is not significant (Table 4.14a). However, in comparison, the use of storage does significantly improve food satisfaction at minimum food consumption (Table 4.14b).

Table 4.14a: Analysis of Hypothesis Two (B)

Storage System	n	Mean	SE	Difference between Means	t-statistic	p-level
		β-Ratio				
ECZ Silo	27	0.35	0.064	0.044	0.76	0.223
Traditional	75	0.3	0.026			

Result
As the p-level (0.223) is greater than the significance level (0.05), the null hypothesis is not rejected. Consequently, households which use the ECZ silo for maize storage do not have a significantly larger proportion of food at minimum food consumption.

Table 4.14b: Effect on the level of Food Satisfaction at Minimum Food Consumption due to Storage Use

Shortage Use	n	Mean	SE	Difference between Means	t-statistic	p-level
		Food Satisfaction Ranking (R_n)				
ECZ Silo	27	3.3	0.31	0.06	1.74	0.043
Traditional	75	2.7	0.17			

4.1.3.3 Question Three

How do the characteristics of farming systems impact on food consumption in households?

Hypothesis Three (A): Planted Crop Area

- Households with a β-ratio of less than one-third have a smaller planted crop area than households with a β-ratio greater than one-third.

From the survey data, the hypothesis can be supported that the households with a β-ratio ≥ 0.333 have a significantly larger area of planted crops than households with a β < 0.333 (Table 4.15).

Table 4.15: Analysis of Hypothesis Three (A)

β-Ratio	n	Mean	SE	Difference between Means	t-statistic	p-level
		Planted Crop Area (ha)				
< 0.333	39	1.44	0.099	-0.64	-2.97	0.002
≥ 0.333	63	2.08	0.211			

Result
As the p-level (0.002) is less than the significance level (0.05), the null hypothesis is rejected and the alternative hypothesis accepted. Consequently, household with a β-ratio greater than 0.333 have a larger planted crop area.

Hypothesis Three (B): Number of Crops

- The number of crops planted by a household effects the level of food intake during minimum food consumption

The χ^2 test indicates that the frequency in the number of crops planted is associated with the β-ratio (Table 4.16a), supporting the given hypothesis.

Table 4.16a: Analysis of Hypothesis Three (B)

β-Ratio		Number of Crops 2	3	4	5	6+	Total
< 0.333	*Observed*	**7**	**18**	**19**	**9**	**5**	**58**
	Expected	(5.1)	(14.2)	-17.6	-12.5	(8.5)	
≥ 0.333	*Observed*	**2**	**7**	**12**	**13**	**10**	**44**
	Expected	(3.9)	-10.8	-13.4	-9.5	(6.5)	
	Total	**9**	**25**	**31**	**22**	**15**	**102**

χ^2 statistic = 9.86 **p-level** = 0.043

Result
As the p-level (0.043) is less than the significance level (0.05), the null hypothesis is rejected and the alternative hypothesis accepted. Consequently, the distribution of planted crops is associated with the household β-ratio.

An assessment of median number of planted crops reveals that households with a β-ratio < 0.333 have a significantly lower number of planted crops compared to households with a β-ratio ≥ 0.333 (Table 4.16b).

Table 4.16b: Effect of the β-Ratio on Number of Planted Crops

β-ratio	n	Number of Planted Crops	Mann-Whitney U-Statistic	p-level *(Two-Tail)*
< 0.333	58	4	1706.5	0.003
≥ 0.333	44	5		

Hypothesis Three (C): Use of Inputs

- The use of agricultural inputs (aggregated use of cattle, fertiliser/certified seed) effects the level of food intake during minimum food consumption

Based on the χ^2 test, the variation in food intake between maximum and minimum food consumption is associated with the use of agricultural inputs, supporting the hypothesis (Table 4.17)[88].

Table 4.17: Analysis of Hypothesis Three (C)

β-Ratio		**Inputs**		**Total**
		Yes	**No**	
< 0.333	*Observed*	**4**	**21**	**25**
	Expected	-7.7	-17.3	
≥ 0.333	*Observed*	**9**	**8**	**17**
	Expected	-5.3	-11.7	
	Total	**13**	**29**	**42**
	χ^2 statistics = 4.85	**p-level**[89] = 0.028		

Result
As the p-level (0.043) is less than the significance level (0.05), the null hypothesis is rejected and the alternative hypothesis accepted. Consequently, the use of agricultural input is associated with the household β-ratio.

* * * * * * * * * * * * * * *

88. Due to the small sample size, the inputs (cattle and fertiliser/certified seed) have been aggregated.

89. Corrected for continuity (refer to Siegel and Castellan (1988))

4.2 DISCUSSION OF RESULTS

4.2.1 Food Consumption

From the survey, households have a preference to consume three meals per day when food is available. Although this study highlights that some households consume less than three meals per day during maximum food consumption but can still be considered as food secure. During the period of maximum food consumption (late May), 60% of households consume three full meals per day, with 99% of the households consuming at least two full meals per day.

Comparatively, during minimum food consumption (late December), 61% of households consume less than one effective meal per day, with 88% of households consuming less than two effective daily meals (Table 4.5b). For 79% of the households, the change occurred through a reduction in both meal frequency and size, with only 5% of the households not adjusting meal consumption during the year. With meal frequency and size being reduced by 46% and 49% respectively, the effective quantity of daily meals at minimum food consumption is reduced to 32% (β-ratio = 0.32) of the daily meals consumed at maximum food consumption.

4.2.2 Rationalisation of Food Consumption

The reduction of daily meal frequency and size is the physical component in the rationalisation process of food consumption. While the movement between maximum and minimum food consumption is unlikely to be linear, the resultant process of rationalisation can be adequately represented by a vector (Figure 4.4). According to key informants, the rationalisation process is a regular occurrence for the Mutanda area, which is followed by the recovery process to return households back to a position of optimum food consumption.

With a β-ratio of 0.32, food intake is rationalised by 68% between the maximum and minimum food consumption. Logically, the rationalisation of food consumption, assuming a constant demand [90], is related to the vulnerability

90. This condition is important, as rationalisation in food can occur through the desire to undertake a diet, or for health reasons.

caused by an unequal temporal distribution of food. Hence, the process of rationalising daily meals represents a coping strategy used by households faced with a changing food supply, due to variations and/or restrictions in food availability, accessibility or utilisation.

