Title
NUTRITIONAL ASSESSMENT OF RURAL SALVADORAN CHILDREN IN AN ANIMAL GIFTING PROGRAM

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Publication Date
2008-04-01

NUTRITIONAL ASSESSMENT OF RURAL SALVADORAN CHILDREN IN AN ANIMAL GIFTING PROGRAM

by

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B.S., B.A. (University of Illinois, Urbana-Champaign) 2003

A thesis submitted in partial satisfaction of the
requirements of the degree of
MASTER OF SCIENCE
in
Health and Medical Sciences
in the
GRADUATE DIVISION
of the
UNIVERSITY OF CALIFORNIA, BERKELEY

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Dr. Lia Fernald

Spring 2008

Table of Contents

List of Tables

List of Figures

Acknowledgements

The research was graciously supported by the Joint Medical Program Research Grant of UC-Berkeley and the Rainer Foundation of UC-San Francisco. I would first like to thank my thesis committee, thesis advisor Dr. Ndola Prata, thesis mentor Dr. Karen Sokal-Gutierrez, and Dr. Lia Fernald of the UC-Berkeley School of Public Health. Thank you for your support, encouragement and persistence in helping me complete this project. I would like to extend special thanks to the staff at ASAPROSAR (Angela Madrid, Elena Grande, Napoleon Silva, Miguel-Jose Bonilla and Lucy Luna) for all their input and support throughout the course of this project. Also, I would like to thank Dr. Karen Sokal-Gutierrez for her role as liaison in initiating my relationship with ASAPROSAR and in supporting the development of this project since its inception. Also, I would like to thank my Salvadoran data collection team for their consistent dedication throughout our work in rural El Salvador. Without their effort, we would have never enrolled as many families as we did for this project. A special thanks to Matthew Messerschmidt, a fellow JMP-alum, who was an invaluable help in collecting follow up data in September of 2007. Finally, thank you to my wife, Tiffany, who never lost faith in me and gave me tireless support since beginning this project in 2005.

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I. Review of Literature

A. Development of Agriculture

For thousands of years, humans have had an arduous relationship with obtaining food and establishing proper nutrition to support a healthy, productive life. Earliest humans were hunters and gatherers over 25,000 years ago, living nomadic lives and practicing agriculture or animal domestication on only small scales (Mazoyer, Roudart 2006). For the past 10,000 years, agriculture has spread over the globe and evolved and assumed many forms, depending on the plants and animals available locally and the ability of imported life forms to adapt to new conditions (Leathers, Foster 2004).

Over time, sedentary agriculture became the dominant mode of life in nearly all of the areas of the world inhabited by humans. In addition, agriculture formed the basis for a new way of life in which humans established small farms in which to support their families and communities. With this new way of living, substantial population growth soon followed close behind. The development of agriculture and subsequent population growth have thus had a symbiotic relationship for thousands of years and while domestication of plants and animals meant more people could be fed, and larger families could be had, it also meant that people were destined to become more dependent on the agricultural system and more susceptible to potential failure of said system (Mazoyer, Roudart 2006).

Although one may be led to believe that the adoption of agriculture led to better health and longer life, evidence suggests that the opposite was actually true (Angel 1984). In the Paleolithic period, prior to widespread adoption of agricultural practices, the average stature of humans was approximately 177 cm (5' 9") for males and 166 cm (5'5") for females and respective average life expectancies were thought to be about 35 and 30 years (Angel 1984). As humans entered the Neolithic period of agricultural production and as diet shifted

from meat/protein-based to plant-based nutrition, there was a relative decline in stature, to 161 cm in males and 154 cm in females, as well as a slight decline in life expectancy (Angel 1984). There are contrasting perspectives on the significance of these anthropometric changes, the first being from a biomedical perspective that says, "poor growth equates to poor health" and the second prevailing from a evolutionary biology stance that poor growth is adaptive (Bailey, Schell 2007). And while there is abundant evidence supporting the biomedical perspective, both perspectives probably contain elements of truth. To clarify, take for example the situation in which there is limited nutrient availability for the individual. In response to this poor nutrient availability at the cellular level, vital functions are preserved, linear growth is blunted and muscle and fat can be metabolized for continued function thus giving credence to the idea that poor growth can be a survival strategy (Victoria, et al. 2007). Hence, the thought is that a population of stunted people will indeed have lower nutritional requirements than will a population of unrestricted growth, which may be thought to be an adaptation. However, a stunted population will also be less likely to be able to compete in the modern world due to diminished human capital (Victoria, et al. 2007). Economic historians have examined this link between nutrition and productivity in even more modern times. Robert Fogel, a Nobel Prize-winning economist, believed that food shortages were so severe during parts of the 18th and early 19th centuries that, "the bottom 20 percent subsisted on such poor diets that they were effectively excluded from the labor force," being too malnourished to perform physical work (Fogel 1994). As a result of increased population densities supported by agriculture, animals and humans being brought into close proximity with one another, and populations becoming largely dependent on agricultural production, infectious diseases began to play an even more prominent role in deciding human mortality (Angel 1984).

In the Paleolithic period of hunting and gathering, infectious disease existed more as an occupational hazard, most likely to befall someone due to an accident or trauma (Angel 1984). But as human density increased, so did the propensity for infectious diseases to affect the health of these humans living in close proximity. Some of these outbreaks were due to unsanitary conditions, which provided breeding grounds for infectious diseases. Still, many outbreaks were also due to what we know as "childhood diseases", like measles, mumps and chickenpox (Leathers, Foster 2004). Before the use of vaccines, these diseases would almost invariably infect a majority of children, many times with devastating consequences for the long-term health of the child (Neumann, et al. 1978). Childhood infectious diseases like measles place an increased burden on the malnourished child, ultimately leading to increased morbidity and mortality (Neumann 2002). In the present-day, developed world, these diseases are well covered by widespread vaccination and are now considered to be mostly harmless descendants of once epidemic-level catastrophes (Scrimshaw 2003).

With the advent of the agricultural revolution of the 18th and early 19th centuries and continuing technologic innovation, the human population currently has the ability to produce an amazing amount of agricultural products, establishing an unprecedented source of food for billions. However, our agricultural system has come under greater scrutiny for still leaving millions of people undernourished around the globe. In the last 150 years, we have been able to produce enough food to supply more than adequate nourishment to the world's entire population (Leathers, Foster 2004). Today, there are between five and a half and six billion people on the planet, almost all of them supported by agriculture (Mazoyer, Roudart 2006). Yet, there are certain regions of the world and specific segments of the population that remain vulnerable to malnutrition.

B. Malnutrition in Present-Day Context

1. Malnutrition Basics- What, Who and Where?

Generally, there are four internationally recognized types of malnutrition throughout the world: (1) protein-calorie malnutrition, (2) micronutrient malnutrition, (3) secondary malnutrition, and (4) overnutrition (Leathers, Foster 2004). When a person consumes too many calories, the resulting condition is overnutrition. Among nutrition problems, this one makes up the vast majority of nutritional problems among industrialized nations such as the U.S. Secondary malnutrition occurs when a person has a condition or illness that prevents proper digestion or absorption of food, even if there is enough food available for adequate nutrition. Some of the most common causes of secondary malnutrition are diarrhea, respiratory illnesses, measles and intestinal parasites (Caulfield 2004). It is deemed "secondary" because it does not result directly from the nature of the diet but instead leads to malnutrition due to factors such as infection, which can lead to loss of appetite (anorexia), alteration of normal metabolism, prevention of nutrient absorption and diversion of nutrients to parasitic agents (Mata 1992).

The next type of malnutrition is known as micronutrient malnutrition. This is a diet lacking in sufficient amounts of one or more essential micronutrients such as vitamins or minerals (Leathers, Foster 2004). When one is lacking in one or more nutrients, this may predispose an individual to illness directly due to lack of the nutrient or may be complicit in cases of secondary malnourishment. A deficiency of any micronutrient may become a serious problem, yet most public health professionals and nutritionists are primarily concerned about deficiencies in vitamin A, zinc, iodine, and iron (Bhutta 2008). The last category of malnutrition is known as protein-calorie malnutrition (PCM). This problem is characterized by the under-consumption of calories or proteins needed for normal growth,

health and activity and can only be solved by increasing the amount of food that an individual eats.

If any dietary deficiencies persist, children may stop growing and become "stunted" (low height-for-age) (Brown 2005). Stunting is a type of chronic malnutrition and occurs during a period of growth, usually within the first five years of life of the child, and especially during the first 18 months of life (FAO 2004). If a child is of normal height but experiences weight loss or "wasting" (low weight-for-height), they are described as suffering from malnutrition (Brown 2005). Both of these presentations of malnutrition may be further classified as moderate or severe. Severe PCM manifests itself as the potentially fatal nutritional disorders known as *kwashiorkor* (edema) or *marasmus* (wasting) (Brown 2005). It usually manifests itself early, in children between 6 months and 2 years of age and is associated with early weaning, delayed introduction of complementary foods, a low-protein diet and severe or frequent infections (Muller, Krawinkel 2005).

Within any given country, malnutrition is likely to be more prevalent in rural areas. Among the 42 countries that have lowest income per capita, rural people represented 65 percent of the population, lending to a strong argument that the majority of the world's hungry are from the rural sector (Leathers, Foster 2004). As a segment of the population, children are by far the most vulnerable to undernutrition, especially at weaning time. "Weaning" is in reference to the transitional period in which an infant's diet is changed from 100 percent breast milk with the slow incorporation of other foods (Leathers, Foster 2004). It is generally accepted that this transitional period lasts during an eighteen-month time span, from about 6 months to 2 years of age (Bhutta 2008). After children, pregnant women and lactating mothers are the next most vulnerable segment at risk for undernutrition, in part due to their increased nutrient requirements and associated postnatal health risks (Leathers,

Foster 2004). There are also cases of food deprivation based on gender, in which girls are deprived of adequate nutrition in some instances, but this bias is by no means universal (Leathers, Foster 2004). The question then remains, "Why do millions of people, especially rural children and women, continue to go without adequate nutrition?" Although most industrialized nations have been able to provide for the majority of their citizens, malnutrition continues to be a major public health problem throughout the developing world.

Before going into further depth on the spectrum, consequences, and effects of malnutrition, it is necessary to first discuss the multiple methods used to measure and assess nutritional status.

2. Measuring Malnutrition

i. Assessment of Malnutrition- Introduction

Measurements of undernutrition in a group of people or community are based upon the nutritional status of the individuals that make up said group. The common methods of direct assessment of the nutritional status of an individual are: clinical, biochemical, dietary and anthropometric (Leathers, Foster 2004). Clinical assessment of nutritional status relies on physical signs of the body that become symptomatic in the presence of nutritional disorders. While a clinical nutritional assessment may prove highly valuable when conducted by a licensed physician or healthcare worker, the correct identification of a physical sign hinges greatly on the training and skill of the clinician, as well as how well physical signs are manifested in the malnourished individual. Many times, these signs are only obvious when at advanced stages of the disease and so clinical assessment proves valuable only in the presence of severe, specific disorders (Leathers, Foster 2004).

A biochemical assessment provides greater depth in understanding nutritional disorders as it requires the examination of bodily fluids, such as blood or urine, to analyze the complex changes in metabolism that accompany nutritional disorders (Leathers, Foster 2004). Current studies of nutritional status around the world employ this method in order to study many different types of nutritional disorders but none more so than micronutrient deficiencies (FAO 2004). Biochemical tests provide an accurate indication of short-term nutrition problems, but their complexity and expense impede a wider use in field surveys. They are also much more invasive than traditional methods of analyzing nutritional status and may be considered unacceptable in certain circumstances or cultures (Leathers, Foster 2004). However, there are other ways in which to measure nutritional status that have enabled researchers to carry out successful field studies.

ii. Assessment of Malnutrition- Dietary Intake

The initial step in assessing dietary intake is to ask oneself if it is important to look at current dietary intake, past dietary intake or a combination of both. Past dietary intake can be assessed using two different methods: (1) dietary history and (2) food-frequency questionnaires. Dietary history estimates food intakes of individuals over a long period of time wherein its advantage lies in being able to detect seasonal changes, obtain data on nutrients and ability to coordinate with biochemical measures (FAO 2004). Disadvantages of this method include the need for a lengthy interview process lending to a burden on the respondent and considerable challenge for the researcher in coding the data so that dietary changes are captured accurately (FAO 2004). Food-frequency questionnaires are considered the best method for conducting studies on diet and disease because it assesses habitual dietary intakes (FAO 2004). The theoretical basis for using food-frequencies is that the

average long-term diet is a better exposure period than short-term intakes and that it is more representative on usual intake than a few days of diet records (FAO 2004). It is limited in that it may not provide precise information in regards to accurate quantities or portion sizes (FAO 2004).

One method that has been employed quite often to assess current nutritional status in individuals is dietary surveys. There are multiple ways in which one can use a dietary survey and the selection of a specific method is subject to the research aims and goals associated. This can be accomplished by one of three ways: (1) dietary recall, in which a subject is asked to recall what he or she ate during a specific period of time; (2) estimated dietary record, in which someone records the amount of food consumed at mealtimes; and (3) weighed food records, which weighs and records actual food consumed (FAO 2004). All three methodologies have their advantages and disadvantages (FAO 2004).

In a dietary recall, an individual is asked to provide estimates on the amount of food they have consumed in 24-hour period. The most accepted value of the 24-hour recall method is that it has the ability to estimate intakes of various foods among population groups (FAO 2004). It also has the advantage of allowing researchers to interview subjects when they are not expecting to be surveyed so that they are less likely to adjust their consumption due to the survey. However, its major limitation is that dietary recalls are seldom representative of usual intake, especially among diets with greater diversity and variability (FAO 2004). An estimated food record is similar to a 24-hour recall: it consists of a detailed description of food and drink consumed over a period (i.e. 3 days, 1 week, etc.). The obvious advantage of this method over 24-hour recalls is that it provides detailed dietary intakes that are more representative of habitual intake (FAO 2004). Drawbacks of this method are several. First, they require a high degree of respondent cooperation and second,

the record keeper may consciously or unconsciously adjust food consumption due to participation in the study, which can lead to inaccurate findings (FAO 2004). In either case, results of the survey can be used to determine amounts of food consumed and then these amounts can be compared to a dietary standard appropriate to the particular country being observed to determine nutritional status (Leathers, Foster 2004).

Weighed food record is closely related to estimated food record, but involves actually weighing foods prior to intake. It is considered the most precise method of estimating food or nutrient intakes but has the drawbacks of being very costly in both time and money and involves highly motivated participants with high levels of literacy (FAO 2004). In all of the above cases, these methodologies are best suited to current dietary intake and in certain situations, current food intake alone is not considered a good indicator of nutritional status and tells us little on past nutrient intake (FAO 2004). Seasonal variation in consumption may confound the data unless adjustments are made as well (Nelson 1991). However, when used in conjunction with anthropometric measurements, dietary assessment increases in value (FAO 2004).

iii. Assessment of Malnutrition- Anthropometry

Anthropometry is the science of measuring the human body and is one of the most common ways of measuring nutritional status of either individuals or populations. It requires two central items: an indicator and a cut-off point. The indicator, often called an "anthropometric index", is a measurement or a combination of measurements made in the field, such as weight and height, or the combination of measurements with additional data, such as age. These indices help one to discriminate between acute and chronic malnutrition, as well as give information on the severity of the malnourishment. The index weight-for-

height indicates thinness or "wasting", and because acutely undernourished persons generally lose body weight but not height, weight-for-height decreases with acute undernutrition (Leathers, Foster 2004). Chronic malnutrition causes physical ramifications even when it is moderate and in those individuals still growing can cause an individual to be of low height-for-age (FAO 2004). This malnutrition effectively stunts growth in the growing child, usually within the first five years of life of the child (FAO 2004). Provided a suitable environment is available, stunting can be alleviated in the still-growing child with proper, varied nutrition, adequate sanitation, clean water, and treatment of any pre-existing infections (Karlberg, Albertsson-Wikland 1995). In the stunted adult, the height-for-age measurement tells nothing of the present situation but is useful for knowing whether or not an individual experienced undernutrition specifically during a period of growth (Branca, Ferrari 2002). Finally, another measurement commonly used in anthropometry is low weight-for-age or a designation of being "underweight". Weight-for-age reflects both acute and chronic undernutrition because both thin children and stunted children are underweight (Leathers, Foster 2004). In many emergency-affected populations, acute undernutrition may be superimposed over a high level of background chronic undernutrition. As a result, both thinness and stunting may be common. But how does one know then the points at which children fall into these categories?

For each anthropometric index, a specific level must be determined as the cut-off point, distinguishing the normal nutritional state from undernourished. Cut-off points are also used to distinguish different levels of undernutrition and are determined statistically (FAO 2004). Each measured child is compared to the reference population to determine how far that child is from the average child in the reference population. This difference between an individual child and the reference can be expressed in a number of ways. The

most frequently used method when assessing individual children is the deviation from the median of a reference standard. For example, the weight of a measured child is compared to the median weight of all children in the reference population of the same gender, age and height. These indices can be found on various domestic and international websites including the CDC, UNICEF and WHO. It is then seen where that child is reference to the median and is expressed as "+1, +2, or +3 SDs" above zero or "-1, -2, -3" (FAO 2004). Being below -2 SD is considered moderate malnutrition and being below -3 SD is considered severe.

In population surveys, the preferred method for expressing the comparison between a specific child and the reference is by using Z-scores. The distribution of weights for all reference children of the same sex and height is described by the median and standard deviation, given in kg. One standard deviation is one Z-score. If anthropometry is being used to determine who needs nutritional intervention, children falling below the selected cut-off point will be included in such an intervention and those falling above this cut-off point will not be included. The application of universal cut-off points has the dual advantage of allowing comparisons of the level of undernutrition between populations and also helping to prevent bias on the part of feeding-centre staff when performing initial assessment or follow-up of patients (WHO 1995).

The proportion of sampled children who are undernourished provides an estimate of the prevalence of undernutrition in the entire population of children. Such surveys are most commonly performed in children 6-59 months of age, but can be undertaken in any population subgroup, such as older adults, adolescents, or pregnant women. Estimates of the prevalence of undernutrition, along with other data on food and health, can be used to plan food aid programs and nutritional therapy, or to evaluate the effect of such programs (FAO

2004). However, anthropometry is limited in that it cannot provide the complete picture of the nutrition and food situation needed for problem solving and program planning. It can provide an estimate of prevalence of undernutrition, but evaluations of food security, food distribution, nutrient content, morbidity and mortality, all contribute essential data to understanding the causal factors resulting in undernutrition (FAO 2004).

Finally, mid-upper arm circumference (MUAC) can be used as a proxy measure for anthropometric status, which is performed by measuring the amount of fat and muscle in the upper arm (FAO 2004). Skin-fold thickness measurements, taken at various places on the body, provide an estimate of the thickness of subcutaneous fat. Acutely undernourished persons metabolize fat and muscle to compensate for decreased nutrient intake, resulting in a decline in skin-fold thickness and MUAC (Leathers, Foster 2004).

3. Famines and Acute Malnutrition

When many of us think of malnutrition, we often conjure up an image of a small boy or girl with a bloated belly, stick-like arms and legs, and too emaciated to stand under his or her own power. Every decade in the last century has provided its own horror stories, and this decade is no different, with famine persisting throughout many different parts of the world. One such example in which widespread famine continues to persist to this day is in North Korea. There, famine had reached such a severe level in 1997 so as there were reports of people eating indigestible substances like grasses and tree bark due to unbearable hunger. In 2003, reports from Oxfam, a leading hunger-related non-governmental organization, stated that the widespread famine in North Korea was leading to cannibalism among people desperate for food. The international response to the famine was substantial. In the context of North Korea and the hundreds of famines that have occurred previously

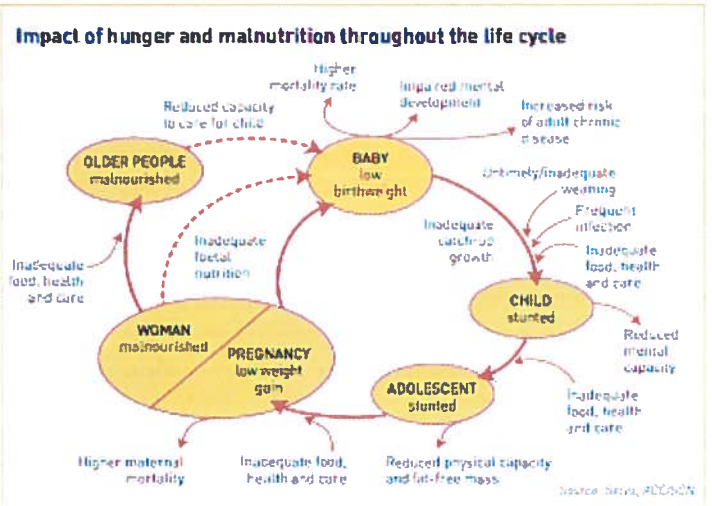
throughout the world, famine only represents a very acute form of crisis and malnutrition; one for which there is improving intervention.

