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# FOOD SECURITY INCIDENCES BASED ON DIETARY ENERGY CONSUMPTION, DIETARY DIVERSITY AND HOUSEHOLD FOOD INSECURITY ACCESS SCALE IN CHAMWINO DISTRICT, TANZANIA

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## ABSTRACT

*Dietary energy consumption (DEC), dietary diversity (DD) and household food insecurity access scale (HFIAS) are used in determining food security. However, it is not known whether their uses give similar incidences of food security. The study on which this paper is based sought to determine food security based on the above methods, with the specific objectives to: a) determine DEC per adult equivalent and per capita both per day, b) determine household dietary diversity, c) measure food access by using HFIAS and (d) compare food security incidences based on the four methods of food security determination. Random sampling was used to select 400 households. The research was a cross sectional one and was conducted through structured interviews using a questionnaire, focus group discussions and key informant interviews. Using DEC per adult equivalent and per capita both per day, it was found that 84.2% and 81.8% of the 400 sampled households were food secure respectively. Using HFIAS and DD, 88% and 31.8% were food secure respectively. It is concluded that DEC per adult equivalent per day, per capita per day and HFIAS give almost similar food security incidences and have good potential to give reasonable results of food security status, while DD tends to exaggerate food insecurity incidences. It is recommended that the government and other stakeholders dealing with food security should use both DEC per adult equivalent, DEC per capita per day and HFIAS almost equally since they give almost similar results. Besides, effort should be made to establish international cut off points and food items to include in the classification of households into food secure and food insecure based on DD.*



**Keywords:** Food security, Dietary energy consumed, Dietary diversity, Household food insecurity access scale, Chamwino, Tanzania.

## 1. INTRODUCTION

Food security remains the world's fundamental challenge for human welfare and for economic growth. It is estimated that 805 million of the global population were chronically undernourished in 2012-14 (FAO, 2014). Of these, 1.8% were inhabitants of developed regions; 34.3% Southern Asia; 26.6% sub-Saharan Africa; 20% Eastern Asia; 7.9% South Eastern Asia; 4.6% Latin America and the Caribbean; 2.3% Western Asia; 1.6% Northern Africa; 0.7% Caucasus and Central Asia while 0.2% were inhabitants of the Oceania (FAO, 2014). In Tanzania, statistics show that, in 2011/12, about 9.7% of the people were food insecure (National Bureau of Statistics (NBS), 2014).

Overall, Tanzania's food security situation appears to be improving (FEWS NET, 2010; WFP/WB, 2013). With respect to national food security, Tanzania has been self-sufficient in food production since 2005 with a peak of 112%



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in 2007 (United Republic of Tanzania (URT), 2011). Tanzania is mainly an agricultural country and produces significant amount of food. Agriculture is the backbone of Tanzania's economy, which means most of the people consume food they produce by themselves (WFP/WB, 2013). In 2010/2011, on average, 37% of households' food energy came from their own production while 60% was purchased from shops and markets (WFP/WB, 2013). In 2012, the Ministry of Agriculture Food Security and Cooperatives (MAFC) reported that food requirements indicated that, overall, the country would attain a Food Self Sufficiency Ratio (SSR) of 113% for the year 2012/13 (URT, 2012). That SSR was slightly above that of the 2011/12 agricultural season, which was 112%.

Although Tanzania has generally experienced an overall satisfactory food availability in some cropping seasons, for example during the 2012/13 marketing year (URT, 2012) and 2009/10 marketing year (FEWS NET, 2010) major inter and intra-regional and council variations existed due to localised food crop failures (URT, 2012) which were caused by poor rainfall (FEWS NET, 2010; WFP/WB, 2013; FEWS NET, 2014). In Total, MAFC identified 41 councils in 14 regions to have crop failures. The regions with their districts in brackets were Shinyanga (Bariadi, Kahama, Kishapu, Maswa, Meatu, Shinyanga); Arusha (Karatu, Longido, Monduli, and Ngorongoro); Kilimanjarao (Hai, Mwanga, Moshi and Same); Tabora (Igunga, Nzega, Sikonge and Uyui); Dodoma (Bahi and Chamwino); Tanga (Korogwe, Lushoto, Mkinga and Pangani); Manyara (Babati, Mbulu, and Simanjiro); Singida (Iramba and Manyoni); Mwanza (Magu, Misungwi, and Kwimba); Mara (Musoma and Rorya); Lindi (Lindi); Morogoro (Morogoro and Mvomero); Iringa (Iringa) and Geita (Geita and Nyang'hwale) (URT, 2012). In Dodoma Region, Chamwino District was among the food insecure districts. In 2011/12, about 11,115 people out of 301,535 in the District were food insecure (stressed) and required food aid intervention for 3 months from the government (URT, 2012). Total food requirement in Chamwino was 400.2 MT; free food relief was 40 MT (URT, 2012).