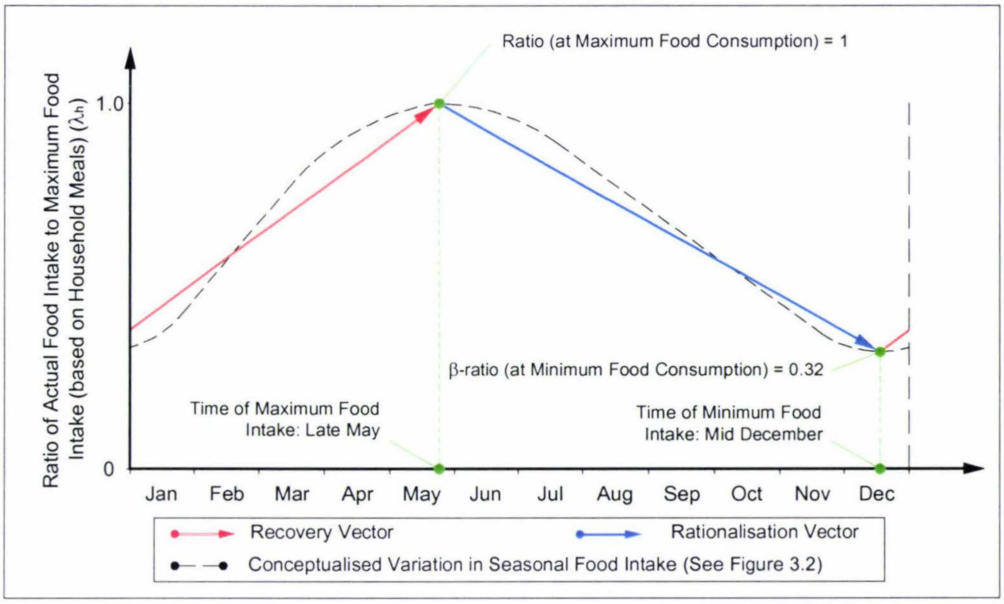

Figure 4.4: Rationalisation and Recovery of Seasonal Food Consumption in Mutanda

4.2.2.1 Food Availability

Food availability is dominated by agricultural production in the Mutanda area, with 98% of households stating this as their primary source of food. With the production systems, especially maize, being confined to a specific growing and harvest period, which is predetermined by the unimodal rainfall patterns of the area, food availability, accordingly, is highly seasonal. It is not, therefore, surprising that the maximum food consumption occurs during the harvest period (i.e. when food is plentiful), while minimum food consumption occurs where crops are growing. Consequently, the reason for the current rationalisation of food consumption in Mutanda is due to the reliance on seasonal agricultural production

The farming system is based around maize [91] production, supplemented by the

91. Due to the importance of maize, this crop receives most of the focus in reports. In this, maize is very much considered an indicator to agricultural production performance. Consequently, maize will dominant most of the discussion in terms of agricultural production.

growing of other crops in significantly smaller quantities. The observed farming system is well described by the 'mixed maize system' as identified by Hall *et.al.* (2001). The present farming practice can be best classified as 'bush fallow' [92], where rotation of land is undertaken within a fixed area (Benneh 1996). The survey highlights that the median planted area (1.5 ha) is less than the total farm area (4.0 ha) [93]. With the limited use of inputs, especially fertiliser and energy, combined with the low outputs, the agricultural system can be classified as "low input - low output". Such systems are well-identified within the sub-Saharan Africa region (Donovan 1999).

The issues affecting agricultural production systems on food security can be grouped into categories: land area and crop yields. This relates back to the concepts of agricultural extensification and agricultural intensification identified in the literature review.

<u>Land Area</u>

The qualified results from the survey supports the view that farmers with leasehold land have a larger farm area, both in total land and planted crop area (Table 4.7a & b). Land area, especially that planted in crops, contributes significantly to the level of increased food consumption (Hypothesis Three (A): Table 4.15). This observation supports literature that considers land area is an important aspect of addressing problems of food insecurity and poverty (Hall *et.al.* 2001; Chapagain 2000; Meliczek 1995).

While leasehold land offers benefits, the cost of surveying prevents this form of land tenure being regularly used, as noted by the farmers. However there is an awareness, especially by key informants, that the underlying constraint to land use in the Mutanda area is the national land tenure policy preventing freehold property. This policy does prevent the use of a potentially important form of collateral and also places the farmers in a state of dependency on the government, restricting

92. Benneh (1996) also uses the term 'land rotation' and 'slash-and-burn agriculture'

93. While the preference is to have an eight-year rotation, with four cropping/four fallow (Department of Agriculture 1979), this is often constrained by land access. Hence, rotation tends to be more dictated by a decrease in crop yields, as noted by Chikwekwe *et.al.* (1996). Key informants suggest that, in practice, land rotation occurs over a four to five year period.

the ability to develop their farms in freedom. This restriction would seem to be in conflict with the free market economy that the government promotes.

The expansion of land for agriculture raises concerns related to environmental issues. As noted in the literature review, these concerns tend to focus on the encroachment of agriculture into marginal lands and tropical forests. However, from observation, and key informants, it would be difficult to justify preventing agricultural extensification on these two issues. While the land is undeveloped, there is no indication from official assessments to support a hypothesis that the land can be classified as marginal (MAFF undated). It is frequently stressed that through good management interventions, the land can be made productive despite the assessed limitation in soil quality.

The potential concern related to deforestation of tropical forests is doubtful for the Mutanda area. While specific forests are designated (see Mutanda Map, p10), the majority of the land is already used for 'bush-fallow' agriculture (with vegetation described as either savanna woodland and/or savanna grasslands). Consequently, while much land is already exposed to some form of agriculture, the underlying issue is one of inadequate land utilisation. Improving the utilisation of land involves aspects of both agricultural extensification (i.e. increased energy inputs) and agricultural intensification (i.e. fertiliser/certified seeds, improved farming practices). The improved land utilisation and the relationship with food security would be worthy of further research within the Mutanda area.

Energy Inputs

The issue of applied energy in farming systems is generally related to the issues of expanding farm area (Rijk 1995; Stout 1990). For the Mutanda area, the predominant means of farm energy input is through manual labour (Level 1 Farm Operation: Opara 1994). 21% of farmers use cattle in their farming operations, mostly confined to ploughing (Level 2 Farming Operation: Opara 1994). The use of machinery, of all types, for farming operations is effectively non-existent in the Mutanda area, with only one farmer irregularly hiring a tractor.

Donovan (1999) considers that manual labour will limit farm area to under two hectares. From the survey, farms using cattle had a median planted crop area of 2.6 hectares, compared to 1.6 hectares for farms using manual labour, which is significantly different (p = 0.032, Table 4.9). Such a result does agree with established theory in literature that highlights the benefits of increased energy inputs and the consequential improvement possible to agricultural productivity and food security (Rijk 1995; Stout 1990).

There is considerable interest by farmers to use cattle in their farming operation, as a means to increase farm production and use of cattle as a source of extra income. Within this interest, there maybe a preference for farmers to use cattle instead of fertiliser/certified seed. While the presence of the cattle project would have an influence in this, there is an implicit view held by farmers that cattle ownership provides greater independence for the farmers over other input types (i.e. there is no need to wait for fertiliser to arrive). As a means to counter the decrease in yields, there is an inference from this survey that farmers may increase the planted crop area to improve aggregate farm production, rather than increasing yields through using fertiliser/certified seeds. While such an increase cannot be supported statistically, farmers who do not use fertiliser and certified seed have farms with a slightly higher planted crop area (Table 4.9). And this increase may, in part, be attributed to the use of cattle as the primary agricultural input.

Crops Yields

According to key informants current yields of maize are between 1170-1350 kg/ha for the Mutanda area. While such yields agree with official statistics (MAFF 2000a, Central Statistical Office 2000, 1999) and local estimates (Chuma 2000), they are considered to be low compared to potential yields. Based on data from key informants, maize yields of 4000-4500 kg/ha can be obtained with the use of fertiliser and certified seed (assuming an average climatic year).

While there is an awareness of yield decreases, as noted in the literature, this could not be accurately quantified[94]. While this study cannot statistically ascribe

94. According to key informants, this is a symptom of production data not being recorded by farmers. Key informants consider the limitations in data collection is one of the major constraints in measuring policy targets.

the reasons for the decrease in yields, it is well accepted by key informants and farmers that this is the result from low input use (Munenu 1996).

Fertiliser

Despite the potential increases, this study identifies that only 23% of the farmers used fertiliser. There are two major reasons identified for the low use of fertiliser: cost and lateness of supply. These reasons have been identified in past reports (Phiri 1998; Chikwekwe *et. al.* 1996 and Munenu 1996). The cost of fertilisers plays a critical role in the economic viability of the farming system, accounting for 60% of all inputs costs (Table 4.10). To enable recovery of input costs, and maintain the food supply for the household, there is a need to increase yields to around 4000 kg/ha[95]. While, as noted above, such yields are possible, achieving such a result is unlikely for smallholder farmers and is an exceptionally risky strategy, especially if the climatic conditions are less than optimal. As smallholder farmers typically make decisions to minimise risk (Boussard 1992), the use of fertiliser quickly becomes a dispensable input in farm decision making.

