DETERMINANTS OF CHILD NUTRITIONAL STATUS: A CASE STUDY IN DROUGHT PRONE AREA OF SOME SELECTED REGIONS WITH NGO'S INTERVENTION

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ABSTRACT

The Food Security and Nutrition Baseline Survey data gathered from survey conducted in June/July 1997 in 47 woredas of eight regional states in the country are used. The Logistic Regression Model is built to assess the association between child demographic and feeding practices, socioeconomic and morbidity variables and the nutritional status of children under the age of 5 years. From the survey report about 62.8% of children under the age of 5 years in the study areas are stunted (low height for age), 8% are wasted (low weight for age) and 47.4% are underweight.

The results of the study suggest that age of the child, sex, education level of the household head, housing condition (the material of which the house is made), source of water supply and availability of private or communal latrine were found to be important predictors of child nutritional status. Besides, diarrhoea during the last 14 days before the survey and vaccination status (completed or not) of the child were also found to be important determinants. Difference in nutritional status of children was also observed across cereals, cash crop, root crop or legumes growers.

The impact of prolonged breast-feeding (above 12 months) and frequency of supplementary food were also found important predictors for children under-3-years of age. In other words, children aged 12 month or older who were still being breast-fed at the time of the survey were of lower nutritional status and children who took additional food at least twice per day are in a better condition. The analysis also showed a difference in nutritional status of children across agroclimatic zones with high rate of prevalence for children residing in Dega (above 2300 m) and Woinadega (1500 – 2300 m) as compared to Qoulla (less than 1500 m) agroclimatic zones.

Chapter I

1. Introduction

The nutritional status of young children in a country or region is a determining factor for the development of that country or region. Malnutrition is a major public health problem in developing countries. A number of studies showed that malnutrition is one of the causes of infant and child mortality (Melville et al., 1988; Vella et al., 1992; Broeck et al., 1993; Boerma et al., 1992).

A study (Onis et al., 1993) based on nationally representative cross-sectional data gathered between 1980 and 1992, which covers 87% of the total population of under-5 years old in developing countries, confirms that more than a third of the world's children are affected by protein energy malnutrition. The study also highlighted that a total of 80% of the children affected live in Asia, mainly in Southern Asia, 15% in Africa and 5% in Latin America. From regional estimate of the study, in Eastern Africa 31% were underweight (maximum of 60.5% in South Asia and minimum of 21.3% in Eastern Asia), 47% were stunted (maximum of 60.3% in South Asia and minimum of 32.1 % in Eastern Asia) and 6.0% were wasted (maximum of 17.3% in Southern Africa and minimum of 5.5% in Melanesia).

From results of the 1992 National Rural Nutrition Survey Central Statistical Authority (CSA, 1993) it was indicated that 64% of children aged 6 – 59 months were stunted (low height for age), 8.0% were wasted (low weight for height) and 47% were underweight (low weight for age). These figures were found to be somewhat lower among infants (6 – 11 months), highest in the second year of life (12 – 23 months) and somewhat lower after 24 months. In a similar manner, result of the 1997 Food and Nutrition Baseline Survey Catholic Relief Service (CRS, 1997) reported that based on the youngest under-five year children, about 62.8% of the children were stunted, 8% were wasted and 47.4% were underweight which clearly indicates the lowest nutritional status of children in the country.

Several factors were found to be associated with malnutrition. But many have the vision that it is the result of inadequate food supply only. However, there is growing evidence that it is a far more complex problem involving multiple intertwined factors.

Many researchers agree that socioeconomic and environmental conditions together with feeding practices are important determinants of child malnutrition. A number of socioeconomic factors were significantly associated with nutritional status of children. Per capita income and per capita land holding (Gopaldas et al., 1988; Devi and Geervani 1994), poor housing and poor sanitary conditions associated with infectious disease (Sommerfelt 1991; Melville et al., 1988) were found to have an adverse effect on child nutritional status. In developing country the major diseases of children are associated with malnutrition since illness highly affects the nutritional status of children thereby creating a loss in appetite.

Several studies underscored the paramount importance of parental education for child nutritional status in relation to the health condition, feeding practices and the general wellbeing of the child. It is strongly confirmed by many researchers that improved level of parental education, associated with proper child-care and feeding practices have significant role in reducing the risk of child mortality. Duration of breast-feeding, age at which supplementary food is started and frequency of supplementary food taken per day were also found to have a strong effect on the nutritional status of children.

Specific studies towards the determining factors of children nutritional status are very small in our country. However, regional and/or national estimates or preliminary analysis by few organizations like the Ethiopian Nutritional Institute (ENI), CSA and very few individual researchers were carried out. But, considering the seriousness of the problem and its ever increasing rate a thorough discussion and application of further statistical analysis is important to find factors that determine the nutritional status of children.

It is in light of the above-mentioned background that this study is designed. Therefore, the current study concentrates on the relationship between child demographic and feeding practices, socioeconomic, morbidity and environmental factors on the one hand and indicator of nutritional status of children under 5 years of age on the other hand. In addition, an attempt will be made to find factors that aggravate the problem in the study areas that needs special attention.

It is evident from various studies that the rate of malnutrition is high in our country. Hence, studies on the factors that affect the nutritional status of children have a paramount importance in identifying areas that need special attention for appropriate intervention. Above all, the result from the study could be important to regional governments and NGO's in setting policies and strategies for improving the general nutritional status of children.

In this study five chapters are covered. A brief discussion on the revised studies is given in chapter two. Discussion about the data for the analysis, the variables expected to predict the nutritional status of children and the methodology applied for the study are covered in chapter three. In chapter four, we give results of the data analysis, a goodness of fit test of the model together with its adequacy and a thorough discussion of the results will lead us to the end of the chapter. Conclusion and recommendation of the study are presented in chapter five. Finally tables and graphs are appended.

Chapter II

2. Literature Review

Many view the cause of malnutrition as shortage of food in both quantity and quality. The causes of malnutrition, however, are intertwined and there are numerous factors that contribute towards the cause. For instance, some underlying causes of malnutrition are believed to be household food insecurity, insufficient health service and inadequate childcare. The relationship between these and some other factors are discussed below considering other countries' experience and works done in our country.

2.1 General Prevalence of Malnutrition

The result of national surveys carried out between 1980 and 1992 in 79 developing countries (Onis et al, 1993) indicated that Latin America has low to moderate prevalence of underweight children (11.9%), while most countries in Asia have high or very high prevalence (42.0%). In Africa, however, both moderate and high prevalence are found (27.4%). A greater variation seems to occur among regions in Africa. The situation in Northern Africa (Algeria, Morocco and Tunisia) is similar to that in Latin America, with a low or moderate prevalence of underweight children. Countries in Western Africa (32.8%) are mostly affected by high and very high prevalence as is the case in Eastern Africa (31.0%).

The difference between geographical area in relation to stunting and wasting resembles the situation for the distribution of underweight, that is, high prevalence in Asia, low prevalence in Latin America, and a combination of both in Africa. However, the situation in Latin America for stunting (22.2%) tends towards in Africa (38.6%). While for wasting the prevalence in Africa (7.2%) tend towards those in Asia (10.8%).

In general, a low prevalence of both stunting and wasting is commonly found in Latin America, whereas the opposite is true in Asia. A combination of high wasting with low stunting, which indicates a predominance of acute malnutrition over chronic malnutrition, is rare in Latin America and Asia but quite common in Africa, particularly in the western part.

2.2 Studies in Ethiopia

The peculiar characteristic of malnutrition in Ethiopia is that a significant number of the victims are children under five years. The 1983 and 1992 National Rural Nutritional Surveys and the 1995/96 Welfare Monitoring Surveys (WMS) clearly indicate that the nutritional status of children in Ethiopia is one of the lowest in the world.

Studies specific to the levels, trends and correlates of children's nutritional status are scanty in Ethiopia. However survey reports and findings of the available few studies reveal that malnutrition is widespread in the country. According to the recent survey report, malnutrition has been increasing in the country, stunting is found in 64.2% of all children, making it the third highest prevalence in the world (slightly behind Bangladesh and Mauritania) for countries with comparable data (UNICEF, 1993). Stunting is very common among infants 6 – 12 months of age (56.5%), reaches a peak of 72.7% among 12 – 23 month old, and shows little variation beyond 24 months of age (63%). Wasting affects 8% of all children in the post-harvest season of the survey, with a peak of 11.7% at 12 – 23 months of age. Underweight affects 47.7% of all children and likewise peaks among those aged 12 – 23 moths. Besides, all three indicators tend to show that males are more affected by malnutrition than females.

A study to examine factors affecting the nutritional status of children under age five in North-Oromo region was carried out by Melaku (1996). The study attempts to analyze the relationship between anthropometric outcomes and demographic characteristics, socioeconomic factors and different agro-ecological settings. The anthropometric outcomes (indicators of children's nutritional status) were used as dependent variables. Type of agricultural system, size of household, number of children under five, and birth-order of the child, size of cultivated land, source of drinking water, religion and ethnic group of the mother were some of the independent variables included in the model.

Bivariate and multivariate statistical techniques were used to find out the variable or set of variables that are associated with nutritional status of children. The finding of the study revealed that stunting was significantly associated with types of means of subsistence while wasting, which is a manifestation of current problems, was significantly related with seasons of harvest and prevalence of endemic disease. Furthermore, the finding of the study indicated that stunting increases with increase in the number of children in the household, which indicates the impact of household size on the limited resources.

Health and nutrition problems during childhood are the results of a wide range of factors, particularly in underprivileged populations, relate to unsatisfactory food intake or sever and repeated infections or a combination of the two. These conditions, in turn are closely linked to the general standard of living and whether a population is able to meet its basic needs such as food, housing and health care.

A study by Gugsa (1998) on the prevalence of malnutrition in the five densely populated zones of southern Ethiopia showed two socioeconomic variables (women education and household economic status) and a demographic factor (child age) to be very important predictors of long term nutritional status of children. For the purpose of screening these important predictors an in-depth analysis on height for age as the measure of nutritional status indicator was carried out. Socioeconomic, demographic, childcare and environmental factors were incorporated in the model as independent variable. Univariate, bivariate and multivariate methods were applied in the analysis. The univariate analysis was used to estimate the prevalence of malnutrition. In the bivariate analysis the relationship between all selected independent variables and the population of stunted children are considered. To identify the relative contribution of each selected variable to the total variance in long term nutritional status of children multiple logistic regression was used. In a similar study on the prevalence and determinants of protein energy malnutrition on under five years children residing in Jimma town, a strong association was revealed between protein energy malnutrition and poor housing conditions, non availability of latrine, prolonged breast feeding (over 12 months) and diet lacking in animal food (Tesfaye et al. 1998).