Some estimates put deaths from acute malnutrition worldwide during the 1990s at 100,000 to 200,000 per year (Kates 1996). These numbers are high but actually miss by a significant margin the great majority of deaths due not to starvation directly, but to many malnutrition-related factors (Leathers, Foster 2004). Many of these factors include infectious diseases like measles, malaria, tuberculosis, and diarrhea, which further exacerbate an already dire situation and subject the most vulnerable to increased risk of morbidity and mortality. All of these diseases have spectrums of severity on the individual and can affect the individual in different ways, depending on additional factors such as access to local healthcare and availability of potable water. In many cases, research has looked at how the risk of death is tied to the degree of malnourishment rather than considering how the risk of death varies according to the nature of the concurrent illness or disease present (Caulfield 2004). Although the risk of overall mortality is increased among the most severely malnourished on an individual level, when one considers both the increased risk of mortality associated with a moderate degree of malnutrition and its high prevalence worldwide, it becomes much clearer that by far the largest number of deaths are attributable to moderate rather than to severe undernutrition (Caulfield, et al. 2004).

The FAO estimates that the number of chronically undernourished people in the developing world in 2000 was about 800 million (FAO 2004). As the 21st century continues along its current trajectory, the problems arising from widespread chronic undernutrition, rather than acute famines, are most likely to pose the continuing danger to the health of populations in poorer countries, although it cannot be ignored that much of what predisposes a population to potential famine is an already significant level of chronic

undernourishment. Although prevalence of malnutrition is closely linked to a country's level of economic development, improved nutrition need not await that development (Leathers, Foster 2004). It is therefore important to identify strategies to combat malnutrition that are comparable with the limited resources of such countries, that at the same time do not detract from long-term development goals. Perhaps the greatest merit of past nutrition projects, like those instituted by the World Bank, is that it highlights the concept that malnutrition is as much a cause as an effect of underdevelopment and that investments in nutrition programs by poor countries are economically justifiable inputs for their overall development and not mere welfare charity operations (Berg 1987).

Figure 1- Impact of hunger and malnutrition throughout the life cycle



4. Chronic Undernutrition

i. Determinants of Malnutrition

Childhood nutritional status is determined by many different factors and may be best understood by focusing on three different levels of causality— immediate determinants, underlying determinants, and basic determinants (UNICEF 1998). The immediate

determinants manifest themselves at the individual level and are (1) dietary intake and (2) overall health status. These factors are themselves interdependent. For example, if a child does not have adequate dietary intake, he or she will be more susceptible to infectious disease. Infection leads to decreased appetite, inhibition of nutrient absorption, and competes for the child's own energy supply (Schaible, Kaufmann 2007). Dietary intake must be adequate in quantity and quality, and nutrients must be consumed in appropriate combinations for the human body to obtain an adequate supply (Schaible, Kaufmann 2007). The immediate determinants are, in turn, influenced by several different underlying determinants, manifesting themselves at the household level (UNICEF 1998).

Underlying determinants include household food security, adequate care for mothers and children, and a proper health environment (i.e. potable water, adequate sanitation, etc.) (UNICEF 1998). A key factor affecting all underlying determinants is poverty, often captured in studies as socioeconomic status (SES) (Smith, Haddad 2000). In studies with an anthropometric component, the FAO (2006) recommends that the following factors be accounted for: maternal educational level; electricity access; toilet facilities; potable water access; household-level income; and household size. A person is considered to be in absolute poverty if he or she is unable to adequately satisfy basic needs like adequate food, healthcare, potable water, shelter and community support (FAO 2000).

Finally, the underlying determinants are influenced by basic determinants. Basic determinants are those manifest at the national, regional or community level and are limited by environment, access to technology and the quality of human resources (Smith, Haddad 2000). For the purposes of this paper, the following discussion will look at both the immediate and underlying determinants of childhood malnutrition, with special attention to micronutrient deficiencies, infectious disease and suboptimal caregiver feeding practices as

these are the factors most frequently implicated in childhood malnutrition. The 'Nutritional Interventions' section of the paper will focus on some of the underlying determinants of child nutritional status such as food security and adequate sanitation.

ii. Mother and Child Origins of Malnutrition

It is no wonder that small children and pregnant women are the two most vulnerable segments of the population to malnutrition and why resources have been spent on targeting these segments for improvement in nutrition (Bhutta, Ahmed, Black 2008). Because both pregnant women and children are in periods of increased risk and morbidity from undernutrition, there exists a vicious cycle (See **Figure 1**). This cycle begins with the malnourished mother giving birth to a low birth weight (LBW) infant that has experienced intrauterine growth restriction (IUGR). Growth failure can occur as early as the second trimester of gestation, resulting in a reduction of both skeletal and soft tissue growth (IUGR) (Branca, Ferrari 2002). If a reduction in nutrient supply occurs during the third trimester of pregnancy, this would cause a depletion of fetal fat stores, with little impairment of skeletal growth (LBW) (Villar, Belizan 1982). LBW babies have an increased risk of dying in infancy, and are subject to stunted physical and cognitive growth (FAO 2004). Even if a child is of normal birth weight, growth impairment can also be experienced soon after birth. It has been observed that the most intense growth faltering takes place between 3 and 18 months of age and shows a cumulative effect, demonstrating that by the fourth or fifth year of life, a greater percentage of children is stunted in these older age groups in comparison to those in the six months or younger group (Martorell 1994). Unfortunately, it is not usually known what proportion of stunted children at age 5 suffered from growth disturbances during

intrauterine life and in what proportion these disturbances started later (Branca, Ferrari 2002).

Stunting, like LBW, is linked to increased illness and mortality (Branca, Ferrari 2002). And as stunting is something that persists into adulthood, stunted adults may become mothers themselves thereby perpetuating the cycle (FAO 2004). Maternal stunting is one of the best predictors for having a LBW infant, which then continues the unfortunate cycle of malnutrition across generations (FAO 2004). The figure above, taken from the Food and Agricultural Organization of the United Nations' (FAO) publication, "The State of Food Insecurity in the World: 2004," provides a basic diagram of impact of chronic malnutrition and its effects throughout the life cycle (see **Figure 1**). As one can see, this is a vicious cycle of malnutrition with consequences well into the adult years for stunted children. Since the 1980s, levels of worldwide child malnutrition have been declining (De Onis 2000). In developing countries, childhood stunting has fallen progressively from 47% in 1980 to about 33% as of the year 2000 (i.e. 40 million). However, progress has been uneven according to region, with stunting prevalence increasing in parts of Eastern and Western Africa and South-eastern Asia, while Northern Africa, the Caribbean, South-central Asia and South America show moderate progress (De Onis 2000). Stunting remains a major public health problem, where a third of all children less than five years of age are stunted. 70% live in Asia, 26% live in Africa and about 4% live in South America (De Onis 2000).

iii. Disease Burden of Malnutrition

Maternal and child malnutrition is quite prevalent in low-income and middle-income countries, which have inevitably led to increases in mortality and overall disease burden (FAO 2004). Recent meta-analyses have better quantified the prevalence of underweight,

stunting and wasting around the world (Black, et al 2008). Weight-for-age or "underweight", data available from 2005 shows that 20% of children younger than five years in low-income and middle-income countries have a weight-for-age Z-score of less than -2 SD. In terms of low height-for-age or "stunting" in all developing countries, the percentage of children younger than five that have a Z-score less than -2 SD was 32%. Eastern and central Africa has the highest prevalence estimates with 50% and 42% respectively, and in Central America, the percentage was about 23%. "Wasting" or low weight-for-height, has also been estimated to be about 10% globally. South-central Asia has the highest prevalence of wasting at 16% while less than 1% of children in Central America fall into this category. It should be noted that the prevalence of severe wasting was higher at younger ages and declined by 24 months while the prevalence of stunting increased progressively until reaching a peak at 24 months. While weight-for-age has been used in previous studies and analyses, it is confounded by either low weight-for-height or low height-for-age, which are presently considered to be of more useful consideration than looking at weight-for-age alone (Black, et al. 2008). However, in order to estimate the disease burden, it is important to know the extent to which wasting and stunting overlap in populations of children under the age of five (Measure DHS 2007). The burden of disease measures the gap between a population's current health and an ideal situation in which everyone in the population lives to old age in full health or "disability-adjusted life-years" (DALYs) (Lopez, et al. 2006). It is estimated that stunting, severe wasting and intrauterine growth restriction (IUGR) together were responsible for about 2.2 million deaths and approximately 21% of disability-adjusted life-years for children under the age of five (Black, et al 2008). Still, in order to better grasp the important nutrition-related factors and their relative contributions leading to

undernutrition in young children, we must first examine the nutritional status of the mother before and after pregnancy (Kramer, Victoria 2001).

Maternal undernutrition, including chronic malnutrition and micronutrient deficiencies are prevalent in regions of Africa, Asia and Latin America and is anywhere from 10% to 19% in these countries (Branca, Ferrari 2002). This undernutrition is generally recorded as a body-mass index (BMI) less than 18.5 kg/m^2, and as short-stature, measured as less than -2 Z-score height-for-age as recorded on current international growth charts. Both of these indicators have been shown to have independent adverse effects on pregnancy outcomes (Black, et al. 2008). While low maternal BMI is a risk factor for complicated labor, it does not independently increase the risk of pregnancy-related complications to the mother. Maternal short-stature acts as a synergist in increasing pregnancy-related complications (WHO 1995). For the child, low maternal BMI is associated with a risk for IUGR, putting the neonate at risk for increased morbidity and mortality (Fishman, et al. 2004). In regards to maternal nutrition and production of breast milk in the postnatal period, maternal undernutrition has little effect on the volume or composition of breast milk unless it is severe (Branca, Ferrari 2002). Concentrations of certain micronutrients, like vitamin A, iodine and thiamine, are dependent on maternal nutritional status and the mother's intake, so there is some risk of infant depletion of these nutrients if there is a maternal deficiency (Allen 1994). Vitamin A is an especially relevant example because the content of vitamin A in breast milk is the main source of infant vitamin A (Allen 1994).

iv. Micronutrient Deficiencies

Vitamin A, iron, zinc, folic acid, and vitamin B-12 are some of the micronutrients that have been implicated in a wide range of diseases and disorders associated with chronic

malnutrition (Branca, Ferrari 2002). Several of these micronutrients possess immunomodulatory functions and thus influence the susceptibility of a host to infectious diseases and the course and outcome of such diseases (Bhaskaram 2002). Vitamin A deficiency has been and continues to be an endemic nutrition problem throughout much of the developing world, affecting especially those sub-populations that are most vulnerable; pregnant women and children. Current estimates by the International Vitamin A Consultative Group indicate that there are more than 127 million vitamin A deficient preschool aged children and over 7 million pregnant women suffering from this micronutrient deficiency (West 2003). This deficiency has been linked to a variety of disorders, which include but are not limited to, xerophthalmia (ocular disease and vision loss), infectious diseases, diarrhea, anemia and subsequently, increased morbidity in young children (Ramakrishnan, et al 1995). Recent evidence shows that vitamin A deficiency in newborn babies, infants and children has resulted in about 6% of under-5 deaths, 5% of under-5 DALYs and about 1.7% of total DALYs (Black, et al. 2008). While vitamin A supplementation trials in Asia have shown reductions in mortality during the first 6 months of life, there is no evidence that vitamin A deficiency has a direct relationship to linear growth (Ramakrishnan, et al 1995). For example, a deficiency in vitamin A can lead to increased susceptibility to infection, hindering the growth of a child, even though vitamin A itself has no direct relationship to growth.

Iron deficiency also represents a chronic micronutrient deficiency from which the WHO has estimated that 42% of pregnant women and 47% of preschool children suffer (Kraemer, Zimmermann 2007). The major cause of iron deficiency anemia is due to low consumption of meat, fish or poultry. In children, the prevalence of iron-deficiency anemia tends to peak around 18 months of age and then subsequently drops as nutritional

requirements decline and as iron intake is increased through complementary feeding (Black, et al. 2008). Iron deficiency anemia has been associated with a decrease in intelligence quotient (IQ) at about 1.73 IQ points per 10g/L decrease in hemoglobin (Stolzfus 2004). This anemia has a very small share of under-5 deaths at 0.2% and DALYs at 0.5% (Black, et al. 2008). Anemia has greater consequences for the pregnant woman and is a major risk factor for maternal mortality, resulting in over 115,000 deaths per year attributable to this risk factor (Stolzfus 2004). The disease burden in children is relatively small, accounting for only 0.5% of under-5 DALYs (Black 2008).

Zinc deficiency in the malnourished child results in increased risk of diarrhea, pneumonia, and malaria (Walker, Black 2004). Zinc deficiency is also thought to have a direct relationship to linear growth, as zinc deficiency at early ages is believed to manifest as stunting (Brown, Weuhler 2001). The predominant evidence from human studies as well as many animal studies support an association between zinc deficiency and decreased linear growth velocity in children (Prasad 1996). Well-controlled, interventional studies have also demonstrated the growth-limiting effect of zinc deficiency among schoolchildren as well as in older children/adolescents (Brown, et al. 1998). In a Guatemalan study looking at the growth of stunted, rural infants, researchers gave zinc supplements for 7 months and found that the most severely stunted at baseline had better growth than their less stunted counterparts (Rivera, et al. 1998). What is interesting is that there seems to be a connection between the national supply of foods with absorbable zinc and prevalence of stunting (IZiNGC 2004). In large population studies, zinc deficiency has been assessed on the basis of 2 indicators, (1) prevalence of stunting and (2) the supply of absorbable zinc in the national food supply, rather than conventional biochemical assessment used with other micronutrient analyses (IZiNGC 2004). Countries at a high risk of zinc deficiency have a

20% stunting prevalence and an estimated prevalence of inadequate zinc intake of 25%; low risk countries have 10% stunting or less and estimated inadequate zinc intake of 15% (Brown 2004). What this means is that there is a connection between decreased zinc supply at a national level and the level of stunting in a country.

Iodine deficiency has implications for the pregnant woman and fetus, as well as small children. Mild iodine deficiency has been linked to impairment of motor and mental development of the fetus and increases risk of miscarriage and IUGR (Black 2008). Some additional sequelae of iodine deficiency include goiter, congenital hypothyroidism and developmental disability (Rastogi, Mathers 2000). When looking at childhood intelligence quotient scores and chronic iodine deficiency, a 13-point reduction of IQ is associated with this chronic micronutrient deficiency (Black, et al. 2008). Presently, iodine deficits make up a very small number of deaths and only a modest amount of DALYs, which result mostly from motor and cognitive sequelae (Rastogi, Mathers 2000).

Calcium, folate, vitamin B12 and vitamin D are also critical for appropriate development. Lack of proper folate status in the pregnant mother has long been implicated in increased risk of neural tube and other birth defects (Ray 2007). B12 deficiency in young children– brought about via postpartum mothers with low B12 content in the breast milk – can appear as failure-to-thrive, stunting, decreased neurocognitive function and global development delays (Ray 2007). Vitamin D deficiency in utero can cause poor fetal growth and is followed by low concentrations in the breast milk (Hollick 2006). In regards to calcium deficiency, while the fetus is relatively protected from maternal calcium deficiency, poor bone mineralization is likely to occur in young children with low calcium intakes (Black 2008).

v. Breastfeeding and Introduction of Complementary Foods

Breastfeeding is accepted as an important postnatal practice to benefit the health of both the mother and infant (Brown 2005). It not only provides balanced nutrition for the infant, but also provides benefits like protection against infection, increased cognitive function and reduced morbidity as breastfed infants experience reduced rates of illness in the setting of poor sanitation and questionable water supplies (Brown 2005). The risks of morbidity and mortality from suboptimum breastfeeding in young children have been documented in several observational studies (Bahl 2005). Although it is recommended to feed children in the first 6 months of life with exclusive breastfeeding, it has been seen that in low-income and middle-income countries, only 47-57% of infants younger than 2 months are exclusively breastfed (Black, et al. 2008). At 2-4 months, this percentage falls to 25-31%. For children between 6-11 months old, 6% in Africa and 10% in Asia have stopped breastfeeding entirely, as well as 32% of mothers Latin America (Black, et al. 2008). If one looks at the risks of childhood morbidity and mortality, compared with exclusive breastfeeding, partial breastfeeding (breastfeeding plus solid foods) had moderately higher relative risks of diarrhea and pneumonia incidence than predominant breastfeeding (breastfeeding plus other liquids) and "not breastfeeding" had very high relative risks (Black 2008). Suboptimum breastfeeding has consequences for increased mortality and contributes to 1.4 million under-5 deaths worldwide. And while exclusive breastfeeding is an important part of good childhood nutrition up to 6 months of age, children will become stunted if they do not receive an adequate quantity and quality of complementary foods after 6 months of age (Black 2008).

The optimal age of introduction of complementary foods represents a compromise between 2 competing nutritional issues. In one scenario, if complementary foods are

introduced too late— when breast milk alone no longer meets all the infant's energy and nutrient needs —nutrient deficiencies and growth faltering may occur (Brown 2000). On the other hand, because these foods are often contaminated with microbial pathogens, premature introduction carries risk of transmission of infection (Brown 2005). Most stunting tends to occur in the first two years of life when nutrient demand for children is at its highest and there are coexisting limitations in the quality or quantity of their diets, especially after the 6 months of exclusive breastfeeding (Black, et al. 2008).

In a review study, information on energy consumption from breast milk was compiled from 21 published studies conducted in developing countries (Brown, Dewey, Allen 1998). Weighted mean energy intakes from breast milk reported from these studies were 413, 379, and 346 kcal/day by children 6 to 8, 9 to 11, and 12 to 23 months of age, respectively. Well-established estimates of children's average energy needs are 682, 830, and 1092 kcal/d for these same age groups (Butte 1995) (Torun, Davies, Livingstone 1995). Thus, the average amounts of energy required from complementary foods are approximately 275, 450, and 750 kcal/d during these age intervals (Brown 2000). To ensure that children are able to consume the desired amount of energy from complementary foods, these foods must be prepared with a minimally adequate energy density and served an appropriate number of times each day (4-6 times/day) (Brown 2005).

Suboptimum complementary diets are a clear determinant of stunting and the WHO recommends both food frequency and energy density be focused upon in order to guarantee a diet that is adequate in both (Brown 2000). Food diversity is just as important as the amount of food available, as micronutrient deficiencies are almost inevitable and may affect growth (Branca, Ferrari 2002). Moreover, even if the micronutrient deficiency doesn't directly affect growth, it may be the increased susceptibility to infectious agents, which will

have consequences for a child's health in an important period of growth (PAHO/WHO 2004). For these reasons, dietary diversity is now included as a specific recommendation in the recently updated guidance for complementary feeding of the breast-fed child aged 6 to 23 mo (PAHO/WHO 2004).

vi. Infectious Disease

The first widespread report on the relationship between malnutrition and infectious disease-related mortality and morbidity was probably by Scrimshaw, in 1968, and has been the focus of many observational studies since. It is now well accepted that infectious disease is both cause and effect in its relation to malnutrition. There is a synergistic relationship that exists as infections adversely affect nutritional status through means of fever (increased metabolic need), anorexia and diarrhea (Neumann 1978). Conversely, if an individual is malnourished primarily from inadequate food intake, the body will be more susceptible to infections due to lack of adequate overall calories or specific micronutrients (Neumann 1978). This situation sets up a vicious cycle of malnutrition and infectious disease. Infectious diseases are present in many developing countries but they have their greatest impact in sub-Saharan Africa and parts of Asia (Neumann 2002). Around the world, the combined effects of malnutrition arising from poverty and infections associated with unsanitary environments continue to be a major determinant of morbidity and mortality (Berg 1987).

There are many different infectious diseases affecting the malnourished individual throughout the world. Some of these diseases include childhood pneumonia, HIV infection, or parasitism from malaria (Caulfield 2004). In many instances, it is not only the disease itself that affects the individual's nutritional status but the symptoms of the disease, like diarrhea, anorexia and fever (Guerrant 1992). Fever and anorexia affect the individual's ability to keep

up adequate food intake during a time of increased need (Neumann 1978). Diarrhea has an important role in malnourishment for two reasons. First, unlike the epidemics of HIV and malaria, which have different regional impacts, diarrhea is a common illness experienced by children throughout the world (Martorell 1980). Second, due to interference of the absorptive properties of digestive tract, diarrhea is a well-known cause of nutrient malabsorption, as well as anorexia and catabolic effects, which siphon nutrient stores (Mata 1992).

