

**Cost Effectiveness Analysis of the Ready-to-Use
Therapeutic Food (RUTF) Program for Treating
Acute Malnutrition Children in Uganda**

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ABSTRACT

This study is an ex-ante cost effectiveness analysis of a United States Agency for International Development (USAID) project for treating and preventing malnourished children in South Western Uganda. The results data used in the analysis in Acholi and Karamoja regions are for previous projects undertaken in the Uganda. For treating acute malnutrition uses Ready to Use Therapeutic Food (RUTF) as the major food for treating and preventing undernourishment children in Uganda .The **costs** of project include the cost of the therapeutic food (RUTF), the cost of the Health Center Visits, the cost of the Technical Assistance and Community Mobilization. The treatment **method** is outlined by Integrate Management of Acute Malnutrition (IMAM) guidelines Uganda ministry of Health, 2012.For **measuring** the **effectiveness** of the intervention in averting deaths we use the disability adjusted life year (DALY) calculated as a measure of mortality and morbidity. The cost per DALY saved is estimated using these parameters. A **sensitivity analysis** is also cleared out for the key variables. The cost effectiveness per DALY averted for the SPRING project is between US\$ 26.28 and 38.98 per DALY saved. In the analysis of health costs in developing countries, this rate of cost effectiveness is considered quite low. It has been recommended by the World Bank that countries should implement all projects and programs that have a rate of cost effectiveness of less than \$50.00 per DALY saved. This health intervention appears to be quite cost effective and should be implemented in Uganda. They key question is whether they will be able to obtain a sufficient volume of RUTF from the local supplier for the project.

Keywords: Cost effectiveness analysis, disability adjusted life year (DALY), sensitivity analysis

ÖZ

Bu çalışma Amerika Birleşik Devletleri Uluslararası Kalkınma Ajansı'nın Güney Batı Uganda'da besin yetmezliği nedeniyle zor durumda olan çocukların beslenmesi ve tedavisi için yürütülen projenin bir ön maliyet-fayda analizini oluşturmaktadır. Daha önceden Acholi ve Karamoja bölgelerinde yapılan çalışmaların sonuçları veri olarak dikkate alınmıştır. Akut beslenme yetersizliğinin tedavisinde temel besin maddesi olarak kullanıma hazır iyileştirici besin maddesi (RUTF) kullanılmıştır. Projenin maliyetleri, iyileştirici besin maddesi (RUTF), sağlık merkezi ziyaretleri, teknik yardım servisi maliyetleriyle toplum seferberliğinden oluşmaktadır. Tedavi yöntemi Akut Malnütrisyon Entegre Yönetimi şeklinde Uganda Sağlık Bakanlığı tarafından 2012 yılında belirlenmiştir. Ölümleri önlemeye yönelik müdahalenin etkinliğini ölçmek için Sakatlık Düzeltilmiş Yaşam Yılı (DALY) hesaplanmış böylece mortalite ve morbidite ölçülmüştür. DALY başına düşen maliyet tasarrufu bu parametreler kullanılarak hesaplanmıştır. Anahtar değişkenler için de bir duyarlılık analizi yapılmıştır. Ölümleri önlemede kullanılan Bahar Projesi'nin maliyet etkinliği DALY başına 26.28 ile 38.93 Amerikan Doları olarak hesaplanmıştır. Gelişmiş ülkeler için yürütülen sağlık maliyeti ile ilgili projelerde bu orandaki bir maliyet verimliliği düşük olarak kabul edilmektedir. Dünya Bankası tarafından tavsiye edilen yöntem bütün gerekli projelerin gelişmekte olan ülkeler tarafından hayata geçirilmesi ve maliyet etkinliğinin DALY başına 50 dolara çıkarılması yönündedir. Bu tarz bir ölümleri önleme projesi elbette ki Uganda için maliyet açısından etkin olacaktır. Anahtar soru ise projeye iyileştirici besini sağlayan üreticinin proje için yeterli miktarda tedariki (arzı) gerçekleştirip gerçekleştiremeyeceğidir.

Anahtar Kelimeler: Maliyet Fayda Analizleri, Sakatlık Düzeltilmiş Yaşam Yılı (DALY), duyarlılık analizleri.

To My Family

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LIST OF ACRONYMS

AIDS:	Acquired Immune Deficiency Syndrome
ART:	Antiretroviral Therapy
CEA:	Cost Effectiveness Analysis
CMAM:	Community-based-Management of Acute Malnutrition
CTC:	Community Therapeutic Care
DALY:	Disability Adjusted Life Years
FAO:	Food and Agriculture Organization
FBF:	Fortified Blended Food
FTF:	Feed the Future
GOU:	Government Of Uganda
HIV:	Human Immune deficiency Virus
HKI:	Helen Keller International program
IMAM:	Integrated Management of Acute Malnutrition
ITC:	Inpatient Therapeutic Care
MAM:	Moderate Malnutrition
MOH:	Ministry Of Health
MUAC:	Middle- Upper Arm Circumferences
NU:	Nutrition Unit
NULIF:	Food and Nutrition Interventions for Uganda

OTC:	Outpatient Therapeutic Care
PLWHA:	People Living With HIV+
PREP:	Pre-Exposure Prophylaxis
QALY:	Quality Adjusted Life Year
RUTF:	Ready to Use Therapeutic Food
SAM:	Severe Acute Malnutrition
TASPIN:	Therapeutic and Supplementary Products for Improved Nutrition
UNICEF:	United Nation Children’s Fund
UNIDO:	United Nations International Development Organization
USAID:	U.S. Agency for International Development
VCT:	Voluntary Counseling and Testing
WFP:	United Nations World Food Program
WHO:	World Health Organization

Chapter 1

INTRODUCTION

1.1 How This Study Is Established?

When I started this study, I was very curious about economic problems in the world. I wanted to learn more about the reasons behind economical issues affecting countries which subsequently lead to underdevelopment. I found out that one of the economic problems affecting many countries worldwide is severe malnourishment. In this context, there were many poor countries in which the mortality rates are high as a result of the undernourishment between infants, children, adolescents and adults. With more studies, it became cleared to me that the root of this catastrophe is number of diseases that affect the health of people and lead to malnutrition. Since the percentages of the population suffering from some sort of morbidity in Sub-Saharan Africa is very high and access to data for that region was possible, I focus my research in this geographical area.

In Sub-Saharan Africa, the high rate of undernourishment is related to the HIV+/AIDS epidemic. The UNAIDS World Aids Day Report 2011 ((UNAIDS, World Aids- Day Report, 2011) estimated the prevalence of HIV infection (adult and children) Worldwide to be between (31.6million-35.2million). In Sub-Saharan Africa, the estimated prevalence of HIV infection is between (21.6 million-24.1 million). In 2010, about 68% of people in the world with HIV+ live in Sub-Saharan

and almost half of deaths from AIDS and related diseases are in South Africa (UNAIDS, 2011).

Uganda is one of the African countries in which the rate of mortality and morbidity among people is very high because of severe acute malnutrition. The percentage of the population suffering from malnutrition in Uganda between 1990-1992 was 19% and between 2004-2006 the proportion was 15% (WIKIPEDIA). However, the incidence of underweight children younger than five years declined from 26% in 1995 to 16% in 2005/2006 (Uganda ministry of finance, planning and economic development September 2010). The percentage in Karamoja was 36%, 22% in the north part of the country and in Kampala the rate was 10% in 2005/2006. The high rate of malnutrition in Uganda is also related to diseases like malaria, tuberculosis, and HIV+. Based on information from World Bank the incidence tuberculosis declined from (264 per 100,000 in 2007 to 209 per 100,000 in 2010) and the mortality rate under 5 years declined from (107 per 1000 live birth in 2007 to 90 per 1000 live birth in 2011). However, the prevalence of HIV+ as a percentage of the total population age 15-49 increased from 6.3% in 2007 to 6.5% in 2009 (Data for Uganda 1996-2012).

1.2 What Are the Gaps?

The Republic of Uganda is located in the East of Africa with its capital being Kampala. Uganda got independent in 1962 from Britain (Macro International Inc. Calverton, 2007). Despite of the fact that the country is well endowed with natural resources but lack of many other things such as education and the knowledge to utilize well those resources that is available. There were many diseases present such as malaria, tuberculosis, and other infectious diseases with the most important

one being HIV. The high rate of mortality from severe acute malnutrition is related to the level of morbidity of the population especially due to the incidence of HIV+/AIDS .Sometimes many children who are admitted for treatment of this undernourishment have complications with HIV+ that they got from birth. It shows that their parents were carrying this virus, father to mother and subsequently during pregnancy to the fetus. Therefore, before undergoing the therapy for malnutrition, the clients should be tested to determine whether they also have one or more of these diseases. Although persuading people to be tested is not easy, the cost of treatment or prevention is not affordable for many patients.