The causes of malnutrition are intertwined. Inadequate amount of food both in quantity and quality is not the only responsible factor. Researchers noted that, war interferes (directly) with food production by preventing farmers from planting and harvesting on time and reducing the labor force through coercive conscription for military service. Indirectly, but more importantly, war militarizes the economy and drains resources which otherwise could have been reinvested to raise the production capacity of the agricultural sector (Yohannes).

Yohannes carried out a study on child malnutrition in a war torn society of Ethiopia using cross-sectional data from a nutrition survey a year after the end of over two decades of civil war. To determine the nutritional status, children were categorized into five distinct groups: normal, stunted, underweight, wasted and both stunted and wasted. Acute and chronic malnutrition (stunting and wasting) are combined in order to identify those groups of children being affected simultaneously by both groups. For data analysis both bivariate and multivariate techniques were employed. In the multivariate analysis a binomial logistic regression model was applied with random terms in the model to capture the unobserved group effects either at family level or location level. However, in the analysis only location rather than family or household level clustering was introduced. The study recommends that location effects of clustering are highly likely as each administrative province with its characteristics, such as agro-ecological factors, morbidity patterns, drought and war experience as well as food habits and child rearing practices, is likely to constitute some form of outcome cluster, which in effect would violate the assumption of independence or randomness.

Result of the analysis showed that to predict risks of malnutrition in the country for variables included in the logistic binomial model, expected duration of breast feeding and age at introduction of supplementary food were found to be highly significant predictors. Furthermore, number of under five siblings, age of the child, per capita land holding, age of household head, religion affiliation and endemic disease in the area of the child residence were also found to be statistically significant predictors. It is also shown that the random term representing group or location effects found to be significant, indicating the presence of extra variations in the likelihood of malnutrition which were not adequately explained by the covariates in the model.

2.3 Studies in other countries

Malnutrition is a major public health problem in developing countries. It contributes to child mortality, poor intellectual and physical development of children, and lowered resistance to disease, and consequently affects development. Some of the responsible factors for the cause of malnutrition include low income, uneven household food distribution, food shortage, infection and inadequate nutrition knowledge.

Horner et al. (1981) studied malnutrition and associated factors in preschool Miskito Indians in Nicaragua. Anthropomatric parameters of nutritional status, expressed as percent of the standard, were the dependent variables in the study. The independent variables considered were months of the study period, age, sex, birth order, physical handicaps, household size, incidence of gastrointestinal and respiratory infection. Multivariate regression techniques were used to determine factors associated with malnutrition.

Result of the analysis indicated the following: A sever rainy season two months prior to the time of the first anthropometric measurements results in crop damage from flooding and extensive food shortages. The highest frequency of poor nutritional status was found in the 12 – 23 month old children. Diseases have overwhelmingly negative impact on nutritional status. The study also suggests insufficient opportunities for breast-feeding and inadequate, contaminated bottle feedings used in substitution were contributing factors to malnutrition and subsequent death in young children. In their concluding remark Horner et al. (1981) stated that malnutrition in infants was manifested in a variety of forms at each measurement period. Besides, the nutritional status of malnourished infants fluctuated during the four-month intervals between measurements.

Delifina et al. (1988) studied the relationship of family characteristics to the nutritional status of preschool children in the Philippines. The study investigated the influence of education of parents, household size, family income, home ownership, birth order, and type of infant feeding on the nutritional status of the preschool child, using percentage of standard weight for age as the dependent variable.

The relationships between nutritional status (in terms of percentage of standard weight for age) and different family characteristic variables were evaluated using Pearson moment correlation. Stepwise regression models were computed to determine variables that best predict the nutritional status of the child. The study revealed that income, education attainments of parents, and family size are significantly associated with the nutritional status of preschool children. Moreover, the study also identifies infant feeding and weaning practices as highly important. A similar study in Jamaica by Melville et al. (1988) on the determinants of child malnutrition indicated disease, economic and social characteristics of the household and duration of breast-feeding as the major determinants of nutritional status of children. Similarly Gopaldas et al. (1988) observed socio-economic, environmental and maternal factors to be important in determining the nutritional status of children from birth to three years of age.

A mother is a principal provider of the primary care that her child needs during the first years of its life. The type of cares she provides depends to a large extent on her knowledge and understanding of some aspects of basic nutrition and health care. Evidence accumulated from several studies show that maternal education is an important determinant of children nutritional status (Sommerfelt, 1991).

In a study on the role of maternal literacy and nutrition knowledge in determining children's nutritional status Christian et al. (1988) used chi-square values to see whether the nutritional status of children depend on the mothers' literacy and nutrition knowledge score. Furthermore, the study attempted to see the association between the two independent variables and their individual relationship to the income status of the family. Analysis of covariance was also employed to see the effect of mothers' nutrition knowledge on the child nutritional status, controlling for their literacy status.

From result of the covariance analysis, the effect of nutrition knowledge scores on weight for age, height for age, and weight for height found to be significant when controlled for literacy and family per capita monthly income. It can, therefore, be implied that, if mothers have sufficient nutrition knowledge it will be effective in improving the nutritional status of their children.

The work status of the mother also plays an important role in determining the health and nutrition status of the child. Abbi et al. (1991) attempted to recognize the impact of maternal work on the nutrition and health status of children. For assessing the nutritional status indicators, weight for age and height for age were used. The relative risk of children becoming malnourished based on mothers' working status was calculated using prevalence Odds ratio with a 95 % confidence interval. Analysis of covariance was also applied to see the effect of maternal employment on child nutrition and health status, controlling for the effect of income and child age. It is found that children of working mothers fared significantly worse than those whose mothers stayed at home. This negative effect was more pronounced among children under the age of three than in those older than three years. Furthermore, analysis controlling for family income and age of the child clearly demonstrated that the working status of women had a significant adverse effect, giving support to the view that maternal childcare time may be an important factor in determining the growth and wellbeing of the child. Similarly, Islam (1994) revealed a strong association between employment of mothers outside homes with five-fold increased risk.

Sommerfelt (1991) in her comparative analysis on the determinant of child nutritional status examined differentials in the anthropometric status of young children using comparable data set from developing countries. Indices of nutritional status height for age, weight for height and weight for age are expressed in standard score units. The study considered percent of children classified as being malnourished (the percent whose z-score fall below –2 standard deviation) as well as the mean z-score to illustrate the differences in overall nutritional status between countries. The mean height for age z-score was used as the outcome variable to show differentials according to socioeconomic and demographic characteristics. The multivariate regression technique was employed in assessing the effect of each of the independent variables. Based on the multivariate model, the urban-rural place of residence and height were significant in seven of the countries. Education of the mother was significant in eleven countries. Effect of drinking water on child's height was significant in five countries and children whose families had a flush toilet were the tallest in all nineteen countries. Children born after a birth interval of less than 24 months were short in 13 of the countries and child's age entered as a covariate in the model found to be significant in all the countries reflecting a deterioration in nutritional status with increasing age.

Sommerfelt (1991) reiterates the fact that levels of malnutrition are high among children in developing countries. A similar study conducted in developing countries on the relationship between food consumption and nutrition reveals significant difference among different economic groups of the society (Chaudhury, 1986).

It is often hypothesized that health and nutritional status positively affect human capital formation and the productivity of low-income persons in work. For instance, several studies maintain that malnutrition represents a source of productivity loss to the individual. A loss in a worker's productivity in the individual economic welfare represents a loss to the nation as a whole.

Devi and Geervani (1994) conducted a longitudinal study in a typical dryland area on the determinants of nutrition status of rural preschool children with low-income households. Information was gathered on child related, maternal, paternal and socioeconomic and environmental factors in order to screen out specific factors that significantly associate with malnutrition. Nutritional status assessment using anthropometry, weight for age, height for age, and weight for height percentage for each child using NCHS standard were used as a dependent variable.

For the purpose of identifying independent variables that have a significant role in influencing the nutritional status of children Devi and Geervani (1994) used the stepwise multiple regression analysis (Backward Elimination). The study showed that among the four categories of factors studied (child related, maternal, paternal and socioeconomic and environmental) two child related factors, namely, number of diarrhea episodes and calorie adequacy of diet result in a high significant effect on a child's current as well as past nutrition status. These factors in turn are highly correlated with other socioeconomic, maternal and paternal factors. Among the maternal factors good health during pregnancy had a positive significant effect on weight for age and weight for height, but not on height for age. Furthermore, health of the father during the study period and the time he spends with family members after work also had a positive and significant effect on the child weight for age but not on height for age. Income from land emerged as a single but significant socioeconomic factor that influences weight for age, height for age and weight for height, implying families who receive higher incomes from land may have fewer constraints in feeding children.

Many researchers agree that socioeconomic and environmental conditions, together with feeding practices, are important determinants of malnutrition in developing countries. Madise and Mpoma (1997) attempted to assess the association between breast feeding practices, socioeconomic and morbidity variables and the nutritional status of children under the age of five years.

They applied the multilevel analysis on weight for age z-scores to determine the socioeconomic, morbidity and feeding variables that are associated with nutritional status indicator. The multilevel analysis is appropriate for household survey data that often contain information on more than one child per mother. There is growing evidence of familial or regional clustering of health outcomes to shared maternal or household characteristics (Madise and Diamond, 1995; Yohannes).

Madise and Mpoma (1997) considered separate multivariate analyses for children aged 4 to 11 months and 12 to 59 months. For the 4 to 11 month age group, single level regression using the stepwise selection procedure was used, and for the 12 to 59 month age group, a two level model was fitted incorporating individual child variables and variables relating to the mother or household. Socioeconomic factors, morbidity and inappropriate feeding practices were found to be the factors associated with malnutrition. High socioeconomic status as measured by urban residence, the presence of modern amenities, and some maternal education are associated with better nutritional status, whereas morbidity within two weeks of the study period is associated with low weight for age z-score. Children aged 12 month or older who were still being breast-fed were of lower nutritional status than those who stopped breast-feeding before 12 months of age. The analysis also revealed a significant intra – family correlation of weight for age z-scores of children of the same family.