The low fertiliser usage is not solely determined by cost and price. Farmers who can purchase fertiliser are frustrated that lateness of supply impacts on their attempts to develop their farming production systems. It is obvious that an increase in yields cannot be achieved when fertiliser arrives two months after field preparation.

Certified Seeds

The use of certified seed, however, is not seen as being constrained by these two problems. The survey results show that only farmers who use fertiliser are willing to use certified seeds. This supports other reports that the use of fertiliser and certified seed are considered to be congruent (Munenu 1996). Hence, without fertiliser, farmers revert to using local varieties of maize which have considerably lower yields than certified seeds and contribute to the decrease levels of production (Phiri 1998; Chikwekwe *et. al.* 1996).

95. This is based on a fertiliser cost of K144,000 per lima, a maize price of K12,000 ($NZ8.03) per 50kg and a current yield of 1300 kg/ha. While the price of maize is fluctuates considerably during the year (Chuma 2000 and 1998), this is the typical price paid during the field research period and would be considered an adequate reflection of a typical price obtained by farmers when maize is sold to millers.

Combined Inputs

Due to the small sample size, it was not possible to relate whether the use of cattle or fertiliser/certified seed had the greater impact on food consumption levels. However, aggregating the use of inputs, households that used either fertiliser/certified seed and/or cattle, had a significantly greater level of food consumption (Hypothesis Three (C): (Table 4.17). Therefore, qualified support can be given to the use of farm inputs playing an important role in food security strategies in Mutanda.

Crop Diversification

The survey results do present a case that a more diversified production system does increase food consumption levels (Hypothesis Three (B): Table 4.16).

While key informants noted that the uptake of diversification strategies were poor, farmers showed a very keen interest to diversify their production system. In particular, there was an interest in soya beans, which is a relatively new crop to the area. While the survey only identified 16% of households growing the soya beans (Figure 4.2), when it was grown, soya beans were the second largest crop grown by individual households (Figure 4.3). Comparatively, households were less interested in growing cassava, mainly due to the preparation required, despite this being a crop promoted to alleviate food security (PAM 2001, Appendix 6).

According to farmers one of the reasons to the limited diversification was due, to a large degree, to the limited extension services available [96]. It cannot be surprising, that households will either not diversify and revert back to cropping systems if new knowledge is not forthcoming. In this diversification is strongly dependent on good education and extension services being available and implemented.

<u>Government Polices</u>

Farmers are concerned about the limited support given by the government for agriculture. In particular, concerns revolve around roading and extension.

96. The limited financial resources was another reason raised but this effects all facets of the local community. Instead, the limited extension services are unique in to this issue and hence potentially more relevant.

Extension services are well recognised as an important contributor to the alleviation of food insecurity in rural areas (IFPRI 2002). While the government has well-developed policies on extension (MAFF 2000b), these intentions are limited by under funding [97]. Consequently, according to farmers, government extension services are very infrequent. In the Mutanda area, the majority of extension is supplied, by default, through the Mutanda Centre. However, due to capital constraints, these extension programmes are also limited.

Roading was frequently raised by respondents as being poor. According to farmers, requests for roads to be repaired or improved have not been enacted upon. The quality of feeder roads (the roads outside of the main highways) is of increasing concern to the farmers, as their poor state restricts the effective transportation of products to the markets. This observation supports conclusions raised by other studies in the Solwezi District (Chikwekwe *et. al.* 1996; Munenu 1996). The importance of good transportation systems to promote economic development is well recognized as an important intervention in rural development (Amandi 1988; Airey 1985), which will ultimately lead to an improvement in food security (Ahmed and Donovan 1997; Wanmali and Islam 1997).

4.2.2.2 Food Accessibility

Although this study only identified 36% of households used income to purchase food, the results support the literature that the use of income has a significant effect on increasing food intake (Hypothesis Two (A): Table 4.13a). Households using income had a significantly higher β-ratio at 0.42, compared to a β-ratio of 0.25 for households not using income. This, in effect, means that households using income to purchase food consume 68% more food (in terms of effective daily meals) at minimum food consumption than households not using income. However, the use of income does not provide enough utility to mitigate against all the vulnerability created by the seasonal dependence on agricultural production. Despite a higher β-ratio of 0.42, households using income still present a signficant difference ($p < 0.001$) between their food intake at minimum and maximum food consumption (t-test against a β-ratio of one - i.e. no difference in food intake).

97. This is supported by confidential report form a key informant, as indicated in the literature review.

One reason for low use of income to purchase food rests with the limited development of a functioning market in the Mutanda area. Currently there is only one small store (operated by the Mutanda Centre), which generally focuses on non-food items and two, very small, informal markets. The closest formalised market is located 40 km to the northeast at Solwezi, although access to this is restricted due to transportation costs, and the limited transport resources available. In this, the issue of transportation infrastructure raised above in regards to food availability, has an equally important role to play in improving food accessibility.

The poorly developed state of local markets is not unique to Mutanda and has been identified as a major constraint in other communities (Munenu 1996). One example of this is the Chafukuma area (50 km northwest of Mutanda), where through the farmers cooperative (and assisted by development grants) a new market has been recently established to counter such problems (Figure 4.5).

Figure 4.5: Development of Cooperative Market at Chafukuma
(Photo by Author)

Another potential explanation for the low use of income to purchase food is related to the high use of agricultural production as the primary means of food acquisition. There is a widespread view held within the community that due to growing their own food, there is a limited need to purchase food. Instead the utility of income is reserved for other essential living expenses, such as housing, school fees and non-food consumables.

4.2.2.3 Food Utilisation [98]

From literature, it is well accepted that adequate storage is an essential part of reducing the vulnerability of seasonal food supplies from agricultural production. However, while households using an ECZ silo had an increase in food consumption during food shortage, compared to households that use traditional storage systems, this increase was not significant. This result is of surprise, considering households using silos presented the strong impression that they had an improved level of food consumption during periods of food shortages [99]. This assessment can be supported, in part, as the households with access to a silo have a significantly greater level of food satisfaction over other households.

There are two potential reasons offered to explain this difference. Firstly, it could be possible that the silos do not actually provide an improvement to food consumption during food shortages as promoted. However, this is unlikely as the data does not suggest that the silos have a negative impact on the levels of food consumption. A more likely explanation is related to the actual utilisation of the food from the silos. The silos have only been used since the late 1990's, hence due to cultural history [100], the adaption from the traditional storage systems to the improved utilisation offered by the ECZ silos maybe taking time to show a significant difference in food consumption. However, simply by owning a silo, households may have a more immediate, and psychological, perception of the benefits to food security, despite only minor changes to food consumption patterns.

While, due to insufficient data, this explanation can only be postulated [101], it would

98. Depending on literature sources, food storage can be classified as either an issue of food availability or food utilisation. In the context of Mutanda, the issue of food storage can be referred to as the 'utilisation of available food', hence this is more of an issue of food utilisation. There would seem to be merits, in terms of simplification, to use the IFAD (2002) category of "Food Stability" when referring to food storage in the future.

99. Even households without the silos felt the same and were eager to purchase one to improve the level of food consumption.

100. According to key informants, households historically tend to 'over-consume' when food is readily available (i.e. after harvest), rather than evening out supply for later consumption. An explanation of this situation could be that households consider it is better to consume the food when it is available, rather than storing it as food is likely to spoil due to the limitations of physical storage. Conceptually, this situation could be considered 'bodily storage', rather than physical storage. However, due to limitations in methodology (resource constraints), this situation was not covered in this study. Clarification of this issue would be worthy of future research.