Food security is not a new concept; it has been defined in a variety of ways by different authors and organizations. Food security is achieved 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, 2015). The converse of this definition is food insecurity, which is inability of people to have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active life. Food security and food insecurity use the same indicators; below a given threshold on those indicators there is food insecurity while there is food security at and above the threshold, for example a cut-point of 2,100 kcal per capita per day. Food security is a concept that has evolved considerably over time. This evolution has resulted in the development of different indicators of food security. For example, one volume on household food security by Maxwell and Frankenberger (1992) lists 25 broadly defined indicators. Hoddinott (1999) suggested roughly 450 food security indicators. Maxwell (2008) suggested that, wherever possible, the use of more than one food security indicator is advisable because one indicator cannot wholly explain the food security status of a household.

Generally, researchers and other development practitioners face some methodological challenges as to which indicators are appropriate when it comes to determining food security. The challenge is driven by lack of a "gold standard measure" of food security (Coates, 2004). Measures of consumption, poverty, and malnutrition are all used as proxy measures, and an indicator of assets and income are used as more distal determining factors (Maxwell *et al.*, 1999). All measures are related to food security; yet none of them captures the concept accurately or completely. This is because food security, in the words of Maxwell *et al.* (1999) is probably too complex to ever adequately be captured by a single indicator (Ndobo, 2013; Zemedu and Mesfin, 2014). It is, therefore, important to search for reliable and cost effective indicators to use based on four pillars of food security (availability, access, utilization and stability). The paper focuses on measuring food sufficiency based on actual food intake as dietary energy consumption and food access based on dietary diversity and household food insecurity access scale (HFIAS).

In practice, the indicator most commonly used to assess access to sufficient quantity of food is dietary energy intake. Energy intake data can be obtained by weighing and measuring food consumed by the household in the reference period (IFPRI, 2006; Bazezew, 2012). Dietary energy consumed (DEC) in terms of kilocalories can be

expressed per capita or per adult equivalent, both per day. When dietary energy consumed is expressed per capita per day, a household is said to be food insecure if it consumes less than 2,100 kcal per capita per day, which is the global average DEC per capita per day (Devereux, 2006; Bogale and Shimelis, 2009). The single most important indicator of food adequacy level of a community is the per capita dietary energy supply measured in kilocalories (Bazezew, 2012). When energy intake is expressed per adult equivalent per day, a household is said to be food insecure if it consumes less than 2,280 kcal per adult equivalent per day. This amount is recommended by the World Health Organization that the minimum dietary energy intake per day per adult should not be less than 80% of the adequate daily caloric intake of 2,850 kCal (Wanmali and Islam, 2002). The above amount (2,280 kCal) is 80% of the 2,850 kCal. In Tanzania, however, the minimum recommended dietary energy intake is 2,200 kcal per adult equivalent per day (NBS, 2014). Bazezew (2012) pointed out that households' calorie intake might be greater than 2100, but the availability of food could be from cereals and/or protein only. In that sense, dietary diversity is considered to be a good measure of dietary quality.

Another measure of food security is dietary diversity. Dietary diversity (DD) is correlated with levels of caloric acquisition (Hoddinott, 2002; Bazezew, 2012). Dietary diversity is defined as the number of different foods or food groups consumed over a given reference period (Hoddinott, 1999; Ruel, 2002). Based on the assumption that no single food can contain all nutrients, DD has been conjectured to have a greater practical potential of meeting nutrient requirements (Labadarios *et al.*, 2011). This could be an indicator of nutrient adequacy and an outcome measure of food security (Hoddinott, 2002) for the main pillars of food security (availability, access, utilisation and stability), which are also positively reflected in DD (Ajani, 2010). At the household level, Vakili *et al.* (2013) and FAO (2013) suggested that DD can be used as a proxy indicator of food access (e.g. of households' capacity to access costly food groups). DD is measured by summing up the number of different foods or food groups consumed over a reference period. Hoddinott (2002) measured DD by calculating a weighted sum, whereby the weights reflect the frequency of consumption and not merely the number of different foods. The reference period usually ranges from one to three days, but seven days is also often used (FAO, 2011) and periods of up to 30 days have been reported (Hoddinott, 2002). In the context where a 2 weeks' intake can be accurately assessed, this reference period is likely to provide even better estimates (Drewnowski *et al.*, 1997). In most developing country contexts, however, a 7 days' recall may be the longest reference period achievable from a practical point to minimize memory error (Ruel, 2003). This recall period is too short to get accurate data on dietary diversity. The plausible explanation is that in rural areas many people have low income which limits their ability to buy a wide variety of food to diversify their diet. This might be the reason why Hoddinott (2002) proposed a recall period of up to 30 days in order to increase dietary diversification. DD can be measured using various approaches. Researchers in China (e.g. (Taren and Chen, 1993; Tarini *et al.*, 1999)) used food group counts, while studies from Ghana and Malawi (Fegurson and Sprecher, 1997) and in Kenya (Onyango *et al.*, 1998) used the number of individual foodstuffs consumed. Studies from Mali (Hatloy *et al.*, 1998); (Ogle *et al.*, 2001); (Savy *et al.*, 2005) and Tanzania (Keding *et al.*, 2012) used both single food counts (called Food Variety Score [FVS]) and a food group count called Dietary Diversity Score [DDS]). Studies in South Africa (Labadarios *et al.*, 2011; Taruvinga *et al.*, 2013) and India (Srivastava *et al.*, 2014) used Dietary Diversity Score. Despite the well-recognized importance of dietary diversity, there is lack of consensus on how to measure and operationalize DD (Ruel, 2003). According to Ruel (2002; 2003) further research should be carried out to validate and compare indicators based on alternative food and food group classification systems, scoring systems, reference periods and cut-off points. It would be useful to continue to explore whether indicators based on food groups (a simpler approach) perform as well as those based on individual foods in predicting outcomes of interest.