1.3 How to Fill These Gaps?

To help address this problem, a number of International Organizations have implemented many programs in underdeveloped countries including Uganda. These organizations are United Nations Children's Fund (UNICEF), World Health Organization (WHO), and U.S Agency for International Development (USAID), United Nations World Food Program (WFP), Ministry Of Agriculture, United Nations International Development Organization (UNIDO), Food and Agriculture Organization (FAO).

These International organizations had many projects in Uganda dealing with these problems. These efforts are focused on improving the health and nutrition of the people. In addition, the rate of mortality decreased.

Three programs have been implemented by USAID for treating acute malnourished children in Uganda since 2008. These projects are based on the production and distribution of a special supplementary food to patients, the peculiarity of this

supplementary and therapeutically food is that it is made ready to use and can be administered without training .It does not spoil quickly because it is made without water. Furthermore, it does not need to be stored in a hygienic place. It is meant to be used as major food for treating patients in hospital and as well at home .This ready to use therapeutic food (RUTF) contains milk powder, sugar, peanut butter or paste, vegetable oil vitamin and mineral premix. The price of RUTF based on milk powder is not cheap, and sometimes need to be imported. Hence, USAID programs were designed to locally produced RUTF as well as distribute it to needy people.

The First USAID project was the **NULIF** project that was undertaken between 2008-2011, it was organized in seven steps and 12 sites all over Uganda. project was implemented for nutrition care and also for people living with HIV+ (PLWHA).NULIF project was both a nutrition intervention and a support program to manufacture RUTF using available locally ingredients.

The Second intervention was the **TASPIN** program which substituted locally RUTF production for the imported one. This program was a continuation of NULIF project. The TASPIN program aimed not only to improve the nutrient of the people living with HIV+, but also to promote the manufacture of domestically produced RUTF. During this program, the peanuts seeds were distributed between local farmers and after cultivation, the peanut were bought by USAID and used to manufacture RUTF in a small scale and simple technology. This process creates jobs for farmers and many women who are HIV+ but who can work in the farms and achieve income to buy their medicines.

The **SPRING** scheme which is the third intervention is a program to be implemented in the south western region of Uganda. The aim of this project is to implement the Integrated Management of Acute Malnutrition (IMAM) guidelines, and develop supervision capacity in the rural health centers. The program is to be implemented by USAID between 2011-2015.

1.4 What Did We Do?

This study is ex-ante cost effectiveness analysis of SPRING project for treating and preventing the severe acute malnourished in children under 5 years of age. The analysis is based on the available data from similar projects implemented in Acholi and Karamoja. Our analysis used the data generated from similar projects in implementing in these two regions. Our method analysis is cost effectiveness analysis .It is an alternative to cost benefit analysis. We will calculate the cost of a death averted as a result of the treatment. Cost benefit analysis would try to compute the monetary value of lives saved and compare this to cost of implementing the project. As this program is a health project, we should analyze it using cost effectiveness.

For computing the costs of the Community-based therapeutic care (CTC), we use the guidelines for the integrated management of Acute Malnutrition (IMAM) guidelines prepared by the Ministry of health in Uganda in 2012. This includes the cost of RUTF, the cost of the health center visits, the technical assistance and the mobilization cost. Our measurement of effectiveness of the program on the target group is the number of disability adjusted life years (DALY) averted. It is a measure of the mortality and morbidity impact of the program. At first we compare the number of death without and with program and calculate the death averted after the

first year. After computed the total number of DALY saved, we divided the total cost of the program by the total number of DALYs saved .In this way, we find the total cost per DALY saved.

Although prevalence of HIV+/AIDS is very high in Uganda and we do not have separate data for Acholi and Karamoja, we use probability of incidence rate of HIV positive patients and calculate the average cost per DALY saved .With sensitivity analysis, we show the changes in the average cost per DALY saved with different rates of HIV positive patients and also for changes in the price of RUTF.

Chapter 2

LITERATURE REVIEW

2.1 Definition

The incidence of severe acute malnutrition in Uganda and elsewhere in the world is related to a number of diseases. The important diseases in Uganda that are associated with severe malnutrition are tuberculosis, malaria and HIV/AIDS. For the treatment of undernourishment, these countries traditionally admitted patients into a hospital and treated them with available methods. There were many difficulties for feeding malnourished people in poor countries such as the lack of hygienic places to store the food and the lack of facilities for preserving food like as refrigerators. The transportation of people to the health centers or to get the food to the sick is another challenge.

To address these problems, inventors devised a kind of food that is quite different from the traditional method of treatment. It has revolutionized the feeding patients who are suffering from malnutrition. This food is called Ready to Use Therapeutic Food (RUTF). RUTF did not need to put into the refrigerator. It is not made with water and hence bacteria do not grow in it. The ingredients are milk powder, oil, sugar, peanuts, vitamins and minerals. It does not require cooking and patients can use it at their homes when they need it. RUTF is accepted as an effective therapeutically food for the treatment of malnutrition by the World Health Organization, World food Program, United Nations System standing Committee on

Nutrition and the United Nations Children’s Fund (UNICEF) , and the program for the Community-based-management of Severe Acute Malnutrition. RUTF is a soft and crushable food that is easy to use. Ready to Use Therapeutic Food (RUTF) was invented as a way for treating severe acute malnutrition in mothers, young children and adolescents. RUTF can be used at home without supervision and used directly by patients for complete recovery.



Figure 1: Ready to Use Therapeutic Food (RUTF)

In 2005, a new effort was made to develop a set of community-based management guidelines for treating accurately malnourished patients with RUTF at home. RUTF has been produced locally and used in other countries like Democratic Republic of Congo, Dominican Republic, Ethiopia, India, Madagascar, Malawi, Niger and Tanzania (Organization). In India, the Norway Compact For Life Company

produces two kinds of RUTF both of them based on community therapeutic care (CTC) and ought to be use at home. BP-100TM is a compressed RUTF with safe shelf components; it was used successfully in Sierra Leone and Burma. Another food make is eeZee paste NUTTM. It is a semi liquid RUTF based on peanut which malnourished children like the tasted (Life). Tanzania is also a country with high rate of malnutrition related to HIV/AIDS (in 2009 the prevalence rate of HIV was 5.9%). For treating such a high rate of malnutrition, the Ministry of Health and other development organizations established RUTF interventions associated with HIV/AIDS Care and Treatment Center (CTC) in Dar, Salaam, Tanzania. In Tanzania, RUTF Plump's Nuis was used for children with severe acute malnutrition under antiretroviral therapy (ART). It was effective in decrease of the mortality of under nutrition and HIV positive children (poudel, 2012). The Helen Keller International program RUTF has used as Plump's Nut based On lipid, vitamin and mineral content equivalent to F-100¹. It is easy to consume from the sachet without the need to put into refrigerator, it can be produced locally with simple equipment. Furthermore, Helen Keller Intervention (HKI) program is based on local public sector to approach Community-Based-Management of Acute Malnutrition (CMAM) services with available health care structures in Burkina Faso, Mali and Niger (International, 2009). In Beira, the largest city of Mozambique, French Company, Nutriest, works with the public sector in a joint effort between private and public sector. RUTF is produced in this factory that is a peanut made of paste and contains a mixture of powder, milk, oil, sugar, vitamins, and minerals suitable for improving nutrition of people with acute malnutrition. The Nutriest factory produced enough RUTF to feed 35000 undernourished children per year (UNICEF, 2010).

¹ : F-75 contains 75 Kcal and 0.9 g protein per 100 ml.

2: F-100 contains more calories and protein: 100 Kcal and 2.9 g protein per 100 ml.