As diarrhea plays such a significant role in nutritional status among children all over the world, research has continued to focus on those factors that increase the risk of diarrhea. Increased diarrhea can lead to longer duration of a single episode of diarrhea, greater severity of diarrhea or frequent episodes, all putting the vulnerable individual at risk for malnutrition (Mata 1992). Diarrhea risk is based on both individual and community factors. Individual factors include baseline anthropometric status, micronutrient deficiency and child feeding practices. Community risk factors include access to adequate health care, prevalence of diarrhea-associated pathogens, and source and quality of the local water supply (Brown 2003). Diarrhea is now known to be associated with linear growth failure in very young children, resulting in further stunting of growth (Muller, Krawinkel 2005). In the 2008 Lancet series on malnutrition, researchers pooled data together from several studies and found that in reference to stunting, "the adjusted odds of stunting at 24 months of age increased by a factor of 1.05 (odds ratio 1.05, 1.03-1.07 95% CI) with each episode of diarrhea in the first 24 months" (Black, et al. 2008).

5. Long-term Effects and Consequences of Chronic Malnutrition

i. Multigenerational Effects of Chronic Malnutrition

As has been discussed previously, health-related risk factors for children under-5 years of age begin well before the child is born. There are several maternal factors that may determine the overall health of the newborn. Short stature of the mother and substandard maternal nutrition are both associated with an increased risk of IUGR (Black, et al. 2008). Undernourished girls tend to become stunted adults and thus, much more likely to have stunted children themselves (Victoria 2008). In a Guatemalan study, it was shown that birth weight rose by 29g for every 100g increase in maternal birth weight and birth length rose by 0.2cm for every 1 cm increase in the mother's birth length (Ramakrishnan 1999). Then the child is born and is subjected to a variety of previously mentioned factors that may facilitate or hamper his or her nutrition and growth. Early growth failure will lead to reduced adult stature unless there exists some period of "catch-up growth", which is dependent on the breadth of the maturational delay and when it occurred (Victoria, et al. 2008). This sets the multigenerational cycle in motion, affecting the futures of children not yet born. Finally, in the recent Lancet series on malnutrition, researchers looked at five different cohorts of children, their mothers and grandmothers. The authors of the paper conclude that, "the effect of undernutrition spans at least three generations, as suggested by a small but significant association between grandmother's height and birth weight of children born to women from these five different cohorts" (Victoria, et al. 2008).

ii. Intelligence and Educational Attainment

Recent research has focused on the potential effects of childhood malnourishment on later intellectual development and educational achievement. It has been shown that

malnutrition occurring as early as the first year of life has a negative impact on overall intelligence (Grantham-McGregor, et al. 1999). Birth weight is now known to have a positive association with cognitive skills in children, but the effect of environmental determinants lessens this association over time (Landon, et al. 2006). Chronic malnutrition in children during the first three years of life can impair mental development directly, as the brain does not have a sufficient source of nutrients, and indirectly as malnourished children are less active, and therefore their brains are less stimulated (World Bank 1997). A seven-year longitudinal study of nutrition and cognitive development among seventy-eight Mexican preschool children showed that those children with little animal food in their diets were short in stature and delayed in cognitive development (Pelto 1987). Moreover, delays in intellectual development resulted from nutritionally induced growth stunting. This lag in intellectual capacity has implications for the level of educational attainment that a child will achieve in his or her lifetime (Grantham-McGregor, Fernald, and Sethuraman 1999).

Recent studies in the Phillipines and Kenya have found a significant relationship between nutritional status and educational attainment as measured by test scores (Glewwe, Jacoby, and King 1996; Bhargava 1996). This lack of intellectual development may be due directly to undernutrition, resulting in long-term effects on IQ level and eventual grade-level attainment. It also may be due indirectly to poor nutrition. For example, even if a well-nourished child goes to school without having had breakfast (direct), it has been shown that his or her school performance will suffer (Glewwe, Jacoby, and King 1996; Bhargava 1996). Another possibility, according to Alan Berg of the World Bank (1987), is that education also suffers from missed days (indirect) of school due to nutrition-related illnesses thus placing the child at a further disadvantage. Strauss and Thomas (1998) show that taller individuals finish more years of schooling, both in the United States and Brazil. While there are few

follow-up studies from childhood to adult age, there is a great deal of evidence to suggest a strong association between stunting and decreased cognitive ability and school performance in children throughout the developing world (Leathers, Foster 2004).

iii. Income and Economic Opportunity

By relying on the anthropometric measure of height-for-age as an indicator of poor nutrition, studies have found that smaller adults are less productive workers in areas of physical labor (Leathers, Foster 2004). The 2004 *State of Food Insecurity in the World* report by the Food and Agricultural Organization (FAO) estimates that stunting causes an economic loss of over $10 billion per year, worldwide due to lost human productivity. In a Brazilian study, Strauss and Thomas (1998) show that in a test of physical capacity, taller people were more likely to be able to carry a heavy load. This same report also showed that an increase in a person's height by 1% is associated with an increase in that person's wages by 1.4%. Moreover, when they limited their comparison to Brazilians with no education, they were able to show that lower wages are not only linked to less education but that wages in the 'no education group' are higher for taller people or people with a higher Body Mass Index. Finally, Strauss and Thomas (1998) find that poorly nourished people are more likely to be unemployed. Among urban males in Brazil, individuals that were 165 cm and taller had average unemployment rates of less than 5 percent while those that reached just 155cm tall had an average unemployment rate of 10%. Adult height is positively associated with income even when adjusted for urban settings and for education (Thomas, Strauss 1997). Those that receive more education stand to earn more over their lifetimes than those who are less educated (Grantham-McGregor, et al. 1999). In the case of Central America, the

economic return of attending school for 1 additional year is associated with a 12-14% increase in lifetime earnings (Psacharopoulos, Patrinos 2004).

iv. Implications for Disease in Adulthood

Undernutrition has also been studied in connection with chronic diseases that occur later, into adulthood. Undernutrition has been linked to cardiovascular disease, hypertension, insulin resistance and type 2 diabetes, function of the immune system, bone-related disorders like osteoporosis, and mental illness (Victoria 2008). Of particular importance is the potential danger of rapid weight gain in countries that are undergoing nutrition transition (Bhutta, et al 2008). "Nutrition transition" refers to the concept of the dietary transition in low-income countries and as a result, undernutrition and obesity existing simultaneously (Popkin 2002). As a result of this transition, more people consume diets high in total fat, cholesterol, sugar, and other refined carbohydrates and low in polyunsaturated fatty acids and fiber, often accompanied by an increasingly sedentary life (Popkin 2002). Although rapid weight gain in infancy is associated with lower morbidity and mortality in these settings, attention should be given to preventing excessive weight gain after the linear growth period (Victoria 2008). For example, a child of low birth weight, who is stunted and underweight at an early age, could represent a worse-case scenario for cardiovascular health later in life (Lawlor, et al. 2007). In a systematic review of available evidence, Cesar Victoria and colleagues (2008) concluded that lower infant weight gain and shorter childhood height combined with accelerated childhood weight gain, are implicated in increased risk of cardiovascular disease later in life.

As the combination of childhood stunting and inappropriate weight gain has implications for low and middle-income countries, it might be argued that in countries

undergoing the nutrition transition, monitoring length-for-age and weight-for-length in young children may be more appropriate than monitoring weight-for-age. Weight-for-age is an out-dated measure as it is confounded by an individual's height and is not precise enough a measure to capture the roughly one-third of stunted children in the developing world (Uauy, Kain 2002). Unfortunately, many health promoters in the developing world continue to use weight-for-age as the principle assessor for malnourishment, when they should be instead assessing children using height-for-age and weight-for-height (FAO 2004). Recent evidence from the Lancet Series on maternal and childhood malnutrition agree with this assessment and state, "height-for-age at 2 years was more closely related to outcomes for human capital than birth weight, weight-for-age or body-mass-index-for-age" (Victoria 2008).

C. Nutrition Interventions

1. Concept of Food Security

"The world has ample food. The growth of global food production has been faster than the unprecedented population growth of the past forty years. Yet many poor countries and hundreds of millions of poor people do not share in this abundance. They suffer from a lack of food security, caused mainly by lack of purchasing power." - Reutlinger et al. (1986)

The tumultuous times of the 1970s brought about the concept of food security, which was the chief concern of the 1974 World Food Conference. At that time, discussions of food security focused on the supply of food at the global and national level and more specifically on the ability of individual countries to obtain an adequate supply of food to feed the country's population (FAO 2000). Although this was not entirely incorrect, due to rising

fertilizer prices at the time and several consecutive years of globally poor grain harvests, the focus on the national level neglected the fact that quite often countries did have adequate food supplies but still were faced with rampant malnutrition among their populations. Clearly, while an adequate national food supply was a necessity when talking about food security, it did not encompass a definition that adequately explained why people continued to starve even though national food levels seemed to be sufficient. Thus, the definition of food security has shifted dramatically over the past thirty years and in the 1996 Rome Declaration on World Food Security, it was declared, "Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." This definition accurately reflects the increasing emphasis on food access versus food supply and the individual nature of the food security question.

A person lacks adequate nutrition if he or she does not have adequate access or "entitlements" to food or is unable to use those entitlements to avoid malnourishment (FAO 2000). This approach shifts the emphasis of food security to food access and away from just looking at food supply. The approach also concentrates on the individual and underlines the idea that an individual may experience malnourishment even when there is adequate food at the "macro-level"- national, sub-national, community or perhaps the household level. At any level, including the household, even if supply of food is adequate, there is no guarantee distribution will be equitable. Understanding food security then requires us to examine the different ways in which individuals exercise command over food. Singular changes affecting food access, like a dramatic rise in food prices, will inevitably affect everyone, but not to the same degree. The poor bear the weight of a price increase on any staple food item because a large percentage of their income is dedicated to paying for

these basic necessities (Riely, et al. 1999). While entitlements do vary from individual to individual, similarities undoubtedly exist and are often closely related to those living in close geographic or social proximities (FAO 2000).

Thus far we have looked at the role of food entitlement or access, but what is the source of these "entitlements"? Entitlements are based on both the individual and the household, and include physical assets like land and machinery, human capital assets (i.e. education, ability to perform labor), institutional assets (i.e. assistance institutions, credit access), social capital assets (i.e. migrant networks) and public assets (i.e. infrastructure, government support) (USAID 2002). Many of these assets are often held at the household level such that the household is an extremely important level for analysis of food security (FAO 2000).

In much of the developing world, food insecurity is usually deemed as "chronic", which implies that people are consistently unable to obtain sufficient nutrient intake. Still, those that are chronically food insecure are likely to experience fluctuations due to two main factors: (1) seasonality and (2) uncertainty. These factors predispose to a situation where periodic food insecurity occurs. Both seasonality and uncertainty are often related to the crop production cycle and is predictable. In terms of seasonality, increased food supply and employment opportunity are more readily available at time of harvest (FAO 2000). The opposite holds true during the planting and non-growing seasons. Food prices, food import, food supply, household income and the potential for disruptions in food distribution all contribute to uncertainty (Leathers, Foster 2004).

2. Interventions to Improve Nutrient Intake

There are many different types of interventions that have been enacted in order to improve birth outcomes and the nutritional status of young children. Some of these strategies include energy and protein supplements during pregnancy, breastfeeding promotion, and nutritional education on complementary feeding. Nutritional supplements have been seen to decrease risk of small-for-gestational age infants by 32% in pregnant women who are also of low BMI during pregnancy (Bhutta, et al 2008). Breastfeeding promotion strategies have been highly touted as improving rates and duration of exclusive-only breastfeeding in postpartum women, but despite the large number of studies looking at breastfeeding practices, few have assessed whether or not nutritional status of the infants improved. Those that have were unable to show a significant increase in weight or height of infants (Bhutta 2008). In regards to complementary-feeding strategies and its promotion via nutritional education, there is every indication that these strategies work well for improving child height-for-age Z-scores (Caufield 1999). Education-only interventions have been proven to work well in food-secure populations, while food supplementation only and supplementation plus education has shown anthropometric improvement in food-insecure populations (Bhutta 2008).

3. Micronutrient Interventions

In recent years, experts have said that it is cheaper to maintain good health than it is to make people well after they have fallen ill (Caulfield 2003). This is shaping many of the current healthcare debates in the developing world, which are emphasizing low-cost delivery of health services to the poor. Some of the clearest historical evidence lies in the water-borne sewage disposal systems in the West during the 1840s (Leathers, Foster 2004). In the 20th century, public health programs began promoting fortification programs of iodized salt

and of flour with vitamins in order to combat micronutrient deficiencies via a low-cost and wide-ranging distribution. This is especially helpful in those countries in which a single grain product supplies a disproportionate share of the total dietary intake (Leathers, Foster 2004). To elaborate, lack of dietary diversity is a particularly severe problem among poor populations in the developing world, where diets are based predominantly on starchy staples and often include few or no animal products and only seasonal fruits and vegetables (PAHO/WHO 2003). For vulnerable infants and young children, the problem is particularly critical because they need energy- and nutrient-dense foods to grow and develop both physically and mentally and to live a healthy life (Brown 2005).

Vitamin A, zinc, iodine and iron-folate are the most common micronutrient deficiencies in developing nations, and as such, fortification programs have targeted these four nutrients. Clearly, the most dramatic results have been seen with the iodization of salt, which has almost completely eliminated goiter and cretinism in most parts of Latin America (Rastogi, Mathers 2007). The results of vitamin A supplementation and iron-folate have been less promising. In low-income countries, recent vitamin A supplementation studies have shown reductions in neonatal mortality, but this is primarily from studies done in Asia (Bhutta 2008). Very large, placebo-controlled community intervention trials have also been done in Africa and showed an overall decrease in mortality by 30% in children 6 to 60 months old when consuming vitamin A fortified foods (Fawzi 1993). It has also recently been found to protect against AIDS-associated mortality in this same age group (Fawzi 1999). However, not all studies showed a significant benefit (Bhutta 2008). Differences among the studies include underlying nutritional status, morbidity patterns, and use of the healthcare system, all of which may have affected the response to vitamin A. In addition,

there has not been sufficient evidence to show vitamin A only supplementation affecting anthropometric measures (Bhutta 2008).

A limited number of iron-folate supplementation programs have been successful in improving hematological status in pregnant women, while the results of iron-folate supplementation for preschoolers has been less successful (Kennedy 1985). While there have been reductions in the occurrence of anemia with iron supplementation in young children, there has been no noted benefit on their growth and there was even evidence to suggest that diarrhea incidence increased slightly in iron-supplemented children (Bhutta 2008). It has also been recommended that untargeted iron supplementation not be implemented in malaria-endemic areas as iron supplementation has been known to have detrimental affects in terms of infectious disease (Iannoti 2006). This is because iron is one of the necessary co-factors desired by human pathogens, like malaria, which may become lethal if iron supplementation is provided (Schaible, Kaufmann 2007).

Zinc supplementation seems to have the greatest promise among micronutrient-oriented intervention programs. In a recent study, using zinc supplementation to improve the growth of stunted, rural Guatemalan infants, children received a daily beverage for almost 7 months, which contained 10 mg of zinc sulfate. Although there was no significant difference in linear growth between the treatment and placebo groups among children at all age levels under five, it was seen that those that were stunted at baseline gained 1.40 cm more than stunted children who received the placebo (Rivera 1998). The implications of these results reflect a potential drawback of nutrient supplementation/fortification; that nutrient supplementation is not necessarily effective for growth deficiencies at mild levels of stunting and that supplementation programs are best targeted at those that are the most stunted or show signs of extremely poor linear growth. However, in the recent Lancet series

on 'Maternal and Child Malnutrition', a pooled analysis of zinc supplementation studies showed that the average effect size for change in height is 0.35 (95% CI 0.19-0.51) and for change in weight of 0.31 (0.18-0.44) (Bhutta 2008). In addition, zinc supplementation was associated with fewer episodes of diarrhea, severe diarrhea, and lower respiratory infections compared with those children given placebos.

4. Disease Prevention Strategies

Some of the most important public health achievements have had the focus of combating and eradicating infectious diseases around the world. With the advent of antibiotics and widespread vaccination campaigns, we have seen unprecedented decreases in infectious disease transmission (Caulfield 2004). Our successes, however, are not without new challenges. Malaria and HIV continue to play significant roles in both maternal and child mortality, but the eradication of such diseases will need to be accomplished with the help of more inputs of regional resources and infrastructure (FAO 2004). In regions where HIV and malaria do not have a significant foothold on child morbidity and mortality, it is the consequence of infectious disease symptoms- diarrhea, upper respiratory infections and chronic disablements- which continue to be the significant factors leading to stunting and chronic malnutrition in children living in food-insecure environments (FAO 2004). In studies looking at the effect of hygiene interventions (i.e. water quality treatment, sanitation, and health education), children under 5 have had decreased diarrhea episodes (Relative Risk 0.67) (Fewtrell 2005). In other interventions like anti-parasitic treatment in children, growth outcome results show that in children age 1 to 16 years, one dose was associated with a 0.24kg average increase in weight (Dickson 2000).

5. Agricultural Interventions

Agriculture interventions have been used in developing regions for years to help improve the nutritional status of malnourished populations. The objectives and settings differ greatly from project to project. A few examples of the many diverse types of agricultural interventions include home vegetable gardening in Bangladesh, livestock-only intervention in Egypt, mixed gardening-livestock project in Kenya, and irrigation interventions in Haiti (Berti 2003). These interventions, which employ home gardening techniques or small-animal production have been potentially relevant and promising, but many have only been implemented or studied at a very small scale (Bhutta 2008).

Agricultural interventions have had mixed results in terms of improving nutritional status in those that participate (Berti 2003). Many agricultural interventions increase food production, but do not necessarily improve nutrition or health within specific populations (Berti 2003). Many use dietary intake and biochemical analysis as indicators for nutrition health and fail to look at anthropometric indicators of nutrition. In a 2003 review article on "Agricultural Interventions" by Berti et al., the researchers concluded, "home gardening projects usually had a higher success rate than other types of interventions, with at least some positive nutrition outcomes in some of the better quality projects". They also noted that nutrition education was of central importance for achieving nutrition improvement in many diverse interventions and believe that those agricultural interventions that invest broadly in different types of capital— human, social, financial and physical —increase the prospect for nutrition improvement. This broad investment in many different types of capital also has the effect of making it difficult to compare the outcomes of different interventions with unique objectives, and so it is difficult to ascertain to what extent results from these studies are generalisable (Berti 2003). In some cases, goals like increased land

ownership, increased crop diversification or increasing economic status of women, are much broader and considered more important goals than nutrition alone.

6. Animal Source Food Interventions

Livestock are common in poor communities across the developing world and an estimated two-thirds of resource-poor rural households keep some type of livestock (Livestock in Development 1999). In the majority of instances, these are smallholder systems that are of lower productivity, letting animals forage for themselves, feeding on local plants and waste (Randolph 2007). To date, there are many different reasons that livestock holding has held promise for alleviating poverty. Among these are the potential for increased food production, generating income, providing fertilizer from manure, serving as financial instruments in places where there is little access to standard financial markets and helping to enhance social status, especially among certain disenfranchised segments of the population (Randolph 2007). These many objectives for keeping livestock suggest that it is misleading to view livestock as a conventional, independent production activity and that animals play a much more complex role in the well-being of the household.

Animal Source Foods (ASFs) are also being considered as viable alternatives for alleviation of chronic malnutrition in low-income and middle-income countries. While plant-based interventions have been seen to show nutritional improvement in some populations, animal source food are richer in protein and have greater bioavailability among six micronutrients, including iron, zinc, vitamin B-12, riboflavin, calcium and vitamin A (see **Table 3**) (Murphy, Allen 2003). Proteins in animal source foods are considered to be of high quality because they contain significant quantities of "essential" amino acids, which cannot be synthesized by the body and must be obtained from the diet (Murphy 2003). In addition,

bioavailability of carotenoids as vitamin A precursors in plant foods is now believed to be lower than has been indicated in traditional nutritional tables, giving another advantage to ASF (Institute of Medicine 2001).