Another measure of food security is Household Food Insecurity Access Scale (HFIAS) (Coates *et al.*, 2007). Household food access is defined as the ability to acquire sufficient quality and quantity of food to meet all household members' nutritional requirements for productive lives (Saaka and Osman, 2013). HFIAS is a continuous measure of the degree of food insecurity (access) in the household in the previous 30 days (Coates *et al.*, 2007; Nyikahadzoi *et*

*al.*, 2011). According to Coates *et al.* (2007) the HFIAS reflects the three universal domains of household food insecurity that is anxiety about household food insecurity, insufficient quality and insufficient quantity of food supplies. This indicator captures the household's perception about their diet regardless of its nutritional composition (Coates *et al.*, 2007). This food insecurity measure focuses on consumption related strategies and captures the household's behavioural and psychological responses to food insecurity or perceived food insecurity. The HFIAS is based on the assumption that households' experiences of food insecurity cause predictable reactions and responses that can be captured and quantified through a survey and then summarized into a score.

Measuring food security incidences using different methods is paramount. This is due to the multidimensional nature of food security (Bazezew, 2012). Researchers in Tanzania (e.g. (Kayunze *et al.*, 2010)) determined dietary energy consumed per capita and per adult equivalent per day from maize and rice consumed based on one week's, 30 days' and one year's data in Rufiji District, Tanzania. Mende *et al.* (2014) determined food security using monetary values of food consumed and dietary energy consumed per adult equivalent per day using 28 days' data in Makete and Mbeya Districts. Ngongi and Urassa (2014) determined dietary energy consumed per adult equivalent based on all foods and dietary energy consumed per capita per day based on grains and number of meals from 24 hour recall period, household income expenditure survey (HIES) for 30 days, amount of grains stored, monetary food poverty per adult equivalent for 28 days, and HFIAS from 7 days' data in Kahama District, Tanzania. However, comparing food security incidences based on dietary energy consumed from all foods, dietary diversity and household food insecurity access scale based on 30 days' data has not been done at least in Tanzania. Therefore, the research for this paper was done to: determine dietary energy consumption per adult equivalent and per capita, determine household dietary diversity, measure food access by using household food insecurity access scale (HFIAS) and compare food security incidences based on the four methods of food security determination.

### 1.1. Contribution to Knowledge

This study is one of a very few studies which investigated new knowledge by establishing cut-off points for measuring DD using weighted sum dietary diversity. Food groups to include in measuring DD based on local availability were also developed.

## 2. METHODOLOGY

### 2.1. Description of the Study Area

The study was conducted in Chamwino District. The District was selected since it had a history of chronic food insecurity in the previous five years (2009-14) (District Agricultural Irrigation and Cooperative Officer (DAICO), Chamwino District, personal communication, 2014). In 2012 the District was among the food insecure districts in Tanzania (URT, 2012). Needs for food aid from the government have been increasing from 2009-14. Generally, food aid in tonnes for the above period was 93.8 (2009/10), 25 (2010/11), 53.8 (2011/12), 69 (2012/13) and 10 (2013/14).

### 2.2. Research Design, Sampling Procedure and Sample Size

A cross-sectional research design was used to collect data that were used for this paper. Based on the nature of the study and absence of longitudinal data, the above design was best suited (Ngongi and Urassa, 2014). Moreover, literature (Babbie, 1990; Bailey, 1998) shows that cross-sectional design can provide information that is useful for descriptive purposes as well as for determing relationships between and among variables. Further to the above, a cross- sectional research design is cost effective and allows inclusion of participants or groups of people from whom a comparison can be made (Matthew and Ross, 2010). The sampling unit for this study was a household since food scarcity is ultimately experienced at the household level (Maxwell, 1996). Chamwino District was selected purposively because of its history of chronic food insecurity. Three wards were selected purposively. Six villages were selected randomly. The villages were Fufu and Suli in Fufu Ward and Idifu and Miganga in Idifu Ward where

chronic food insecurity was relatively higher. The other villages were Membe and Mlimwa in Membe Ward where chronic food insecurity was relatively low. The selection criterion of these villages was based on a history of receiving food aid from the government (DAICO, Chamwino District, personal communication, 2014) (Appendix 4). Respondents were selected randomly from the sampling frames which were constructed from the village registers. The sample size was 400 households. The formula for sample size determination by Cochran (1977, cited by Bartlett *et al*. (2001) was used to determine the sample size as indicated in Appendix 1. In addition, 13 key informants were purposively selected based on their positions and being considered to have much knowledge and experience about food security in the research villages.