101. A follow-up survey to confirm this would be a worthy consideration.

suggest that additional education to inform households of the improved utilisation provided by the silos (i.e. the ability to smooth out food supply) could lead to increased levels of food consumption during food shortages. It is widely accepted that education and training are critical to the potential benefits offered by technological interventions to be realised (Vandenban and Hawkins 1996; IFPRI 1991).

4.2.2.4 Nutrition

In terms of energy, maize accounts for an estimated 73% of the diet, with total carbohydrate and starch-based food's accounting for up to 95% of energy consumed by households [102]. The rationalisation of meals is partially a response to the role maize (in the form of nshima) plays in the local diet. Due to the preference for maize, there seems to be little desire to use other foods to augment the food supply when maize is limited, instead households choose to rationalise food. It is clear from key informants that the extent of seasonal food insecurity can be mitigated, at least in part, by the increased use of crops already available (i.e. cassava, sweet potato). While this reluctant change maybe due to personal preference, it could also be related to the lack of education/extension services encountered with the problems faced with crop diversification.

4.2.3 Rationalisation of Food Consumption and the Inference of Food Insecurity

As noted in the literature review, food security is well established as a tension between actual food intake and the recommended food intake for the human body to maintain an acceptable level of health. The result of this survey focuses on the food consumption aspects of the food security inequality (left-hand side of Equation 3.1 and numerator of Equation 3.2).

This survey provides evidence that between maximum and minimum food consumption, the level of food intake is, for the average household, reduced by

102. While this information is based on the crop's grown, as food acquisition is heavily dependent on agricultural production, it follows that such an attribute will extend into the diets of households.

68% (as β = 0.32). For food insecurity not to occur, there would need to be a similar reduction in recommended food intakes. However, as explained in the adapted conceptual model (Section 3.1.3), the primary variation in food security occurs due to changes in food consumption rather than in the level of food required to meet the body's needs. It is extremely unlikely that the level of food requirement would vary by a magnitude similar to the 68% identified from the survey [103].

Providing complementary redundancy to support of food insecurity occurring is the change in food satisfaction (Figure 4.1). At maximum food consumption, the clear majority of respondents indicated that their households were "always well fed". This would tend to be a strong indicator that, at this time, the overwhelming majority households are food secure. Further support to this conclusion rests on key informant views that food supply is not restricted at this period, due to being the harvest season. Also, from literature, there is an implicit view that it is more likely households can be classified as being food secure when there is a consumption of two or three full meals per day.

However, at minimum food consumption, the perception of food satisfaction is significantly altered. At this time, 63% of the households consider they suffer from a degree of hunger. Combined with the majority of households (61%) consuming less than one effective meal per day, there can be qualified support presented to conclude that food insecurity is prevalent during the period of minimum food consumption. Key informants are aware that food supply at this time is considerably restricted.

From the survey, this period of inadequate food supply can be identified as a defined hunger season which occurs between mid-November and mid-March in the Mutanda area (Table 4.3). Similar hunger seasons have been recorded in the wider Solwezi District (Phiri 1998; Chikwekwe *et.al.* 1996; Munenu 1996). Food shortages occur, on average, for four months but does not extend over half a year

103. The nutrient with the most variation is the energy requirement. Based on the standard equations from James and Schofield (1990), the maximum possible variation in energy requirements for any person (between two different days) is 35%. This situation would only occur in extreme (and under unrealistic) conditions. By using standard values the variations in energy requirements can be effectively held constant (Section 3.1.3).

(Table 4.11). The onset of food shortages is typically defined by a reduction in the frequency of meals from the household optimum (as opposed to a specific reduction in size). For the Mutanda area, this tends to occur when meal frequencies are rationalised from three to two meals per day. It follows, from this, that food shortages are considered to end when there is a return to the optimum meal frequency.

The existence of a hunger season does not, however, infer that food insecurity occurs throughout the whole period of food shortages. The hunger season simply denotes when the available food does not meet the quantity that household considers to be adequate for their needs. This situation can be identified, in part, from the responses given in the food consumption survey. While 95% of the respondents indicated that they suffered from food shortages, 32% considered that the food shortages were not severe enough to induce a state of hunger (Figure 4.1), even through these households may experience a decrease in satisfaction from food.

Based on the rationalisation of meals (as a measure of food intake), the satisfaction of food (as an indication of adequacy of intake) and the occurrence of a well-defined hunger season, a qualified inference can be presented to conclude that food insecurity does occurs in the Mutanda area for part of the year. Logically, it follows that the occurrence of food insecurity falls sometime within the period bounded by the start and end of food shortages, that is, between mid-November and Mid March.

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5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 The Characteristics of Food Insecurity in Mutanda

5.1.1.1 Overview

Despite the limitations of resources preventing a more complete assessment of food security, qualified support can be given to conclude that Mutanda suffers from food insecurity. The characteristics identified in this study would classify the Mutanda area as having **'transitory (seasonal) food insecurity'**. Food insecurity occurs within the period of food shortages from mid-November to mid-March. During the period of food insecurity, food consumption is reduced to 32% of that consumed during maximum food consumption. Both frequency and size of daily meals are rationalised, by 46% and 49% respectively.

5.1.1.2 Food Availability

The survey results indicate that for 98% of households, the main source of food is that obtained from the farm/garden. This result lays the foundation of the food system in the Mutanda area. There can be little coincidence that the period of food insecurity occurs during the part of the year where food supply from the farm/garden is the lowest. Hence, the Mutanda area is vulnerable to food insecurity due to the seasonal constraints on agricultural production. These constraints, in turn, stem from the unimodal rainfall pattern that dominates the Mutanda area and predetermines farming activities.

The farming system in the Mutanda area can be accurately described as a 'mixed maize system', with characteristics of both resource-poor and smallholder farmers being present. Farming operates on a bush fallow farming practice, rotating crops within a fixed area of land. Farmers use a low level of inputs, with only 23% and 21% using fertiliser/seed and cattle respectively. Only one farmer used machinery.

While the sample size is small, qualified support can be given to agricultural production playing an important role in food consumption. Households with greater levels of food consumption at minimum food consumption tend to have larger areas planted in crops, greater diversity of crops and an increased use of inputs (fertiliser/certified seed and cattle).

5.1.1.3 Food Accessibility

Due to the physical constraints, remoteness and poorly developed transportation networks, food accessibility is constrained. Combined with the limited market opportunities in the area, only 36% of the households purchased food. Most income was spent on non-food items, such as housing and clothing. The use of income did, however, provide a means by which households could augment their food supply. From the results, households using income consumed 68% more food at minimum food consumption than households not using income.

5.1.1.4 Food Utilisation

The use of storage in literature is well documented for being an important contributor to smoothing-out the effects of seasonality. The results from the survey showed only a small positive improvement in food consumption, with the use of improved storage (the ECZ silo) over traditional methods. This small increase could not be supported as being statistically different. However, the use of the silos did increase the level of food satisfaction, a difference that was significant. It is not possible, due to the limited data, to adequately present an explanation for the contrasting results. However, there is the possibility that the contrasting results could be related to limited education on how to utilise the silos. There would be value in undertaking further research to clarify this issue.

5.1.2 Summary

Despite food consumption being improved by income, agricultural production and, to a lesser extent, improved storage, food insecurity can be said to still occur at a concerning level. The results indicate that no single intervention provided a satisfactory solution to improving food consumption. However, there are indications that multiple strategies provide the greatest opportunity to improve food security. In particular, the combination of using income to purchase food, increased farm production and improved storage seemed to offer the best, and more immediate, strategies for households to move into a food secure livelihood.