The main advantage of ASF, particularly meat, is the high content and bioavailability of micronutrients and although some plant foods are relatively high in iron, zinc or calcium, the micronutrients are poorly absorbed (Murphy, Allen 2003). To put this in perspective, it is estimated that to meet the average daily requirements for energy, iron or zinc, a child would need to consume over 1.7-2.0 kilograms of corn and beans in one day, while the same requirement may be achieved with 60g or 2 oz. of meat per day. Animal products are also great sources of dietary vitamin B-12 and a good source of preformed vitamin A, particularly in milk (Haenlein 2003). Levels and bioavailability of micronutrients are not equivalent among meat, milk and eggs. Meat and eggs are high in protein, iron, zinc and B group vitamins while milk is high in calcium, vitamin B12 and moderately high in vitamin A (see **Table 3**). One potential drawback is that milk, if consumed with meat, reduces the bioavailability of iron and zinc because of the high calcium and casein protein content which form insoluble complexes with iron and zinc thus impeding their ability to be absorbed in the intestine (Ferguson, Gibson, Opare-Obisau 1993). Despite the high nutritional value of animal source foods, many people living in low-income countries eat little or none of these foods. This lack of consumption happens because of poor availability and accessibility to animals for poor people, mainly due to animal products being priced out of reach and forcing poorer people to rely more heavily on less expensive cereal grains, legumes or starchy roots (Neumann, Harris, Rogers 2002).

The evidence for use of animal food source products and small-scale livestock husbandry projects on improved child growth has not been completely convincing. For one,

studies with direct measurements of the impact of ASFs on nutritional status are rare (Leroy, Frongillo 2007). Secondly, many studies suffer from serious limitations in design, evaluation and analysis (Ruel 2001). Livestock development efforts in lower-income countries are primarily intended to generate income and improve nutritional status of the population in need but increased animal holdings do not always translate to improved nutrition among participants (Randolph 2007). Thus, many studies have focused on impact of nutritional status via increased dietary intakes of ASFs and biochemical analysis, in a cross-sectional view without long-term anthropometric observation (Leroy, Frongillo 2007). These cross-sectional studies are limited because they only describe the individual's current nutritional status, and tell nothing about the baseline from which he or she started, or what type of growth the individual experienced during the first 5 years of life. A recent review of agricultural interventions examined 3 small-scale, livestock-only studies designed to improve health of participants in both India and Ethiopia (Berti 2003). Among these 3 studies, the nutritional status 'outcome' only consisted of a dietary consumption indicator based on the milk production from animals. The participants in 2 out of the 3 studies showed increased overall energy intake, but only a small increase in milk consumption as compared to controls. Anthropometric and biochemical indicators were not included in the studies, making determinations difficult on how well ASFs improved the nutritional status of participants. The difficulties in adequately assessing the affect of ASF interventions on nutritional status underscores the need for continued study in this field. Consequently, it is important to continually assess how to evaluate nutritional status in ASF interventions, especially before concluding on their degree of effectiveness in alleviating chronic malnutrition in the developing world.

II. Study of Salvadoran Children in an Animal Gifting Program

A. Statement of the Problem

Approximately 800 million people worldwide are chronically undernourished (FAO 2004) in spite of the fact that world food production is sufficient (Leathers, Foster 2004). Of these people, the populations most vulnerable to chronic malnutrition include women, children and the elderly (Black 2008). Recent meta-analyses have better quantified the prevalence of underweight, stunting and wasting around the world (Black, et al 2008). Weight-for-age or "underweight", data available from 2005 shows that 20% of children younger than 5 years in low-income and middle-income countries have a weight-for-age Z-score of less than -2 SD. In terms of low height-for-age or "stunting" in all developing countries, the percentage of children younger than 5 that have a Z-score less than -2 SD was 32%. There is now a large body of literature citing causes, complications and long-term sequelae of chronic malnourishment within poor and middle-income countries (Black 2008) (Bhutta 2008).

Efforts aimed at improving nutrition within vulnerable populations have been wide-ranging and dependent on regional and local factors (Bhutta 2008). Some of the most common interventions include those designed to increase food intake, others targeting specific micronutrient deficiencies, and those that the use disease prevention strategies like water-purification to reduce incidence of diarrhea (Fewtrell 2005). Other interventions include use of animal-agriculture solutions for impoverished families and those designed to strength food security and social capital over the long-term (Berti 2003).

Animal Source Foods (ASFs) have also been considered as viable alternatives for alleviation of chronic malnutrition in low-income and middle-income countries. Animal source food is considered to be rich in protein and have high bioavailability among several

micronutrients (see **Table 3**) (Murphy, Allen 2003). The promotion of consumption of ASFs is a potentially powerful intervention with substantial evidence for increased dietary intakes among those exposed to the marketing of ASFs (Gittlesohn, Vastine 2003). Many studies of agricultural interventions have focused on impact of nutritional status via increased dietary intakes of ASFs and biochemical analysis, but few have implemented anthropometric assessments and have shown mixed results in trying to demonstrate improved child growth resulting from project participation (Leroy, Frongillo 2007).

B. The El Salvador Situation

1. Background

El Salvador is the smallest of the Central American countries at approximately 8,000 sq. miles with a 2007 population estimated to be at 5.8 million people. It is a democratic republic with a presidency and a government that has been through considerable turmoil since the mid-1970s. The country's people are largely Roman Catholic and Protestant and Spanish is the language spoken by virtually all inhabitants. The capital city of San Salvador has about 2.2 million people while an estimated 40.3% of El Salvador's population lives in rural areas. (U.S. State Dept. 2008)

Recent Salvadoran history is marked by the brutal civil war lasting from 1980 to 1992 (Grummer-Strawn et al. 1996). The Salvadoran war was primarily begun as a result of economic inequity, especially in regards to land distribution, but is historically known for its human rights abuses. More than 75,000 people are estimated to have died in the conflict. In January 1992, after prolonged negotiations, the opposing sides signed peace accords, which ended the war, brought the military under civilian control, and allowed the former guerillas to form a legitimate political party and participate in elections. Among other problems, El

Salvador saw destruction of infrastructure, worsening economic conditions, marginalization of its rural inhabitants and an exacerbation of the chronic problem of hunger.

Currently, the Salvadoran economy continues to improve from a commitment to free markets and careful fiscal management. The economy has been growing at a steady and moderate pace since the signing of peace accords in 1992, and poverty has been cut from 66% in 1991 to 31% in 2006 (U.S State Dept. 2008). Much of the improvement in El Salvador's economy is a result of the privatization of the banking system, telecommunications, public pensions, electrical distribution and some electrical generation; reduction of import duties; elimination of price controls; and improved enforcement of intellectual property rights (Government of El Salvador). Culminating with those reforms, the U.S. dollar became legal tender in El Salvador in 2001 and the Salvadoran economy now finds itself using the U.S. dollar exclusively (U.S. State Dept. 2008).

The civil war also had a devastating impact on agricultural production in El Salvador. Currently, the agricultural sector has experienced significant recovery, buoyed in part by higher world prices for coffee and sugarcane and increased diversification into horticultural crops (BBC News 2008). Seeking to develop new growth sectors and employment opportunities, El Salvador created new export industries through fiscal incentives for free trade zones. The largest beneficiary has been the textile and apparel (maquila) sector, which directly provides approximately 70,000 jobs. Services, including retail and financial, have also shown strong employment growth, with about 51% of the total labor force now employed in the sector (U.S. State Dept. 2008).

2. Impact of Civil War on Child Malnutrition

The effects of the Salvadorian Civil War between 1980 and 1992, were wide-ranging and affected the country not only economically and socially but also the health of the most vulnerable sector of the population; children under the age of five. Child malnutrition worsened over the course of the war, leaving more young children at increased risk for morbidity and mortality (Grummer-Strawan et al. 1996). In a study conducted by researchers from the CDC, looking at the nutritional status of Salvadoran children under five between 1988 and 1993, after the signing of the peace accords, they found that the prevalence of low weight-for-age (<-2 SD) dropped from 15% in 1988 to 10.5% in 1993 (Grummer-Strawn et al. 1996). Similar decreases were seen in weight-for-height measures (3.9% to 2.9%) and height-for-age (28% to 22%). In regards to chronic malnutrition (low height-for-age), rates were highest among rural children whose mothers had less education and who lived in households of lower socioeconomic status. In general, improvements were most prevalent among segments of the population that were "better off"- children of better-educated mothers, those living in urban areas and those of higher socioeconomic status. While these results are promising, they do suggest that the anthropometric improvements lie among those that were in the most advantageous position to improve.

Expensive international efforts to relieve suffering and promote peace have become common in the 20th and 21st centuries, although doubts linger as to their effectiveness (Braine 2006). In the case of El Salvador, the international donor community contributed approximately US $200 million per year in reconstruction aid (Brentlinger, et al. 1999). Plans for reconstruction constituted an increase in basic health services in the form of reestablishing local health clinics and potable water systems, as well as the move toward land redistribution in zones of conflict (Government of El Salvador). Although some of this

reconstruction would be delayed up to 6 years after the signing of the peace accord, these principal elements of reconstruction helped alleviate some of the severe resource constraints that had been associated with malnutrition and mortality among children in rural El Salvador (Brentlinger, et al. 1999).

In a follow-up study by Brentlinger and colleagues, looking at childhood malnutrition and postwar reconstruction in rural El Salvador with particular emphasis on land redistribution, it was seen that less than a third of rural redistributed land was under active cultivation. As of 1997, when this study was carried out, the overall prevalence of stunting, wasting and underweight in rural areas only were 32.4%, 1.3% and 9.2% respectively. Clearly, prevalence of stunting in rural areas differed greatly from the Grummer-Strawn study, which failed to differentiate between urban and rural prevalence. Factors found to be strongly associated with stunting were smaller land area under cultivation, delayed cultivation of recently redistributed land, less crop variety, more children under the age of five in the household, lack of potable water and not having livestock. The only questionable result found was in the small association of low maternal education and stunting, which has remained an important risk factor elsewhere.

3. Effect of Natural Disasters on Salvadoran Health

In recent years, there has been increasing discussion of natural disasters, climate change, and how to provide aid to affected areas. The year 2005 experienced several devastating global natural disasters including, the earthquake and tsunami destruction of Southeast Asia, hurricanes in central and north America, and famine in Niger after crops were destroyed by locusts (WHO 2006). As it becomes clearer that people's inherent vulnerabilities, resulting from poverty and inequity, greatly determine how severely they are

affected by natural disasters, research will continue to examine the affect on people's overall health (Braine 2006). Dr. Ciro Ugarte, the Regional Advisor for Emergency Preparedness and Disaster Relief with the Pan American Health Organization (PAHO) in Washington DC, believes that, "natural disasters would not have such a devastating effect on people's lives if they were not exposed to such risks in the first place" (Braine 2006).

After the 1992 peace agreement ended the civil war, no sooner had El Salvador begun to recover, when it was hit by a series of natural disasters, notably Hurricane Mitch in 1998 and earthquakes in January and February 2001 (WHO 2006). Combined, these natural disasters left at least 1,200 people dead and more than a million others homeless (BBC 2006). One study looked at water reconstruction programs among 8 Central American countries after Hurricane Mitch and noted the extensive damage to water and sanitation infrastructure, disproportionately affecting rural areas (Moll 2007). Hurricanes also have short-term consequences for health, including increased infection and shortages of basic resources, but it is troubling that almost 6 years after the hurricane, many of the previous infrastructures still had yet to be restored (Moll 2007).

Immediately after the earthquakes in 2001, several students from Nursing Students Without Borders (NSWB) set out to study the effects of the earthquakes on the health of rural communities in El Salvador (Woersching, Snyder 2003). Among other findings, the study concluded that rural Salvadorans were 30% more likely to be left homeless after an earthquake than their urban counterparts (Woershing, Snyder 2003). There was also a substantial spike in the incidence of infectious diseases in rural areas, the majority consisting of skin, upper-respiratory and gastrointestinal infections (Woershing, Snyder 2003). Through field work and interviews with rural Salvadoran families, the study also found that immediately post-earthquake, rural infrastructure was unreliable and largely unusable, local

water supplies were contaminated, and sanitary conditions quickly worsened, all leading to worsened health of rural residents. International support poured in, but this aid proved to be minimal to rural areas that had seen increased barriers in transportation, access and communication to the outside world (Woersching, Snyder 2004). Clearly, natural disasters disproportionately affect those rural families who already find themselves extremely vulnerable to food insecurity and chronic malnutrition.

4. Seasonal Changes in Child Malnutrition

Many rural populations in Central America have seasonal patterns of agricultural-based employment, food availability and disease prevalence. These patterns are often seen in relation to the onset of rains in April or May, at which time nutrient availability is decreased, as well as employment, with a concomitant increase in diarrhea, respiratory and dengue-related disease (Trowbridge 1979). Because this "rainy season" from May through mid-August is one of both low family income and higher disease prevalence, higher levels of protein-calorie malnutrition might be expected. The opposite holds true for the "dry months" during and post-cultivation of crops such as corn, coffee and sugar cane, in which there is a boon of available agricultural work and nutrient availability. It also appears that seasonal changes in the prevalence of malnutrition are directly related to the occurrence of diarrheal disease, which has been shown to peak during the May-July timeframe (Trowbridge 1979). In a follow-up study by the same researchers in 1981, it was found that children with low weight-for-height, especially when combined with low height-for-age, had a significantly increased risk of a recent episode of diarrhea (Stetler, et al. 1981).

No matter the mechanism leading to diarrhea illness and subsequent malnutrition, it is undoubtedly the combination of increased diarrhea incidence at a time of increased

economic hardship, which leads to a plausible explanation for the seasonality of malnutrition. Thusly, these seasonal changes have two very important implications for the study of malnutrition in El Salvador and many Central American countries sharing similar seasonality. First, documentation of seasonal malnutrition prevalence has implications for the timing of field surveys, since survey results during one season might be significantly different from those obtained during another (FAO 2004). Second, this knowledge of seasonality also has potential implications for the timing of nutrition intervention programs, since it would be prudent to enact or increase nutrition intervention activities during the time of greatest hardship (Trowbridge 1979).

5. Local Dietary Factors

Food security continues to be an issue for the Salvadoran population, affecting both the urban and rural sectors (FAO 2002). The food security factors that continue to play a prominent role for Salvadorans are a deficit in the availability of nutrients, substandard economic access to food stores, a diet that is deficient in quality of nutrients versus quantity, poor diversification of the agricultural sector, an increasing deterioration of the local ecologic environment due to ill-advised agricultural practices, a lack of local infrastructure to support agricultural improvements and a lack of employment opportunity or access to credit accounts (FAO 2002). Among these factors, the lack of dietary diversity is of particular importance.

El Salvador has made significant gains in overall calories available per capita. In the period from 1964 to 1966, there were roughly 1831 kcal/person/day available based on imports and domestic food production, which was below the 2060 kcal/person/day needed at that time (FAO 2002) (James and Schofield 1990). Between 1968 and 1988, the dietary

energy available climbed to 2175 kcal/person/day but decreased to 1833 kcal/person/day during the Salvadoran civil war due to instability and economic uncertainty (FAO 2002). This overall calorie availability increased to over 2500 kcal/person/day as of 1998 with a 39% increase and clearly surpassing the calories needed per person per day (FAO 2002). Nevertheless, there has been a lack of dietary diversity within the Salvadoran diet with carbohydrates existing as the principal source of calories, making up 71% of the diet (FAO 2002). The basic Salvadoran diet consists of three staples: corn tortillas, rice and whole beans. Among the remaining 29% of the Salvadoran diet, 19% is made up of fats from oils and the remaining 10% in the form of protein (FAO 2002). In addition, of the total protein consumed, 74% is estimated to be of vegetable origin, giving credence to the belief that the quality of the Salvadoran diet is inadequate in essential amino acids and specific micronutrients like iron, which is known to have greater bioavailability in animal source foods (James and Schofield 1990). This reflects a diet that is low in animal products like milk, eggs and meat.

C. Heifer International

1. Background

Heifer International (HI) is charitable organization headquartered in Little Rock , Arkansas and has been providing livestock, training in animal husbandry and sustainable agriculture to developing areas throughout the world for the past 60 years (Heifer International). Heifer International was founded by Daniel West, a U.S. Midwestern farmer, who had handed out milk rations to the nation's poor during the Spanish Civil War. He recognized early on that such rationing was giving little credence to the future of the poor and the milk rations were barely helping to sustain them at present (Heifer International). In

1943, he returned home to form Heifers for Relief, dedicated to ending hunger permanently by providing families with livestock and training so that they "could be spared the indignity of depending on others to feed their children" (Heifer International). It was in 1944 when the first shipment of 17 heifers left Pennsylvania for Puerto Rico, where many of this country's children had never tasted milk. This simple idea of giving people a source of food rather than handouts is what has helped HI continue to expand and evolve its business over the past 60 years. HI has had projects operating in more than 120 countries worldwide and specializes in 20 different kinds of food- and income-producing animals (Heifer International).

Heifer International has grown from a $7-million organization in 1992 to a $95-million organization (2005) with corresponding growth in its programs worldwide (Guidestar 2008). As of 2006, the most recent year for which there is record, HI will have 726 current projects active in 57 countries and 29 U.S. States (Guidestar 2008). In this same year, HI received over 75 million dollars in contributions, mainly from individuals and religious organizations (IRS Record 2006). Roughly one-quarter of all revenue is spent on administrative costs while the remaining 75% goes directly to programs services (Guidestar 2008). Heifer has made considerable efforts to cut down costs in recent years, in order to ensure that the majority of contributions reach those for whom they are intended.

Heifer has sought to give relief of the world hunger problem with an idea known as "passing on the gift". This is the idea that all Heifer Project recipients must pass on part of the offspring of their heifer-donated animals and HI training to a needy neighbor and in this way encouraging, "people helping each other to end poverty" (Pelant 1999). "Passing on the Gift" also ensures a sustainable development focus and is a broad enough principle that there are many different forms of it all over the world (Heifer International). Yet, it is also

Heifer's attention to detail that has allowed it to grow substantially in the last several decades. Through use of participatory practices, HI has made a commitment to collaboration with grassroots, educational, religious, institutional, and governmental organizations within each country and has assisted to tailor the project to suit those in need (Pelant 1999). This is a long-term approach to development and one in which training and technical services are an essential component to the long-term survival of a project.

It is important to target the most needy within communities but there are criteria that must be met in order for someone to begin a local project with HI's funding and collaboration. Animals in all projects must have access to adequate feed, water and shelter and be humanely treated (Pelant 1999). Once these basics are assessed to be sufficient, project participants are then given training and on-site technical advice to improve their skills and knowledge in animal care, planning and management (Rangnekar 2001). The type of animals used in projects varies according to local needs and requests, former experience, natural resources and marketability of surplus production are also taken into account (Heifer 2008). Projects are selected on the basis of meeting HI's twelve 'Cornerstones for Just and Sustainable Development' (Aaker, Shumaker 1996).

2. Structure and Goals

In the 1980 as and early 1990s, HI used several USAID Matching Grants to strengthen capacity in several areas including training, gender, participatory development and evaluation (Dierolf 2002). As a part of this, HI developed the Cornerstones Model for program planning and refers to these twelve cornerstones via an acronym, "**PASSING** on the **GIFTS**". Basic information on this can be found on Heifer's website, www.heifer.org. They are as follows:

1. **P**assing on the Gift- the previously commented upon principle allowing individuals and families receiving animals to be donors themselves.
2. **A**ccountability- autonomy and organization at the grassroots level. Community members decide together what kind of animal and assistance they would like. They also set goals, plan appropriate strategies to achieve those goals and evaluate their successes.
3. **S**haring & Caring-this reiterates Heifer's belief that global problems can be solved if all people are committed to sharing what they have.
4. **S**ustainability & Self-reliance- a necessity for the long-term success of projects. Heifer can only fund a project for a limited time (2-3 years) so communities and families must plan to support themselves.
5. **I**mproved Animal Management- project participants learn techniques in animal husbandry and how to care for the animals through proper food, shelter, healthcare and reproductive management.
6. **N**utrition & Income- these are the benefits Heifer expects recipients to obtain from their animal(s) through the consumption and/or sale of products such as milk, eggs, cheese and honey.
7. **G**ender & Family Focus- based upon the empowerment of women throughout the world and helping to bring men and women together so that they may share in decision-making, as well as in the benefits the animals and training bring.
8. **G**enuine Need & Justice- the aim being that those most in need are given priority in receiving animals and training.

9. Improving the Environment- based in agroecological techniques such as improving soil fertility with animal manure, promoting forestation, respecting and encouraging biodiversity, monitoring watershed conditions and minimizing erosion.
10. Full Participation- a "participatory approach" is encouraged in these groups, in order to fulfill the commitment to involve all members in the decision making process.
11. Training & Education- each project group decides on their own training needs and local people are involved as trainers. Some topics of education include human nutrition, food processing, marketing and leadership development
12. Spirituality- Heifer International's commitment to working with people of all beliefs and forming common values around those beliefs that help those in need have a "sense of connectedness to the earth and a shared vision of the future" (Heifer International).