2.4 Comment on the Revised Studies

In some of the revised studies, important variables that are expected to be the cause for malnutrition are not incorporated. For instance, the number of children under five years in a house hold, the age at which supplementary food is introduced, birth order of the children, food security of the household, and the presence of radio, bicycle are a few to mention. Interaction effects of combination of some of the variables were not included. Especially when variables like source of water supply by availability of private latrine, illness by vaccination status, child age by area of cultivated land and education of household head by availability of radio present the interaction effect must not be overlooked. Few studies including relevant interaction terms like availability of radio or electricity by urban-rural residence, water source by private latrine and others found their importance in predicting the nutritional status of children.

In assessing the nutritional status of children, all indicators are separately analyzed in most of the studies. Even though the indicators measure different level of nutritional status, there exists a strong correlation among them. Therefore, performing individual analysis may cause a problem and hence all the indicators must be considered jointly in order to demean the probability of accepting a false hypothesis.

Whenever we build a statistical model, it is important to examine the adequacy of the resulting model. These are valuable tools for identifying points for which the model doesn't fit well, points that exert a strong influence on the coefficient of the estimates, and variables that are highly related to each other. Besides the goodness of fit of the model, its predictive ability must be checked before use. However, in the revised studies examination of the fitted model for possible failure is not checked and hence direct use of the model ignoring its adequacy will result in a serious problem. In this study, however, appropriate statistical techniques will be applied, and we will try to select the most appropriate model that best explains the nutritional status of children and mitigate the drawbacks mentioned in the revised studies.

Chapter III

3. Objectives and Methodology

3.1 Objectives

Malnutrition is a serious problem in developing countries. As stated in the revised studies, its underlying causes are the interplay of many factors. Our country with most of its society residing in areas of insufficient amount of food, with unprotected water supply, with no toilet facility and very few health centers is very prone to the problem. Mostly, in the rural part of the country the knowledge about nutrition, the education status and economic activity of the household members are very scanty and hence, children of under-five years of age in the areas are very susceptible to the problem.

In areas where drought is more prevalent, the problem of malnutrition is very high. Children living in these areas are highly exposed to the problem since they are running short of food adequacy both in quantity and quality and are very susceptible to different kinds of illness such as diarrhea, malaria, TB and the like. Therefore, the study in this paper focuses on the problem of malnutrition in drought prone areas and hence important variables associated with the problem in the area are incorporated.

Noting the severity of the problem in these areas, the main objective of the study focuses on identifying socioeconomic, child related and environmental factors that are expected to be causes of the problem. Among other things, the specific objective in the study include:

- To provide estimate of the regional average of prevalence of malnutrition.

- To find important factors that aggravate the problem in the regions under consideration and to investigate causes of regional variation.

- To identify group of population that require special attention by considering the variables that are important predictors of the problem.

- To provide information to governments and NGO's in setting priorities, policies and strategies for improving nutrition and provide a basis for reviewing progresses on the ongoing programs, projects and polices in the regions.

3.2 The Data

The data for the study were obtained from Food Security and Nutritional Baseline Survey conducted under the auspices of Catholic Relief Service (CRS) in June/July 1997. The survey covered 47 woredas in Tigray, Amhara, Oromia, Southern Nations, Nationalities and Peoples Region, Somali, Harari, Dire Dawa and Addis Ababa regional states. In the chosen woredas a total of 9682 households were interviewed and paired selection of peasant association was made from each woreda. From the selected peasant association 190 households were interviewed.

The sample was designed in such a way that it includes samples of all areas in which Title II co-operating Sponsors will be working in the next five years. A stratified two-stage design was used in which the woredas served as strata and peasant associations (PAs) or sometimes villages or kebeles as primary sampling units. Paired selection of PAs was made from each woreda and from the selected PAs households were selected and interviewed.

List of woredas was obtained for each cooperating sponsor. At the primary stage sampling, two PAs or villages were selected from each woreda with probability proportional to size (number) of households in the PAs. The second stage in sampling was selecting households from the selected PAs or villages. In order to select households, sampling interval was determined by dividing the total number of households in the PA or village into the required number of households (95 Households). After sampling intervals were determined, households were then selected using systematic sampling methods. In some woredas it had been possible to secure lists of households. In others the number of households were known in totality only and no lists were available. In the former case, households were identified from the list while in the latter households were selected on the ground using sample intervals.

The data used for the study has certain limitations. As certain questions are referring to time frames and were answered by referring to major events. It is expected that respondents may not entirely be accurate and genuine in the quantitative information they provided particularly on age at which breast-feeding stopped, age at which supplementary food started, food access and months of food insecurity.

3.3 Variables in the Study

Variables to be included in the study are selected based on information from the revised studies and those that are expected to be relevant to the situation in our country, in particular, those variables that are expected to be responsible for the problem in drought prone areas.

3.3.1 The Dependent Variable

In assessing the nutritional status of children the basic anthropometric measurements weight and height were considered. Since children height and weight changes with age, these measurements, taking age and sex into consideration, were converted into z – scores based on the United States National Center for Health Statistics reference population (WHO Working Group, 1986, as cited in Sommerfelt). Three indices of nutritional status, height for age, weight for height and weight for age are expressed in standard z-score unit and the transformation for these indices was performed using the **ANTHRO** software.

The standard z-score (standard deviation score) is the deviation of the value for an individual from the median value of the reference population divided by the standard deviation for the reference population which is given by

$$\text{z - score} = \frac{\text{(Observed value) - (Median reference value)}}{\text{Standard deviation of reference population}}$$

A fixed z-score interval implies a fixed height or weight difference for children of a given age (WHO Technical Report Series, 1995).

The indices of nutritional status assessment express different aspects of a child's anthropometric status (Sommerfelt, 1991).

- **Stunting (low height for age)** $\Rightarrow$ It is a reflection of the life long experience of a child. That is, sometimes referred to as an indicator of **"Chronic Malnutrition".**

- **Wasting (Low weight for height)** $\Rightarrow$ It is a reflection of the thinness of a child. Thinness tends to respond to a more recent experience (food intake and disease). Wasting is sometimes referred to as an indicator of **"Acute Malnutrition".**

- **Underweight (Low weight for age)** $\Rightarrow$ It is a summery reflection of the degree of wasting and stunting in a child, because height deficits and thinness will both result in the child weighing less than normal for his or her age. This can't distinguish between long term and more recent experience affecting the child.

Prevalence of Stunting (low height for age), Wasting (low weight for height) and underweight (low weight for age) were determined according to the criterion of -2 z-scores cut off point (That is, **HAZ < -2, WAZ < -2** and **WHZ < -2** imply the child is stunted, underweight and wasted, respectively). The response variable, which is a measure of malnutrition, is dichotomized as 1 if the child is stunted, wasted or underweight and as 0 if normal. Hence the dependent variable denoted by **NUT_STAT,** which measure the general nutritional status of the child, assumes possible values

Nut_stat $\Rightarrow$ 0 : Normal

1 : Malnourished (Stunted, Wasted or Underweight)

3.3.2 Independent Variables

Most of the independent variables included in the study are expected to depict marked differential in the Nutritional Status of children. Variables to be included in the analysis are grouped as child related, socioeconomic and environmental and listed below:

⇒ Child Related Variables

- **Chil_Sex:** sex of the child.

  0 – Female

  1 - Male

- **Child_ age:** age of the child

- **Ch_ag_sq:** Square of child age – included to capture the non-linear relationship expected to have with the dependent variable.

- **Vaccinate:** Vaccination Status

  0 – Complete

  1 - Incomplete

- **Illness:** Illness during the last two weeks before the survey

  0 – Not ill

  1 – ill

- **Breast_f:** Breast-feeding

  0 – Yes

  1 - No

- **Brst_age:** Duration of breast-feeding

  0 – age <=12 and Breast

  1 – age > 12 and breast

  2 – No Breast

- **Supp_f:** Supplementary food

  1 – Exclusive Breast-feeding

  2 – Food at most twice

  3 – Food at least twice

- **Chil_u5:** Number of children under 5 years of age in a household

⇒ Socioeconomic Variables

- **HH_Size:** Household size
- **Cultv_sz:** Size of cultivated land in hectare
- **Wtr_supply:** Source of water supply

    0 – Protected

    1 – Unprotected

- **Prvt_lat:** Private latrine

    0 – Yes

    1 – No

- **Comm_lat:** Communal latrine

    0 – Yes

    1 – No

- **Food_wrk:** Participation in food for work – which justifies the fact that household was disadvantaged group.

    0 – Participate

    1 – Don't participate

- **Dvlp_ext:** Participation in development Extension program

    0 – Yes

    1 – No

- **Insf_l12:** Months of insufficient amount of food in the last 12 months
- **Head_age:** Household head age
- **Head_mar:** Household head marital status

    0 – Married

    1 – Others

- **Head_eco:** Household head economic activity

  0 – Farm

  1 – Others

- **Head_edu:** Household head educational attainment

  0 – Literate

  1 – Illiterate

- **Head_sex:** Household head sex

  0 – Female

  1 – Male

- **Spo_age:** Spouse age

- **Spo_mar:** Marital status of spouse

  0 – Married

  1 – Others

- **Spo_eco:** Economic activity of spouse

  0 – Housewife

  1 – Others

- **Cereals**: Grow cereals – Binary variable with possible values 1 if the household grew Maize, Barely, Sorghum, Teff, Wheat or Millet and 0 otherwise.

  0 – Didn't grow

  1 - Grow

- **Legumes:** Grow legumes – Binary variable with possible values 1 if the household grew Horse beans, Peas, Haricot beans, Lentils or Chick peas and 0 otherwise.

  0 – Didn't grow

  1 - Grow

- **Cash_cr:** Grow cash crop – Binary variable with possible values 1 if the household grew coffee or chat and 0 otherwise.

  0 – Didn't grow

  1 - Grow

- **Root_cr:** Grow root crop – Binary variable with possible values 1 if the household grew Potato, Sweet potato or Godere and 0 otherwise.

  0 – Didn't grow

  1 - Grow

- **Radown:** Radio ownership

  0 – Yes

  1 – No

- **Potown:** Pot ownership

  0 – Yes

  1 – No

- **Platown:** Metal plate ownership

  0 – Yes

  1 – No

- **Floor:** Material for Floor

  0 – Others

  1 - Mud

- **Walls:** Material for Walls

  0 – Others

  1 – Wood/Bamboo

- **Windows:** Material for Windows.