5.2 RECOMMENDATIONS

The rationalisation of food consumption is a representation of the vulnerability caused by the high reliance on seasonal agricultural production. However, as noted by Sahn (1989), seasonal food production is a global phenomenon which has been controlled in many countries. In these countries, the mitigation of rationalising food consumption rests with strategies that can augment and/or smooth out the food supply. Critical in achieving this is the provision of alternative means of food acquisition, so the inherent vulnerability that accompanies a dependence on seasonal agricultural production is reduced.

Similar strategies to this are required in the Mutanda area. Based on this study, three recommendations are suggested to advance the improvement of food security.

5.2.1 Increasing Agricultural Production

The survey results support the view that food security is linked to agricultural production. Increasing agricultural production will have two effects on food security. Firstly, due to agricultural production being the primary means of food acquisition, increasing agricultural production will, logically, have a flow on effect through the food system for the household. The strategy to increase agricultural production as a means to increasing food security is well-accepted in literature. While such a recommendation may sound trivial and too simplistic [104], agricultural production is absolutely critical for food security for Mutanda. The importance of this recommendation can only be underestimated by this research.

Secondly, and potential more important, is that agricultural production is the most dominant contributor to household livelihoods and the local economy in Mutanda. As this situation is unlikely to change in the foreseeable future, strategies to increase income will largely rely on the economic growth generated through agricultural production and related sectors . This reality needs to be accepted so proactive steps can be taken to alleviate food insecurity and poverty in the

104. However, this is no more trivial than making a recommendation that economic growth will lead to a more food secure Third World. Such a recommendation is a frequent result of economically based food security research.

Mutanda area. To achieve this recommendation, three intervention strategies are raised:

- *Fertiliser/Seed:* The use of fertiliser and certified seed positively contribute to improving yields. The availability of fertiliser and certified seed needs to be matched with the time of demand. Attention to the cost of inputs, especially fertiliser, needs to become a critical part of macroeconomic policies to support agricultural growth in Mutanda.
- *Cattle Usage:* Cattle provide increased land utilisation, leading to increased production. The current focus on introducing cattle to farms (i.e. the Mutanda Centre Cattle Project, government extension objectives) is realistic and should be actively supported. The primary constraints for this to be an effective strategy relates to land access, the ability to acquire additional land and limited veterinary services.
- *Diversification:* The survey shows that farmers are more than willing to learn about growing new crops, and food consumption is increased by the number of crops. There are two key constraints to this strategy. Firstly, there are poor extension services to assist farmers diversify their crops. Secondly, the current climate patterns are not advantageous for significant diversification without the installation of irrigation systems. This issue is raised as a point for future investigation (Section 5.4).

5.2.2 Market Development

The results from the survey show the influence income can have in mitigating the vulnerability caused for seasonal agricultural production. In this, the use of income to purchase food needs to be encouraged in the Mutanda area. At present the market is very informal, offering limited products. The formalising and expansion of this market should be a priority. The development of the market at Chafukuma offers an excellent template from which to develop the market at Mutanda.

5.2.3 Improving Storage and Post-Harvest Processing

Despite the survey showing the use of ECZ silos only has a slight improvement to food consumption (which is statistically non-significant), this scheme should still be supported as their use does have a significantly positive influence on food satisfaction. In particular, the project can be strengthened by incorporating food education as part of the silo building programme. This should be enable households to understand the improved utilisation the silos provide for smoothing out the available food over the season.

Post-harvest processing provides additional utility in smoothing out seasonality. There are realistic opportunities to expand current post-harvest processing operations, especially when an electrical supply is secured. The inclusion of a coolstore as part of the market development plans can aid future post-harvest processing and support the diversification into new products (i.e. vegetables).

5.2.4 Implementation

The implementation of the recommendations requires an integrated and systematic approach, involving government agencies and local community organisations. While government intervention is required for most recommendations to be successful, the effective implementation of the recommendations can begin through the proactive coordination between the local community organisations.

The Mutanda Centre is already involved in local development work, although additional expansion is frequently restrained by available capital. While the Mutanda Centre is an indigenous organisation, it is well established in literature that participation of people directly impacted by proposed development will improve the success of the interventions (Pretty 1995). With the importance of agricultural production in the development strategies, such participation can be effectively achieved though the active involvement of the Solwezi District Farmers Cooperative Union.

In particular, the coordination between these organisations should focus on:

- the establishment of a local market
- improving the supply of farm inputs. In particular, improving financial access to fertiliser (i.e. credit services) and making sure inputs are available on time.
- post-harvest processing and marketing of agricultural production.
- diversification of agricultural production.

5.3 POLICY IMPLICATIONS

There are a number of policy related issues that have been raised by this research. These issues, however, are not new and interventions to address these issues are frequently debated in literature. However, it is of concern that these debates - most of which are theoretical rather than practical - are often focussed at the macro-scale economic level (and with a strong western bias) rather than what is best for households and individuals in developing countries. It is disappointing - and a criticism of current development interventions - that these interventions need to be repeated here. This research strongly recommends that the following policy implications need to be considered from a micro-scale perspective rather than the seemingly current emphasis on the macro-scale.

The potential for development to occur is the Mutanda area is greatly restricted by macroeconomic policies. The Zambian government has a responsibility to implement policies that improve conditions for the rural sector and alleviating rural food insecurity. In particular, the implementation of policy needs to urgently address the following issue:

- *increased funding of extension services:* There is considerable research that shows an investment in extension will show significant benefits in alleviating rural food insecurity and poverty [105].
- *subsidising fertiliser costs:* While literature is varied on this issue, and it being a politically sensitive (especially in international trade arena), the subsidisation of fertiliser needs to be seriously considered. Due to the cost, resource poor and smallholder farmers find it difficult to justify the use of fertiliser. The consequence of diminishing fertiliser use will only exacerbate the decrease in agricultural production and, most likely, increase the extent of food insecurity.
- *market development:* The recommendation to develop a local market can only succeed when the national macroeconomic policy is strong to encourage economic stability for the rural sector. Implicit in this is the need for stable and good governance to support the market.
- *increased funding of rural infrastructure:* For agricultural growth, there is a

105. Such services can be contracted out to community organisations. For example, the Mutanda Centre has show interest in running the Chafukuma Farm Institute to provide extension services to farmers.

pressing need for an improvement to roading, especially feeder roads. This would support both farm input supply and product distribution to markets.

- *land access:* Access to land forms an important consideration in agricultural development. With the potential increase in cattle use, larger farm areas will result. Initially this will impact on chiefs having to increase the demarcated land area for households, and permitting larger areas to be certified for leasehold tenure. However, ultimately, the current national land policy is an underlying constraint. The prevention of freehold land ownership limits farmer's freedom, promotes state dependancy and restricts capital and credit through limited collateral. Literature raises positive responses to land reform in terms of poverty and food insecurity alleviation. While land reform is a controversial topic, it should not be overlooked as means to promote agricultural development. There are a variety of options presented in literature by which agricultural production can be improved, yet the national sovereignty of land can be protected.

The policy implications extend beyond the national government, as much of the macroeconomic policy depends on the pressures exerted by external financial institutions. The requirement to implement structural adjustment policies as a condition of financial loans is ultimately resulting in spending cuts to the rural sector. If the external organisations are truly interested at promoting development, there is a need to reconsider these conditions. This issue is of so much importance, that it raised as an urgent matter of future research (Section 5.4).

Finally, this study recommends the involvement of farmer cooperatives in development. To provide the necessary level of skills, there is an urgent need to provide capacity building for farmers, and farming organisations, so they can manage their own development. Currently, there seems to be a bias towards capacity building in urban areas, which needs to be addressed by donors and funding agencies of developing projects.