Figure 2. Therapeutic and Ready to Use food



Figure 3. eeZeePaste™



Figure 4. BP-100™



Figure 5. Supplementary Food



Figure 6. eeZeeRUSF™

- eeZeePaste RUTF - available from Dubai
- BP-5 available from Kuala Lumpur, Malaysia
- Important information on patents and eeZeePaste™NUT
- New approval for Seven OceanS® in Singapore
- Compact is member of the Global Compact
- Save the Children - Hunger and Malnutrition
- Medicins Sans Frontieres - Starved for attention

The original feeding formulas for treating acute malnourished children were F-75¹ and F-100². F-75 is the starter formula for malnourishment in children till they will be able to tolerate the protein and sodium stabilized. After that F-100 continues the treatment and it contains more calories and protein (Management of Malnutrition in children Under Five years, 2007). RUTF formula is based on F-100 but without water inside. Normally undernourished people had been treated by traditional way in hospital before which was based on milk with F-75 and F-100 formulas. That traditional way required that patients be in the hospital for four weeks and use therapeutic food. Those methods addressed some difficulties, such those traditional ways need hygienic place, refrigerator for milk and facilities for transportation to buy and distributed fresh milk. These foods need cooking and for cooking it needs mixture of water. That water prepares a suitable base for increasing bacteria and will sour very soon.

According to the research work on developed new RUTF, researchers found out that the old version of RUTF that could not be produced in a way that is transferable to small volume manufactures. Vice versa RUTF based on Plump's Nut addressed a simple technology in small scale to produce locally Plump's Nut made up of peanuts, sugar, milk powder, vegetable oil and vitamin mineral mixture. Milk powder is expensive and often imported and sometimes the children show allergenic

reaction to peanut and the zinc ratio in RUTF. The idea for developing the locally produce RUTF, with rich protein, energy and ready for feeding children grew in early 1950s, with regards to the work of Jelliffe (1955) and Brock(1961), They declare that RUTF formula should regard quality of RUTF, long shelf life, good taste and require no additional process before feeding (Henry, 2004).

In Uganda, malnourished children were treated in the Kami Hospital located in Kumi district in the Eastern region in the Nutrition Unit in 1998. The acute undernourished children with or without complication admitted to Nutrition Unit and treated under the guild lines using F-75 and F-100. They used fresh cow's milk, oil, sugar, and vitamin-mineral complex. In addition, the nutrition unit identified severe acute malnourish people in the area, train caretakers about nutrition, hygiene. The nutrition units in addition have a program to grow vegetables, fruits, ground nuts and take care of outpatients. During these periods, two groups of children have been fed, one group with locally produced F-100 and another one locally produced RUTF. Although some of children didn't like the taste of RUTF, they managed to use it with nutrition unit diet. The procedure of producing RUTF was developed during August/September 2005. As there were a few children to use it, it was locally produce in small amounts and based on peanut paste, milk powder, vegetable oil, sugar and vitamin-mineral mix. In comparison between the cost of F-100 and RUTF, the cost of F100 based on Fresh cow's milk was cheaper than the cost of RUTF. The high cost of RUTF arises from the cost of milk powder (Tina Krumbein, 2006), which is after imported. They tried to improve the RUTF production with local available resources.

In Uganda the system of treating malnourished people was improved by the World Health Organization which supported the Development of National Level Nutrition's guidelines. The middle-upper arm circumferences (MUAC) were tapes for diagnosis that makes it easy for community members to identify acute malnourished people and treat them. This easy method reduces the costs for diagnosing and treating the malnourished people. Three programs have been implemented for improving nourishment in Uganda since 2008 by the United States Agency for international Development (USAID). The first was the **NULIFE** project implemented during 2008-2011 for severe malnourished people who suffer from HIV⁺. This program was undertaken in seven steps in 12 sites. In seven steps Nulife project improved the method for treating malnourished people by educating the health center workers, improving their management, and providing better facilities for services and the use RUTF. As a whole this program tried to improve a high quality and low cost RUTF with available resources (AIDSTAR-ONE, 2011, p. 14). This project implemented was based on the Integrated Management of Acute Malnutrition (IMAM) guidelines. In this program the major components of RUTF are imported, hence the price of it is very expensive. The **TASPIN** project substituted domestically produced RUTF instead of imported RUTF. The **SPRING** project that used to be undertaken in South Western region of Uganda during 2011-2015 is based on the NULIFE project and designed to improve the method for treating severely malnourished children.

This thesis address to ex-ante cost effectiveness analysis of **SPRING** project, which utilizes the available data come from Acholi and Karamoja. In all of the projects mentioned above RUTF is used as major item for feeding malnourished people.

Although the cost of RUTF is the highest, it is not the only cost for treatment. In addition there is the cost of the health centre visit, the technical assistance and the mobilization costs.

2.2 Discuss about RUTF

In spite of the fact that RUTF is a revolution any way for feeding severe acute malnourished people in the world, scientists argue about advantages and disadvantages of using it instead of traditional method. They represent that these different kinds of RUTF are almost commercial products based on plumpy'nuts. It was manufactured by **Nutriset a French Firm**. Nutriset now extended its product line to include Ready-To-Use-Supplementary Food (RUSF). The goal is to prevent acute malnutrition. This RUSF is used in addition to breastfeeding for children above 6 months and traditional supplementary food.

These scientists illustrated that disadvantages of RUTF are 1) RUTF today used not only for treating severe acute malnutrition, but also it uses for preventing young child of malnutrition .2)The commercially produced RUTF, distributed by international organizations is not governmental organizations, hence in poor country most people cannot afford to buy it.3) using RUTF may undermine breastfeeding for 6-24⁺ months of age children.4)because there is not water inside RUTF and children need a lot of water during the day, RUTF should use with a lot of water and fruit juice.5). Severe anorexia children may do not use a sufficient quantity of RUTF to improve the condition of malnourished child (George Kent T. O., 2011, p. 5).

Although RUTF is very effective in treating severe acute malnutrition, it should be used with consideration of other measures (page 8). The rapidly expanding use of

RUTF moves children away from breastfeeding and family food, which is very important for people who live in poverty. The RUTF products are expensive and when it is promoted, many parents with severe acute malnutrition cannot afford this. When communities promote using RUTF they became dependent on it. Maybe this is not good for people in poverty. In non-industrialized countries there is lack of funding for health and nutrition project, it is better to spend money to control diseases and better breastfeeding. Breastfeeding reduces mortality, and protects children from diseases (page-11). Because of its benefits and relatively low cost, the promotion of breast feeding is one of the most cost-effective public health interventions today. It would also significantly decrease the need for commercially manufactured complementary foods, including RUTF (page-13). More effort is needed to have children use traditional local foods that are preferred to any commercial manufactured food, particularly if it is imported and more over expensive (page-17). These scientists requested controlling the promotion and marketing of RUTF. There is an urgent need to develop guidelines on the quality standards, composition and use of RUTF in all circumstances (page-21).