  0 – No Window

  1 – Open

  2 – Wood or others

Region is included in the model to capture the regional variations. It is incorporated in the model as a binary variable where by it assumes a value 1 if a child is from the specified region and 0 otherwise. The model also contains interaction terms that are expected to exacerbate the problem in a jointly manner. The interaction effects are incorporated in the model by considering some of the revised studies and looking at the general pattern of the variables under consideration. The following are some of the variables expected to have joint effect on the problem.

i. **HH_size * Chil_age:** Which depicts that if the household size is considerable children try to share their supplementary food with members of the household leading to shortage of food both in quality and quantity. Particularly children above their third year of life are highly susceptible.

ii. **HH_size * Insuf_l12:** Interaction effect of household size with the number of months with insufficient amount of food. Clearly, when the household size is large and the number of months with insufficient amount of food in the household is large the problem will be more serious than the other possible combinations.

iii. **Illness * prvt_lat**: Interaction effect of illness during last two weeks and availability of private latrine. If a child is ill during the last two weeks and there is no private latrine in the household the problem with no doubt will aggravate.

iv. **Prvt_lat * Wtr_sppl:** Interaction effect of availability of private latrine with the type of water supply. A child from a household with no private latrine and unprotected water supply is expected to be a victim of the problem as compared to children of other groups.

v. **Region * wtr_spply:** Interaction effect of region under study by the type of water supply. This enables to see regional variation together with the kind of water supply the child is exposed to.

vi. **Brst_f * Vaccinat:** Interaction effect of breast feeding status of the child with his or her being vaccinated completely. Children who stopped breast-feeding and not completely immunized are more likely exposed to child malnutrition in comparison with the other group.

vii. **Head_edu * Radown:** Interaction effect of education status of the head of the household with the availability of radio. In a household with illiterate head and no radio access information towards health and nutrition is very rare and hence children from this household are expected to be malnourished than the other groups.

3.4 Methodology

Several Multivariate statistical techniques can be used to predict a binary dependent variable from a set of independent variables. Multivariate Regression Analysis, Discriminant Analysis and Logistic Regression are cases in point. However, use of Multiple Regression Analysis when the dependent variable assumes only two values and Discriminant analysis under certain form of the independent variables pose difficulty.

The linear regression analysis under the assumption of normal errors and well-defined covariance matrix has special features. There are, however, many situations for which the assumptions are not satisfied. For instance, when the dependent variable takes only two values hypothesis testing and confidence interval estimation are impossible (Hocking, 1996).

Application of discriminant analysis in binary response data also has difficulty since the independent variables are a combination of categorical data and continuous variables, and hence the multivariate normality assumption will not hold. Therefore, the logistic regression technique, that does not make any assumptions about the distribution of the independent variables, is preferred to predict a binary dependent variable from a set of independent variables. For that reason, logistic regression is extensively applied in the study and a brief discussion of it follows.

3.4.1 Logistic Regression

Logistic regression is widely applicable when the response variable is binary and is concerned with the estimation of the probability of the occurrence of an event. The relationship between the set of independent variables and the probability of occurrence of an event is non-linear, because considering linear model is very unrealistic due to the fact that predicted values can not be interpreted as probabilities and may not fall in the interval (0, 1).

3.4.2 Logistic Regression Model

In Logistic regression, we directly estimate the probability of the occurrence of an event. Let $\mathbf{X}' = (\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_q)$ be a vector of $\mathbf{q}$ independent continuous measurements corresponding to covariates and dummy variables corresponding to factor levels and let $\mathbf{P}\ (\mathbf{Y=1} \mid \mathbf{x}) = \pi(\mathbf{x})$ be the conditional probability of the occurrence of success. The logistic regression model is given by:

$$\pi(x) = \frac{e^{g(x)}}{1 + e^{g(x)}}$$

where

$$g(x) = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \text{- - -} + \beta_q x_q = X'\beta$$

and the β_i's are unknown coefficients.

In using a linear model for the dependence of the success probability on explanatory variables, the probability scale is transformed from the range (0, 1) to $(-\infty,\infty)$. Applying the linear model procedure on the transformed data ensures that the fitted success probabilities will lie between 0 and 1. Hence, the logit transformation of the success probability $\mathbf{p}_i$, $\mathbf{log[p_i /(1 - p_i)]}$, is employed where $\mathbf{p}_i/(1 - \mathbf{p}_i)$ is the odds of a success. Therefore, the linear logistic model for the dependence of $\mathbf{p}_i$ on the values of q explanatory variables, $\mathbf{x}_{1i}, \mathbf{x}_{2i}, \text{- - -}, \mathbf{x}_{qi}$ associated with the $\mathbf{i}^{th}$ observation is

$$\mathbf{Logit\ (p_i) = log\ [p_i / (1 - p_i)] = \beta_o + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \text{- - -} + \beta_q x_{qi}}$$

The slope coefficient β_i's represents the change in the logit for a unit change in the independent variable x_i, keeping the other variables constant, and $\exp(\beta_i)$ is the multiplicative effect on the odds of a unit increase in x_i, at a fixed level of the other **x's**.

3.4.3 Parameter Estimation

Maximum likelihood estimation is the most popular technique for estimating the parameters of the logistic regression model. For a binary random variable Y assuming values either 0 or 1, the probability, **P (Y = 1)** is given as

$$P(Y=1) = p = \frac{1}{1+e^{-X'\beta}}$$

$$\mathbf{Logit(p) = \log(\, p/(1\text{-}p)\,) = X'\beta,}$$

where β is a vector of coefficients and **X** is the vector of independent variables.

Since the values of the outcome variable are not available, we can't estimate the parameters directly, however, the likelihood provides a solution (Sharma, 1996).

Each observation can be considered as an outcome of a Bernoulli trial, and hence for the i^{th} observation

$$p(Y=y_i) = p_i^{y_i}\,(1-p_i)^{1-y_i}$$

Assuming the n- observations are independent, the likelihood function is

$$L = \prod_{i=1}^{n} p_i\,(1-p_i)^{1-y_i} = \prod_{i=1}^{n}\left(\frac{1}{1+e^{-X'\beta}}\right)^{y_i}\left(\frac{e^{-X'\beta}}{1+e^{-X'\beta}}\right)^{1-y_i}$$

And the log likelihood function is given as

$$\operatorname{Log} L = \sum_{i=1}^{n} y_i \left(\frac{1}{1+e^{-X'\beta}} \right) + \sum_{i=1}^{n} (1 - y_i) \left(\frac{e^{-X'\beta}}{1+e^{-X'\beta}} \right) \qquad (*)$$

Hence, by maximizing (*) we can theoretically estimate the parameter vector β. However, the resulting equations obtained by taking the first order derivatives do not have an analytical solution. Therefore, β will be obtained by maximizing (*) using numerical iterative techniques.

3.4.4 Goodness of Fit of Logistic Regression

After fitting a model to a set of data, it is necessary to check whether or not the model fits well the sample data. That is, we have to compare the extent to which the fitted values of the response variable by the model agree with the observed values. If the observed values and fitted values agree, the model may be acceptable, otherwise the model must be revised. Hence, direct use of the fitted model overlooking its reliability may lead to a wrong conclusion.

In assessing the goodness of a model, the first step is to check the overall fit of the model to the data. That is, testing the hypothesis

H_0: ***The hypothesized model fits the data***

H_1: ***The hypothesized model doesn't fit the data***

The test statistics is based on the likelihood function **L**, that is the probability that the estimated hypothesized model represents the input data, and a good model is one that results in a high likelihood of the observed results. The value of the likelihood when the unknown parameters are replaced by maximum likelihood estimates can be used to summarize the extent to which the sample data are fitted by the model. The log-likelihood,

–2LL, has a chi-square distribution with n - $(q+1)$ degrees of freedom, where $q+1$ is the number of parameters in the model. A small chi – square value indicates that the model fits well the sample data.

To investigate if the inclusion of independent variables significantly improves model fit we again use the log-likelihood ratio statistic. This is equivalent to testing whether the coefficients of the selected independent variables are significantly different from zero.

$$H_0: \quad \beta = 0$$

$$H_1: \quad \beta \neq 0$$

The hypothesis indicated above can be tested by considering the difference between the **–2LL** for the model with the intercept and the independent variables and the **–2LL** for the model with only the intercept. Let

$\hat{L}_c$: ***Maximized Likelihood corresponding to the fitted model.***

$\hat{L}_o$: ***Maximized Likelihood corresponding to constant model.***

Hence, the log-likelihood ratio statistic is given by

$$\mathbf{G} = -2 \, [\, \log(\hat{L}_0) - \log(\hat{L}_c) \,]$$

The statistics **G** has a chi square distribution with **q** degrees of freedom, and it measures the extent to which the current model deviates from the constant model. Large value of **G** indicates that the model is good.

The hypothesis pertaining to the statistical significance of an independent variable in the model can be assessed using the normal theory or the Wald χ^2- statistic. As discussed earlier, parameters in logistic regression are estimated using the technique of maximum likelihood. Estimators obtained from this technique under certain regularity conditions are best asymptotically normal (**BAN**) and hence employing the normal theory in testing the significance of a covariate in the model is reasonable (Agresti, 1996; Dobson, 1990). The Wald χ^2 – statistic, which is the square of the t-value with a single degree of freedom to test the significance of a binary covariate can be used.

The predictive ability of the fitted model, that is how well the model classifies the observed data, is one way of determining the performance of the model. If a model predicts group membership accurately according to some criteria, then the model fits the observed data well (Hosmer & Lemshow, 1989). To assign an individual to one of the two groups 0.5 is often considered as a cut off point, however, it is sometimes advisable to take values other than 0.5. The choice should be based on the original data, that is, by identifying values that minimizes overall proportion of misclassification or by compromising between the minimization of the two proportion of misclassifications (Collett, 1991).

In model building it is good to examine several possible models and try to choose among them on the basis of subject matter interpretation and parsimony. The SPSS logistic regression procedure includes all the variables identified as independent in the model by the ***ENTER*** method. We have also the option of building the model with the ***FORWARD STEPWISE SELECTION*** or ***BACKWARD STEPWISE ELIMINATION***. The stepwise procedures use the score statistic for entering variables into a model, the Wald statistic, the change in likelihood, or the conditional statistics for removing variables from a model. Whenever the sample size is considerably large these statistics result in the same value under the null hypothesis (SPSS manual).

3.4.5 Model Checking

Once a model is fitted, it is essential to check its adequacy. A more pressing concern after fitting a model is thorough examination of the extent to which the fitted model provides an appropriate description of the observed data.

A fitted model may be inadequate in a number of ways. The data may contain unusual observations, known as outliers, that are not well fitted by the model or observations, termed influential values, whose inclusion or exclusion has a major impact on the parameter estimates and predictors or failure of the systematic pattern of the model are a few to mention.

In order to check the adequacy of a fitted model the residuals from the model fitting exercise and other statistics can be examined.