### 2.3. Data Collection

Primary data were collected using a questionnaire, which was administered to household heads. Key informant interviews were held with people who were considered to have in-depth understanding and knowledge on food security in the district. Key informants included one District Agricultural Irrigation and Cooperatives Officers (DAICO), six Village and Ward Extension Officers, three Village Government Leaders and three Ward Executive Officers (WEO). Twelve focus group discussions were conducted in the 6 villages (2 FGD per village) with 8 to 10 villagers. The FGD participants were a mixture of old and young farmers, the youth and women, and villagers doing various activities. In this study, secondary information was collected through reviewing literature on the state of food insecurity in Tanzania and reports on the trend of food aid from Chamwino District Office. A person responsible for meal preparation was requested to provide information on all types of food consumed by all household members in the previous 30 days prior to the survey date, including items consumed outside home (Appendix 3). Information on household food security was collected using a questionnaire which included a validated nine item household food insecurity access scale. HFIAS was used to assess whether households had experienced problems in accessing food during the reference period of 30 days prior to the survey date. A person responsible for meal preparation was interviewed to provide information on the modifications a household made in the diet or food consumption patterns due to limited resources to acquire food.

### 2.4. Data Processing and Analysis

Qualitative and quantitative methods were employed to analyze collected data. Qualitative data were analyzed by being summarized by their themes, and comparing and contrasting arguments given by different interviewees. Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel software. The data were analysed by computing descriptive statistics to determine frequencies, percentages, statistical means, and standard deviations of individual variables. Descriptive analysis was used to determine dietary energy consumption per adult equivalent and per capita, household dietary diversity, and food access by using household food insecurity access scale.

### 2.5. Adult Equivalent Units Computation

Cognizant of the fact that if variables like income and dietary energy consumed are expressed per capita they do not reflect good comparative figures in households with different sizes and composition by age and sex, DEC was expressed per adult equivalent following the procedure used by Collier *et al*. (1990). In order to calculate adult equivalent units, the sex and age of every household member were recorded. A two-step procedure was followed whereby in the first step adult equivalent scales for East Africa by age and sex were added up for all household members to get all the household members in terms of adult equivalents. The equivalent scales are presented in Appendix 2. The second step involved adjusting the above adult equivalents for economies of scale due to the fact that larger households need fewer resources per person due to sharing some facilities. The economies of scale are taken into account by multiplying the adult equivalent units by the average cost (Appendix 2) corresponding to the

number of people in the household. The adjusted adult equivalent units were used as denominators for calculating values per adult equivalent in particular households.

### 2.6. Determination of Dietary Energy Consumed

In order to determine food security based on dietary energy consumed per adult equivalent and per capita, all food items consumed by all household members were recorded in kilograms. Based on data collected using a household questionnaire, quantities of all food items consumed for 30 days were recorded. Quantities of dietary energy consumed in all the food items were computed based on Tanzania Food Composition Tables by Lukmanji *et al.* (2008). Dietary energy consumed was adjusted for the number of individuals in the household based on sex and age. Appendix 2 gives the adult equivalent scales that translate children into adult equivalents and also compare women and men. Moreover, household size is represented by the number of adult equivalents rather than simply the number of individuals. The basis for such translation has mostly been the nutritional requirements of individuals by age and sex. Based on these adjustments, the quantities of DEC by all household members were expressed per adult equivalent units per day and per capita per day based on all foodstuffs consumed for 30 days. In this case households were said to be food insecure if they had consumed less than 2200 kCal per adult equivalent per day or less than 2100 kCal per capita per day.

### 2.7. Determination of Dietary Diversity

In this study, a weighted sum of dietary diversity was adopted. In this context, a person responsible for preparation of food was asked to indicate different foodstuffs (e.g. maize, sorghum, vegetables) the household had eaten in the previous 30 days. The foodstuffs were location specific, and food groups were developed from focused group discussions. The score (Appendix 3) was done using the following categories: 16-30 days in the previous month (score of 24) i.e. at least every other day; 4-15 days in the previous month (score of 10) i.e. once or twice a week; 1-3 days in the previous month (score of 3) and 0, i.e. not at all (score of 0). The dietary diversity index was achieved by the calculation of the weighted sum adopted from Hoddinott (2002). The following weights were assigned: J: 24; S: 10; M: 3 and R; 0. However, it is important to note that Hoddinott (2002) did not indicate the reasons for use of the letters J, S, M and R for weighting scores of dietary diversity. The letters were used for convenience purposes in data coding and analysis. There are no internationally accepted cut-off points below those cut-off points to assist in making judgments on whether households below a certain dietary diversity score have low dietary diversity or not. According to Ruel (2002; 2003) the international cut off points to define high or low diversity are likely to be meaningless. Cut-off points to define varying levels of diversity have to be defined in the context where they are used, taking into account local food systems and dietary patterns. It is important to define in each context the set of foods and food groups that can contribute to improve dietary quality. This study classified households into two categories: A household was said to be food insecure if the weighted sum score was less than 126.54 and food secure if the weighted sum score was 126.54 and above. The cut-off of 126.54 was chosen because it was the mean weighted sum score in the sample. Using the mean of the sample to establish cut-off points has been used by Saaka and Osman (2013) in determining food consumption score based on dietary diversity in Ghana.