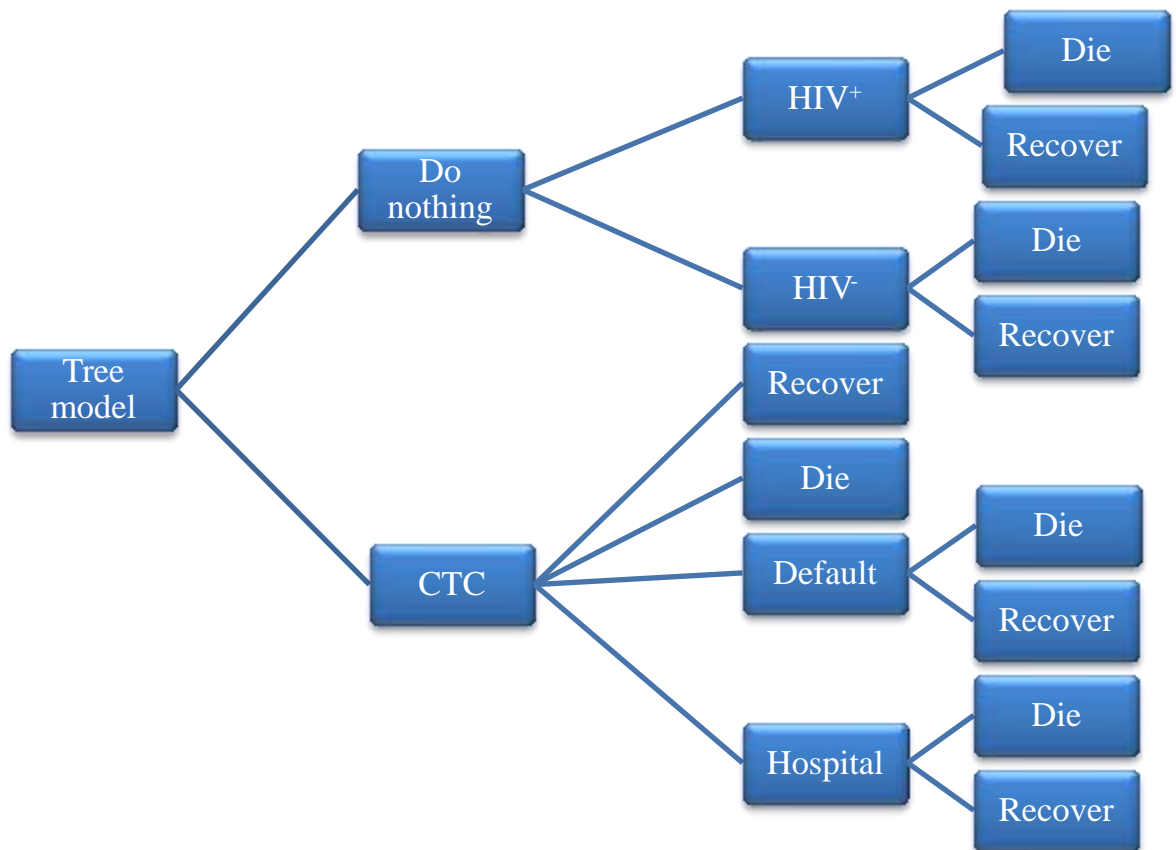


Figure 7. Plumpy Nut Food

2.3 Other Cost Effectiveness Studies

Zambia is one of the African countries with highest rate of mortality of children under five years old with severe acute malnutrition (SAM). For treating (SAM) they used RUTF recommended by the World Health Organization (WHO). The treatment program for (SAM) children in **Lusaka, Zambia** was undertaken by a community-based therapeutic care (CTC) model. An estimate was made of the cost effectiveness

of (CTC). This was done by comparing the with treatment and the without treatment situation. In this cost effective analysis the based on a decision tree model.



September 2005 to September 2007

Costs were made up of the cost of RUTF, the cost of the Health center visits and the hospital admissions.

The effectiveness is measured by the decrease in the mortality rate with treatment and the subsequent increase in the expected number of DALY_s. The sensitivity analyses indicated that the most sensitive variables affecting the cost effectiveness estimates were, 1) the rate of mortality without treatment 2) the cost of RUTF. 3) the Cost of technical support. It seems that the least costly RUTF formulas is made from locally grown soya, sorghum and maize instead of imported milk powder and

peanuts. The large scale production of the food reduces the costs as well (Bachmann, 2009).

2.4 HIV Epidemic

2.4.1 HIV in the World

Indeed HIV⁺/AIDS have created one of the most important disease burdens in the world. In many countries there is also a high incidence of malnutrition that is also relating the incidence of HIV⁺/AIDS. At the end of 2011, 34 million [31.4 million---35.9 million] people globally are living with HIV⁺. In 2011 a total of 2.5 million [2.2 million---2.8 million] people became newly infected with HIV worldwide while 1.7 million [1.5 million---1.9million] people died from the HIV positive (HIV/AIDS(UNAIDS), 2012, p. 11).

Among the countries which suffer from HIV, there is Sub-Saharan Africa having the highest rate of people suffering from AIDS with nearly 1 in every 20 adults 4.9% living with HIV comparing 69% of the people who are living with HIV in the world. In Sub-Saharan Africa the HIV infection is 25 times higher than Asia. After Sub-Saharan, Caribbean and Eastern Europe and Central Asia populations that are the heaviest infected by HIV (see table1).However the number of people newly infected is continually being reduced by implementing interventional programs. The number of adults and children newly infected by HIV in 2011: 2.5 million [2.2 million---2.8 million] was 20% lower than in 2001. There has been a decrease in the new infections of HIV in the Caribbean of 42% and in Sub-Saharan Africa of 25%. The largest epidemics are in Ethiopia, Nigeria, South Africa, Zambia and Zimbabwe (AIDS, 2011).

Table 1. Estimated prevalence of HIV infection in World region

World region	Estimated prevalence of HIV infection (adults and children)	Estimated adult and child deaths during 2010	Adult prevalence (%)
Worldwide	31.6 million – 35.2 million	1.6 to 1.9 million	0.8%
<u>Sub-Saharan Africa</u>	21.6 million – 24.1 million	1.2 million	5.0%
South and South-East Asia	3.6 million – 4.5 million	250,000	0.3%
<u>Eastern Europe and Central Asia</u>	1.3 million – 1.7 million	90,000	0.9%
Latin America	1.2 million – 1.7 million	67,000	0.4%
North America	1.0 million – 1.9 million	20,000	0.6%
East Asia	580,000 – 1.1 million	56,000	0.1%
Western and Central Europe	770,000 – 930,000	9,900	0.2%

Source: [UNAIDS](#) World Aids Day Report 2011. The ranges define the boundaries within which the actual numbers lie, based on the best available information.^[9]

Wikipedia

2.4.2 HIV and Impact on Cost Effectiveness

As illustrated before, the high rate of mortality related to HIV/AIDS in Africa is very high and there is a great need to control it by health programs. In fact the African governments face a balancing act between prevention, treatment, and care. As budgets are restricted, the costs of treatment affect the outcome of the cohort who has been infected.

The estimate of the Cost–effectiveness varies greatly across interventions. Some cases of HIV/AIDS can be prevented at a low cost per DALY gained while other interventions have a very high cost per DALY gained. New treatments have become available to prevent and treat this disease. The new resources are available in the world now to prevent and care this disease. The new treatments are more effective in dealing with the epidemic; although the new treatments required more cost. In developing countries it is very important to make a cost-effectiveness analysis in order to making the benefits from the available funds. In low –income and middle – income countries especially Africa, scientists have focused on individual HIV/AIDS related interventions (Andrew creese). Cost effectiveness in poor countries should consider the affordability of the treatments because public funding is limited. In Africa Antiretroviral treatment for HIV⁺ adult may not be the same cost-effectiveness as other interventions and yet government may be forced politically such care. Statistically these days 20%, 40%, 50% of health resources are consuming by HIV people in Malawi, Zambia, and Zimbabwe respectively (page 7). In the short term, the immediate priority is the care and support to the people with difficulties. Cost effective preventive intervention may not be available to treat people with low incomes (page 7). A group of scientists undertook some tests of HIV, **Voluntary Counseling and Testing (VCT)** to estimate the impact of cost and cost effectiveness of alternative treatments in Kenya and Tanzania. They found that HIV voluntary counseling and testing (VCT) is highly cost effectiveness but access is very limited (Michael Sweat). The other researcher evaluates a cost-effectiveness of **Pre-Exposure Prophylaxis (PREP)** and the potential impact of that program on averting new infection in South Africa. They found that (PREP) can avert 30% of new infections among women 25-35 years old. Furthermore, they found that cost

effectiveness of (PREP) is related to the antiretroviral therapy (ART). When (ART) program provide coverage to more than 65% of HIV⁺ individuals, the cost effective of (PREP) in 2010 declined three times. The (ART) program has a significant effect on many HIV-related treatment and prevention strategies. A combination of (PREP) and (ART) has prevented the spread of AIDS and reduced the mortality rate. Consequently, those researchers study (ART) program in South Africa (Carel Pretorius, 2010).

Chapter 3

METHODOLOGY

3.1 Cost Effectiveness Analysis

The Cost Effectiveness Analysis to be conducted here is used as an alternative to cost benefit analysis. In this thesis this technique is used to study a Health Project to improve nutrition among children in Uganda. Cost effectiveness analysis (CEA) is a type of economic analysis where both the cost and outcome (impact, result, effect, benefit, health gain) of an intervention are evaluated and then expressed in the form of a cost-effectiveness (CE) ratio (Pedro Belli, 2001). In Health projects the measure of cost effectiveness is the amount of cost required in order to save a person's life. If there are two alternatives the analyst should attempt to find the least-cost option to achieve a satisfactory outcome (Glenn P. Jenkins, 2011).

This health intervention project is designed to reduce the acute malnutrition among people; therefore the project makers plan to improve the quality of life of those treated. They gather information on the target group and sources of money to design a program for improving health and change the life style with the lowest costs available. Cost-effectiveness analysis is a method to use a procedure for treating diseases with most effectiveness way which is affordable. In fact there are many ways to treat or prevent a disease in a society but cost-effectiveness analysis find a way that has lower cost and under certain conditions will have more effectiveness of outcomes will be possible.