An outlier for a binary data occurs when $Y = 1$ and the corresponding fitted probability is near zero or when $Y = 0$ and the corresponding fitted probability is near unity (Collett, 1991). This arises due to the fact that the explanatory variables have extreme values. Several techniques can be applied for the detection of extreme observations. Studentized residual for a case, which is the change in deviance when the case is excluded, plot of leverage values over the number of cases and half normal plot of the standardized residual are some of the methods.

An observation is said to be influential if its omission from the data set results in considerable changes in certain aspects of the fit of the model. **Cook's distance**, which is a measure of the influence of a case and **DfBeta**, which is a measure of the change in logistic coefficients when a case is deleted from the model, can be assessed. Multicollinearity in the explanatory variables has also an effect on the result of the analysis. Examination of the presence of multicollinearity can be made through ***variance inflation factor*** (VIF) or the ***condition indices*** (CI).

Chapter IV

4. Result and Discussion

4.1 Result of Data Analysis

This chapter presents results of the data analysis. The population considered in the study is children who are under 5 years of age. Before the analysis, the data were checked for all possible errors. In checking the data there was a situation where unrealistic data values were coded incorrectly for some of the observations. Above all, the basic anthropometric measurements, weight and height, from which the dependent variable is derived were not available for some of the children. Therefore, correcting the possible errors and excluding children whose height and weight measurements were missed was indispensable. After every possible correction the total number of children under study (6 - 59 months) was reduced from 8300 to 7575 of these 1893 are normal and 5682 are malnourished (stunted, wasted or underweight).

For the purpose of data analysis, both the bivariate and multivariate statistical techniques were employed. The bivariate analysis, based on the chi - square statistics, serves as a preliminary insight towards the relationship between all suspected independent variables and indicator of nutritional status of children (stunted, wasted or underweight).

4.1.1 Bivariate Finding

The bivariate association between measures of nutritional status indicator and selected child-related and socioeconomic variables is shown in Table 1 below. Based on the results, it was found that among child related variables the age of the child showed a significant association. Particularly, the problem was worse in the second year of life (12 - 23 months) of which 88% are malnourished in the specified age group. It is also observed that the problem is more prevalent in male children than females.

A significant association between the common infections of childhood (diarrhoea, cough, TB, injury) and measure of nutritional status was observed. A difference in nutritional status is also revealed between fully vaccinated children (DPT3, Measles, OPV3 and BCG) and unvaccinated and partially vaccinated children.

Frequency of supplementary food and duration of breast feeding for children whose age is between 6 and 36 months are also found to have marked significant association with indicator of nutritional status. The effect of prolonged breast feeding (above 12 months) on nutritional status is indicated in 85.5% of children in the specified age group.

Differences in nutritional status are also observed among the different socioeconomic variables. The educational status of both the head and spouse of the household had significant association, i.e., the problem is more prevalent in a household with illiterate head or spouse. The sanitary condition of the household, source of water supply and availability of private latrine or communal latrine is significantly associated.

Variables that are expected to represent economic or possessions summary, such as, material used for walls, roof, windows and ownership of radio, metal plate, or blanket are found to have a significant association. A marked difference in nutritional status is also depicted by the growing status of different kinds of crops, such as, cereals, cash crops (Coffee or Chat), root crops (Potato, Sweet potato or Godere), fruit or vegetables. The association between indicator of nutritional status of children and selected-child related and socioeconomic variables with the associated Pearson chi-square value and significance probability is given in the table below.

Table 1. Bivariate association between selected predictors and Nutritional Status of Children

➢ Child Related Variables			
Variables	**Pearson chi-square**	**D.f.**	**Significance**
Child Sex	59.67	1	0.0000
Child age by group	238.60	2	0.0000
Breast-feeding	78.53	1	0.0000
Duration of Breast-feeding	176.37	2	0.0000
Type of Breast-feeding	81.35	2	0.0000
Frequency of Supplementary food	63.45	2	0.0000
Diarrhoea	63.53	1	0.0000
Illness during last two weeks	48.74	1	0.0000
Vaccination	52.43	1	0.0000
➢ **Socioeconomic variables**			
Variables	**Pearson chi-square**	**D.f.**	**Significance**
Head Sex	3.14	1	0.0766
Education status of head	13.79	1	0.0002
Availability of communal latrine	33.32	1	0.0000
Availability of private latrine	99.80	1	0.0000
Availability of water supply	18.74	1	0.0000
Participation in development extension	35.51	1	0.0000
Engaged in share cropping	57.97	1	0.0000
Participation in food for work	32.10	1	0.0000
Education of spouse	22.71	1	0.0000
Blanket ownership	10.34	1	0.0027
Radio ownership	29.66	1	0.0000
Pot ownership	38.54	1	0.0000
Metal plate ownership	11.21	1	0.0014
Grow cash crop	135.07	1	0.0000
Grow cereals	41.18	1	0.0000

Grow Fruit or Vegetables	22.80	1	0.0000
Grow Legumes	38.28	1	0.0000
Material for Roofing	4.78	1	0.0288
Material for Walls	378.10	1	0.0000
Material for Windows	76.19	2	0.0000
Agroclimatic Zone	144.20	2	0.0000

4.1.2 Multivariate Findings

The main problem with the bivariate approach is that it ignores the possibility that a collection of variables, each of which is weakly associated with the outcome, can become an important predictor of outcome when taken together (Hosmer and Lemshow, 1989). Hence, the multivariate logistic regression approach that takes into account the drawback mentioned by the bivariate technique was considered in the analysis.

To identify subset of independent variables that are good predictors of the dependent variable different algorithms are available. However, according to parsimony and interpretability of the significant variables the backward stepwise selection criterion was used in the study and results obtained from the technique are given in Table 2 below. As a matter of fact none of the algorithms result in a **"Best"** model. This is because the choices they force are often of a very arbitrary character and are often not the most appropriate for the purpose either of prediction or of interpretation (Cox and Snell, 1989). But, for comparison results obtained using the other algorithms are displayed in the Appendix.

The logistic regression model used in predicting the nutritional status of children was constructed based on variables that were significantly associated in the preliminary analysis and by considering variables that are expected to have significant effect when taken in a joint manner. Results obtained by the technique are shown in Table 2. The results shown in the table depict that among child-related variables age of the child, sex of the child, diarrhoea during the last 14 days before the survey and vaccination status of the child (fully vaccinated or not) are found to be important predictors of child nutritional status. The sanitary condition of the household with respect to the availability of private latrine or communal latrine and/or the source of water supply are also significantly associated with the problem under study in combination with other variables. The housing condition of the household, i.e., material from which the house is made particularly, material for walls and windows are shown to be important predictors.

A difference in nutritional status among children is also shown by the growing practice of different kind of crops by household. Children from a household who grew cash crop, root crops, fruit or vegetables are in a better condition than those who are in a cereal or legume grower household. Participation of household members in food for work and status of being engaged in share cropping are found to have a paramount importance in predicting the nutritional status of the child. The educational status of the household head and/or the spouse (a proxy for nutrition knowledge, health status of the child and good sanitation of the household) and availability of radio, which is assumed to assess the economic activity of the household, are also found to be important predictors.

In assessing the nutritional status of children by using the logistic model the importance of interaction effects was not overlooked. As shown in the result, it is found that the interaction effect of illness during the last 14 days before the survey and vaccination status of the child, child age and area of cultivated land, illness during the last two weeks and availability of private latrine, source of water supply and availability of private latrine are found to have joint effect in predicting the nutritional status of the child.

Pot ownership	0.4642	0.0727	40.7861	1	0.0000	0.0721	1.5908
Private Latrine	0.8373	0.1582	28.0070	1	0.0000	0.0591	2.3102
Radio Ownership	0.7140	0.1468	23.6655	1	0.0000	0.0539	2.0421
Engaged in share cropping	-0.5769	0.1008	32.7422	1	0.0000	-0.0642	0.5616
Roofing	-0.1726	0.0952	3.2917	1	0.0696	-0.0132	0.8414
Root crop	0.3213	0.0810	15.7471	1	0.0001	0.0429	1.3789
Vaccination	0.3029	0.0757	16.0067	1	0.0001	0.0433	1.3537
Windows			15.8358	2	0.0004	0.0398	
Open	0.6828	0.1771	14.8638	1	0.0001	0.0415	1.9794
None	0.1237	0.1110	1.2415	1	0.2652	0.0000	1.1316
Water Supply	0.4748	0.1904	6.2203	1	0.0126	0.0238	1.6077
Illness X Private Latrine	0.2621	0.1071	5.9887	1	0.0144	0.0231	1.2996
Child age X Cultivated size	-0.0052	0.0013	16.9898	1	0.0000	-0.0448	0.9948
Illness X Vaccination	0.3764	0.1343	7.8581	1	0.0051	0.0280	1.4571
Private latrine by water supply	-0.3423	0.2059	2.7634	1	0.0964	-0.0101	0.7101
Head education by radio ownership	-1.0343	0.2085	24.6079	1	0.0000	-0.0551	0.3555
Constant	-3.8070	0.3194	142.0488	1			

Table 2 above contains the estimated coefficients (under the column heading β) and related statistics from the logistic regression model that predict the nutritional status and the variables. The standard error of the estimates (under the column heading **S.E.**) will helps in computing the **Wald** statistics. The **Wald** statistics, which is the square of the ratio of the coefficient to its standard error, has a chi-square distribution with a single degree of freedom. The significance of the **Wald** statistics (under the column labeled **Sig**) will tell us the importance of the predictor variable in the model.

A statistic that is used to look at the partial correlation between the nutritional status of children and each of the independent variables is indicated in the column labeled **R**. A positive value indicates as the variable increases in value, so does the likelihood of being malnourished. If **R** is negative, the opposite is true. Small values of **R** indicate the variable has small partial contribution to the model.

The last column of the Table, **exp(β)**, is the factor by which the odds of being malnourished change when the i^{th} independent variable increases by one unit. If β_i is positive, **exp(β_i)** will be greater than one, which means the odds of being malnourished increases. If β_i is negative, **exp(β_i)** will be less than one, which means the odds of being malnourished decreases. For instance, the odds of being malnourished decrease when one moves from cereal grower to those who do not, implying the nutritional status of a child is worse in cereal grower areas. Similarly, the odds of being malnourished increased when we move from households with private latrine to those without, implying the prevalence of the problem in households without this facility.