### 2.8. Determination of Food Access by Using Household Food Insecurity Access Scale (HFIAS)

Food access was measured through HFIAS, which is an adaptation of the approach used to estimate the prevalence of food insecurity in the United States of America (Coates *et al.*, 2007). The HFIAS was developed for use in developing country settings and is a tool that asks respondents about three domains of food insecurity: (1) experiencing anxiety and uncertainty about the household food supply, (2) altering quality of the diet and (3) reducing quantity of food consumed (Coates *et al.*, 2007). The tool consists of nine questions that ask about changes households made in their diet or food consumption patterns due to limited resources to acquire food in the preceding

30 days. Based on the responses given to the nine questions and frequency of occurrence over the past 30 days, households are assigned a score that ranges from 0 to 27. A higher HFIAS score is indicative of poorer access to food and greater household food insecurity. For this analysis, households were classified into two groups based on overall distribution of the HFIAS in the sample. The lower the score, the higher the food security situation in the household. Consequently, a score of 17 and less was classified as food secure, and a score of more than 17 was classified as food insecure. HFIAS allows assessment of food poverty (i.e. the inability to obtain healthy and affordable food).

## 3. RESULTS AND DISCUSSION

### 3.1 Incidence of Food Security Based on Dietary Energy Consumed per AE per Day

The results on food secure and food insecure households based on DEC per adult equivalent showed the mean of 3,573.4 kcal per adult equivalent per day. They also showed minimum and maximum values of 1,530.3 and 6,461.0 kcal per adult equivalent per day respectively and a standard deviation of 862.0 kcal per adult equivalent per day. The results in Table 1 further show that 84.2% of the households surveyed were food secure while 15.8% were food insecure.

**Table-1**. Food security based on the four methods of food security determination

| Food security status | Frequency | Percentage |
|---|---|---|
| Incidence of food security based on DEC per AE per day | | |
| Food secure | 337 | 84.2 |
| Food insecure | 63 | 15.8 |
| Total | 400 | 100 |
| | | |
| Incidence of food security based on DEC per capita per day | | |
| Food secure | 327 | 81.8 |
| Food insecure | 73 | 18.2 |
| Total | 400 | 100 |
| | | |
| Incidence of food security based on dietary diversity | | |
| Food secure | 123 | 30.8 |
| Food insecure | 277 | 69.2 |
| Total | 400 | 100 |
| | | |
| Incidence of food security based on Household Food Insecurity Access Scale | | |
| Food secure | 352.0 | 88.0 |
| Food insecure | 48.0 | 12 |
| Total | 400 | 100 |

Field Data, 2014 Source

### 3.2. Incidence of Food Security Based on DEC per Capita per Day

The results on food secure and food insecure households based on dietary energy consumed (DEC) per capita showed the mean of 2,351.2 kcal. They also showed minimum and maximum values of 1,035.3 and 4,185.5 kcal per capita per day respectively and a standard deviation of 537.5 kcal per capita per day. The results further showed that 81.8% of the households surveyed were food secure while 18.2% were food insecure (see Table 1). These results are slightly different from those of DEC per adult equivalent per day. The results show that the incidence of food insecurity based on DEC per capita per day was slightly higher than that based on DEC per adult equivalent per day. The probable explanation is that the value of 2,100 kcal which is used as a cut-off point in measuring DEC per capita is too close to the value of 2,200 kcal per adult equivalent per day which is used in Tanzania. The international cut off point is 2,280 kcal per adult equivalent per day (Wanmali and Islam, 2002). Besides, if you take the mean DEC eaten per day per household which was 13,932.3 kcal and divide it by the mean household size which was 5.90, the answer

is 2,361.4 kcal. However, if you take the mean kcal eaten per day per household, which was 13,932.3 kcal and divide it by the mean adult equivalent units, which was 3.845, the answer is 3,625.4 kcal. There is a huge difference between the two answers. Therefore, it is quite possible that measuring food security using DEC per capita tends to exaggerate food insecurity compared to measuring DEC per adult equivalent. Moreover, measuring food security using DEC per adult equivalent per day takes into consideration the caloric requirement by age and sex of every household member while measuring DEC per capita per day takes the absolute number of household size.

### 3.3. Incidence of Food Security Based on Dietary Diversity

The results on food secure and food insecure households based on DD showed the mean of 126.54 weighted sum scores. They also showed minimum and maximum values of 72 and 295 respectively and a standard deviation of 46.60 weighted sum scores. The results in Table 1 show that 38.8% of the households surveyed were food secure while 61.2% were food insecure. These results show that many households in the study area were consuming limited dietary varieties. It is apparent that poor dietary variety is a feature of many developing countries (Labadarios *et al.*, 2011). Several studies have suggested a positive association between household income and dietary diversity (Ruel, 2002). Households in the study area were constrained in terms of cash, which could be used for buying foods in order to diversify their diet. During FGDs they reported that household income from the sale of crops was decreasing because the food was available in the markets and shops. The income farmers were getting from the sale of crops had declined, according to 2007 Household Budget Survey, from 60% in 2000/01 to 50% in 2007 (NBS, 2009). Moreover, during FGDs it was reported that a few households were buying foodstuffs from market places and shops.