For applying the cost-effectiveness we first should compute the present values of costs of the intervention. The cost is the budget for the project or program and the effectiveness criterion is the number of lives saved, and cost-effectiveness ratio indicates the average cost per life saved. If the effectiveness of two projects are the same, project which has a lower cost is dominant; sometimes the scales are different among programs and increasing the cost could also achieve more effectiveness. In this case if the incremental cost-effectiveness ratio of those two projects was not high, decision makers sometimes prefer to spend money to obtain for more effectiveness (Anthony E.Boardman, 2006). Most countries are willing to save lives through public health programs but they don't want to put a dollar value on a life saved, but when effectiveness is used as measure of benefit then (CEA) became important, In (mutually exclusive) cases the ratio of cost and effectiveness may lead to the incorrect choice of project because it does not adjust for the scale of the project. The cost-effectiveness ratios of a health project would explain as dollar per life saved and the lower cost per life saved is the more efficient. Cost-effectiveness ratios can be use as measure of efficiency for health care (Anthony E. Boardman, 2006). As (CEA) doesn't monetize benefits, costs are measured in dollars, while effectiveness measured in units such as lives saved.

The ratio express in two ways (CE ratio) or (EC ratio), It is better to reduce the (CE) ratio and improve (EC) ratio. Costs and effectiveness measured incrementally between two policies i, j and $CE_{i,j}$ is a ratio that indicate incrementally compare cost and effectiveness between two programs i and j :

$$CE_{i,j} = \frac{C_i - C_j}{E_i - E_j}$$

(Antony E.Boardman, 2006).In general when we want to compare two or more projects if the costs are the same, the project that has more effectiveness become

dominant. Cost effectiveness ratios can compare treatment programs of many types. The results can be listed in a table and choose the projects with more effectiveness within the constraint of the available resources.

We start our analysis by collecting the data about the people who have malnutrition and the data about people who are admitted to this program and evaluate the effect of this intervention program on reducing the diseases and malnutrition of all people with or without complication.

Health strategies form the medical and pharmaceutical treatments to improve health and prevent people from getting diseases. For a health intervention, it is necessary to spend money to reduce the mortality and reduce morbidity. The cost of treatment in a country maybe changes and consequently the effectiveness changes as well; As a matter of fact medical care or the cost of a health project is mostly borne by the government or insurance companies. When the price of health care increases many people with an income constraint cannot afford these treatment services and maybe die or suffer and lose their healthy years of life and subsequently their life expectancy declines. A cost effectiveness analysis finds ways to minimize expenditures and maximize health benefits. Prices of inputs are risky variables which affects the cost effectiveness ratio. Changing the price will determine if the treatment is affordable or not. The cost effectiveness ratio will in turn determine the number of life saves with the available resources for the intervention. This study is ex-ante cost effectiveness analysis of the Ready to Use Therapeutic Food (RUTF).which is a program for treating acute malnutrition of children in Uganda. The incident of malnutrition in Uganda is related to the diseases with complications

like HIV⁺(AIDS).The government wishes to implement a project to improve nutrition, healthy years of life and reduce mortality and morbidity.

3.2 Measurements of Costs

The costs of such a nutrition project are actually the costs of providing a treatment or a preservative measure .For Instance the price of medication, the cost of a visit to the doctor, the duration of time to wait when visiting a clinic, the cost of transportation and the cost of the care services. Sometimes for implemented a health project it requires expenditure on the cost of education of the patients. Education is very effective for treating and preventative projects. In addition, the cost of death averted by undertaken of these projects is included health costs (Muennig, 2002). In Sub Sahara Africa, prematurely death is a problem. There are many diseases like tuberculosis, AIDS, and malaria that effect the development of these countries. The costs for treating of these complications or preventing these diseases are types of health costs. Sometimes these costs are more than the costs of other interventions that have better level of efficiency. In Sub-Sahara Africa the mortality rate is also as a risky variable for these projects as it is not known for certain. Costs in the cost effectiveness ratio are allocated in indirect costs, costs associated with the value of goods, equipment, medical care and the time that patient spend in a doctor's office and other costs that are not involve in pain and suffering. The costs related to quality of life referred to as morbidity costs, while costs associated to death are called mortality costs (Muennig, Designing and Conducting Cost-Effectiveness Analyses in Medicine and Health care , 2002).

Costs of community-based therapeutic care (CTC) per child in a program for treating acute malnutrition in Zambia contains: RUTF cost, health center visits cost,

hospital admissions cost, technical support while establishing the program cost (Bachmann, 15 January 2009). In a cost effectiveness analysis for a health project it is important to know which cost changes the quality of the life expected. The costs which change mortality and morbidity before and after intervention are important to consider. The cost calculation must be measured in the presence level of a given period by adjusting for inflation (Muenning, 2002). The average cost effectiveness ratio in treating programs is:

(Costs of treatment – costs averted by treatment) / QALYs gained by treatment

(Muennig, Designing and Conducting Cost-Effectiveness Analyses in Medicine and Health Care, 2002). In a health project the reduction averted costs of these had been no treatment is an effect of the treatment costs. Suppose that a health project have some costs for treatment but if a life is saved by the treatment rather than remaining sick and incurring other costs, these other costs will averted by the treatment that cures the individual. Hence, these averted costs should be treated as a reduction in the treatment costs that save a life.

In this project when children admitted into treatment program they become outpatients or inpatients. Inpatients stayed at a referred health facility for period of 4 to 7 days during the 8-weeks treatment period. Most of the inpatients are those having complications such as HIV positive statuses, malaria, tuberculosis, and other medical ailments that require supervision. In either case, children are fed RUTF rations. The outcome of each of these treatment programs can be a) Recovery to normal health. b) Default (if the child leaves the program before completing it). C) Death. d) Non-response. The Cost effectiveness analysis here is based on the data from the **Integrate Management of Acute Malnutrition (IMAM)** guidelines

(Uganda Ministry of Health 2012).The (CEA) estimate the cost per patient and the cost per Disability Adjusted Life Year (DALY) averted for an integrated project of supplying RUTF. The analysis includes the costs of employing the staff and facilities of health centers and the promotional services for physically delivering the services. The cost effectiveness of such a program for treating children who have contacted the HIV virus will be changed as the incidence of HIV is change.

Integrated management of acute malnutrition (IMAM) was implemented in the north of Uganda in 2003/2004 and it updated in 2005/2006 into national guidelines .In 2006 Ministry of Health (MOH)developed the first version of (IMAM)guide line by supporting from VALID International (Health, December 2010).That version combined with existing Community Therapeutic Care(CTC) and was integrated into the treatment of malnourished HIV/AIDS children and adult. The present IMAM guidelines go further to treatment of all malnourished people. The IMAM guidelines in Uganda were developed by national and international technical experts (Integrated Management of Acute Malnutrition Guidelines, December 2010).Malnutrition among the people is a result of lack of protein, energy, vitamins and minerals. So the IMAM guidelines try to address each of these deficiencies.

IMAM focuses on the managing of routine health care and supporting services. In Uganda IMAM has four components: 1) Community outreach. 2) Inpatient Therapeutic Care (ITC) 3) Outpatient Therapeutic Care (OTC). 4) Supplementary feeding programmers (Integrated Management of Acute Malnutrition Guidelines, December 2010).The (IMAM) guidelines instruct how to identify, treat and manage the treatment of acute malnourished people. The IMAM guidelines improved

management instructions for the treatment of malnourished people. This is done through treatment of **Severe Malnutrition (SAM)** cases either ITC or OTC. (IMAM) guidelines also guide management of **Moderate Malnutrition (MAM)** and people with **HIV** and the other chronic diseases. There is a village Health Team (VHT) strategy in Uganda which has members in every village. They work together and with the communities for better health. The success of the IMAM depends on maximizing the access to the publically available health services. For feeding undernourished people they use ready to use therapeutic food (RUTF) as a supplementary food for each beneficiary (Integrated Management of Acute Malnutrition Guidelines, December 2010). This cost effectiveness analysis is based on the IMAM guidelines of the minister of Health in Uganda calculate: 1) RUTF cost 2) cost of Health center visits 3) Technical assistance cost 4) community Mobilization cost. When total of these costs divided total number of DALY_s saved reveal the total cost per DALY Saved.

3.3 Measurement of Effectiveness

The disability Adjusted Life Year (DALY) first developed by Harvard University for World Bank in 1990 and World Health Organization adopted that method in 2000. After that time DALY is used in health projects as a measure of mortality and morbidity. DALY is calculated as: Disability adjusted life year indicate years life lost because of disease.

$$DALY = YLL + YLD$$

YLL: Sum of the years of life lost due to premature mortality in the population. YLD: The years lost due to disability for incident cases of the health condition. $YLL = N * L$ N: number of deaths L: standard life expectancy at age of death in years. $YLD = I * DW * L$ I: number of incident cases DW:

disability weight L: average duration of the case until remission or death
(WIKIPEDIA) .