Before applying the fitted model for the designed purpose, it has to be assessed and diagnosed for all possible inadequacies. One way of assessing the goodness of a fitted model is to see how well the model classifies the observed data. The classification table is shown below in Table 3. The chi-square goodness of fit test of the fitted model is another way of assessing its goodness. To measure how well the estimated model fits the data, -2 times the log of the likelihood (**-2LL**) is used. A good model is one that results in a high likelihood, that is the same as to say a small **–2LL**.

Table 4 below holds the goodness of fit statistics for the fitted model. The model chi-square is the difference between **-2LL** for the model with only a constant and **–2LL** for the fitted model. The model chi-square tests the null hypothesis that the coefficients for all the terms in the current model are zero. The degree of freedom for model chi-square is the difference between the number of parameters in the two models (the fitted and the constant model).

Table 3. Classification Table

		Correct Prediction
Observed Group	**Normal**	51.63%
	Malnourished	80.82%
	Total	74.02%

* The Classification was made using 0.65 as a cut off point.

Table 4. Goodness of Fit Statistic for the fitted Model

Statistic	**Values**
➢ -2 log likelihood (Constant Model)	7455.5266
➢ -2 log likelihood (Fitted Model)	6013.247
➢ Goodness of Fit	5448.294
➢ Model Chi-square	1442.33
➢ Degree of Freedom	29
➢ Significance	0.0000

After the goodness of fit of the model was assessed then its adequacy was checked. For a binary response variable plots of residual against explanatory variables in the model will be uninformative and distribution of residuals obtained from modeling binary data will not be approximated by a normal distribution even when the fitted model is correct (Collett, 1991). However, case-wise plot and half-normal plots of the residuals can provide useful information. Besides, for binary response variable a careful examination of the predicted probabilities across the significant variables provides valuable information about the reliability of the fitted model.

For the fitted model, outliers, that is, observations that have relatively large standardized deviance, were identified from either a case-wise or half-normal plot of the residuals. The half-normal plot of residuals is indicated in the figure shown in the Appendix. Cases with standardized deviance greater than -4 were removed. Influence of an observation on overall fit of model and a single parameter estimate was performed using case-wise plot of **COOK'S** distance and **DfBETA's,** respectively. Influential observations with cooks distance greater than 0.1 were removed since the sample size was considerable. For the existence of **Multicollinearity** in the predictor variables the variance inflation factor and condition indices were computed (See Table 6 in the appendix).

4.2 Discussion

The logistic regression model indicates that numerous factors affect child nutrition. Among the child-related variables, the nutritional status of children deteriorated rapidly with age, particularly, during their first year of life. That is, the highest frequency of poor nutritional status was found in the 12 – 23 month old children. It is suggested that associated with malnutrition in this age group are beginning of supplementary food and/or stopping from breast milk, decreased protection from the mothers and increased exposure to environmental pathogens. This result is in agreement with studies by Horner et al. (1981) and Madise and Mapoma(1997). It has been hypothesized that the better nutritional status of infants is probably due to their being able to satisfy their nutritional needs through breast milk and some supplementary foods and increased protection from the mothers Gopaldas et al. (1988).

The results also suggest that on the average girls had better nutritional status as compared to boys (The odds of being malnourished for male children were increased by 70% compared to female children). Quinn et al. (1995), Madise and Mpoma(1997) and Greiner and Latham (1981) found similar results. Madise and Mapoma (1997) suggested that the observed sex difference could be due to the biological frailty of boys. However, a study in Jamaica by Melville et al. (1988) revealed the opposite.

The bivariate finding revealed the significant importance of duration of breast feeding and the frequency of supplementary food as a predictor of the nutritional status of children. The multivariate technique, however, didn't consider these variables into account for the simple reason that the variables were considered only to children under-3 years. But a separate logistic regression was performed for these children and result indicated the paramount importance of duration of breast-feeding and frequency of supplementary food in predicting the nutritional status of children (see Table 4. in the Appendix). From the result the risk of malnutrition for children who are still being breast-fed above 12 months increased by 68% as compared to those who were breast-fed below 12 months of age.

Several studies confirmed the negative effect of prolonged breast-feeding (above 12 months) on the nutritional status of children. Madise and Mpoma (1997) documented that breast-feeding beyond infancy was associated with poor nutritional status for the children. Chen and Taren (1995) also stated that children who were being breast-fed for a longer period of time seem to be shorter. The reason given was that extended breast-feeding was not adequately supplemented with other types of food and that adversely affects child health. Another possible reason was the fact that children who were being breast-fed longer were from poor socioeconomic groups (Ahn and Shariff, 1995). Brakohiapa et al. (1988) also mentioned that protein and calorie intake was reduced in those who were still on breast-feeding beyond 12 months.

As regards the frequency of supplementary food it is found that children who were taking supplementary food at least twice per day had better nutritional status compared to those who were exclusively breast-fed **(OR = 1.37)** or taking supplementary food less than twice per day **(OR = 2.01**). The good nutritional status of children who were taking supplementary food at least twice revealed the better socioeconomic standard of the household and the timing the mother had in preparation of child's food separately (supplementary food may be taken with or with out breast-feeding).

Child morbidity, especially diarrhoea, was negatively associated to nutritional status. That is, diarrhoea often causes deterioration of nutritional status and poor nutritional status has been shown to increase the duration of diarrhoeal illness. This has been confirmed by several studies (Melville et al., 1988; Tomkins and Watson, 1989). In the Malawi demographic and health survey, Madise and Mapoma (1997) revealed that in 17% of the children who were still being breast-fed the frequency of feeding reduced when they had diarrhoea. Devi and Geervani (1994) also highlighted the effect of number of diarrhoal episodes on child's current as well as past nutritional status. A review on malnutrition and infection by Tomkins and Watson (1989) stated that to prevent diarrhoea, by minimizing infants exposure to its pathogens, exclusive breast feeding is recommended for the first 4 – 6 months of life. For the management of diarrhoea in children 4 – 6 months of age, continued exclusive breast-feeding is the most important nutritional aspect of management.

The level of immunization in our country is low compared to that of many developing countries (UNICEF, 1993). This would mean that the life of many infants' could not be saved from deaths of vaccine preventable diseases. In the study it was found that fully vaccinated children were in a better nutritional status compared to children who were partially or not vaccinated at all. The odds of being malnourished for children who were partially or not vaccinated at all were 54% compared to those who were fully vaccinated. Many researchers found the importance of immunization in predicting the nutritional status of children (Tesfaye et al. 1998; Devi and Geervani, 1994).

Improved sanitation of any kind is beneficial in terms of nutritional status and is important for preventation of diarrhoeal illness. Regarding source of drinking water, piped water followed by protected well/spring or bore hole, was associated with better nutritional status. The association between water supply and nutritional status of the child has been confirmed by several studies (Chen and Taren, 1995; Sommerfelt, 1991; Tesfaye et al., 1998). With regard to toilet facilities, children from houses with no toilet (private or communal) had lower nutritional status than those from homes with toilet facilities. The paramount importance of availability of private latrine in predicting the nutritional status of children was mentioned in several studies. For instance, studies in Sir Lanka (Esrey and sommerfelt, 1991), Kenya (Anker and Knowles, 1980) and Malawi (Madise and Mapoma,

1997) revealed the deterioration of child nutritional status from houses with no toilet facility. The risk of a child being malnourished was increased by three fold for children who didn't have communal latrine (**OR = 3.10**) and more than twice for children who didn't have private latrine.

The socioeconomic status of a family is important because it determines in most cases the availability and quality of food for the children. In addition, the housing condition of the household, i.e., material for walls, windows and floors had positive association with child malnutrition. That is, children from houses with better housing conditions have good nutritional status since better quality housing suggests the role of these in improving overall household hygiene and reducing the risk of infections. In addition, households with better amenities, such as radio, bicycle (a proxy for the economic standard of the household) tend to have better sanitation and hence children from these houses are less likely to be exposed to infections.

The educational level of the head or the spouse of the household was found to be important in predicting the nutritional status of children. Even though the educational level of the spouse was not significant in the multivariate analysis, the bivariate finding shows that the rate of malnutrition is higher in households with illiterate spouse (76%) as compared to their literate counterparts (68.8%). Regarding the education level of the household head, the prevalence of malnutrition is more than twice (**OR = 2.82**) if the household head is illiterate. It has been found in many studies that the level of education of the household head or spouse is an important factor in predicting the nutritional status of the child. The possible reason given was household heads or spouses tend to follow instructions about feeding and caring for children's much better than their uneducated counterparts. It has been also reasoned out that, knowledge about nutrition, sanitation condition and use of

One possible explanation for the finding could be that, cereals and legumes are reported to be crops of low nutritional value. For instance, Teff, the staple food in our country, except for its high iron content is a crop of low nutritional value. In cash crop areas, however, the economic situation of the household is better, the housing condition is good and they can have the chance to feed their children animal products (Meat, egg, or Milk) which have better nutritional value.

Pelletier et al. (1996) stated that 61% of the rural population in Ethiopia are cereal growers and the rate of stunting was between 62% and 66% in households who grew cereals, cereals plus root or cereals plus cattle. The finding is also in agreement with studies in Jimma (Tesfaye et al., 1998) which identified that for children whose diet was cereal based the prevalence of malnutrition was more than twice the prevalence in those getting animal products. The study also confirmed (Tesfaye et al., 1998) the inadequacy of cereals alone or with legumes to meet the nutritional status of the child. In a similar manner, Melaku (1996) found that stunting was more prevalent in households whose means of subsistence depended entirely on cereal production. He also highlighted that stunting was lowest among children whose parents were engaged in the production of cereals and cash crops (Here we see the better nutritional status of children in cash crop grower households).

In this study the multivariate logistic regression showed no significance difference among the regions under study, however, the bivariate approach revealed a marked differential in nutritional status. The problem is worse in Tigray (82%) and Amhara (75.8%) which are known to be drought prone areas.

Even though no regional difference was revealed, the result indicates a differential in nutritional status across agroclimatic zones. It is depicted in the analysis that children from Dega (above 2500 m) and Woinadega (1500 – 2300 m) agroclimatic zones had poor curative and preventive health services is better when the household head or spouse is literate than when illiterate.

Several studies found the paramount importance of the education level of parents in achieving better nutritional status of the child. Sommerfelt (1991) stated that nutritional status is consistently better with increasing levels of maternal, paternal or childcare taker education. Chen and Taren (1995), Christian et al. (1988), Goplads et al. (1988) and Delfina et al. (1988) were in the same line about the importance of parental or maternal education towards better nutritional status of the child.