### 3.4. Incidence of Food Security Based on Household Food Insecurity Access Scale

The results on food secure and food insecure households based on HFIAS showed the mean of 12.65 scores. They also showed minimum and maximum values of 4 and 27 respectively, the standard deviation being 4.05 scores. The results in Table 1 show that 88% of the households were food secure while 12% were food insecure. These results indicate that majority of the households had enough access to food. During FGDs they reported that they were accessing food through production, purchasing and assistance by relatives. During focus group discussions it was pointed out that a few households were buying food from shops and market places due to low income at the household level. Additionally, during FGDs it was pointed out that all households owned land which was used for crop production. During focus group discussions they reported that all households had access to, and were collecting, various wild foodstuffs which included vegetables, fruits and small animals. Both wild vegetables and fruits were reported in Gogo language. The wild vegetables included *kidingulio* (*Aloe nutii*), *mhilile* (*Cleome hirta*), *mzimwe* (*Gynandropsisgynandra*) and *ilendi-lyamhonjela* (*Sesamumangolense*)(Ruffo et al., 2002).The wild fruits included *mpela* (*Adansoniadigitata*),*msis*i (*Tamarindusindica*), *mgwelu* (*Grewiafallax*), *mhafuta* (*Grewiahexamita*), *mfulu* (*Vitexdoniana, Vitexferruginea and Vitexpayos var. payos*) and *mpelemehe* (*Grewiaplatyclada*) (Ruffo *et al.*, 2002). The wild animals included dikdik (*Madoquakirkii*), impala (*Aepycerosmelampus*), hare (*unidentified species*), helmeted guinea-fowl (*Numidameleagris*), bush pig (*Potamochoerusporcus*), francolin (*unidentified species*), dove (*unidentified species*) and African civet (*Civettictiscivett*). The mentioned foods show dietary diversity. However, wild fruits and vegetables are available seasonally. Vegetables and some fruits are plenty during rainy season and decrease during dry season. During focus group discussions they reported that they usually collect wild vegetables during rainy season. They process these vegetables by drying and storing them for consumption during dry season. This was further confirmed during focus group discussions; they reported that the number of meals of wild vegetables was 2 to 3 per day. Wild animals were available occasionally.

### 3.5. Comparison of Food Security Incidences Based on the Four Methods of Food SecurityDetermination Used

The incidences of food insecurity and food security obtained based on DEC per adult equivalent per day, dietary energy consumed per capita per day, dietary diversity, and household food insecurity access scale based on 30 days' data are summarized in Fig. 1.

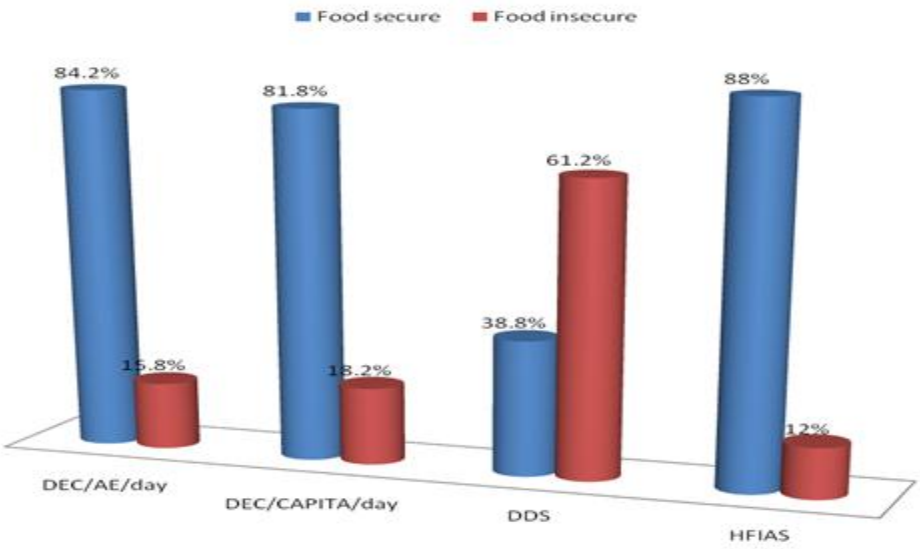


**Figure-1**. Food Security Levels Based on four methods of Food Security Determination

The results showed that food insecurity incidences in Chamwino District based on DEC per adult equivalent and per capita, DD and HFIAS were much higher than the national levels of food insecurity in Tanzania, which was 9.7% in 2011/12 (NBS, 2014). The high food insecurity incidences based on DD (See Fig.1) could be due to methodological problems because food groups were developed during FGDs based on the local classification system according to the foods which were available and could contribute to improved diet in the study area. The cut-off points were established using the mean score on DD in the sample. Moreover, high food insecurity obtained using DD could be due to low agricultural diversity in Chamwino District and also because only one ethnic group with similar food habits dominates the district. It is argued that strong food habits cannot be affected by poverty. However, income level has been reported to have positive infuence on food habits (Dunneram *et al.*, 2013). For example, Dunneram *et al.* (2013) found that health foods were consumed by high income earners compared to low income earners among Mauritians in Mauritania.