The cost effectiveness analysis, the measure of effectiveness is the impact of the treatment on the target group. In Uganda the most of the malnourishment is connected to diseases, measure of effectiveness of a program is how this program saves lives, and compares the rate of death before and after that project. In this way one can compute the rate of deaths averted. The disability adjusted life year (DALY) is a measure of morbidity and mortality that can be used to show the number of years life lost because of diseases, and for calculation the number of DALY_s saved. DALY as a measure of mortality and morbidity is alternative measurement of QALY .Quality adjusted life year (QALY) estimate the quality of life with treatment. In a malnourished project because the measure of effectiveness is about death averted by undertaken a treatment program, it is better to use DALY as a measure of effectiveness. To indicate the effectiveness of the RUTF program, DALYs is measured by the number of treatment.

According to the World Health Organization Index, DALY per life saved for a child malnutrition treatment program countries like Uganda is (33).Therefore when calculated total number of death averted after treatment we then multiply this results by (33) to estimate the total number of DALY_s saved. That outcome uses as a measure of effectiveness on target group. Total cost per DALY saved is (**total Cost/total number of DALYs saved**) and total number of DALYs saved is(**death averted after first Year*DALY per life saved**). For cost effectiveness analysis total number of DALY_s saved estimated for ranking these Programs.

3.4 Data and Information

The data and information were used in cost effectiveness analysis came from more than 19000 cases of treatment of children with acute malnutrition. The data from World Bank, World Health Organization, UNICEF and data from Integrated Management of Acute Malnutrition (IMAM) guidelines (Uganda Ministry Of Health 2012).The information from(Uganda Ministry of Finance, Planning and Economic Development). The data about Acholi and Karamoja regions from the 2011 data were provided by UNICEF and NULIFE project (2008-2011, USAID finance) are measuring the results obtained by following the treatment in IMAM guidelines for Uganda, and the information based on reports of outcomes for programs undertaken by U.S. Agency for International Development (USAID)/Uganda on treatment of child malnutrition.

3.5 Sensitivity Analysis

With sensitivity analysis the important risky variables were found and the effect on the cost estimation calculated. One of the risky variables in this study is RUTF price which varied as a result of treatments, cost of technical support, the level of health programs and the price of RUTF material. Subsequently the cost per DALY changes when price of RUTF changes and changes of technical assistance. As the rate of HIV+ is high in Uganda calculation of the sensitivity per DALY saved is important to incident rate of HIV+ among malnourished people.

Chapter 4

DATA ANALYSIS

4.1 Tables of Parameters

This thesis is an ex-ante cost effectiveness analysis of **SPRING** project which is being implemented by United State Agency International Development (USAID) in Uganda. This project is to be undertaken in Southwest region of Uganda and is aimed at improving the health and nutritional status of children, women and people living with HIV/AIDS. This program is to be implemented within the government of Uganda (GOU) health system and its community health assistance program. In this program malnourished people are identified, and treated with locally produced Ready to Use Therapeutic Food (RUTF). This is done under the sponsorship of the USAID's Feed The Future (FTF), initiative. For this purpose the USAID have proposed a 5 year budget of approximately US\$8.25million (Boyo, 2012).Our analysis is based on the available results data from similar treatment programs in the Acholi and Karamoja regions of Uganda for children under 5 years of age. Parameters values used for the model are presented in Table 1:

Table 2. Parameter Values Used in Model

Without Intervention:	
child Under 5 Mortality Rate(Uganda 2009) 128 out 1000	0.128
Relative risk of death for Maln.(HIV+)	2
Death rate of malnourished (HIV-)	0.18
Death rate malnutrition(HIV+)	0.36
Prevalence of HIV+ among U5 maln. children admitted	0.50
Average death rate from Malnutrition	0.270
With Intervention:	
Non-response death rate	0.50
Probability of survival in one year after successful treatment	0.974
DALY per Life Saved (average)	33
DALYs saved if malnutrition treated but without HIV+	54
DALYs saved if malnutrition treated but with HIV+	12

Table 1 show that the mortality rate for children under 5 years is 128 out of 1000 (Uganda 2009).The death rate without complication is 18% and if there are complications from HIV positive the death rate is 36%. As some of the deaths happened after one year of treatment, an adjustment is made for effectiveness of treatment after the first year. For measuring the effectiveness of treating in Community – based on Therapeutic Care (CTC)we used DALY per from life saved 33 with incident rate of HIV+ among U5 malnourished children of 50%, the DALY’s averted are 12 for those HIV+ children who are cured from malnutrition and 54 for those who are HIV- .This figure is very close to the DALY per life saved for the case studied by Bachmann for Zambia (Bachmann, 2009, p. 3)see also

(Bhutta Z, 2008) and the World Health Organization Bulletin OMS.Vol 72 1994 page 435. The DALYs for children under 5 years among female and male varied between (32.34 - 35.85) (1994, p. 435). For the SPRING project the available parameters are in **Table 2**. In this table the value of Technical assistance is \$3,300,000 and the percentage of children to total beneficiaries is 22%. That rate was found by dividing the target number of children by the total target number of beneficiaries ($36709 / 166513 = 22\%$).

Table 3. Parameters of SPRING

Parameters of SPRING	
SPRING Technical Assistance US\$	3,300,000
Target Number of pregnant and Lactating Women	129804
Target Number of children	36709
Total target Number of Beneficiaries	166513
Children as percentage of total participant	22%

For computing the cost of RUTF, data in **Table 3** are used as based on Integrated management of acute malnutrition (IMAM) guideline. They indicate the amount of consumption of RUTF for treating patients and the based price of RUTF is \$5/Kg. It is the same price which USAID paid to the local producers under a complementary project which is also financed by USAID.

Table 4. Parameter values of a RUTF Treatment

RUTF package weight Kg	0.092
RUTF Consumption package /day	2.5
Length of Treatment (Recovery)/days	56
Length of Treatment (Defaulters)/days	36
Length of Treatment (Non response)/days	34
Length of Treatment (Death /days)	25
RUTF Price US \$/kg	5,00

Furthermore, for determination all costs of treatment we need to verify the cost of technical support, cost of a Health center visit, the cost of staying in a Hospital and the cost of community mobilization, all of units are expressed in dollars. They are showed in Table4 .

Table 5. Cost parameter values of a RUTF Treatment

• Cost of Technical Support US \$/child	19.82
• Cost per Health Center Visit US\$	8
• Cost of staying in Hospital/day US\$	21.73
• Average Number of days spend in hospital	5
• Cost of Community Mobilization US\$ /person	0.74

In **table 4** ,the cost of Technical Support is computed by dividing planned budget for SPRING Technical Assistance by the Total Target Number of Beneficiaries ($3300000/166513=19.82$)in table 2.The cost per health center visit is taken from WHO document on CHOICE. The average number of days spent in hospital is assumed to be 5 days based on the program data for the NULIFE project.

4.1.1 Measure of Effectiveness

Table 5 shows the results of application of the data to the **SPRING** program which is our model for analysis. It begins with the total admissions under the Inpatients Therapeutic Care (ITC) and Outpatients Therapeutic Care (OTC). Most of the inpatients are those having complication with diseases like **HIV⁺**, **Tuberculosis**, **Malaria** and other **illnesses** that require medical therapy. For all of these cases the children were fed with RUTF as major food supplement in the treatment of severe acute malnutrition.

Table 6. Application to SPRING

	Acholi	Karamoja
Total Admission	36709	36709
ITC	5621	5621
OTC	31088	31088
Recovery	26256	28792
Defaulters	3771	4603
Non-Response	4364	2742
Death with treatment	2312	572
Defaulters Death	1018	1243
None- Response Death	2182	1371
Total Death With Intervention	5512	3186
Death Rate With Intervention	15.02%	8.68%
Number of Death without Treatment	9911	9911
Death averted	4399	6726
Death averted after first year	4287	6553
Total Number of DALYs saved	141455	216261

In Table 5, the outcome of treatment programs is categorized into recovery, defaulter, non-response and death. From the data available from previous intervention, the total deaths experienced with intervention for **Acholi** is higher than

for **Karamoja**, the rate of death with intervention in **Acholi** is about two times more than **Karamoja** as a result of the incidence rate of HIV⁺ in **Acholi** which is also higher than most other regions in Uganda. When we compare total death with intervention and total death without treatment and subtracted these two figures we derive the total death averted. Death averted is a measurement of the effectiveness of treatment. When we multiply the adjusted rate of effectiveness after the first year of intervention we get the deaths averted after the first year. In Table 5 the deaths averted after the first year in **Acholi** is 4287 and in **Karamoja** is 6553. As we see the rate of deaths averted after first year in **Acholi** is much lower than in **Karamoja**. For the cost effectiveness analysis, we find total number of DALY_s saved by multiplying the rate of deaths averted after first year of the intervention with the DALY per life saved. **(death averted after first year)*(33)=(Total Number of DALY_s saved)**. From this analysis, the total number of DALY_s saved for Acholi is 141455 for Karamoja is 216261. This shows that number of DALY_s saved in Acholi is very much lower than the number of DALY_s saved in Karamoja. In this study we found that treatment in Karamoja is more effective than in Acholi. The number of DALY_s saved is used in the cost effectiveness analysis as a measure the effect of treatment on the target cohort.