These principles represent Heifer's mission to help people not only have a source of food but also help develop the capacity of rural, community-based organizations for the planning and management of future small livestock projects (Dierolf 2002). Much of HI's evaluation of its country programs is based in self-evaluation strategies (Heifer International). Project participants are asked to define project goals and decide on outcomes, much of which is viewed through the lens of the 12 cornerstones. HI also extends this participatory learning approach to the inner-workings of the organization itself and has encouraged the use of diverse learning mechanisms to improve the impact(s) of HI's operations abroad (Dierolf 2002). But based on Heifer's objectives and Cornerstones

Model, how have HI's programs impacted communities and what outcomes are typically measured?

3. Evaluation of Heifer International Programs

As Heifer International grows in size and complexity, the need for evaluation of its regional programs and individual projects is a necessary component of future success. To date, HI has focused on individual accounts and testimonies of Heifer's success in programs throughout the world. In one instance, there is the story of Pedro Martinez, a Guatemalan farmer, who saw his crops and food security for his 8-member family destroyed by Hurricane Stan in 2005 (Heifer International). Pedro's story is primarily of hope and describes his initiative to replant crops such as tomatoes and onions with the help of HI. Yet, this type of evaluation lends to personal anecdote and is not the type of rigorous, well-controlled study that can identify key outcomes from Mr. Martinez's participation in the Heifer project. While stories like these are immensely popular for methods of fundraising, they lack evidence for wider benefits among many participants.

There are only a few published studies on HI projects and almost all of them focus on animal husbandry and social capital. They have a largely qualitative structure and base impact measures on personal observations of the evaluators and from interviews with beneficiaries (Njwe, 2002 and Pelant 1999). For example, a HI project aimed at small-scale dairy development in the Cameroon found the following impacts: change in people's social value about livestock raising; change in consumption patterns or habits to include milk and other dairy products; intensification of exchange and relations with other economic agents in their environments; diversifications of economic activities; change in farming systems and structure to include livestock production in general and dairy production and marketing in

particular (Njwe 2002). While many of these impacts are in line with many of Heifer's cornerstones, the methods by which the researchers determined certain impacts may be brought into question. In one instance of measuring 'nutrition', researchers determined that project participants had improved nutrition vis-à-vis "increased dairy consumption" (Njwe 2002). While this is promising, "increased consumption" may be considered an inadequate outcome measure for nutritional status without the use of parallel micronutrient or anthropometric evaluation (Leroy 2007). Instead, these researchers should have deemed this a measure of "dietary intake" and only as a loose proxy for nutritional status.

Recently, Heifer began a global effort to measure the impact of the organization's field programs. In an evaluation of projects both in the U.S. and Peru, a team from Western Michigan University, under the direction of Dr. Michael Scriven, sought to evaluate the impact of Heifer's projects in these regions with the hope of revealing how people's lives have changed because of Heifer's contribution (Heifer International). These studies were conducted between June and August 2005, and focused on projects in the North America Program's South Central Region and among the Latin America Program's Peru projects. The specific evaluation approach that was used was the "Heifer Hoofprint Model", which responds to Heifer's main interest in assessing the impact of its programming on the lives of project recipients and provides a comprehensive, qualitative assessment of the merit, worth, and significance of Heifer's work (Heifer International).

The researchers at Western Michigan gathered information from project participants using a mixed methodology and looked at impacts through dimensions of sustainability and comprehensive conception of impact based on Heifer's Cornerstones Model (Heifer International). Like other previous evaluations performed by Heifer or its constituents, information was collected from beneficiaries using interviews, focus groups, home visits and

brief questionnaires ultimately culminating in a largely qualitative assessment. While researchers had hoped to perform a more quantitative analysis of the project impacts, they concluded that the 30 days they were allowed for evaluation did not permit enough time to perform a rigorous quantitative assessment (Scriven 2005). There were of course notable results, with the most promising impacts occurring in the Peruvian projects. For example, when looking at the cornerstone of "Sharing and Caring", cases were found where the community decided that they should pass on more animals than they received, a sign to the evaluation team of changing community values and "internalizing the spirit of giving to others and not just maximizing gains for oneself" (Scriven 2005). Another notable impact, in line with Heifer's "Gender and Family Focus", found cases in which the gender organization in the family was materially reversed as a result of the intervention. Other broad impacts included increased economic security, improved health due to lower smoke levels in house, more money for better diet, medication and healthcare, lowered anxiety about food and bettered water access, availability and use. Still, these outcomes are largely derived from the testimonials and perceptions of project participants versus more rigorous outcome measures like anthropometric status, biochemical assessment or data on the use of local healthcare resources.

The evaluators also recognized another central problem of their study, as well as many other studies on HI impact evaluations, which was the lack of baseline data available on project participants. This made it difficult, if not impossible, to track changes in the many different outcomes targeted and to control for baseline status of the families prior to participating in the project (Scriven 2005 and Njwe 2002). One of the direct benefits outlined in the report claimed impacts included, "Lives saved or substantially lengthened by reduction of severe hunger, thirst, toxins in the air or food" (Scriven 2005). While this is an

important change in perception by project participants, a well-controlled, longitudinal study is needed to show strong evidence of reduced morbidity and mortality in Heifer participants when compared to their non-Heifer counterparts. Moreover, the question of improved health and nutrition requires stronger outcome measures and more rigorous evaluation of dietary intake of animal source foods.

Finally, the Western Michigan researchers recommended, among other suggestions, that Heifer consider prioritizing the 12 Cornerstones that guide all of Heifer's work as, "priorities are crucial in the allocation of resources and in resolving conflicts between values" (Heifer International). Without Heifer prioritizing their desired outcomes, it made it difficult for Western Michigan to prioritize field data collection and little quantitative assessment was able to take place (Scriven 2005). Follow up studies to the 2005 report are now being done in an effort to look at outcomes in other project sites such as Albania, Nepal and Thailand (Chianca 2006).

D. Salvadoran Association for Rural Health

1. Overview

In El Salvador, Heifer International has worked in conjunction with a rural health non-governmental organization (NGO) known as Asociación Salvadoreña Pro-Salud Rural (ASAPROSAR) or Salvadoran Association for Rural Health. Dr. Vicky Guzman, founder of ASAPROSAR in 1970, gained a unique understanding of rural health problems after her experience as a physician in rural Mexico in the 1960s (ASAPROSAR). Through theories of self-empowerment, ASAPROSAR has grown to have several different health programs. Among their most robust is ASAPROSAR's Eye Care Program, which has a substantial commitment to improved eye care among rural populations through use of subsidized

services and mobile eye care units (ASAPROSAR). Other ASAPROSAR programs include the following: Rural Health and Education, which touts preventative health practices with education as a central tenet; the Rural Preschool Program, which targets children under the age of 6 for Head-Start style curriculum; the Barefoot Angels Program, which serves to help adolescent-aged children continue their education and delay entry into the workforce; the Microcredit Program, which is much the style of microcredit programs sponsored by the Grameen Bank in Bangladesh and encourages women to organize and participate in the local economy; and Sustainable Agriculture Program, which looks to reverse the trends of ecological degradation of El Salvador's countryside by teaching alternative farming strategies to local farmers (ASAPROSAR). Clearly, ASAPROSAR has many different programs throughout rural El Salvador and its work with Heifer International in the "Especies Menores", or "Small Species" Program, comprises a small section of the social development wing at this particular NGO often sharing human capital and transportation resources with the 'Sustainable Agriculture Program'.

2. Small Species Program

In an effort to curb malnutrition in rural El Salvador, over 260 families, in two provinces (Santa Ana and Ahuachapan) and 13 different communities, have become recipients of animals such as goats, hens and rabbits over the last three years while participating in the Small Species Program. At the start of the project in 2004-2005, ASAPROSAR had four full-time staff members oversee the project within the different communities. In hierarchical order, the positions were: Project director, who oversaw the several different social development projects; Program manager, who was in charge of both the Small Species Project and Sustainable Agriculture; An agricultural engineer dedicated

entirely to the Small Species Project; And a field coordinator who organized training meetings and held nutrition education classes in rural communities. Among these 4 positions, the agricultural engineer and field coordinator were the only full-time ASAPROSAR staff that worked on the project day-to-day and it should be noted that many of the program responsibilities have more overlap among the 3 staff members than their titles would otherwise suggest.

The Small Species Project worked closely with Heifer International to implement the project using Heifer's Cornerstones Model and has objectives and outcomes in line with these principles (ASAPROSAR). ASAPROSAR has structured the Small Species Project so that the majority of decision-making is done at the community-level with participatory practices in mind. When starting a project within a new community, ASAPROSAR starts by talking with local people and evaluating the community's interest in starting a project. People who do show interest are asked to attend several introductory meetings and once a group of participants is established (usually 8-12 families), they further organize into a "committee" comprising of positions such as president, vice president, treasurer, secretary and potentially one or two other positions depending on the total number of people participating. Those that wish to receive animals must complete animal husbandry training, have a suitable habitat built for the animals and show the ability to feed and care for the animal(s) once received. All of these requirements are in line with the model put forth by Heifer International (Heifer). While those at ASAPROSAR claim to target families specifically in "nutritional need", especially those with small children, it appears that recruitment has been defined by potential participant interest and evidence that the participants can adequately care for the animals. After participants have received animals, they are required to pass on offspring to another family in order to complete the project

requirements. If a participant elects to raise a goat, then she must pass along two female goats, but no more than 3 total goats, to complete the project. In regards to hens and rabbits, participants must pass 6 total offspring, with the gender ratio being approximately 5 females to 1 male. Once a participant has completed this portion of the project, they are free to independently make animal husbandry decisions as they see fit.

After 3 years of funding, the collaboration with Heifer has come to a close, as Heifer seeks to maintain its model of sustainability (Heifer International). With that loss of funding, ASAPROSAR could no longer afford to keep the agricultural engineer employed. Currently, the Small Species Project continues to help train new project participants in many communities, as animal offspring becomes available from current participants "passing on the gift". Funding for the continuing project is obtained from a portion of revenues dedicated to social development programs and independent donor donations.

E. Study Objectives

Broadly, this project seeks to add to the growing body of literature investigating the effect of animal food source interventions on child nutrition and growth in the developing world. It is designed to evaluate the effectiveness of the Small Species Project in improving child nutritional status via increased intake of animal food sources. It is hoped that research into the effectiveness of this intervention will help guide ASAPROSAR in its ability to better define goals and meet objectives, thus aiding ASAPROSAR staff in their decisions about how to manage and evaluate this particular project.

This study had one primary aim and three sub-aims:

1. Is participation in the Small Species Project (SSP) associated with improvements in anthropometric status among children under the age of five?

i. Are there differences in anthropometric status and impact of program during the Salvadoran rainy season (May – August)?

ii. Is there a "dose-response" relationship between SSP participation and child nutrition outcomes?

iii. Were improvements in anthropometric status among the children due to increased intakes of animal source foods (eggs, meat and milk)?

F. Study Methods

1. Study Design and Setting

This study was done in close cooperation with the non-governmental organization, ASAPROSAR (Asociación Salvadoreña Pro-Salud Rural). Prior to data collection, the primary researcher made two visits to ASAPROSAR in January and August 2006 to meet with program staff and multiple community committees of the Small Species Project. In an effort to explore the role of animal food source interventions on child malnutrition, the study involved participants in 7 different rural communities of the Santa Ana Province in El Salvador. In each community, an exhaustive sampling was undertaken, in an attempt to involve as many project participants as possible. The study was designed as a prospective, cross-sectional study, involving a questionnaire-based interview of the primary project participant, and nutritional evaluation of children in the household under the age of five. The animal food source intervention was started in 2004 and was completely independent of this study. This limited the data that could be collected, especially in regards to setting up pre- and post-groups. There was little or no baseline data available since the Small Species Project's inception several years ago. The questionnaire included household demographic questions and basic questions on the project progress. The nutritional evaluation of children

under the age of five consisted of anthropometric data collection at two points in time (6 months apart) and an estimated food record designed to estimate weekly consumption of common, rural Salvadoran foods.

2. Study Population

A total of 91 families and 112 children ultimately participated in the study. The only requirement for study inclusion is that study participants must have completed their induction into the Heifer Program, having either already received animals or waiting to receive an animal, and have at least one child between the ages of 6 and 60 months. At the time of first data collection, if the child was under the age of 60 months, they were included in the study and also measured during follow up even if they were beyond 5 years old. If a participating household did not have a child under the age of five, they were not invited to participate in the study. Among those that did participate, participants that had already received animals were deemed the "exposure group" and those that had not yet received animals were the "control group". Child subjects were excluded only on the basis of pre-existing medical conditions such as chronic asthma, history of seizure disorder, physical disability or if receiving treatment for parasitic illnesses such as Chagas' Disease. If a child was breastfed 'exclusively' at the time of study, they were also not included, as they were not yet consuming animal products. The lower end of the age criteria was set at 6 months as national data indicates that by 6 months, over 76% of Salvadoran children are already eating complimentary foods (UNICEF 2006). It should be noted that in one case, a child was 5.9 months old and permitted into the study as her mother indicated she was consuming complementary foods.

3. Survey Instruments

i. Household Level Survey

Data collection occurred over a six-month period between March and September 2007. Each caregiver (primary project participant) was administered a household data survey by members of the Salvadoran field team, which was comprised of community members. This survey asked basic socioeconomic questions as well as program-specific questions regarding each family's participation in the Heifer project. Basic socioeconomic questions are vital to proper analysis of anthropometric data in undernourished populations and included the following components, as recommended by the Food and Agricultural Organization of the United Nations: Mother's educational level; household monthly income; household size; toilet facilities; access to potable water; and whether or not the house has electricity (FAO 2006).

There were a few program-specific questions also asked as a part of the survey. These questions were done in order to get some sort of a baseline assessment of participant progress during their involvement in the project. ASAPROSAR has little baseline data on the project as a whole, mostly consisting of individual household information taken at the initiation of the project. However, the baseline data was so limited that, it was not useful for the purposes of this study. In regards to program-specific questions, first, survey respondents were asked how long they had been participating in the project. They were also asked animal-specific questions regarding the animal they chose first upon entering into the program, whether or not they had completed the project requirements, and what, if any, additional animals they had received since completing requirements. There were also further questions on animal details, such as asking how they used different animal products and whether or not they were presently selling animals or animal products.

ii. Collection of Anthropometric Data

Changes in anthropometric status were measured by conducting a series of anthropometric surveys in April 2007 and September 2007. In each survey the same methodology was used to measure height and weight. Two-person field teams carried out measurements. Standing height of children more than 2 years old and supine length of children less than 2 years old was measured, in accordance with 2006 WHO international growth charts. Height was measured using a portable stadiometer, the Seca Road Rod 214 Portable Stadiometer[1] and following standard methods (WHO 2006). Weight was measured using Tanita HS301 solar-powered[2], digital scales. Scales were deemed accurate by calibration with 1 lb. block before daily use. Each child was weighed once and then a second time, with only equal values sufficing for a recordable measurement. If these numbers differed then the weighings were repeated for each subject in order to ensure accuracy of the measurement.

Every caregiver was requested to provide its child's vaccination card, which contained the recorded birth date of each child. Prior measurement dates and weight data, originally filled out by local health promoters, was also recorded from the card. Unfortunately, there was no height data available on these vaccination cards as local health promoters use weight-for-age as the primary outcome for determining growth status. After collecting past data and recording present heights and weights, each caregiver was shown the appropriate growth chart for their child and was given an explanation of their child's current anthropometric status based upon that day's measurement.

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[1] http://www.stadiometer.com/214.html
[2] http://www.ekitchengadgets.com/tahssosc1.html

iii. Dietary Survey

Every caregiver was administered a weekly estimation of dietary intake for each child under the age of five. This survey was administered by one member of each two-person field team (see **Appendix** for survey example). The survey was designed in a checklist-type format with the caregiver asked to estimate the number of times in a day a particular food item was consumed as well as the estimated days per week of consumption. Each survey contained 29 different food items, which was assembled with the help of ASAPROSAR staff and from previous meetings with rural participants in January and August 2006. One member of the field team administered the survey, while the second member reviewed survey answers post-interview to check for accuracy and completeness. An example of this survey can be found in the appendix of this document.

4. CPHS Approval

Project Protocol and data collection materials, as well as changes to protocol, were approved by the University of California-Berkeley, Committee for the Protection of human Subjects under CPHS protocol number #2006-11-27. Project approval expired as of 03/15/2008.

5. Data Analysis

Anthropometric data was analyzed using 2006 WHO standard growth charts in STATA Version 9.0. For anthropometric measurements, the standard deviation scores (Z-scores) were calculated and the -2.0 standard deviation score was used as a cut-off point for determining under-nutrition. For both sexes, the Z-score values of weight-for-age (WAZ) that are used as indicators of underweight, height-for-age (HAZ) employed to evaluate

stunting, and weight-for-height (WHZ) which is used as a sign of wasting were also calculated so as to make comparisons across groups.

The dietary survey was also coded and entered for each child into STATA 9.0. For each food variable (explained in further detail below), the coding was performed as follows: Any food consumed less than 1 time per week equaled '0'; Foods consumed 1 to 2 times per week equaled '1'; Foods consumed 3 to 5 times per week equaled '2'; And foods consumed 6 or more times per week equaled '3'. This dietary data was taken on all children in the project and analysis was performed by comparing the estimated weekly intakes of animal source foods between those that had received animals (experimental group) and those that had not yet received animals (control group).

The linear regression analysis of the Small Species Project also included a few codes of interest. The 'Housing SES' variable includes many of the major determinants of socio-economic status that are recommended by the FAO to be collected in the setting of anthropometric data collection (FAO 2006). These determinants include the following: educational level of the mother; household income; toilet facilities; cooking fuel; access to potable water; and whether or not the house has electricity (FAO 2006). This variable was formed using principal component analysis (pca) in the Stata program.

The dietary portion of the regression also merits some explanation. There were five main categories created or "food groups". These groups were formed from a list of 28 different food items and included the 'meat group', 'dairy group', 'vegetable group', 'fruit group' and 'dietary staple group'. The meat group included goat meat, rabbit meat, chicken, steak, sheep, pig meat, and any type of fish. The dairy group included eggs, cheese, cream, goat milk, cow's milk and breast milk. The 'staple group' was made up of corn, rice, potatoes and whole beans. The vegetable group included edible flowers, tomatoes, native

squash, and two native plants called 'chipilin' (leafy legume) and 'ayote' (squash-like vegetable). The 'fruit group' included melon, watermelon, banana, 'zapote', mango, and oranges. All of these vegetables and fruits were identified as "commonly consumed", local food items during informal, participatory community group sessions during the preliminary research visit in August 2006. These food items were also identified by participants as the items most likely to be consumed during the Salvadoran 'rainy season' (April to mid-August).

G. Results

1. Results: Study Involvement

A total of 91 families and a total of 112 children under five participated in the study. The participants of the study were selected among all families that participate in the ASAPROSAR project within seven rural communities who have children 5 years old or younger. At the time of data collection, not all families had received animals and were waiting for another project participant to "pass on the gift". Consequently, of the 91 total families, 66 families were deemed part of the "experimental group", having already received animals, and 25 families were "controls" since they had not yet been given an animal. The children were also divided accordingly, with 82 children part of the "experimental group" and 30 children designated as "controls". A total of 3 children in the experimental group were excluded from the study due to a chronic disease or treatment for recent parasitism. Of the control children, 16 of the 30 children were lost to follow up measurements done in September 2007. Data was still collected for them during the April 2007 visit.

2. Results: Project Participant Characteristics

Among the 66 families participating in the Small Species Project, 100% of the principal project participants were women. All of the primary demographic statistics are shown in Table 1 below. The average age of small species project respondents was 31 years old with the control group almost equivalent. Almost 90% of the women had a grade-school level education or less between both the small species and control group. The size of the average project family was 5.6 members (Range 3-14 members per household).