Unlike urban people who depend more on food purchased from shops, supermarkets and market places; rural people mainly depend on own produced food. Such dependence has been reported by some scholars. For example, Olney *et al.* (2009) reported that homestead production has a direct positive impact on dietary diversity, and Keller *et al.* (2005) reported that Kongwa and Singida had low dietary diversity due to low agriculural diversity. Chamwino District has semi-arid charactreristics like Kongwa and Singida. These three districts (Kongwa, Singida and Chamwino) are found in the same agroecological zone. In spite of own production having direct and positive impact on dietary diversity, Ruel (2002) argues that household income is positively related to dietary diversity. In areas with low agricultural diversity, dietary diversity could be improved by purchasing foods from market places and shops. During FGDs it was said that a small proportion of households were buying food items from market places and shops. Moreovere, it was pointed out that household income from the sale of crop products was decreasing because, during the survey, food was availabe in market places, shops and households. Besides, a large proportion of households from four out of the six surveyed villages (Fufu, Idifu, Miganga and Mlimwa) had food stored in their households. However, in two villages (Suli and Membe) a large proporion of households had no food stored in their households. At Suli, most of the produce (sorghum and bullrush millet) was devoured by destructive birds. At Membe, they

depended much on maize production, but during the agricultural season covered by the research (2013/14) they did not harvest any grain due to extended drought.

DEC per adult equivalent and per capita per day and HFIAS gave almost similar results of food security incidences, although slightly more food insecurity incicences were obtained using DEC per capita per day. The results on DEC per adult equivalent per day showed that 84.2% were food secure while 15.8% were food insecure. The results on DEC per capita showed that 81.8% were food secure while 18.2% were food insecure. The results on HFIAS showed that 88% were food secure while 12.0% were food insecure. The results on DD showed that 38.8% were food secure while 61.2% were food insecure. These results of food insecurity incidences were higher than the national levels of food insecurity in Tanzania, which was 9.7 % in 2011/12 (NBS, 2014). Of all the methods in Fig.1, DEC per adult equivalent and per capita per day and HFIAS gave the best results in determing food security incidences. Incidences of food security based on kCal per adult equivalent and per capita being different has also been reported by Kayunze *et al.* (2010) they attributed the differences to kCal per adult equivalent being based on adult equivalent units, the determination of which is subjective.

## 4. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, it is concluded that DEC per adult equivalent per day, DEC per capita per day and HFIAS give almost similar food security incidences and have good potential to give reasonable results of food security status while DD tends to exaggerate food insecurity incidences. It is recommended that the government and other stakeholders dealing with food security should use both DEC per adult equivalent, DEC per capita per day and HFIAS almost equally since they give almost similar results. Besides, effort should be made to establish international cut-off points and food items to include in the classification of households into food secure and food insecure based on DD.

Based on food insecurity incidences which were higher than national levels, it is concluded that food insecurity observed in this study could be associated with limited access to food due to limited financial resources to access food. Accordingly, it is recommended that the government should support these households of Chamwino District through various non-farm activities in order to minimize financial constraints.

Based on the food groups which were developed during focus group discussion and using a weighed sum dietary diversity procedure to determine dietary diversity, it is concluded that most households were food insecure. Most households reduced the diversity of the food items they consumed due to cash constraints; this was reflected in lower scores on the measure of dietary diversity. Furthermore, using the weighted sum score procedure, local food systems limit generalization of the research findings. This is due to the fact that there is no agreed international cut-off points and food classification system based on DD. Therefore, it is recommended that effort geared at alleviating household food insecurity should contribute to consumption of a wide range of food items at the household level.

Food access which was measured using HFIAS gave low incidences of food insecurity compared to other measures of food security, leaving alone DD. Accordingly it is recommended that the government and other stakeholders dealing with food security should use HFIAS because it is a good measure of food insecurity in several settings.

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**Appendix 1: Determination of sample size using Cochran (1977) formula**

The formula is:

The sample size is justified on the fact that "too large a sample implies a waste of resources, and too small a sample diminishes the utility of the results" (Cochran, 1977, cited by Bartlett *et al.* (2001). Therefore, the following formula will be used to determine the reasonable sample size:

n = sample size;

$n = \frac{Z^2 * p (1 - p)}{d^2}$ (Cochran, 1977, cited by Bartlett *et al.* (2001) where:

Z = a value on the abscissa of a standard normal distribution (from an assumption that the sample elements are normally distributed), which is 1.96 or approximately 2.0 and corresponds to 95% confidence interval;

p = estimated variance in the population from which the sample is drawn, which is normally 0.5 for a population whose size is not known;

d = acceptable margin of error (or precision), whereby the general rule is that in social research d should be 5% for categorical data and 3% for continuous data (Krejcie& Morgan, 1970, cited by Bartlett *et al.* (2001). In this research, 5% will be used since substantial categorical data will be collected.