4.1.2 Total Cost

Total cost included that of the **Cost of RUTF**, the **Cost of the Health center visits**, the **Technical Assistance and the Mobilization Cost**. The **cost of RUTF** is calculated by multiplying the quantity consumed by the price which in this estimation is \$5. The RUTF cost is computed by multiplying the consumption package per day by length of treatment and RUTF package weight/Kg as shown in

table 3: the outcome presented in table 6.

Cost of Health center visits is computed by cost per Health Center visit in table 4 multiply by number of Health care visits and number of admissions.

Cost of technical assistance is calculated by multiplying cost of technical support per child and number of children and community mobilization cost by multiplying the cost of community mobilization in table 4 and total admissions.

Table 7. Total Costs

RUTF Cost	Acholi	Karamoja
Recovery	1690894.84	1854204.89
Defaulters	154803.76	188962.10
Non-Response	168643.92	105964.40
Death	67000.87	16576.30
Total RUTF cost :US\$	2081343.39	2165707.70
Proportion of Total Cost	37.74%	38.11%
Cost of Health Center Visits		
Recovery	1680392.38	1842688.09
Defaulters	153842.25	187788.43
Non-Response	167596.45	105306.24
Death	66584.72	16473.34
Hospital Bed Cost	610762.06	610762.06
Total Health Center Visits Cost:US\$	2679177.85	2763018.16
Proportion of Total Cost	48.58%	48.61%
Technical Assistance Cost	727508.96	727508.96
Community Mobilization Cost	27164.66	27164.66
Total Technical Assistance and Mobilization cost :US\$	754673.62	754673.62
The Proportion of Total Cost	13.68%	13.28%
Total Cost: US\$	5,515,194.87	5,683,399.48

As seen in **Table 6** above the percentages of Health Center Visits cost is 48.58% of total cost in Acholi and 48.61% in Karamoja. Comparing with other components of cost, the cost of a health center Visit makes up the largest proportion in total cost

.This is as a result of the high rate nutritional diseases which need supervision.

4.1.3 Cost Effectiveness in SPRING Project

For analysis the cost effectiveness we should find the cost per DALY saved. The cost per DALY saved is calculated by dividing the total costs in (table 6) with the total number of DALYs saved as in table 5. **Table 8-1:** indicates the total Cost per DALY saved in Acholi and Karamoja.

Table 8. Total Cost per DALY Saved US\$, Price RUTF 5\$. DALY per Life Saved: 33

	Acholi	Karamoja
Total cost	5515195	5683399
Total Number of DALYs saved	141455	216261
Total Cost per DALY saved	38.99	26.28

Table 8.1, shows that total cost per DALY saved in Acholi is 38.99 and in Karamoja is 26.28. This follows that if the SPRING project would perform similar to the feature of Karamoja, the cost per effectiveness could be better than if it performs under those of Acholi.

The **DALY per Life Saved** can be computed by multiplying **(rate of incidence of HIV+)*(DALYs with HIV+) + (1-rate of incidence)*(DALYs without HIV+)**.

The DALY per life Saved with 50% percent of incidence rate of HIV positive is **:[(0.5)*(12)+(1-0.5)(54)]=33**. Furthermore, the **total number of DALY saved** is calculated by multiplying the death averted after first year to DALY per Life saved, those were indicated in **table 5**. The total Number of DALYs saved with incidence rate of HIV+ 50% and DALY per Life saved 33 for **Acholi is (4287*33=141471)** and

for **Karamoja** is $(6553*33=216249)$. Consequently the **total cost per DALY Saved** calculated by total cost in **table 6** divided by total number of DALYs saved. With incidence rate of 50% and DALY per Life Saved equal to 33 for **Acholi** ,the **cost per DALY Saved** is $(5515195.24/141471=38.98)$ and for **Karamoja** is $(5683399/216249=26.28)$.

4.2 Sensitivity Analysis

With the Sensitivity Analysis it was found that the cost per DALYs saved changes. When the Price of RUTF and other cost for treating malnutrition children and also the incidence of HIV positive vary, the cost per DALY save changes with a moderate intonation.

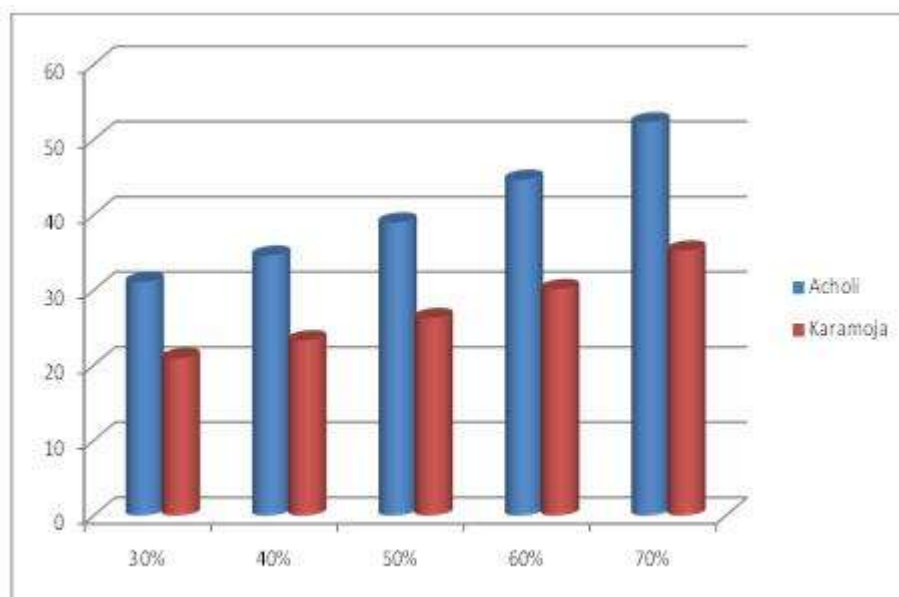
Table 9. Cost per DALY saved US\$

Incidence Rate of HIV positive	DALY per Life Saved	Total Cost per DALY Saved US\$	
		Acholi	Karamoja
30%	41.4	31.07	20.95
40%	37.2	34.58	23.31
50%	33	38.98	26.28
60%	28.8	44.67	30.11
70%	24.6	52.30	35.26

DALY per Life Saved shows the effect of treatment, it changes with change of incidence rate of HIV+. Table 8-2 indicated DALY per Life saved fluctuated 24.6 to 41.4 by variation of incidence rate of HIV+ from 30% to 70% and consequently effect on per DALY saved. Cost per DALY saved conversions for Acholi is 31.07 to 52.30 and for Karamoja is 20.95 to 35.26. These figures show that the treatment

program with prevalence of HIV+ 50%, DALY per Life saved 33 and cost per DALY Saved US\$ 38.98 for Acholi and 26.28 for Karamoja is cost effective.

Incidence Rate Of HIV positive	Total Cost per DALY saved US\$ RUTF : US\$5	
	Acholi	Karamoja
30%	31.07	20.95
40%	34.58	23.31
50%	38.98	26.28
60%	44.67	30.11
70%	52.30	35.26



As it was illustrated before and shows clearly from data on the table and graph, cost per DALY saved in Karamoja is less than the cost per DALY saved in Acholi with difference in the rate of HIV+. In fact these results indicate that, this treatment program is cost effective. Based on the NULIFE data which is used to set our outcome parameter for this study, the cost of treatment is lower for Acholi. However, the effectiveness is even lower for Acholi than Karamoja. This makes the cost per DALY under Karamoja to give better indication for the proposed SPRING

program.

SPRING project is undertaken in both treatments and preventions of malnutrition by fortified food, it is implemented based on previous NULIFE project which they affect on decline the rate of mortality as malnutrition with or without complication. These programs are cost effectiveness and decrease mortality and morbidity in Uganda.