5.4 FURTHER RESEARCH

1. Further Validation the Conceptual Model

Due to the limited resources, the full intention of this research was not possible. It would be highly beneficial for this study to be repeated, this time collecting data on actual food intake and human requirements so that the conceptual model could be fully validated. This survey can provide direction for future research, especially in regards to timing.

Particular attention of future research should focus on the more accurate assessment of temporal variations in food security, especially by quantifying the level of food consumption based on nutrient intake and requirement. This should lead to a better understanding of how and why food consumption varies over a season. This is of particular interest in situations similar to Mutanda where agricultural production plays such a dominant role in food acquisition. Additional to this, such research should also include how improved storage impacts on the level of food consumption, especially during periods of food shortages.

2. Improved Theory and Measurement of Seasonality

The primary conclusion from this research highlights the critical importance of seasonal food insecurity. While seasonality is noted in literature, the current food security framework incorporating the determinants of food availability, accessibility and utilisation does not seem to adequately address seasonality with a degree of rigour it deserves. A reason for this oversight could be that seasonality is a cross-cutting issue across all three determinants (and possibly the influence of a western and urban bias in the development of food security theory). While some assessments include a fourth determinant to deal with this issue of seasonality, at least in part, (i.e. 'Food Stability'(IFAD 2001) and 'Asset Creation' (World Vision 2000), the theory of these "new concepts" needs to be strengthened to be incorporated in future food security frameworks. An adequate framework that explicitly includes an assessment seasonal food security would seem to be long overdue.

The issue of seasonality is not just theoretical - there is also a weakness in the adequate measurement of seasonal effects of food security. Current measurements of food security fall into two categories:

- *Aggregated Measurements:* While data aggregation is an accepted part of the spatial dimension, it also occurs with the temporal dimension but this is often not mentioned. Temporal aggregation often occurs in production based indicators (i.e. the FAO method) where data is aggregated over time (normally annually) and used to assess food security.
- *Instantaneous Measurements:* These occur at a certain point in time, often resulting from single research exercises. Such measurements occur in single food consumption surveys and tend to be extrapolated to infer a food security status over time.

The implicit assumption underlying these methods is that food security is consistent over time - despite an awareness that this is rarely the case. While developing analytical methods to measure the seasonality of food security may seem to be trivial issue, the measurement of food security is, in reality, highly political. Due to this, there is an obligation to measure food security accurately, and provide information that is realistically portrays the actual conditions experienced by people.

3. Effect of Structural Adjustment Policies on Rural Food Security

While outside of this research, one issue was of frequently observed with concern. This relates to the decrease in government spending and the reduction in support given to farmers and rural services. This issue is of immense importance and it cannot be ignored as a contributing and compounding problem to the increase in food security. Of particular interest are the conditions of loans applied by external donors (governments and institutions) onto the Zambian government. Non-politicalised research to consider how these interventions effect rural households, farmers and food security needs to be implemented with haste.

4. Investigation of Irrigation Schemes

The underlying reason for the seasonality of food security is the unimodal rainfall that determines agricultural production cycle in the Mutanda area. To mitigate against this dependence, there is an urgent need to investigate the establishment of irrigation systems, on a variety of scales. Annual water resources are plentiful in Mutanda area, hence the development of irrigation schemes would seem to be scientifically realistic. There is a desire from key informants for such investigations to begin.

5. Improved Understanding of Land Utilisation

The current limitation of agricultural production in the Mutanda area is related, to a large degree, to the poor utilisation of land use. Identifying strategies to improve land utilisation, which uniquely suit the people and culture of the Mutanda area, would be worthy of further research.

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APPENDIX 1: NOTATIONS FOR SURVEY AND CONCEPTUAL MODEL

β Proportion of effective daily meals at minimum food consumption to the effective daily meals at maximum food consumption, such that:

$$\beta = \frac{eM_n}{eM_x} \tag{A1.1}$$

β is a measure of variation of food intake between maximum and minimum food consumption.

DA Weighted actual daily food intake

eM Effective daily meals, the product of frequency and size.

eM_n Effective daily meals at minimum food consumption, the product of M_n and S_n, such that:

$$eM_n = M_n \cdot S_n \tag{A1.2}$$

eM_x Effective daily meals at maximum food consumption, the product of M_x and S_x, such that:

$$eM_x = M_x \cdot S_x \tag{A1.3}$$

Therefore as $S_x = 1$, then $eM_x \equiv M_x$

h Household spatial boundary

i Individual spatial boundary

λ Ratio of actual food intake to maximum food intake, such that:

$$\lambda = \frac{DA}{DA_{max}} \approx \frac{eM}{eM_x} \tag{A1.4}$$

Λ Ratio of actual food intake to recommended food intake for the human body, such that:

$$\Lambda = \frac{DA}{N} \tag{A1.5}$$

Λ is a proxy for the relative status of food security. If $\Lambda \geq 1$, food security is said to occur, if $\Lambda < 1$, then food security occurs

M_n Frequency of daily meals per day at minimum food consumption

M_x Frequency of daily meals per day at maximum food consumption

n *n* th nutritional value (when used as a superscript)

N weighted recommended daily intake

R_n Ranking of food satisfaction at minimum food consumption. (1 = Always hungry and 7 = always well fed)

R_x Ranking of food satisfaction at maximum food consumption. (1 = Always hungry and 7 = always well fed)

S_n Relative size of meals at minimum food consumption, compared to size of meals at maximum food consumption

S_x Relative size of meals at maximum food consumption. For the survey this is set at one ($S_x = 1$).

T_e Time (in months) when food shortages end

T_n Time (in months) of minimum food consumption

T_s Time (in months) when food shortages start

T_x Time (in months) of maximum food consumption

APPENDIX 2: MACRO-SCALE FOOD SECURITY INDICATORS

While there is an increasing focus on household food security, macro-scale indicators still play an essential role in food security assessment, especially in regards to macroeconomic policy. In terms of food specific indicators, common macro-scale indicators used are:

- agricultural production
- food balance sheets
- food inadequacy (FAO Method)

Agricultural production is an adequate measure of national food self-sufficiency. Food balance sheets account for food produced and sourced through trade and storage, hence can be considered to be a measure of food self-reliance (Hubbard 1995). However, both methods are not seen as an adequately measuring food security, as they do not account for accessibility and utilisation. (Also the collection of data and its reliability, especially from agricultural production, is an issue for developing countries).

The Food Inadequacy method developed by the FAO (Nakien 2002, FAO 1996) is widely used in current literature - and policy development - to classify and compare macro-scale (national and regional) food insecurity. It is a mathematical model (essentially an energy based inequality) that determines the proportion of a country/region assessed as being food insecure and determines the amount of food deficit experienced by those people (Table A2.1).

However, the underlying model is based largely on food balance sheets, and despite factoring in the effect of accessibility and utilisation, is still seen as being largely a measure of national level food supplies, simply measured on a per capita basis (Short 2001). Hence, the concerns with this measurement reflects those of other aggregated macro-scale indicators in that they do not reflect the conditions of food security that occur at the micro-scale level [107]. Despite this, the food

107. While the FAO measurement is undertaken on a macro-scale level, there would not seem to be any mathematical reason why this measurement could not be applied to micro-scale level (i.e. the household). The only limitation would be the collection of the appropriate data.

inadequacy measurement will remain an important food security indicator, especially with the ability to compare countries and undertaken trend analysis.

The following table provides a brief stepwise description of the method FAO uses to estimate the prevalence and depth of undernourishment. For more details on the FAO method, refer to FAO (2000) and FAO (1996).