The multivariate analysis showed no significant difference between the nutritional status of children and the sex of the household head. However, at $\alpha = 0.10$ level of significance the bivariate analysis showed a significant association implying that the nutritional status of children is a little worse in female headed households (78.4%) compared to their male counterparts (75.4%).

The finding of the study also revealed a significant difference in the risk of malnutrition associated with the growing status of different crop types. It is indicated that the risk is higher in cereal growers (Teff, Barely, Wheat, Maize, Sorghum or Millet) and/or legumes growers (Peas, Lentils, Horse beans, Haricot beans Chickpeas). From the result one can infer that the odds of being malnourished for a child from household with cereals growers increased by 43%, and from legumes growers increased by 27 %. On the other hand, children from cash crop (coffee or chat) or root crop (Potato, Sweet potato or Godere) growers were in a better condition as compared to those who were not. The result indicated that the odds of being malnourished for a child from households who didn't grow cash crop increased by 42% and those who didn't grow root crops increased by 38%.

nutritional status as compared to those in Quolla (less than 1500 m). The risk of being malnourished for children residing in Dega and Woinadega agroclimatic zone increased by 59% and 25% as compared to children from Quolla climatic zone. This finding is in agreement with the survey report given by CRS (1997). That is, in Tigray and Amhara regional states almost all the respondent found to be in Dega and Woinadega agroclimatic zone had poor nutritional status (75% stunted, 10.4% wasted and 63.6% underweight for Tigray regional state and 70.3% stunted, 19.9% wasted and 51.4% underweight for Amhara regional state).

The fitted logistic model also depicted the importance of interaction terms in predicting the nutritional status of children. The interaction between illness during the last 14 days before the survey and availability of private latrine becomes important. The risk of being malnourished for a child who had been ill during the last 14 days before the survey and lack of private latrine in the house increased by 30% as compared to the other possible combinations. This may outshine the lack of proper sanitation for an ever-increasing pattern of infectious disease. The non-availability of private or communal latrine may aggravate the problem of malnutrition by enhancing the rate of infectious disease, particularly transmittable disease.

As far as the child nutritional status is concerned, it is important to note that being ill and not vaccinated completely is the worst combination. At early childhood most illnesses are vaccine preventable, however, due to lack of knowledge of the child care- taker or non-availability of nearby health facility children become exposed to different kinds of illness. The result in the study confirms this idea which revealed that the risk of being malnourished increased by 46% for children who were ill and not completely vaccinated compared to other possible combinations.

As regards the interaction between child age and cultivated size, it has been hypothesized that there are strong theoretical reasons to expect that child's age and size of cultivated area may modify the effects of economic activity on nutritional status. This is because the variables are closely related to women's time allocation and the vulnerability of children (Pelletier et al., 1996).

Chapter v

5. Conclusion and Recommendation

In the study an attempt is made to indicate the sole determinants of the nutritional status of children under-5 years of age. It could be observed that several factors were intertwined. Among other things, decline in food availability, level of parental education, health status of the child, housing condition and proper sanitation which may also be linked to hygiene and the risk of infections were observed to be important determinants.

The study demonstrates that the risk of child malnutrition is due to household and child demographic and socioeconomic characteristics. Educational attainments of the parents, availability of certain amenities (a proxy for household economic status), household conditions (material from which the house is made, walls, windows or floor), source of water supply and availability of private or communal latrine were found to have significant effect on the child nutritional status. In this respect, if the problem is to be reduced in the study areas, families must be educated about appropriate feeding practices for their children and how to keep the health condition of the children. From the result it is known that the problem is at the peak for children at the second year of life (12 – 23 months). The risk is more than six-fold as compared to children below 12 months of age. Therefore, parents must give special attention, especially good care from the mothers for children at the specified age group since children in this age group stop breast-feeding and are exposed to environmental pathogens.

For infants (below 12 months), mothers must follow the recommended practice of exclusive breast feeding under the age of 4 months (WHO technical report) and the recommended age for introduction of appropriate supplementary food for infants 4 – 6 months.

The sanitary condition of the household with respect to the source of water supply and availability of private or communal latrine is found to be an important risk factor. Lack of the aforementioned facilities at household or community level aggravates the problem since the health status of the household, particularly the vulnerability of children towards infections and any other transmittable diseases, is highly related to the availability of these facilities. Therefore, to mitigate the problem attention must be given to these households to improve their economic standard thereby improving the sanitary condition and health status.

We recognize a marked differential in the risk of malnutrition across households by the growing status of different kinds of crops. It is revealed from the study that the risk of child malnutrition is higher in cereal and/or legume growers unlike cash crop or root crop growers. This is due to the lower nutritional value of cereals or legumes. Therefore, special consideration at national or regional level must be given to these areas in order to bring the risk at the lowest possible rate thereby creating a healthy environment and productive society.

In general, to make the problem less sever in the areas under study, a joint effort is indispensable. Therefore, we have to give special attention to children at their second year of life, households with no toilet facility and use unprotected water resources, environments for which there is no nearby health facility and in areas in which households livelihood entirely depends on cereals and/or legumes production.

Above all, the government, regional states and/or the various NGO's must stand to improve the overall economic standard of the households by improving their housing conditions, building nearby health facility in areas where the need is high, improving the educational level of the parents towards child care and feeding practices. For cereals and/or legumes growers we have to find a means to improve their economic standards at the national or regional level or through the various NGO's in that their children can have a better nutritional status from animal or high calorie products (Egg, Meat or Milk and Milk products).

Finally, I would like to forward that up to date investigation in the nutritional status of children at national and/or regional level is very important. Researchers who try to examine the determining factors of child nutritional status in the future have to take into account those variables that are not included in this study. Variables such as birth order of the child, number of children under 5 years of age, nutrition knowledge of the parents, height of the mother, father and/or mothers affections towards children and the likes have to be incorporated since several studies showed the paramount importance of these variables in determining the nutritional status of children in many developing countries.

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Half-Normal Probability Plot of Deviance: For Detection of Outlier

Fig. 1 Before Deletion

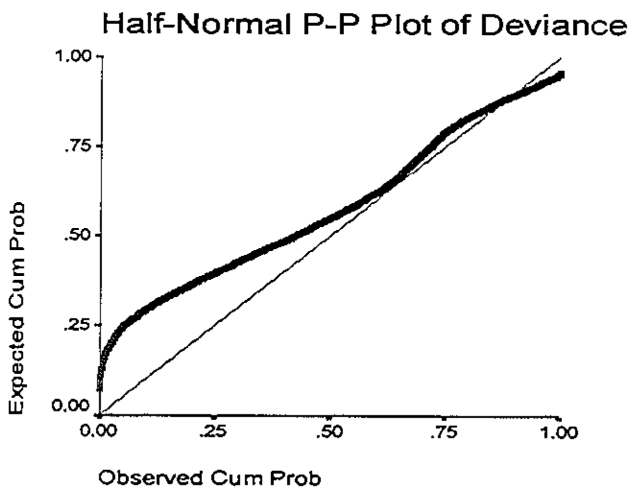

Fig. 2 After Deletion

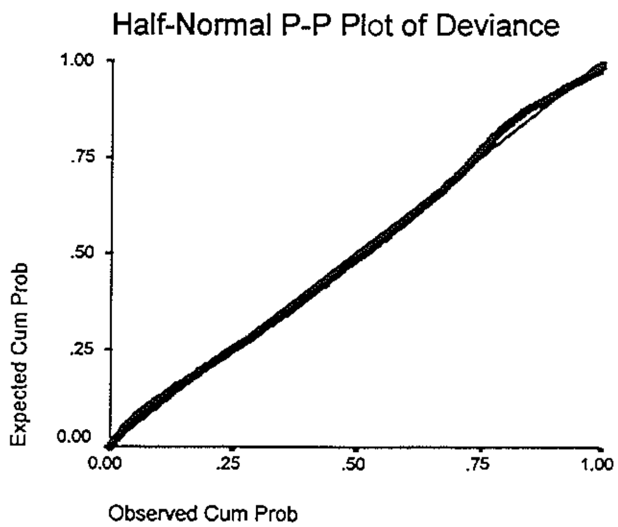

Table 1. Predictor Variables For General Nutritional Status(Backward Wald)

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
CH_AG_GR			271.1945	3	.0000	.1886	
CH_AG_GR(1)	1.8828	.1382	185.5248	1	.0000	.1569	6.5721
CH_AG_GR(2)	.4387	.1655	7.0286	1	.0080	.0260	1.5506
CH_AG_GR(3)	.0290	.2461	.0139	1	.9063	.0000	1.0294
AGRCLM			17.3559	2	.0002	.0423	
AGRCLM(1)	.2249	.0833	7.2837	1	.0070	.0266	1.2522
AGRCLM(2)	.4637	.1138	16.5984	1	.0000	.0442	1.5900
CASH_CR	.3516	.0775	20.6047	1	.0000	.0500	1.4213
CEREALS	-.5674	.1158	23.9989	1	.0000	-.0543	.5670
CHIL_AGE	.0286	.0063	20.2973	1	.0000	.0495	1.0290
CHIL_SEX	.5496	.0649	71.7660	1	.0000	.0967	1.7325
COMM_LAT	1.1305	.2017	31.4143	1	.0000	.0628	3.0973
DIARRHOE	.6351	.1336	22.5875	1	.0000	.0525	1.8873
WALLS	1.6717	.0980	290.8798	1	.0000	.1968	5.3215
HEAD_EDU	1.0349	.1949	28.1902	1	.0000	.0593	2.8149
LEGUMES	-.3200	.0740	18.6984	1	.0000	-.0473	.7261
PLATOWN	-.1442	.0703	4.2046	1	.0403	-.0172	.8657
POTOWN	.4642	.0727	40.7861	1	.0000	.0721	1.5908
PRVT_LAT	.8373	.1582	28.0070	1	.0000	.0591	2.3102
RADOWN	.7140	.1468	23.6655	1	.0000	.0539	2.0421
ROOFING	-.1726	.0952	3.2917	1	.0696	-.0132	.8414
ROOT_CR	.3213	.0810	15.7471	1	.0001	.0429	1.3789
SHARE_CR	-.5769	.1008	32.7422	1	.0000	-.0642	.5616
VACCINAT	.3029	.0757	16.0067	1	.0001	.0433	1.3537
WINDOWS			15.8358	2	.0004	.0398	
WINDOWS(1)	.6828	.1771	14.8638	1	.0001	.0415	1.9794
WINDOWS(2)	.1237	.1110	1.2415	1	.2652	.0000	1.1316
WTR_SPPL	.4748	.1904	6.2203	1	.0126	.0238	1.6077
INT_3	.2621	.1071	5.9887	1	.0144	.0231	1.2996
INT_5	-.0052	.0013	16.9898	1	.0000	-.0448	.9948
INT_6	.3764	.1343	7.8581	1	.0051	.0280	1.4571
INT_8	-.3423	.2059	2.7634	1	.0964	-.0101	.7101
INT_9	-1.0343	.2085	24.6079	1	.0000	-.0551	.3555
Constant	-3.8070	.3194	142.0488	1	.0000		