Chapter 5

CONCLUSION

As I mentioned before this thesis is about ex-ante Cost Effectiveness Analysis of manufacturing the Ready-To-Use Therapeutic Food (RUTF) program for treating acute malnourished children in Uganda. In Uganda the root of severe acute malnutrition is also related to diseases like malaria, tuberculosis and especially epidemical HIV positive infection. USAID have been implemented some programs for treating and preventing the severe acute malnourished people since 2008 in Uganda. Based on the available data, I analyzed the cost and effectiveness of one of its projects using results data from two previous projects in the two regions of Uganda, Acholi and Karamoja. In spite of the fact that the program is cost effective in all circumstances, the incidence rate of HIV+ in Acholi is higher than Karamoja and subsequently the cost per DALY saved is more as well when the results data from that report is used.

There were three programs undertaken in Uganda, **NULIFE** program was performed among 2008-2011 in 12 sites in seven steps all over Uganda regions by United State Agency International Development (USAID). This program was designing to improve the nutrition of the people who were living with HIV and also suffering from severe acute malnutrition. These patients were fed with supplementary ready to use therapeutically food (RUTF). According to the data available during April 2009-June 2011 indicated that 65% of the malnourished

people in Uganda were also live with HIV+ in which 27.5% referred to children 6months to 18 years and 71% to adult over 18 years. These figures show that malnutrition of children who have contacted with HIV+ are concerned to their parents, most of these children were born carrying the diseases. Therefore for treating children it should considered that also curing their parents of these diseases are very important for the health of children.

Other information about NULIFE project declared that 28.4% of malnourished people living in Uganda were under Antiretroviral Therapy (ART) in which 29.6% were the people with severe acute malnutrition (SAM) and 70.4% related to the moderate acute malnutrition (MAM).In these rates 68.7% of people who had malnutrition were under treatment.

The result of this program addressed the effectiveness of treating malnourished people with or without complications. The data indicated that the percentages of exit among 2009-2011 were 42.8% related to the cured people and 3.7% death. Consequently the rate of malnourished people decrease after treating. For feeding the malnourished people used ready-to-use therapeutic food (RUTF) as well as fortified blended food (FBF). RUTF is the major food for treating and preventing undernourishment, it contains milk powder, sugar, peanut butter or paste, vegetable oil, vitamin and mineral premix. Some of these constituents are imported and they are more expensive than local resources. Hence USAID initiated the **TASPIN** project to produce this food. In this program RUTF is produced locally with the available resources. The objective of the TASPIN project is to produce RUTF at a lower price and to improvement the reliability and availability of the supply of

RUTF. Because it produces the food locally it generates income for farmers. After the NULIFE and TASPIN projects, USAID initiated **SPRING** program in 2011 that is planned to operate up to 2015 in south western region of Uganda. The aim of this project is more than treating malnutrition. There is to develop the health of people with the integrated management of acute malnutrition (IMAM) Guidelines for promotion of health services, supporting locally RUTF supplementary, managing to improve the facilities and effects of the programs on target group with low cost and more effectiveness is also desired.

With analysis the impact of outcome which illuminates that all of those programs are cost effectiveness, their impact should be sustainable for people of Uganda. After this intervention the rate of mortality and morbidity in Uganda should declines and RUTF will be locally produced. For continuity it is necessary to educate the locals, generate income, produce domestically RUTF with low cost, and prevent their population against diseases along with treatment and uprooted infectious illnesses should consider .With healthy educated people it is possible to have a more active society and gradually develop. Uganda has a high capacity and with the use of international investments and better utilization of its potential resources, improvements in the health of families can be achieved.

REFERENCES

AIDS, U. W. (2011). *Day Report Sub-Sahara*.

AIDSTAR-ONE. (2011). *NULIFE-FOOD AND NUTRITION INTERVENTIONS FOR UGANDA. Nutritional Assessment, Counseling, And Support*. AIDSTAR-ONE USAID.

Andrew creese, K. F. (n.d.). Cost effectiveness of HIV/AIDS interventions in Africa, a systematic review of the evidence.

Anthony E. Boardman, D. H. (2006). *COST-BENEFIT ANALYSIS Concepts and Practice THIRD EDITION*. Upper Saddle River ,New Jersey: PEARSON Prentice Hall.

Bachmann, M. O. (2009, January 15). Cost effectiveness of community - based therapeutic care for children with severe acute malnutrition in Zambia. p. 3.

Bachmann, M. O. (2009). Cost effectiveness of community-based therapeutic care for children with severe acute malnutrition in Zambia: decision tree model.

Bachmann, M. O. (15 January 2009). Cost Effectiveness and Resource Allocation in Zambia .

Bank, W. *Data for Uganda 1996-2012*.

Bhutta Z, A. T. (2008). What works ? Interventions for maternal and child undernutrition and survival.

Boyo, D. (2012). *USAID FIELD SUPPORT MECHANISM FOR MALNUTRITION PREVENTION AND TREATMENT ACTIVITIES IN SOUTHWEST UGANDA "SPRING"PROJECT:A COST-EFFECTIVENESS ANALYSIS FINAL REPORT*. UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID).

C.J.Murray. (1994). Quantifying the burden of diseases:The technical basis for disability-adjusted life years. *Bulletin of the World Health Organization-v,72(3)*, 435.

Carel Pretorius, J. S. (2010). Evaluating the cost-effectiveness of Pre- Exposure Prophylaxis(PREP)and its impact on HIV-1 transmission in South Africa.

George Kent, T. O. (2011). Commentary Ready -To-Use Therapeutic Food .RUTF STUFF.Can the children be saved with fortified peanut paste? *World Public Health Nutrition Association www.wphna.org* .

Glenn P. Jenkins, C.-Y. K. (2011). *Cost - Benefit Analysis for Investment Decisions*. Jenkins G.P,C.Y.K Kuo and A.C.Harberger,.

Health, T. R. (December 2010). Integrated Management of Acute Malnutrition Guidelines. *The Republic of Uganda Ministry of Health* .

Henry, S. c. (2004). Alternative RUTF formulations(special supplement).

HIV AIDS information : HIV-AIDS and related Diseases Home.Archive for April, 2. (2012). *Life After Being Diagnosed HIV positive*. HIV and AIDS information.

HIV/AIDS(UNAIDS), U. N. (2012). *World AIDS Day Report On the Global AIDS EPIDEMIC*. UNAIDS.

Integrated Management of Acute Malnutrition Guidelines. (December 2010).

International, H. K. (2009). Internal HKI program approach Community-Based Mangement of Acute Malnutrition(CMAM). *Hellen Keller international* .

Life, C. F. (n.d.). Therapeutic food for Malnutrition Treatment .Treating severe acute malnutrition in Soefteland,Bergen,Norway. *.BP-100TM RUTF,..Zee paste NUTTM RUTF* .

Macro International Inc.Calverton, M. (2007). Uganda Demographic and Health Survey 2006. *Uganda Bureau of Statistics Kampala,Uganda* .

Management of Malnutrition in children Under Five years. (2007).

Michael Sweat, S. G. (n.d.). Cost -effectiveness of Voluntary HIV-1 Counselling and testing in reducing sexual transmission of HIV-1 in Kenya and Tanzania.

Muennig, P. (2002). *Designing and Conducting Cost-Effectiveness Analyses in Medicine and Health care* . San Francisco: JOSSEY-BASS A Wiley company
www.josseybass.com.

Organization, W. H. (n.d.). *Maternal, New born, Child and Adolescent Health* .

Pedro Belli, J. R.-P. (2001). *Economic Analysis of Investment Operations - Analytical Tools and Practical Applications*. Washington,D.C.: The World Bank.

Poudel, K. (2012). Ready to use Therapeutic Food (RUTF) improves undernutrition among ART-treated,HIV-positive children in Dar es Salam,Tanzania. *Nutrition Journal*

Tina Krumbein, V. s. (2006). *Treatment of severe malnutrition categories ,Keywords RUTF acceptability,RUTF costs. Locally produced RUTF in a hospital setting in Uganda* .

UNAIDS. (2011). *World Aids- Day Report*. WIKIPEDIA.

UNAIDS. (2011). *World Aids-Day Report-Sub-Sahara*.

UNICEF, J. A. (2010, April). Mozambique's first Ready-to-Use Therapeutic Food (RUTF)factory opens in Beira.

WIKIPEDIA. *Disability Adjusted Year (DALY)*.