Table 1- Demographic Characteristics of Study Participants

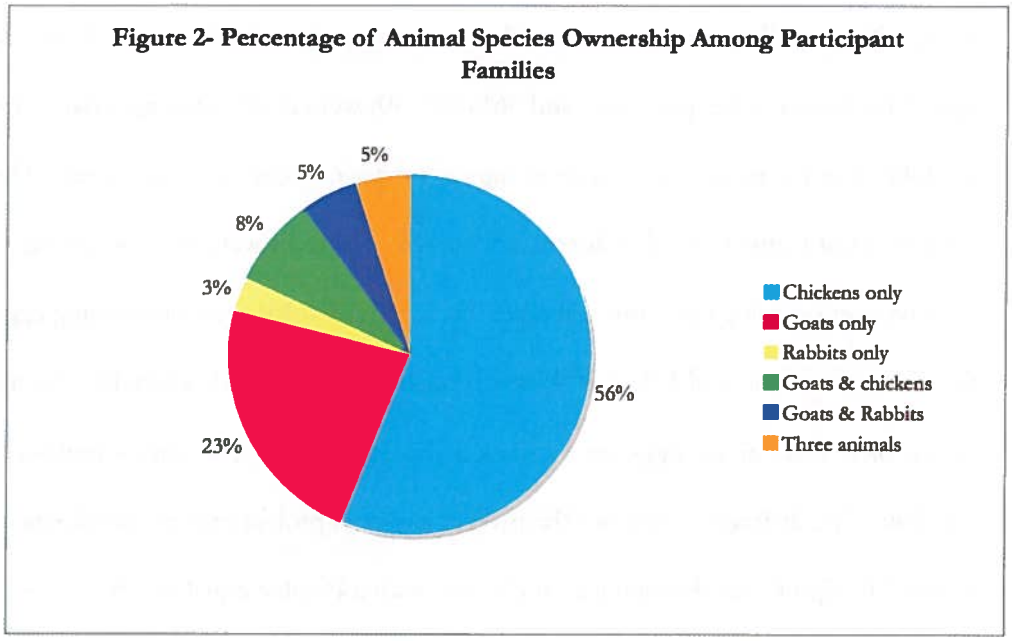
Selected Demographic Characteristics of Study Participants	Small Species Project Group (n=66 families)	Control Group (n=25 families)
Participant Age (Mean)	31 yrs. old	27 yrs. old
Participant Gender	100% Women (n=66)	100% Women (n=25)
Participant School Level A. No School B. Some Grade School C. Some High School or +	 15% (n=10) 74% (n=49) 11% (n=7)	 16% (n=4) 68% (n=17) 16% (n=4)
Avg. Child Age (in months)	37 mo. (n= 79)	28 mo. (n=30)
Gender Male Female	 54% (n=44) 46% (n=38)	 40% (n=12) 60% (n=18)
Avg. Family Size	5.6 members (n=66)	4.8 members (n=25)
# of children under five in household A. 1 child B. 2 children C. 3 children	 A. 70% (n= 46) B. 27% (n=18) C. 3% (n=2)	 A. 84% (n=21) B. 26% (n=4)
% of families with electricity	82% (n=54)	68% (n=17)
% of families with potable water	94% (n-62)	88% (n=22)
Principle Fuel Source A. Gas B. Wood	 A. 52% (n=34) B. 48% (n=32)	 56% (n=14) 44% (n=11)
% of Families who have Latrine	88% (n= 58)	64% (n=16)

The average number of children per family under the age of five was 1.5, with an absolute range of 1 to 3 children per family. The average age of children under five in the project as a whole was 37 months old with the range between 5.9 months and 60 months.

Among project participant households, 72% had a source of electricity, 94% had adequate access to potable water, 88% had adequate access to a latrine, and 52% of households used gas as their principle cooking fuel, as opposed to wood. Current statistics indicate that on a national level, 66% of rural Salvadoran households have electricity, 70% have access to potable water, and 39% had access to adequate sanitation (UNICEF 2006). There is no current, national data on the percentage of rural households that use gas as their primary cooking fuel.

The participant families were able to choose among 3 different animal species when participating in the project. They chose among goats, chickens or rabbits. When selecting their first animal, 64% (n= 42) of families chose chickens, 33% (n=22) chose goats and 3% (n=2) chose rabbits. Over the course of the project, families also had the opportunity to obtain additional animals, provided that they had completed the requirements of the original commitment to pass on offspring. At the time of data collection, 82% (n= 54) of families had one animal species, 14% (n=9) had two species and 5% (n= 3) had all three animal species. 56% of families (n= 37) had only chickens, 23% (n= 15) had only goats and 3% had only rabbits. Among the different possible combinations of animals, 8% of families (n= 5) had goats and chickens, 5% of families (n= 3) had goats and rabbits, and the remaining 5% (n=3) had all three animals presently. The aforementioned data is shown in Figure 2 below.

Figure 2- Percentage of Animal Species Ownership Among Participant Families



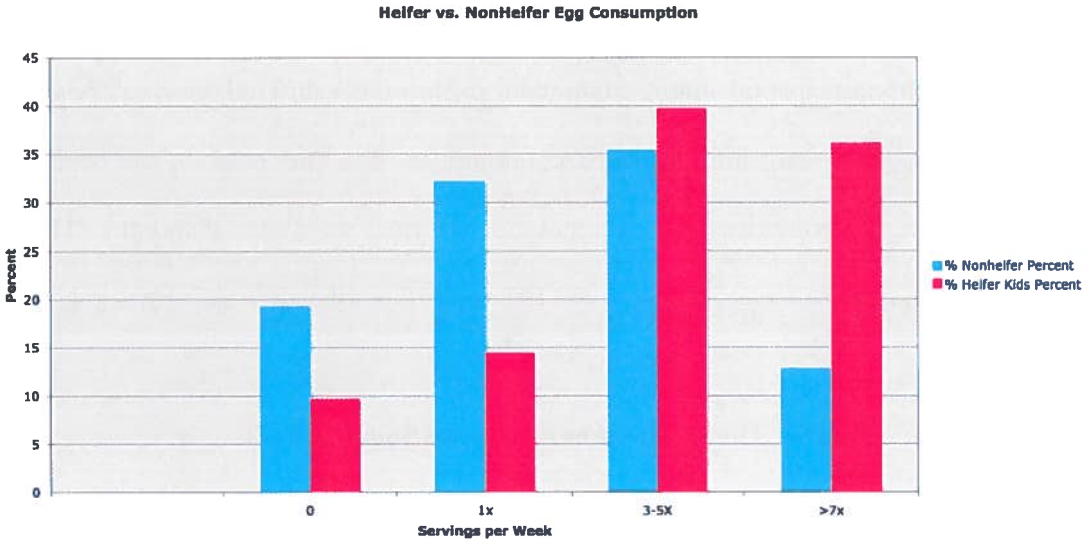
In regards to length of time spent by each family in the project, there were varying levels of participation among communities. Start times differed greatly among project participants, even within individual communities. The minimum amount of time anyone had been in the project was 6 months and the maximum was about 45 months. The average time in the small species project was 19.5 months among all project participants.

3. Results: Dietary Intakes of Animal Source Foods

Dietary data was collected from both the experimental group (n= 82) and control group (n= 30). Each of the main animal source foods (milk, eggs and chicken) was analyzed to see if there was increased weekly consumption of these products among project participant children versus their non-project counterparts.

Among the project participants, nearly 10% (n= 7) were not consuming any eggs per week, 15% (n= 12) were consuming at least one egg per week, 40% (n= 33) were consuming eggs three to five times per week, and 36% (n= 30) were consuming eggs daily. Over 75% of children in the project were consuming eggs three or more times per week. This is in stark contrast to the control children, 20% (n= 6) of whom were not consuming eggs at all, 32% were consuming eggs only once per week, 36% (n= 11) were consuming eggs three to five times per week, and 13% (n= 4) were consuming eggs nearly everyday. Nearly 70% of non-project children eat eggs once a week or less it appears. This data summarized in Figure 3 below. The difference between the project and non-project groups was deemed to be statistically significant through use of chi^2 test with a P-value equal to .05.

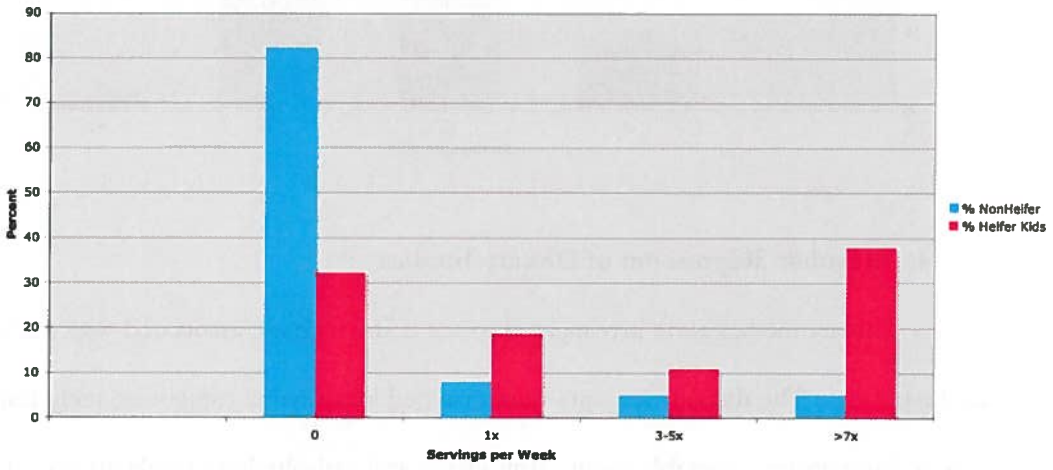
Figure 3- Heifer versus Non-Heifer Egg Consumption by Children Under Five



Among project participant children that, 32% (n= 26) of children were not consuming any milk per week, 19% (n= 16) of children were drinking milk at least one time per week, 11% (n= 9) of children were consuming milk at least three to five times per week,

and 38% (n= 31) of children were consuming milk nearly every day of the week. In summary, almost 50% of project children were consuming milk at least three times per week. Milk consumption, much like egg consumption, differed greatly between project and non-project children (see **Figure 4**). Among those children not participating in the project, 82% (n= 25) were not consuming any milk per week, 9% (n= 3) were consuming milk at least once per week, 3% (n= 1) of children were consuming milk three to five times per week, and 3% (n= 1) of children were consuming milk nearly every day. To summarize, over 90% of non-project children were consuming some form of milk once a week or less. The difference between the project group and non-project group was statistically significant through use of chi^2 test with a P-value equal to .05.

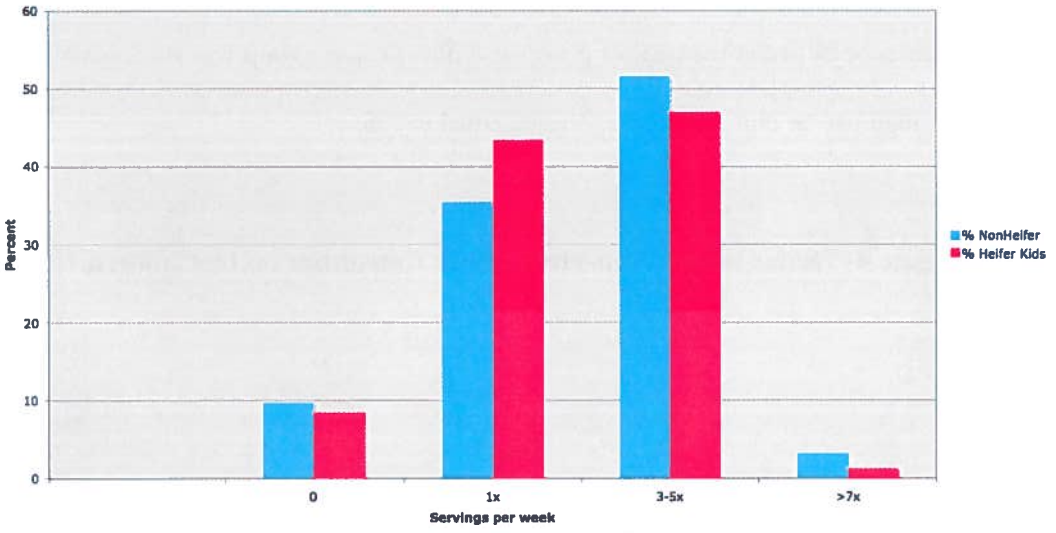
Figure 4- Heifer versus Non-Heifer Milk Consumption by Children Under 5



Among Small Species Project children, 8% (n= 6) were not consuming any chicken, 43% (n= 36) were consuming chicken at least one time per week, 47% (n= 39) were consuming chicken three to five times per week, and a mere 1% (n=1) were consuming

chicken on a daily basis. Among those children not in the project, almost 10% (n= 3) were not consuming any chicken, 35% (n= 11) were consuming chicken at least once per week, 52% (n= 16) were consuming chicken three to five times per week, and 3% (n= 1) were consuming chicken daily (see **Figure 5**). The difference between the project and non-project group was not statistically significant through use of chi^2 test with P=0.8.

Figure 5- Heifer versus Non-Heifer Chicken Consumption in Children Under Five



4. Results: Regression of Dietary Intakes

Dietary intakes were investigated to see if any increase associated with participation in the project. The dietary elements were grouped into several categories, including: meat group, dairy group, vegetable group, fruit group and carbohydrate staple groups. Further explanation of these groups may be found in the methods portion of this document. These regressions are included in WAZ, HAZ and WHZ regressions (**Tables 4, 5 and 6**) located in the appendix. When looking at these different groups, there was no association in any of the categories of increased intake and improved anthropometric status. In addition, regressions

were run for individual ASFs (eggs, chicken and milk) and no association is seen between increased intake of these individual foods and improved anthropometric status. After grouping all of the individual ASFs into one category, there was also no association seen between increased intake of all ASFs and improved anthropometric status.

5. Results: Anthropometrics

The prevalence of moderate (-2 SD or less) and severe (-3 SD or less) underweight (WAZ), stunting (HAZ) and wasting (WHZ) in children was equivalent to national means (see **Table 2** below). Underweight was present in 14% of children as compared to 10% of children under five nationally (UNICEF 2006). Wasting was moderate or severe in 5% of children, which is slightly higher than the national average of 1% (UNICEF 2006). Stunting was present in 20% of children under five, as compared with the 2006 national stunting prevalence of 19% (UNICEF 2006). WAZ, HAZ and WHZ values did not differ between boys and girls (P=0.44, P=0.74, P=0.36 respectively). Table 2 below summarizes the anthropometric results for children under 5 participating in the Small Species Project.

Table 2. Under-weight, stunted and wasted under-five year old children by age group (in months)

WAZ	<6m	6-9m	10-11m	12-15m	16-23m	24-35m	36-47m	48m +	Total
-1SD	(1) 100%	(4) 100%	0	(4) 66.7%	(5) 71.4%	(15) 93.8%	(19) 82.6%	(20) 95.2%	(68) 86%
-2SD	0	0	(1) 100%	(2) 33.3%	(2) 28.6%	(1) 6.2%	(4) 17.4%	(1) 4.8%	(11) 14%
-3SD	0	0	0	0	0	0	0	0	0
Total	(1) 100	(4) 100	(1) 100	(6) 100	(7) 100	(16) 100	(23) 100	(21) 100	(79) 100

HAZ	<6m	6-9m	10-11m	12-15m	16-23m	24-35m	36-47m	48m +	Total
-1SD	(1) 100%	(4) 100%	0	(4) 66.7%	(5) 71.4%	(15) 93.8%	(19) 82.6%	(15) 71.4%	(63) 79.8%
-2SD	0	0	(1) 100%	0	(2) 28.6%	0	(4) 17.4%	(6) 28.6%	(13) 16.4%
-3SD	0	0	0	(2) 33.3%	0	(1) 6.2%	0	0	(3) 3.8%
Total	(1) 100	(4) 100	(1) 100	(6) 100	(7) 100	(16) 100	(23) 100	(21) 100	(79) 100

WHZ	<6m	6-9m	10-11m	12-15m	16-23m	24-35m	36-47m	48m +	Total
-1SD	(1) 100%	(4) 100%	(1) 100%	(5) 83.3%	(5) 71.4%	(16) 100	(22) 95.7%	(21) 100%	(75) 95.0%
-2SD	0	0	0	(1) 16.7%	(2) 28.6%	0	(1) 4.3%	0	(4) 5.0%
-3SD	0	0	0	0	0	0	0	0	0
Total	(1) 100	(4) 100	(1) 100	(6) 100	(7) 100	(16) 100	(23) 100	(21) 100%	(79) 100

6. Results: Anthropometric Regression

Participation (Heifer) in the Small Species Project was associated with a 0.48 (95% CI 0.20-0.76, p<.001) increase in Z-score for WAZ and a 0.60 (95% CI 0.26-0.93, p<.001) increase in Z-score for HAZ (see **Tables 4 and 6**). There was no program participation effect on wasting. Results for weight-for-age (0.51) (95% CI 0.27-0.75, p=.01) and height-for-age (0.57) (95% CI 0.27-0.89, p=.01) scores remained significant when controlling for weight and height at baseline. Baseline height had a significant negative association with the project effect (-0.23, 95% CI -0.37-0.12, p=.01).

When looking at the effect of the project, several other factors were included in the model: age of child (in months); sex of child; housing SES variable (explanation in methods

section); family size; number of children under five in the home; and time in the program. The effect of project participation for both HAZ and WAZ was significant throughout (please see **Tables 4, 5 and 6** in Appendix) with HAZ effect at 0.53 (95% CI 0.21-0.86 $p<.01$) and WAZ effect of 0.52 (95% CI 0.26-0.78, $p<.01$). "Time in project" was not shown to have an association with an increased WAZ, HAZ, WHZ, as children spent more time in the project.

H. Discussion

1. Discussion: Anthropometric Questions

The principal aim of this study, as outlined in 'Study Objectives', was to determine if children under the age of five benefited anthropometrically from participation in the Small Species Project. Based on the results of the anthropometric regressions, it was seen that those children participating in the project had increased Z-scores for both weight-for-age and height-for-age. While the weight-for-age improvement is important in determining whether or not a child is underweight, it is confounded by the fact that height is not included in the indicator. Thus, while participation in the project was associated with a 0.53 increase in Z-score, it impossible to know whether this gain in status was due to weight gain or linear growth of the child. It is entirely plausible that a stunted child may not experience any "catch-up growth" and that this increase in Z-score only reflects a gain in soft tissue growth.

However, when we look at height-for-age Z-score improvement, it was seen that participation in the project was associated with a 0.53 increase in Z-score. Because stunting is the most important nutritional problem in Central America (prevalence of 19% in children under five in El Salvador), projects such as this one have important implications for helping decrease stunting among children at risk. There also seems to be a limited window for

catch-up growth in stunted children (Branca, Ferrari 2002), and these results hold some promise that catch-up growth can be attainable with increased consumption of animal source foods.

There is another important implication from the association of participating in the project and increased HAZ in children. When adjusting for baseline HAZ in the regression analysis, it was seen that there was a negative association with baseline status and project participation. Does this mean that the project was less effective after adjusting for the baseline? Not necessarily. Rather, what this actually indicates is that those children who were worse off initially, or "more severely stunted", were the ones that were likely to benefit most from participation in the project. As a child's HAZ baseline was higher (better off), that child is less likely to experience an anthropometric benefit from participating in the project. Although it would be ideal to have all children show benefit from participating in the project, this result is important because it indicates that those children who are in greatest need of the project are likely to benefit from the project's implementation. As stunting becomes more severe, it may cause worse short-term and long-term consequences for an individual (Black 2008 and Bhutta 2008). Consequently, it remains crucial to target those that are most in need, so as to minimize the adverse consequences of moderate and severe stunting now and in the future.

One of the sub-aims of the study was to see if children showed improved anthropometric status during the Salvadoran rainy season (May-August). For seasonal fluctuations of malnutrition in which crops are planted and not yet harvested, with concomitant scarcity of employment, the rainy season in El Salvador may be one of acute famine for rural populations (Trowbridge 1979). This type of malnutrition usually presents as wasting or low weight-for-height (FAO 2004). The results from this study indicate that

there was a slight increase in WHZ associated with project participation, but as the results were not statistically significant, one cannot conclude that the children showed conclusive anthropometric improvement during this time period. Because there was a positive association seen in an increase in both WAZ and HAZ among project-children during this time period, one cannot completely disprove the idea that participants may have experienced a protective effect due to increased animal source foods (ASFs). Moreover, previous studies (Stetler, et al. 1981) have shown that there are additional risks to a child's health when acute wasting occurs in the setting of an already stunted population. Among other consequences, it has been found that children with low weight-for-height, especially when combined with low height-for-age, have a significantly increased risk of a recent episode of diarrhea (Stetler, et al. 1981).

Another sub-aim of the study was to determine if children showed better nutritional status with more time spent in the project. Unfortunately, there is limited evidence for this effect. When including "time spent in program" in the regression analysis, there was no association with improved anthropometric status and "program time". There was also the option of looking at just one anthropometric data point and the amount of time spent in the program, but the study sample size is too small too detect a difference. There may very well be an association between anthropometric status and program time, but this study was unable to adequately answer this particular question. As of now, the benefits from the project seem to derive from some other factor or a combination of factors.