Using a Z-value of 2.0, a p-value of 0.5, a q-value of 0.5, and a d-value of 0.5% (which is equivalent to 0.05), the sample size (n) was determined to be 400.

$n = \frac{2^2 * 0.5 (1 – 0.5)}{0.05^2} = (4 \times 0.25)/0.0025 = 1/0.0025 = 400.$

**Appendix-2.**Adult equivalent scales and Household economies of scale constants for East Africa

| Age group | Adult equivalents by Sex | |
|---|---|---|
| | **Male** | **Female** |
| 0 – 2 | 0.4 | 0.40 |
| 3 – 4 | 0.48 | 0.48 |
| 5 - 6 | 0.56 | 0.56 |
| 7 - 8 | 0.64 | 0.64 |
| 9 - 10 | 0.76 | 0.76 |
| 11 - 12 | 0.8 | 0.88 |
| 13 - 14 | 1.00 | 1.00 |
| 15 - 18 | 1.2 | 1.00 |
| 19 - 59 | 1.00 | 0.88 |
| Above 60+ | 0.88 | 0.72 |
| Household economies of scale constants | | |
| Household size | Marginal costs | Average costs |
| 1 | 1.000 | 1.000 |
| 2 | 0.892 | 0.946 |
| 3 | 0.798 | 0.897 |
| 4 | 0.713 | 0.851 |
| 5 | 0.632 | 0.807 |
| 6 | 0.632 | 0.778 |
| 7 | 0.632 | 0.757 |
| 8 | 0.632 | 0.741 |
| 9 | 0.632 | 0.729 |
| Above 10+ | 0.632 | 0.719 |

**Source:** Latham (1965) and Deaton (1980) cited by Collier *et al.* (1990)

**Appendix-3**. Dietary Diversity Indicate all the different foods that you have eaten in the last 30 days. Enter the following codes as indicated

| ITEMS | FREQUENCY | Wt[1] |
|---|---|---|
| | [1] 16 - 30 days in a month | 24 |
| | [2] 4 - 15 days in a month | 10 |
| | [3] 1 – 3 days in a month | 3 |
| | [4] 0 days in a month | 0 |
| **Cereals** | | |
| Maize | | |
| Bullrush millet | | |
| Sorghum | | |
| Rice | | |
| Wheat | | |
| Other cereals | | |
| **Tubers** | | |
| Sweet potatoes | | |
| Round potatoes | | |
| Other tubers | | |
| **Vegetables** | | |
| Tomato | | |
| Onion | | |
| Carrot | | |
| Cabbage | | |
| Leaf vegetables | | |
| **Legumes, nuts and other seeds** | | |
| Beans | | |
| Cow peas | | |
| Bambara nut | | |
| Groundnuts | | |
| **Fish** | | |
| Dried | | |
| Smoked | | |

| ITEMS | FREQUENCY | Wt |
|---|---|---|
| | [1]16 - 30 days in a month | 24 |
| | [2] 4 - 15 days in a month | 10 |
| | [3] 1 – 3 days in a month | 3 |
| | [4] 0 days in a month | 0 |
| **Fruits** | | |
| Bananas | | |
| Mangoes | | |
| Oranges | | |
| Pawpaw | | |
| Pineapple | | |
| Baobab | | |
| Other fruits | | |
| **Meat** | | |
| Beef | | |
| Chicken | | |
| Sheep/goat | | |
| Pork | | |
| Other meat | | |
| **Milk products** | | |
| Cow milk | | |
| Goat milk | | |
| **Other items** | | |
| Sugar | | |
| Honey | | |
| Tea | | |
| Salt | | |
| Butter | | |

[1]Following Hoddinott (2002).

**Appendix-4.** Food aid allocation for food insecure households in Chamwino District

| Season | Village | Number of households | Tons of cereals (maize) | Remarks |
|---|---|---|---|---|
| 2009/10 | Membe | 247 | 17 | |
| | Fufu | 414 | 28 | First allocation |
| | Idifu | 325 | 22 | |
| 2009/10 | Membe | | 12 | |
| | Fufu | | 6 | Second allocation |
| | Idifu | | 8.8 | |
| | Membe | 0 | 0 | |
| 2010/11 | Fufu | 640 | 7 | |
| | Idifu | 310 | 18 | |
| | Fufu | 120 | 13 | First allocation |
| 2011/12 | Idifu | 240 | 26 | |
| | Membe | 0 | 0 | |
| 2011/12 | Idifu | | 14.8 | Second allocation |
| 2012/13 | Membe | 259 | 30 | |
| | Fufu | 198 | 13 | |
| | Idifu | 276 | 26 | |
| 2013/14 | Fufu | 17 | 10 | Disaster (floods) |

**Source:** DAICO, Chamwino District, personal communication, 2014