Table 2. Predicor Variables For General Nutritional Status (Forward Likelihood)

Variable	B	S.E.	Wald	df	Sig	R	Exp (B)
CH_AG_GR			263.4970	3	.0000	.1858	
CH_AG_GR(1)	1.8309	.1371	178.3935	1	.0000	.1538	6.2392
CH_AG_GR(2)	.4036	.1643	6.0298	1	.0141	.0232	1.4972
CH_AG_GR(3)	-.0052	.2443	.0005	1	.9830	.0000	.9948
AGRCLM			18.4751	2	.0001	.0441	
AGRCLM(1)	.2309	.0829	7.7643	1	.0053	.0278	1.2598
AGRCLM(2)	.4761	.1133	17.6555	1	.0000	.0458	1.6098
CASH_CR	.3323	.0768	18.7286	1	.0000	.0474	1.3942
CEREALS	-.5896	.1146	26.4855	1	.0000	-.0573	.5545
CHIL_AGE	.0288	.0063	20.8801	1	.0000	.0503	1.0292
CHIL_SEX	.5381	.0645	69.5280	1	.0000	.0952	1.7128
COMM_LAT	1.1341	.1991	32.4379	1	.0000	.0639	3.1085
DIARRHOE	.6487	.1330	23.7784	1	.0000	.0540	1.9131
WALLS	1.5930	.0945	284.4775	1	.0000	.1946	4.9187
LEGUMES	-.3120	.0734	18.0553	1	.0000	-.0464	.7320
POTOWN	.4709	.0709	44.0789	1	.0000	.0751	1.6015
PRVT_LAT	.6841	.1136	36.2441	1	.0000	.0678	1.9819
RADOWN	.2159	.1045	4.2654	1	.0389	.0174	1.2410
ROOT_CR	.3068	.0803	14.5882	1	.0001	.0411	1.3590
SHARE_CR	-.5841	.0999	34.1867	1	.0000	-.0657	.5576
VACCINAT	.3124	.0751	17.2957	1	.0000	.0453	1.3667
WINDOWS			19.6340	2	.0001	.0458	
WINDOWS(1)	.7637	.1724	19.6242	1	.0000	.0486	2.1463
WINDOWS(2)	.2202	.1005	4.8030	1	.0284	.0194	1.2463
WTR_SPPL	.1997	.0770	6.7203	1	.0095	.0252	1.2211
INT_3	.2656	.1065	6.2150	1	.0127	.0238	1.3042
INT_5	-.0051	.0013	15.9617	1	.0001	-.0433	.9949
INT_6	.3519	.1336	6.9407	1	.0084	.0257	1.4218
Constant	-3.3615	.2819	142.1540	1	.0000		

Table 3. Predictor Variables For General Nutritional Status (Forward Wald)

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
CH_AG_GR			263.4970	3	.0000	.1858	
CH_AG_GR(1)	1.8309	.1371	178.3935	1	.0000	.1538	6.2392
CH_AG_GR(2)	.4036	.1643	6.0298	1	.0141	.0232	1.4972
CH_AG_GR(3)	-.0052	.2443	.0005	1	.9830	.0000	.9948
AGRCLM			18.4751	2	.0001	.0441	
AGRCLM(1)	.2309	.0829	7.7643	1	.0053	.0278	1.2598
AGRCLM(2)	.4761	.1133	17.6555	1	.0000	.0458	1.6098
CASH_CR	.3323	.0768	18.7286	1	.0000	.0474	1.3942
CEREALS	-.5896	.1146	26.4855	1	.0000	-.0573	.5545
CHIL_AGE	.0288	.0063	20.8801	1	.0000	.0503	1.0292
CHIL_SEX	.5381	.0645	69.5280	1	.0000	.0952	1.7128
COMM_LAT	1.1341	.1991	32.4379	1	.0000	.0639	3.1085
DIARRHOE	.6487	.1330	23.7784	1	.0000	.0540	1.9131
WALLS	1.5930	.0945	284.4775	1	.0000	.1946	4.9187
LEGUMES	-.3120	.0734	18.0553	1	.0000	-.0464	.7320
POTOWN	.4709	.0709	44.0789	1	.0000	.0751	1.6015
PRVT_LAT	.6841	.1136	36.2441	1	.0000	.0678	1.9819
RADOWN	.2159	.1045	4.2654	1	.0389	.0174	1.2410
ROOT_CR	.3068	.0803	14.5882	1	.0001	.0411	1.3590
SHARE_CR	-.5841	.0999	34.1867	1	.0000	-.0657	.5576
VACCINAT	.3124	.0751	17.2957	1	.0000	.0453	1.3667
WINDOWS			19.6340	2	.0001	.0458	
WINDOWS(1)	.7637	.1724	19.6242	1	.0000	.0486	2.1463
WINDOWS(2)	.2202	.1005	4.8030	1	.0284	.0194	1.2463
WTR_SPPL	.1997	.0770	6.7203	1	.0095	.0252	1.2211
INT_3	.2656	.1065	6.2150	1	.0127	.0238	1.3042
INT_5	-.0051	.0013	15.9617	1	.0001	-.0433	.9949
INT_6	.3519	.1336	6.9407	1	.0084	.0257	1.4218
Constant	-3.3615	.2819	142.1540	1	.0000		

Table 4. Predictor Variables For General Nutritional Status of Children 6 - 36 month

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
CH_AG_GR			31.3874	2	.0000	.0789	
CH_AG_GR(1)	1.2409	.2249	30.4555	1	.0000	.0805	3.4588
CH_AG_GR(2)	1.1346	.2586	19.2516	1	.0000	.0627	3.1100
AGRCLM			7.9473	2	.0188	.0300	
AGRCLM(1)	.1733	.1141	2.3077	1	.1287	.0084	1.1892
AGRCLM(2)	.4311	.1529	7.9472	1	.0048	.0368	1.5390
CASH_CR	.3312	.0998	11.0200	1	.0009	.0453	1.3926
CEREALS	-.3780	.1541	6.0173	1	.0142	-.0302	.6852
CHIL_SEX	.4992	.0847	34.7185	1	.0000	.0863	1.6474
COMM_LAT	1.0990	.3074	12.7802	1	.0004	.0495	3.0010
DIARRHOE	.3179	.1435	4.9056	1	.0268	.0257	1.3742
DVLP_EXT	-.1828	.0915	3.9911	1	.0457	-.0213	.8329
FRU_VEG	.2618	.0943	7.6997	1	.0055	.0360	1.2992
HEAD_EDU	.6413	.2583	6.1667	1	.0130	.0308	1.8990
LEGUMES	-.4457	.0961	21.5177	1	.0000	-.0666	.6404
PLATOWN	.3015	.0927	10.5742	1	.0011	.0442	1.3519
PRVT_LAT	.4918	.1789	7.5564	1	.0060	.0356	1.6353
RADOWN	.4016	.1968	4.1665	1	.0412	.0222	1.4942
BRST_AGE			44.7242	2	.0000	.0963	
BRST_AGE(1)	.5182	.2194	5.5795	1	.0182	.0285	1.6790
BRST_AGE(2)	-.2495	.2410	1.0715	1	.3006	.0000	.7792
ROOT_CR	.5113	.1058	23.3587	1	.0000	.0697	1.6674
SHARE_CR	-.6414	.1389	21.3266	1	.0000	-.0663	.5266
SUPP_F			40.8106	2	.0000	.0915	
SUPP_F(1)	.3173	.2097	2.2905	1	.1302	.0081	1.3735
SUPP_F(2)	.6997	.1109	39.7915	1	.0000	.0927	2.0132
VACCINAT	.2443	.1015	5.7905	1	.0161	.0294	1.2767
WALLS	1.0461	.1099	90.6504	1	.0000	.1420	2.8465
WINDOWS			26.0461	2	.0000	.0708	
WINDOWS(1)	.9001	.2161	17.3425	1	.0000	.0591	2.4598
WINDOWS(2)	-.3384	.1363	6.1660	1	.0130	-.0308	.7129
INT_1	.3462	.1396	6.1495	1	.0131	.0307	1.4137
INT_6	-.0049	.0026	3.5688	1	.0589	-.0189	.9951
INT_7	-.7573	.1120	45.7572	1	.0000	-.0998	.4689
INT_14	.4663	.1367	11.6426	1	.0006	.0468	1.5941
Constant	-3.0276	.4310	49.3373	1	.0000		

Table 5. Classification Table and the Chi-square goodness of fit for children 6 – 36 months.

Classification Table

		Correct Prediction
Observed	**Normal**	53.85%
	Malnourished	81.39%
	Total	74.74%

Goodness of Fit Statistics

Statistics	Values
-2 log likelihood (constant Model)	4394.868
-2 log likelihood (Fitted Model)	3503.194
Goodness of Fit	3173.951
Model Chi-square	891.674
Degree of freedom	32
Significance	0.0000

Table 6 **Multicollinearity Diagnostics**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.420	.176	.173	.39	1.863

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	221.379	30	7.379	49.370	.000
	Residual	1034.321	6920	.149		
	Total	1255.700	6950			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity
		B	Std. Error	Beta			VIF
1	(Constant)	-4.873E-02	.050		-.982	.326	
	Age x cult_size	-9.001E-04	.000	-.057	-4.328	.000	1.433
	Age 12 - 23	.254	.019	.247	13.230	.000	2.940
	Age 24 - 35	8.402E-02	.025	.083	3.311	.001	5.247
	Age 36 - 59	1.859E-02	.037	.022	.499	.618	5.973
	1500 - 2300	2.847E-02	.013	.033	2.211	.027	1.919
	Above 2300	5.370E-02	.015	.054	3.465	.001	2.026
	Grow cash crop	5.768E-02	.012	.066	4.916	.000	1.510
	Grow cereals	-7.650E-02	.018	-.053	-4.238	.000	1.322
	Child age	4.212E-03	.001	.144	4.491	.000	8.577
	Child sex	7.625E-02	.009	.090	8.194	.000	1.006