2. Discussion: Dietary Questions

The last sub-aim of this study was to determine if children showed increased intakes of ASFs (eggs, meat and milk) as compared to controls. As has been stated before, there is

evidence for the rural Salvadoran diet lacking diversity, with carbohydrates existing as the principal source of calories (FAO 2002). The basic Salvadorian diet consists of three staples: corn tortillas, rice and whole beans. In addition, of the total dietary protein consumed, 74% is estimated to be of vegetable origin (FAO 2002). This reflects a diet that is inadequate in essential amino acids and specific micronutrients like iron, which is known to have greater bioavailability in animal source foods (James and Schofield 1990).

When we first examine the consumption of chicken only, there seems to be little difference between the children in the project and those controls yet to receive animals. In both groups, a majority of children was eating chicken at least once a week, and for others, as much as three to five times per week. These results could have been found for several reasons. For one, chicken is one of the most popular sources of animal protein in rural El Salvador (FAO 2002) because it is relatively inexpensive and animal husbandry is relatively straightforward. This might explain why many project-children and control-children both showed evidence of moderate intakes (3-5 times per week). As for the high percentage of project-children eating chicken only one time per week, this may be a function of animal husbandry as well. The opportunity to eat chicken presupposes that there are mature hens available for slaughter. If it were the family's desire to receive chickens and instead focus on nutrition via egg consumption, then it would make sense that not all children in the program may see increased intakes of chicken. In the regression analysis, overall meat consumption did not appear to have an independent association with improved anthropometric status. The same regression was done for "chicken only" and there was not a positive association observed in either case. Further study is needed in order to show increased chicken consumption.

When looking at egg consumption, results show that over 75% of children in the project were consuming three or more eggs per week with almost half of these same children consuming eggs daily. These data differed greatly from non-project children, 70% of whom were eating one egg or less per week. As this data was statistically significant, this is so far the best evidence for increased consumption of ASFs among those participating in the project. Eggs are an excellent source of protein with 12.1 grams per serving and Vitamin A (see **Table 3**). Depending on egg production in individual households, eggs have the potential to be among the primary ASFs consumed in these types of projects. It stands to reason that this egg production is a more sustainable form of having consistent access to ASFs than would be slaughtering chickens for consumption. In addition, hens do not require a large amount of feed in order to produce eggs and are among the most efficient non-ruminant animals at converting plant calories into animal source protein. While heifers require a large amount of plant calories to produce milk, hens require much fewer inputs in order to produce eggs (Leathers, Foster 2004). This is a distinct advantage for hens, especially in resource poor areas like rural El Salvador.

Finally, when analyzing total milk consumption between project- and non-project participating children, it was found that 50% of participating children were consuming milk at least three times per week. Three-fourths of those children claimed to be consuming milk nearly every day of the week. Both goat milk and cow milk are good sources of vitamin A, calcium and balanced in fat and protein (see **Table 3**). The vast majority of children not in the program were drinking milk one time or less per week, with many responding that their children were not drinking milk at all. Akin to egg consumption, this shows that participation in the project lends to increased consumption of ASFs. In this case, goat milk.

In some ways, goat milk may be considered superior to cow milk. Although the nutrient content of goat milk is slightly less than cow milk, goat milk is more digestible because the fat molecules are one-fifth the size of those from cow milk -- making it easily tolerated by those with compromised digestive systems (Haenlein 2003). In this same vein, although goat milk contains less total vitamin A than cow milk, the vitamin A in goat's milk contains a large proportion of pre-formed vitamin A in the milk fat, making it readily available for the human body (Haenlein 2003). Finally, goat milk is not known to cause lactose allergy like cow milk and it actually contains a very little lactose (Haenlein 2003). Thusly, unlike cow milk, goat milk is considered safe to feed very young children with still-developing digestive systems.

3. Discussion: Strengths and Limitations

i. Strengths

One of the principle strengths of this study is that it is the first one to look at the effectiveness of a Heifer International project via anthropometric analysis. Heifer International, since its founding some 60 years ago, has never assessed a single one of its projects by looking at anthropometric outcomes for either children or adults. Anthropometry is an excellent outcome indicator for nutrition because it looks at nutritional status not by food intake, but instead by the final outcome (weight gain or growth) from said intake. To date, research on Heifers' projects has focused on project participant testimonials and perceptions instead of more rigorous outcome measures like anthropometric status or biochemical assessment.

In the spirit of Heifer International's participatory model, every effort was made to make the research culturally sensitive and accessible to study participants. The primary

researcher made two preliminary trips to Santa Ana, El Salvador prior to any data collection. The first trip was in order to establish relationships with staff at ASAPROSAR, tour the different ASAPROSAR programs and talk with ASAPROSAR staff about interest in collaborating on a research project. The second trip was made in order to make connections with various communities involved in the Small Species Program. Participatory focus groups were held in various communities in order to get a better sense of community priorities and the types of research in which they would be willing to participate. During these groups we also discussed local food items, which aided in the building of the estimated food record checklist.

In this same spirit of participation, the anthropometric data collection was designed to make raw data more accessible to study participants. Although not included in many anthropometric field assessments, growth charts were attached to each child's anthropometric record. This allowed anthropometric data to be collected and instant feedback given to every caregiver on their child's anthropometric status. One of the priorities of this research was to give information and education at the same time it was being collected. In this way, it can be seen as a success. In addition, it was also perceived that the data collection team, derived from local community members, found data collection to be a more tolerable (sometimes enjoyable) experience when given the opportunity to educate people in their own community.

ii. Limitations

In an impact study like this, there are two major design problems to be faced. First, there is the problem of establishing causation, since "impact" means an effect caused by the program under study. In any impact study, it is usually argued that the ideal method for

doing this would be to use a full experimental design with random allocation of "subjects" to the experimental and control groups. However, we are examining a community project that have been in existence for some time and hence cannot be allocated to a no-treatment condition, even if there were not ethical and economic reasons that make such an approach unfeasible. That means that the most powerful ideal method for establishing causation (that is, establishing the effects of the animal intervention) is excluded. However, it is not the only method for establishing causation; and it proved possible, with due care, to use alternative methods.

Secondly, this study also had a limited sample size and very small control group. While there was a positive effect on growth in children associated with participation in the project, this may have been partly due to the small size of the study in general. Previous research has shown that larger anthropometric studies of agricultural interventions has shown mixed results, in part due to a decreased overall effect on growth when sample sizes are much larger (Berti 2004).

There were some problems with the use of an estimated food record. In this study, we asked the primary caregiver to estimate the weekly intake of a given food item. The FAO (2004) recommends that an estimated food record be taken for three to five days as opposed to an entire week, mainly because it can be difficult for respondents to accurately estimate food intake for an entire week. Regardless, the decision was made to have respondents estimate for an entire week so as to account for any meals that might occur outside the scope of a standard 3 to 5 day period. Prior to implementation of the field instrument, community focus groups indicated that one day per week, families ate certain items on Saturdays and Sundays that may not be consumed regularly during the week (Monday-Friday). Some examples include central food items analyzed in this study, such as chicken,

as well as rarer items like fish. Because we hoped to capture as much of the diversity as possible in peoples food consumption, the decision was made to look at an entire seven-day period. In addition, this type of estimated food record was ill-designed to capture larger questions like overall food diversity. For instance, the principle researcher failed to include certain "high-sugar items" like sodas, candy and other similar items often purchased from local convenient stores. In research done by Dr. Sokal-Gutierrez on the prevalence of dental caries among children in rural El Salvador, there is some indication that these high-sugar, poor-nutrition items have a foothold in the diet of rural Salvadoran children. A better-designed food record should include such items, as well as a greater diversity of everyday foods, so as to draw conclusions on overall dietary diversity among rural populations. This would enable future research to determine if participation in similar nutrition projects increases dietary diversity in project participants.

Finally, this research was intended to capture an element of infectious disease as a part of the anthropometric assessment of children. Because the field collection team was made up of community members and not healthcare professionals, a proper assessment for a recent diarrhea episode or upper respiratory infection was not feasible. This aspect would have given the research an additional dimension to explore; one that sits at the center of the malnutrition issue. Instead, this section was primarily used for inclusion/exclusion criteria of chronic diseases and recent treatment for parasitism.

4. Discussion: Generalizability

Another limitation of this study is that it is not generalizable. Agricultural interventions vary a great deal from country to country and within a country; project to project (Berti 2004). Thusly, it makes it very difficult to state for certain that these results

could hold in another setting, in other circumstances. Even though this was a study on a Heifer International Project, Heifer acknowledges that projects vary greatly from site to site, as the projects are ultimately carried out by local organizations (Heifer International).

Due to the fact that the study was designed to evaluate the nutritional status of children under five, families were recruited into the study based on the criteria of actually having a child under-five years of age. Consequently, this sample is not representative of the project as a whole and as such, cannot make conclusions about broader project benefits and goals. Such goals might involve economic benefits, improved animal husbandry techniques, or use of alternative agriculture methods.

I. Conclusions

In summary, this study finds that participation in the Small Species Project is positively associated with WAZ and HAZ anthropometric outcomes, namely for more severely underweight and stunted children. As the greatest benefit exists for those children most in need, this affirms that the Small Species Project has served to improve the nutrition of rural Salvadoran children under the age of five. In addition to anthropometric indicators, there was also an increased consumption of animal food source products such as goat milk and hen eggs. There was little evidence for the effect of program time on improved anthropometric status and further study is needed to determine the benefits of participating in the project for a longer period of time. There is a lot that can occur over the course of an animal husbandry project such as this one and with uncertainty looming around each corner, it is tough to make any conclusions about the effect of time in the program without having adequate baseline data or the ability to follow subjects over a longer period than this study permitted. There were many reports of animal deaths over the course of the project,

especially in regards to spontaneous abortions of goats, but this was an aspect that was difficult to capture in this study.

Community projects like this one have additional benefits than simply improved nutrition. Every project participant interviewed as a part of this study was a woman and mother or grandmother of the children studied. While results like these are promising and seem in line with Heifer International's goal of empowering women, one would have to do an exhaustive study of all the Small Species Project participants to definitively state that women are becoming more empowered. The same holds true when attempting to analyze such aspects as program attrition rate, animal production and economic benefits. Since the focus of this study was child nutrition, it is not possible to state how successful this particular project has been overall. The only real statement that can be made about the success of the program is that these children who are currently participating have shown both increased intakes of ASFs and improved anthropometric status. A larger, more in-depth study is needed to look at other aspects of the Small Species Project.

Moving forward, ASAPROSAR will have to weigh the advantages and disadvantages of continuing to target populations that are of greatest need. While it is important to target those families with the greatest need of such a project, it is also vital that the family is prepared to succeed in the project as well. Project participation does not presuppose success and this particular study was not designed with the intention of evaluating the different ways projects have succeed or failed within different communities.

APPENDIX

Table 3- Approximate Nutrient Composition of Animal Source Foods per 100g

Food	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron	Zinc	Vit. A (RE)	Vit B12 (µg)
Cow's Milk Goat's Milk	72 69	3.3 2.9	4.0 3.0	76 90	0.04 0.04	0.31 0.22	28 46	0.29 0.05
Beef	263	18.5	20	7	3.2	6.0	0	2.4
Chicken	161	31.0	6.0	13	1.3	1.8	42	0.23
Goat	269	13.4	3.4	17	3.7	0	0	1.2
Rabbit	173	30.4	8.4	20	2.4	2.4	0	6.5
Fish	85	17.0	5.6	37	8.4	0.6	14	0.6
Eggs	150	12.1	10	50	1.54	1.1	192	1.0
Corn (Maize)	207	5.9	3.1	47	2.9	0.33	0	0
Beans	127	9.0	0	35	2.0	0.3	2	0
Soy	403	34.1	17.1	0	0	0	0	0
Rice	130	2.7	0.3	10	0	0	0	0

*Sources (Pennington 1998) (Calorie King Food Database)

TABLE 4- HEIGHT-FOR-AGE Z-scores

Models	Unadj.	Adj. for Baseline Height	Adj. for Age	Adj. for Sex	Adj. for housing SES	Adj. for family size	Adj. for kids <5 in home
Heifer	0.60** (0.26-0.93)	0.57** (0.27-0.89)	0.54** (0.23-0.85)	0.54** (0.23-0.85)	0.53** (0.21-0.84)	0.52** (0.20-0.85)	0.53** (0.21-0.86)
Haz1		-0.23** -(0.37-0.12)	-0.20** -(0.32-.096)	-0.21 -(0.33-0.10)	-0.22 -(0.35-0.11)	-0.23 -(0.34-0.11)	-0.23 -(0.35-0.11)
Age			.004 (-.003-0.01)	.003 (-.003-0.01)	.004 (-0.003-0.01)	.004 (-0.003-0.01)	.004 (-0.003-0.01)
Sex				-.194 (-0.41-0.02)	-0.20 (-0.42-0.02)	-0.20 (-0.42-0.02)	-0.20 (-0.42-0.02)
SES					0.03 (-0.07-0.13)	0.03 (-0.07-0.13)	0.02 (-0.03-0.07)
Family size						0.002 (-0.04-0.04)	0.02 (-0.04-0.04)
Children Under 5							-0.15 (-0.37-0.08)
Food Frequency	**Dairy**	**Meat**	**Vegetables**	**Fruits**	**Carbs**		
Heifer	0.04 (-.001-0.1)						
Heifer		0.05 (-0.03-0.14)					
Heifer			-0.01 (-0.05-0.03)				
Heifer				-0.03 (-0.06-0.01)			
Heifer					-0.05 (-0.14- 0.04)		
KEY Value=β coef. (95% CI)	* p<.05 significant difference ** p<.01 significant difference						

TABLE 5- WEIGHT-FOR-HEIGHT Z-scores

Models	Unadj.	Adj. for Baseline Wt-for-Ht	Adj. for Age	Adj. for Sex	Adj. for housing SES	Adj. for family size	Adj. for kids <5 in home
Heifer	0.14 (-0.24-0.52)	0.21 (-0.12-0.55)	0.32 (-0.01- 0.64)	0.31 (-0.02-0.64)	0.31 (-0.02-0.64)	0.26 (-0.08-0.61)	0.27 (-0.08-0.61)
Baseline Wt-for-Ht		-0.28** -(0.39-0.17)	-0.28** -(0.39-0.17)	-0.21** -(0.38-0.17)	-0.28** -(0.38-0.17)	-0.26** -(0.37-0.15)	-0.26** -(0.37-0.15)
Age			-0.01** -(0.02-0.004)	-0.01** -(0.02-0.004)	-0.01** -(0.02-0.004)	-0.01** -(0.02-0.004)	-0.01** -(0.02-0.004)
Sex				0.13 (-0.09-0.36)	0.13 (-0.09-0.36)	0.13 (-0.09-0.36)	0.13 (-0.09-0.36)
SES					0.005 (-0.1-0.11)	0.01 (-0.09-0.12)	0.01 (-0.02-0.09)
Family size						0.02 (-0.02-0.07)	0.03 (-0.02-0.09)
Children Under 5							-0.07 (-0.31-0.16)
Food Frequency	**Dairy**	**Meat**	**Vegetables**	**Fruits**	**Carbs**		
Heifer	0.02 (-.04-0.8)						
Heifer		-0.02 (-0.11-0.07)					
Heifer			0.01 (-0.03-0.05)				
Heifer				-0.05** -(0.09-0.01)			
Heifer					0.07 (-0.02- 0.17)		
KEY Value= β coef. (95% CI)	* p<.05 significant difference ** p<.01 significant difference						

TABLE 6- WEIGHT-FOR-AGE Z-scores

Models	Unadj.	Adj. for Baseline Wt-for-Ht	Adj. for Age	Adj. for Sex	Adj. for housing SES	Adj. for family size	Adj. for kids <5 in home
Heifer	0.48** (0.20-0.76)	0.51** (0.27-0.75)	0.50** (0.25- 0.75)	0.50** (0.25- 0.75)	0.48** (0.23-0.74)	0.52** (0.26-0.78)	0.52** (0.26-0.78)
Baseline Wt-for-Ht		-0.23** -(0.32-0.15)	-0.23** -(0.32-0.15)	-0.23** -(0.32-0.15)	-0.23** -(0.32-0.15)	-0.24** -(0.33-0.15)	-0.24** -(0.33-0.15)
Age			<0.001	<0.001	<0.001	<0.001	<0.001
Sex				<-0.001	<-0.001	<-0.001	<-0.001
SES					0.03 (-0.05-0.11)	0.03 (-0.05-0.11)	0.03 (-0.05-0.11)
Family size						-0.02 (-0.05-0.1)	-0.02 (-0.06-0.03)
Children Under 5							-0.04 (-0.22-0.14)
Food Frequency	**Dairy**	**Meat**	**Vegetables**	**Fruits**	**Carbs**		
Heifer	0.03 (-.01-0.08)						
Heifer		0.03 (-0.5-0.09)					
Heifer			0.01 (-0.02-0.04)				
Heifer				-0.04** -(0.07-0.01)			
Heifer					0.02 (-0.06- 0.10)		
KEY Value=β coef. (95% CI)	* p<.05 significant difference ** p<.01 significant difference						

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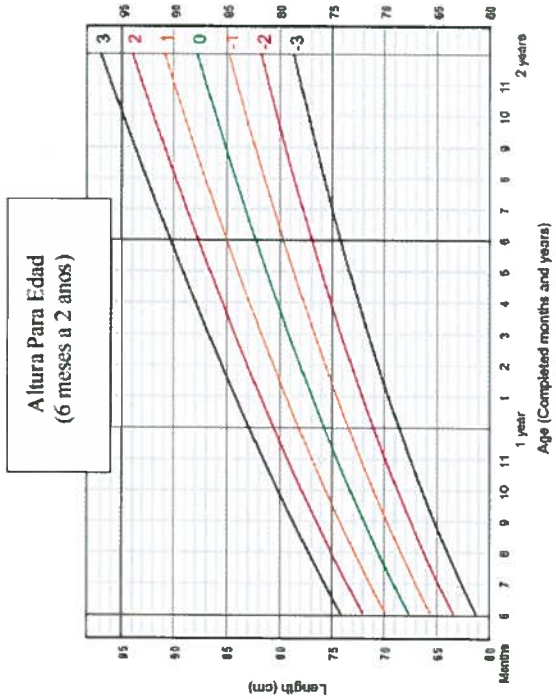
CONTROL DE NINOS Y SU ALIMENTACION **(Este pertenece a ASAPROSAR)**

Nombre: Codigo-	Sexo H/M	Fecha de Hoy	Cabeza (cm) (<24m)	Estatura (cm)	Peso (kg)	Enfermadades? (< 4semanas) Resp?	Diarren?	Otro?
F de N: (dd/mm/aaaa) / /								
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Informacion del control de vacunacion		**Fecha de visita**						
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Edad: (meses)								
Edad								
Edad								

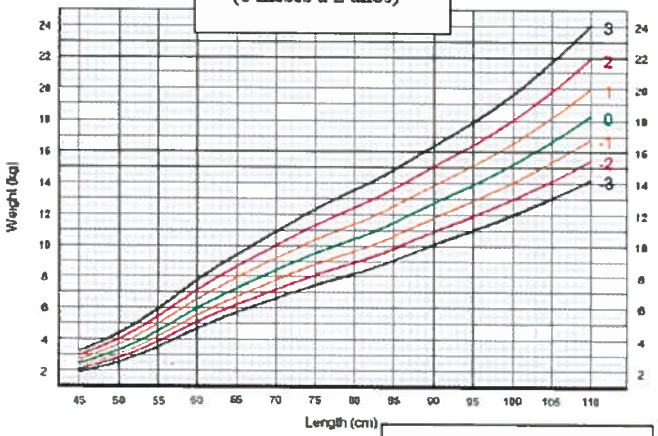
NUTRICION Animal/producto De mimal	Frecuencia de Consumo En la Ultima Semana, cuantos dias comio (tomo) su hijo el siguiente? 0	1	2-4	5-6	7	Cuantas veces al dia comio (tomo)?
Carne de Cabra						1 2-3 4-5 6
Carne de conejo						1 2-3 4-5 6
Pollo						1 2-3 4-5 6
Carne de res						1 2-3 4-5 6
Oveja						1 2-3 4-5 6
Puerco						1 2-3 4-5 6
Pescado						1 2-3 4-5 6
Frijoles						1 2-3 4-5 6
Chipilin						1 2-3 4-5 6
Moras						1 2-3 4-5 6
Lorocos						1 2-3 4-5 6
Arroz						1 2-3 4-5 6
Tomate						1 2-3 4-5 6
Berro						1 2-3 4-5 6
Ayote						1 2-3 4-5 6
Guisquil						1 2-3 4-5 6
Maiz						1 2-3 4-5 6
Papas						1 2-3 4-5 6
Huevo (s)						1 2-3 4-5 6
Queso/crema						1 2-3 4-5 6
Leche de Cabra						1 2-3 4-5 6
Leche de Vaca						1 2-3 4-5 6
Leche del Pecho						1 2-3 4-5 6
Melon						
Sandia						
Banana						1 2-3 4-5 6
Sapote						1 2-3 4-5 6
Mango						1 2-3 4-5 6
Naranja						1 2-3 4-5 6
Otras Frutas						1 2-3 4-5 6
Otras Verduras						1 2-3 4-5 6