Table A2.1: Brief description of FAO Undernourishment Indicator. (FAO 2000)

Step	Description of Analysis
1.	Calculate the total food energy available from local food production, trade and stocks.
2.	Calculate an average minimum energy requirement for the population, based on the energy requirement needed by different age and gender groups and the proportion of the population represented by each group.
3.	Divide the total food energy available by the number of people in the country.
4.	Factor in a coefficient for distribution to take account of inequality in access to food.
5.	Combine the above information to construct the distribution of the food supply within the country and determine the percentage of the population whose food intake falls below the minimum requirement. This is the prevalence of undernourishment.
6.	Multiply this percentage by the size of the population to obtain the number of undernourished people.
7.	Divide the total food energy available to the undernourished by the number of undernourished to obtain the average dietary energy intake per undernourished person.
8.	Subtract the average dietary energy intake of undernourished people from their minimum energy requirement, expressed in kilojoules (or kilocalories) per person per day, to get the average dietary energy deficit of the undernourished. This is the depth of hunger.

APPENDIX 3: BODY MASS INDEX

The BMI is a ratio of body mass to height and is frequently used to classify the nutritional status of an adolescent or adult. It is defined by the following equation:

$$BMI = \frac{\text{Body Mass (kg)}}{\text{Height}^2\text{ (m)}} \qquad (A2.1)$$

The acceptable (healthy) range for BMI is between 20.5 - 25.0 kg/m^2 for men and 18.7 - 23.8 kg/m^2 for women. Persons with values less than these are considered underweight (and potentially suffering from undernutrition), while persons with larger BMI's maybe indicate they are overweight.

However, care needs to be used in interpreting the BMI is developed from a European-American view of the body size. Hence, the BMI will vary for differing ethnic groups that have different body characteristics to the western "ideal". In such cases, the use of BMI requires sound professional judgement in its use (FAO 2000a).

APPENDIX 4: STANDARD NUTRITION VALUES USED IN RELIEF

Standardised Nutritional Requirements

Nutritional requirements can be standardised to simplify assessment. An example of this is provided by 'The Sphere Project'. While these figures are designed to be used in emergency and relief situations, they also can be used as minimum targets for development interventions.

Table A4.1: Minimum Guidelines for Nutrients in Disaster Relief (The Sphere Project 2000, p122)

Nutrient	Mean population requirements
Energy	8.8 MJ (2100 kcal)
Protein	10-12% total energy (52-63g), but < 15%
Fat	17% of total energy (40 g)
Vitamin A	1666 IU (or 0.5 mg Retinol Equivalents)
Thiamine (B1)	0.9 mg (or 0.1 mg per 1000 kJ intake)
Riboflavin (B2)	1.4 mg (or 0.1 mg per 1000 kJ intake)
Niacin (B3)	12.0 mg (or 1.6 mg per 1000 kJ intake)
Vitamin C	28.0 mg
Vitamin D	3.2 - 3.8 μg calciferol
Iron	22 mg (low bioavailability (i.e. 5-9%))
Iodine	150 μg

Table A4.2: Provisional Mineral Requirements for Disaster Relief* (The Sphere Project 2000, p123). All values are per 100 kJ intake.

Minerals	Unit	Desirable Nutrient Density#	Lower Threshold Density#
Potassium (K)	mg	45	18
Sodium (Na)	mg	14	6
Magnesium (Mg)	mg	7	2
Calcium (Ca)	mg	20	7
Phosphorus (P)	mg	17	5
Zinc (Zn)	mg	0.2	0.1
Copper (Cu)	mg	23	7
Selenium (Se)	mg	0.9	0.4
Manganese (Mn)	μmol	0.1	
Chromium (Cr)	nmol	0.5	
Molybdenum (Mo)	nmol	1.2	
Flourine (Fl)	μmol	<0.2	

* The nutrient values are proposed as a provisional tool for planning purposes. Expert consultations in 1998 may result in new recommendations.

The Desirable Nutrient Densities relate to a refugee diet. The Lower Threshold Density is suggested as the minimum value below which the nutrient density of the whole diet should not fall.

APPENDIX 5: SOIL CHARACTERISTICS OF THE SOLWEZI DISTRICT

In general, soils in the Solwezi District:

- are predominantly sandy clay loams
- are hard weathered, with poor structure (compaction by heavy vehicles is a potential problem)
- have low water holding capacity and high hydraulic conductivities. Thus the soil is highly leached
- are acidic (pH 4-4.5)
- have low cation exchange capacity (mostly <10 milliequivalents)
- have low electrical conductivity and low base saturation
- have high aluminium saturation due to acid soils
- have low organic matter content
- are low in micronutrients, especially Calcium

Soil fertility is considered the major problem, with the most important inputs being:

1. the use of lime (due to acid soils)
2. increasing soil organic matter (i.e. returning crop residues to soil instead of burning; use of manure)
3. the use of chemical fertilisers

Sources

MAFF (undated)

Key Informants: Provincial and District Agricultural Offices (Solwezi)

APPENDIX 6: PROGRAMME AGAINST MALNUTRITION

One of the primary tools used by the 'Programme Against Malnutrition' (PAM) is the Food Security Pack. This strategy is targeted towards vulnerable groups that are prone to severe food insecurity (in no order).

- female and child headed households,
- farmers cultivating less than one hectare,
- households having terminally ill patients, disabled person or orphans
- and those affected by floods, droughts and natural calamities.

The specific strategies in the Food Security Pack consist of:

<u>Crop Diversification</u>

The pack is composed of seeds for cereals (i.e. maize, millets, rice), legume (groundnuts, beans), and a root/ tuber crop (sweet potato, cassava[70]) and other crops. Loans for fertiliser also included.

<u>Market Entrepreneurship and Seed/Cereal Bank Development</u>

This will focus on capacity building among NGO's, farmers, traders and beneficiaries in entrepreneurship skills, post-harvest handling, value adding and marketing skills and cereal bank development. All loan recoveries are channelled through cereal banks.

<u>Alternative Livelihood Interventions</u>

This provides alternative packs such as fish farming, small livestock rearing draft power, animal care health services other than crop production taking into account the comparative advantages of a particular area.

<u>Conservation Farming</u>

This forms the basis for increasing crop production through practices that encourage sustainability such as conservation tillage, soil fertility improvement and erosion control.

Source: PAM (2001)

APPENDIX 7: FOOD CONSUMPTION SURVEY

Village: ____________________ Number: ________ Date: _________ Gender: M / F

1. **a)** What is the main source of food for your household?

O Farm/Garden

O Income *(☐ on-farm or ☐ off-farm)*

O Other *(specify)* ____

b) Can you list, in order of importance, the other sources of food for your household?

( ) Farm/Garden

( ) Income *(☐ on-farm or ☐ off-farm)*

( ) Hunting/Gathering *(specify)* ______________________________

( ) Aid/Relief

( ) Other *(specify)* ____

2. Does your household have provision to store harvested crops?

O No

O Yes *(what type and size?)* ___________________________________

3. What are the main types of foods eaten in your household. If food is grown, list area planted above ¼ Lima.

Food	Area	Food	Area	Food	Area	Food	Notes	Area
Maize		Cassava		Groundnuts		Vegetables		
Millet		Sweet Potato		Irish Potato		Other I		
Sorghum		Beans		Soya Beans		Other II		

(All areas in Lima, where 1 Lima = ¼ hectare)

4. How many people live in your household? *(if possible ask or estimate ages of children)*

Group	Age Group	Male		Female	
		Number	Ages	Number	Ages
Children	37264				
Adolescents	10-17				
Adults	18-29				
	30-59				
	60+				

5. Does your household experience food shortages during the year?

- O Yes (*continue with all remaining questions*)
- O No (*go to Question 7)*

6. In which month(s) do you notice food shortages....

a) *Starting:*

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

b) *Ending:*

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

7a. (i) In which month(s) does your household have the most food to eat?