PARA NINOS 6 meses a 2 anos

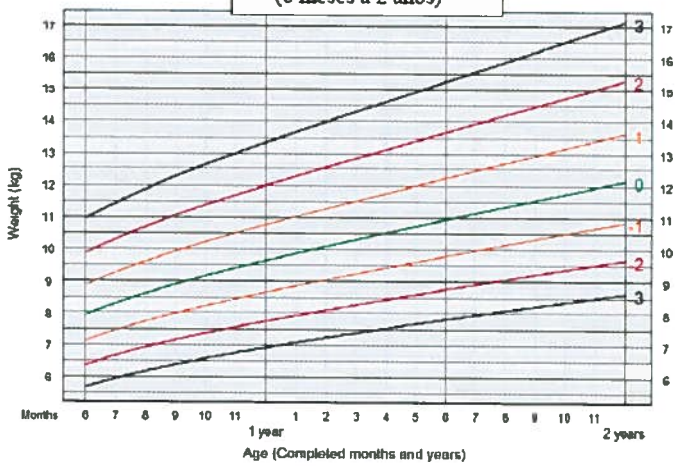
Altura Para Edad
(6 meses a 2 anos)



Peso Para Altura
(6 meses a 2 anos)

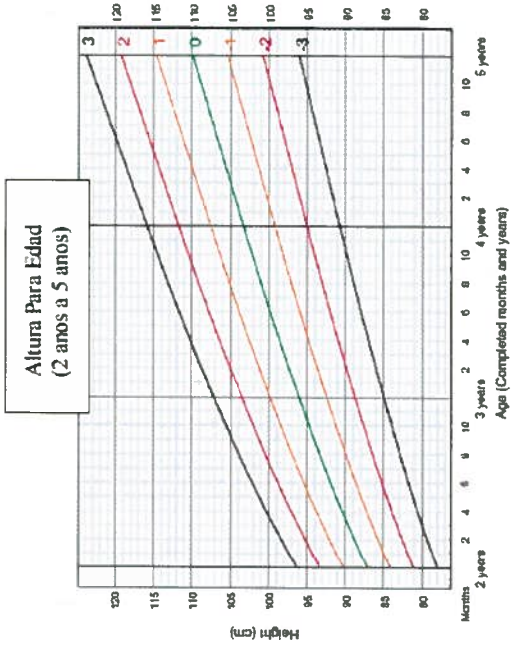


Peso Para Edad
(6 meses a 2 anos)

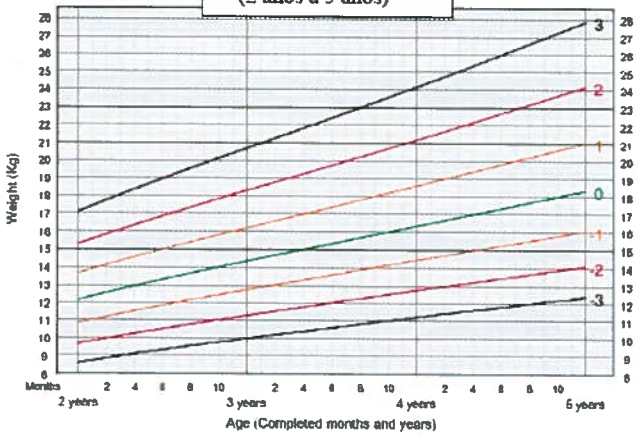


PARA NINOS 2 anos a 5 anos

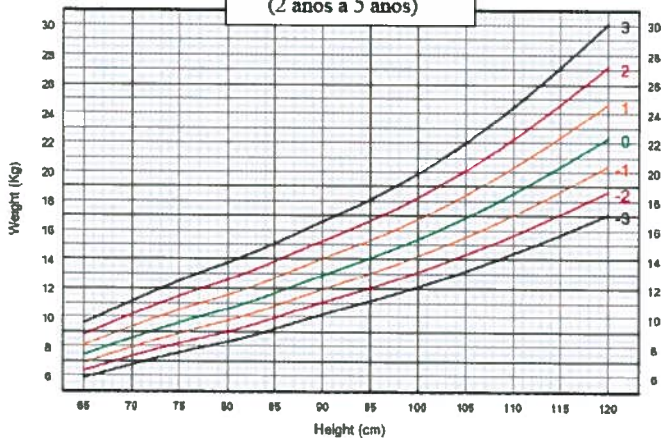
Altura Para Edad
(2 anos a 5 anos)



Peso Para Edad
(2 anos a 5 anos)

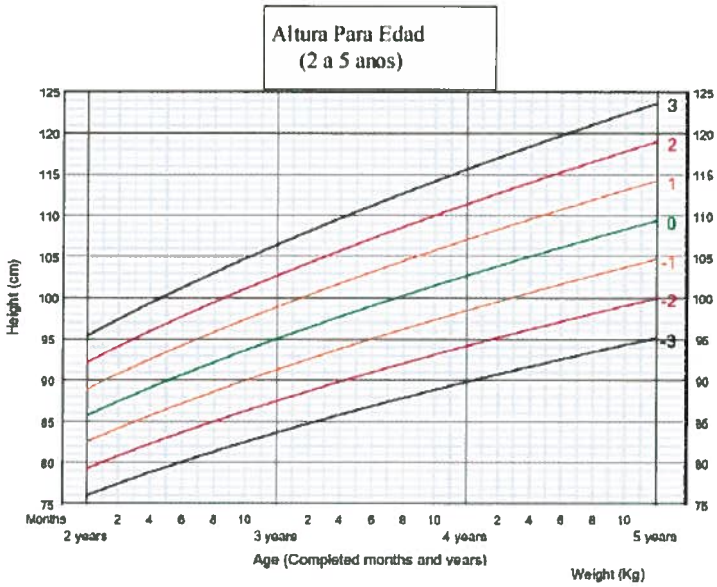


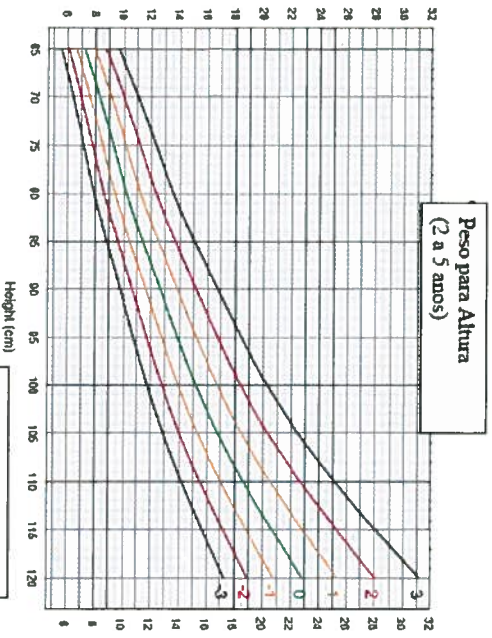
Peso Para Altura
(2 anos a 5 anos)

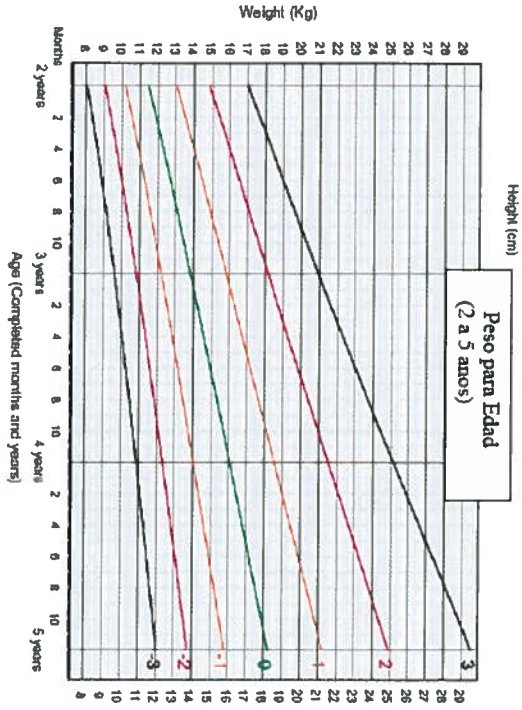


PI6

PARA NINAS 2 a 5 anos

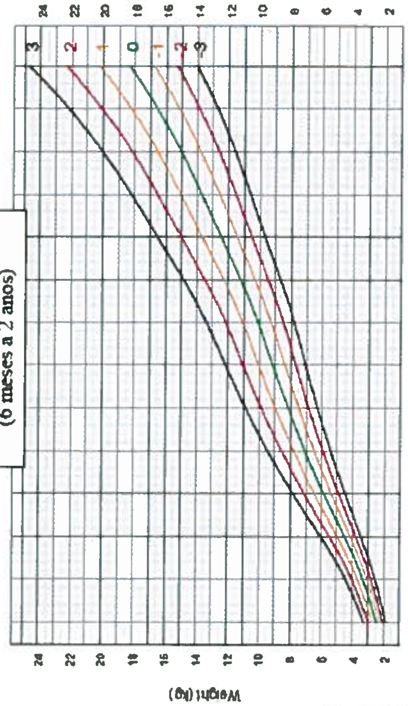




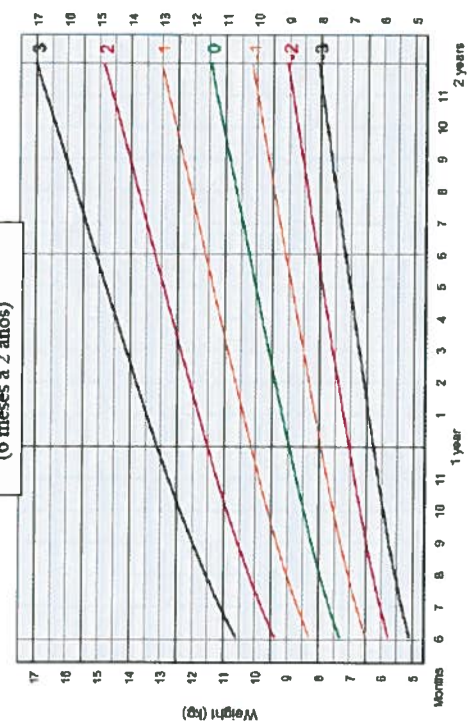


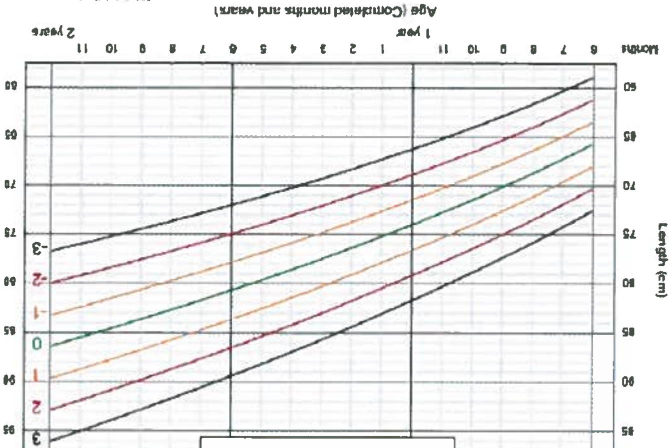
PARA NINAS 6 meses a 2 anos

Peso Para Altura
(6 meses a 2 anos)



Peso Para Edad
(6 meses a 2 anos)





Altura Para Edad
(6 mese a 2 anos)

Fecha: / / (dd/mm/aaaa) Nombre de Madre/Padre:
Comunidad: Promotora:

Primero, tengo algunas preguntas basicas acerca de Ud. y su familia: (Llene el espacio con la informacion o marque con 'X')

1.1 Su edad:

1.2 Cual fue el ultimo grado aprobo Ud. en la escuela?:

a) Primaria ☐ b) Secundaria ☐ c) Universidad ☐

1.3 Cuantas personas viven aqui?

1.4 Cuantos hijos tiene que menores de 5 anos?

1.5 Nombres/edades de los hijos menores:

A.N: Edad (meses): Codigo
B.N: Edad (meses): Codigo
C.N: Edad (meses): Codigo
D.N: Edad (meses): Codigo

1.6 Su casa tiene luz electrica? Si ☐ No ☐

1.7 Donde saca Ud. agua para tomar?

a) Fuente de casa ☐ b) pozo protejido ☐ c) el rio ☐
d) Otro?

1.8 Cocina Ud. con lena o gas? Lena ☐ gas ☐

1.9 Tiene excusado letrina para uso exclusivo de los miembros del hogar? Si ☐ No ☐

1.10 Cual es la fecha en que Ud. entro en el proyecto de Heifer?

Fecha: / (mm/aaaa)

1.11 Antes de ingresar en el proyecto cuales eran los animales que Ud. habia tenido?

a) Gallinas ☐ b) Cabras ☐ c) Vacas ☐ d)Patos ☐ e) Bueys ☐
f) Ninguno animal ☐

1.12 En su opinion, cuanta necesidad habia tenido su familia los beneficios de este proyecto?

a) Muy poca ☐ b) Poca ☐ c)Alguna ☐ d)Mucha ☐

1.13 Porque eligio Ud. esta respuesta?

1.14 Hablar de la alimentacion que les hacia falta mas a los adultos antes de ingresar en el proyecto?

a) leche ☐ b) huevos ☐ c) carne/pollo ☐

1.15 Porque responde asi?

1.16 A sus hijos?....(elige uno)

a) leche ☐ b) huevos ☐ c) carne/pollo ☐

1.17 Porque responde asi?

CONTROL DE ANIMALES

(Marque con 'X' o todos que aplican a la familia)

2.1 Cual fue el primer animal que Ud. eligio al ingresar al proyecto?

a) Cabra ☐ b) Gallinas ☐ c) Conjeos ☐ d) Abejas ☐

2.2 CABRAS- Completo Ud. la pase en cadena? Si ☐ No ☐

2.3 Cuantas cabras obtuvo Ud. al ingresar en el proyecto?

Machos? Hembras?

2.4 Cuantos tiene Ud. ahora? Machos? Hembras?

2.5 Para Ud., para que sirve las cabras?

a) leche ☐ b) carne ☐
c) otra cosa?

2.6 Para que usa Ud. la leche de cabra?**

a) alimentacion ☐ b) vender ☐ c) regalar a los vecinos ☐

2.7 Quien toma la leche?**

a) Usted ☐ b) Nino < 5 anos ☐ c) Nino > 5 anos ☐

d) Su esposo/a ☐ e) Anciano/a ☐

2.8 En que forma consumen la leche?**

a) cruda ☐ b) hervida ☐ c) cocinada con comida ☐

d) otra? ☐

2.9 Antes de ingresar en el proyecto, donde habia consigido la leche Ud?

a) La compro ☐ b) De un vecino ☐ c) No tomamos leche ☐

2.10 Ha estado cargada la cabra alguna vez? Si ☐ No ☐

2.11 Como se da cuenta de eso Ud.?

☐

2.12 Cuanto tiempo dura este periodo? (meses) ☐

2.13 Que hicieron para obtener leche durante la carga?

a) comprar de la tienda ☐ b) seguir sin leche ☐

c) pedirla a los vecinos ☐ d) otro ☐

3.1 GALLINAS- Completo Ud. la pase en cadena? Si ☐ No ☐

3.2 Cuantas gallinas obtuvo Ud. al ingresar en el proyecto?

Machos? ☐ Hembras? ☐

3.3 Cuantas tiene Ahora? Machos? ☐ Hembras? ☐ Pollos? ☐

3.4 Como usa Ud. las gallinas para comer?

a) Carne ☐ b) Huevos ☐

c) Otro? ☐

3.5 Cuantos huevos tiene disponible cada semana? ☐

3.6 Quien come los huevos?

a) Usted ☐ b) Nino < 5 anos ☐ c) Nino > 5 anos ☐

d) Su esposo/a ☐ e) Anciano/a ☐

3.7 Antes de ingresar en el proyecto donde habia consigido los huevos?

a) La compro ☐ b) De un vecino ☐ c) No comiamos huevo ☐

3.8 Antes de ingresar en el proyecto donde habia consigido el pollo?

a) La compro ☐ b) De un vecino ☐ c) No comiamos pollo ☐

3.9 Quien come la carne ahora?

a) Usted ☐ b) Nino < 5 anos ☐ c) Nino > 5 anos ☐

d) Su esposo/a ☐ e) Anciano/a ☐

4.1 CONEJOS- Completo Ud. la pase en cadena? Si ☐ No ☐

4.2 Cuantos obtuvo Ud. al ingresar en el proyecto?

Machos? ☐ Hembras? ☐

4.3 Cuantos tiene Ud. ahora?

Machos? ☐ Hembras? ☐

4.4 Para Ud., para que sirve el conejo?

a) Carne para comer ☐ b) Para vender ☐

c) Usa el pelo para artesenales ☐ d) vender el pelo ☐

4.5 Quien come el carne?

a) Usted ☐ b) Nino < 5 anos ☐ c) Nino > 5 anos ☐

d) Su esposo/a ☐ e) Anciano/a ☐

4.6 Antes de ingresar en el proyecto donde habia consigido la carne?

a) La compro ☐ b) De un vecino ☐ c) No comiamos carne ☐

4.7 Como decide matarlo?

☐

4.8 Ha estado cargada la coneja alguna vez? Si ☐ No ☐

4.9 Como se da cuenta de eso Ud.?

☐

4.10 Cuanto tiempo dura este periodo? (meses) ☐

PREGUNTAS GENERALES

5.1 Desde de empezar con este proyecto de ASAPROSAR, (A) La alimentacion de Usted…(elige uno) a) disminuyo mucho ☐
b) disminuyo ☐ c) no cambio ☐ d) incremento ☐
e) incremento mucho ☐ f) no sabe ☐

5.2 De sus hijos?….(elige uno)
a) disminuyo mucho ☐ b) disminuyo ☐ c) no cambio ☐
d) incremento ☐ e) incremento mucho ☐ f) no sabe ☐

PREGUNTAS ECONOMICAS

5.3 Usted esta vendiendo animales o productos ahora? Si ☐ No ☐

5.4 Si, responde que 'Si' entonces cual vende Ud. tipicamente?
Animales vivos ☐ Carne ☐ Productos ☐ De todo ☐

5.5 De Animales vivos…
a) Cabras ☐ b)Conejos ☐ c) Gallinas ☐

5.6 Cuanto gana al mes venderlos? ☐

5.7 De Carne…
a) Cabras ☐ b)Conejos ☐ c) Gallinas ☐

5.8 Cuanto gana al mes venderlos? ☐

5.9 De Productos…
a) Huevos ☐ b)Leche ☐

5.10 Cuanto gana al mes venderlos? ☐

5.11 Usted tiene otra empresa o trabajo ahora? Si ☐ No ☐

5.12 Si, responde que 'Si' entonces cuanto gana mensualmente? ☐

5.13 Su esposo/a tiene empresa o trabajo ahora? Si ☐ No ☐

5.14 Si, responde que 'Si' entonces cuanto gana mensualmente? ☐

5.15 Hay alguien mas que contribuye al ingresos de la familia?
Si ☐ No ☐

5.16 Y si dice que 'Si', cuanto contribuye mensualmente? ☐

5.17 De las siguientes respuestas, cual es la primera cosa que Ud. compra con el dinero de vender? Y la segunda y la tercera… (Marque de 1 a 5)
a) Invertir en la casa ☐ b) Invertir en el proyecto ☐ c) Cosas de Salud ☐
d) Empresa economica ☐ e) Comida/refrescos ☐ f) Cosas para la casa ☐
g) Ahorros personales ☐ h) Ropa/Zapatos ☐
i) Cosas para escuela de los ninos ☐
h) Otras cosas ☐

5.18 Desde se incorporo al programa de ASAPROSAR, (A) sus ingresos…(elige uno) a) disminuyeron mucho ☐ b) disminuyeron ☐
c) no cambiaron ☐ d) incrementaron ☐ e) incrementaron mucho ☐
f) no sabe ☐

5.13 Sus ahorros personales….(elige uno)
a) disminuyeron mucho ☐ b) disminuyeron ☐ c) no cambiaron ☐
d) incrementaron ☐ e) incrementaron mucho ☐ f) no sabe ☐

TERMINA

(Preguntale si tiene preguntas en este momento)