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

(ii) During _*7a(i)*_, would you consider your household to be:

Always hunger **1 2 3 4 5 6 7** *Always well fed*

(iii) During _*7a(i)*_, how many meals would you have daily?

0 1 2 3 4

7b. (i) In which month(s) does your household have the least food to eat?

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

(ii) During _*7b(i)*_, would you consider your household to be:

Always hunger **1 2 3 4 5 6 7** *Always well fed*

(iii) During _*7b(i)*_, how many meals would you have daily?

0 1 2 3 4

8. Are the size of your household meals during _*7b(i)*_ smaller, larger or the same when compared to meals during _*7a(i)*_?

- O Smaller
  - → How much smaller are the meals? **0 ¼ ½ ¾ 1**
- O Larger
  - → How much larger are the meals? **1 1¼ 1½**
- O Same

APPENDIX 8: FARMING SYSTEMS SURVEY [108]

Village: ____________________ Number: ________ Date: _________ Gender: M / F

1. Do you raise any livestock *(list number if possible)*?

O No

O Yes

Type	Number	Type	Number	Type	Number	Type	Number
Cattle		Chickens		Goats		Pigs	
Sheep		Horses		Other I		Other II	

2a. Do you use fertiliser on your farm?

O No

→ Prompt for reasons

____

O Yes

→ List type and amount

____

2b. Do you use certified seed on your farm?

O No

→ Prompt for reasons

____

O Yes

→ List type and amount

____

3. Do you know the total area of your farm?

O No

O Yes *(List area)* ____________________

4. Do you hold a title deed for your farmland?

O No

O Yes

108. Note: Crop information was asked in the Food Consumption Survey (Question 3)

5. What implements do you use on your farm?

O Hoes O Axes O Ploughs

O Other *(specify)* ______________________________

6. How many people work on your farm during the growing season, including yourself?

(______)

7. Do you use animal power on your farm?

O No

→ Prompt for reasons ______________________________

O Yes

→ Do you own the animals?

O Yes

O No *(who owns them)* ______________________________

8. Do you use any type of machinery on your farm?

O No

→ Prompt for reasons ______________________________

O Yes

→ Do you own the machinery?

O Yes

O No *(who owns it)* ______________________________

→ If possible, list type, engine size and who services it

____

9. If a tractor was available to hire, would you be willing to hire it?

O No

→ Prompt for reasons ______________________________

O Yes

→ How much would you be willing to pay to hire a tractor for per day *(with driver but excluding fuel)*?

____

10. How interested would you be to learn about growing other crops?

Not Interested **1 2 3 4 5 6 7** *Very Interested*

11. Do you sell some of your crops and/or livestock?

O No

O Yes *(estimate how much)* ______________________________

APPENDIX 9: FARMER AND KEY INFORMANT INTERVIEWS

In general the interviews were unstructured and informal. The questions asked during the interviews were based around the following areas of interest. For the key informants, questions varied depending on the role of the interviewee.

Farmer Informants

1. The use of income, especially related to food and farming practices.
2. Level of production (especially from maize)
3. The constraints experienced in farming.
4. Their expectations of farming (i.e. reasons for farming, future plans).

Key Informants

1. The extent and prevalence of food security in the area
2. The use of inputs in farming, especially related to costs
3. Levels of production, especially maize, and the response of inputs to yields
4. The constraints experienced in farming, especially those related to policy.
5. Issues related to resource access
6. An understanding of cultural issues that effect agricultural production and food security.

APPENDIX 10: RANDOM NUMBER GENERATION

A10.1 PILOT SURVEY

For the pilot survey, participants were ordered alphabetically. A random number, between 0 and 1 was generated by the field calculator (HP-21S Hewlett Packard). The person selected from the list was determined by:

$$i = r \cdot n \qquad \text{(A10.1)}$$

where:
r = random number generated (between 0 and 1)
n = number in list = 32
i = the *i* th person on the list

If a person had already been selected, another selection was made.

A10.2 VILLAGE SURVEY

The random selection of the household in this village was achieved through using a random number generated from the field calculator. The random number had a form of:

$$0.nyz \qquad \text{(A10.2)}$$

<u>Selection Criteria</u>

- if 'y' was an odd number, the left side of the road was selected (in the direction of the transect). Consequently, if 'y' was an even number the right side is selected.
- the nth house, was surveyed (where $0 \leq n \leq 9$; if n = 0, the tenth house was surveyed).
- if the random selection process extended beyond the village, the transect was retraced in reverse, until twenty surveys were completed. (If a household previously interviewed was selected, the selection process was repeated).
- a new random number was generated after each completed survey, and if a house was unoccupied or the householder declined to be surveyed.

APPENDIX 11: CONSIDERATION OF BIAS THROUGH GENDER AND MILL INTERVIEWS

11.1 ASSESSMENT OF BIAS IN RESULTS DUE TO METHODS USED

The data obtained was assessed to determine whether the results were potentially biassed by other factors, namely gender and the use of the mill for the interviews.

11.1.1 Gender

The survey respondents consisted of 64 females and 38 males. Comparison of the data segregated on gender highlights only one dataset that was significantly different at the 5% level. Females had a lower frequency of daily meals at maximum food consumption compared to males ($p = 0.010$). For the β-ratio, no significant difference was found ($p = 0.767$).

11.1.2 Mill Interviews

A comparison between mill and village interviews highlights significant differences in four datasets at the 5% level. Respondents at the mill had:

1. significantly less area planted in crops ($p < 0.001$) and maize ($p < 0.001$) than those interviewed in the villages.
2. a lower frequency of meals at maximum food consumption ($p = 0.015$). This, in part, contributes to a significantly lower β ratio ($p = 0.006$)[109].

11.2 COMMENTS ON POTENTIAL BIAS

11.2.1 Gender

This study focussed on food security as it affected the household. As stressed in Section 3.2.4.2, the respondents were asked to respond to the questions as it impacted the household. However, while not knowing the actual extent, it is quite possible that individual influences did filter into the responses. To counter this influence, all household members would need to have been interviewed, and the individual responses aggregated for the household. This methodology would have

109. The meal size at minimum food consumption was marginally non-significant ($p = 0.06$), although meal frequency at this time was not significant ($p = 0.51$).

increased resources, especially time[110]. (If individual responses were considered necessary, it would have been more worthwhile, and effective, to have undertaken a full food consumption survey due to the resources that would have been invested). The choice of one respondent per household (the head male or female) was taken as a means to manage available resources.

The assessment of gender responses, however, does tend to indicate that personal influences in the responses may have been low. Only one dataset showed a significant difference between gender. Female respondents indicated that their households had a lower meal frequency at maximum food consumption than male households. While, from a nutritional perspective, it is accepted that females require less food, such a difference could also be due to a personal response being expressed. However, as no other dataset is significantly different (including the β-ratio), then it would seem to be more likely that this difference is by chance (Type I error). Consequently, the potential bias introduced by gender (if any) can be considered to be very low.

11.2.2 Mill Interviews

The comparisons between mill and village-based interviews did present significant differences with four datasets, and marginally non-significant in one other. Interestingly, these differences were confined to the area of planted crops and meal data. It would seem unlikely that these differences are by chance due to being confined to these specific questions, rather being random over the survey.

Due to specific nature of the survey, necessary data to make an inference on these differences was not collected. In discussion with key informants, there was no awareness of any reasons that would account for the differences. However, from the data, it would seem that interviews from the mill could bias the results, although the reasons for this cannot be established with certainty.

While the use of the mill was a means to manage resources, in hindsight, it would have been best to have undertaken all surveys in the villages to have removed any possibility of such bias occurring.

* * * * * * * * * * * * * * *

110. Based on the household data, the survey of 102 households covered some 783 people.