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Abstract

This thesis explores the use of technological fixes by humanitarian aid and international development programs. Technological fixes are often promoted by international aid organizations, but they face several potential limitations. First, technological fixes can be controlled via international patents. Secondly, technological fixes are often foreign supplied and distributed. This thesis attempts to identify how these two characteristics impact the effectiveness of technologies used for international humanitarian aid.

Specifically, this research was carried out through a qualitative comparative study of three representative technologies aimed at improving child health in the developing world. The three technologies chosen were: Plumpy'nut, Golden Rice, and Oral Rehydration Therapy. Plumpy'nut is patented and of simple design, Golden Rice is patented and scientifically complex, and Oral Rehydration Therapy has a simple structure and was never patented.

By comparing the cases of these three technologies, several preliminary conclusions were drawn. First, patents can slow the development, limit the supply, and increase the price of technological fixes and detract from their ability to effectively meet the health needs of children in the developing world. Secondly, technological fixes risk being band-aid solutions that only address the curative side of child health problems, without addressing their causes. Lastly, when technological fixes are developed and supplied by companies and organizations in the developed world, they often fail to create the local health knowledge and community-based capacity that is needed for long-term improvement in child health.

Introduction

Child Mortality in the Developing World:

At the beginning of the 21st Century, the international community acknowledged the importance of tackling the growing global inequalities that were becoming increasingly apparent in a globalizing world. In 2000, the United Nations (UN) established the Millennium Development Goals, which set lofty targets to end poverty and hunger around the world, obtain universal education, improve gender equality, child health, and maternal health, combat Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS), increase environmental sustainability, and create global partnerships by the fast approaching date of 2015 (UN 2010).

Although it seems doubtful that any of the Millennium Development Goals will be achieved by their target date, one issue that has shown particularly slow, and in some regions a lack of, improvements is child health. The Millennium Development Goal for child health is to reduce the under five-mortality rate by two thirds. While there have been slight improvements in parts of the world, in 2006 9.7 million children were still dying under the age of five and in 27 countries (primarily located in Sub-Saharan Africa) rates had not changed or had worsened. At the current rate of change, under-five mortality will not be reduced by two thirds by 2015 and the Millennium Development Goal will not be reached on time (UN 2010).

Of the 10 million children who die, on average, each year before reaching their fifth birthday, two thirds of the deaths are considered preventable. One third of these total deaths are caused by malnutrition. The second most prevalent, and equally preventable, cause of child mortality, responsible for one fifth of all child deaths, is diarrhea (WHO 2010). Both of these main causes are due to dietary deficiency and inadequacy.

Malnutrition can be caused by both a lack of the sufficient quantity of food as well as a lack of the consumption of food with key nutrients, like Vitamin A and iodine, necessary for good health. Diarrhea is caused primarily by contaminated water, food, and unsanitary living conditions. Additionally, the two illnesses promote each other. When children have diarrhea, they are unable to absorb the food they consume and repeated bouts of diarrhea often lead to malnutrition. Additionally, when children are malnourished, they have weakened immune systems, and are more susceptible to diarrhea (WHO 2010).

All in all, lack of a balanced diet, without nutrient rich food, adequate quantities of food, and uncontaminated food and water leads to millions of child deaths annually in the developing world. If the international community is truly committed to the aims it set with the Millennium Development Goals, then addressing both malnutrition and diarrheal disease in children is essential.

Technological Fixes and Patents:

One strategy for improving child health has been through technological fixes. The use of technology to address problems faced in the developing world is a popular method. Technologies like computers, water filters, and windmills have been heralded as being tools with which to fight against poverty (PRI 2009). Biotechnology and genetically engineered organisms, like drought-resistant crops, are promoted as being a plausible solution to crop failures and famines in regions of the world plagued by food shortages, like Sub-Saharan Africa (Paarlberg 2008).

Although technological fixes appear to be a positive and plausible means through which to approach international development and humanitarian aid projects, they face potential limitations. One of these comes through intellectual property rights. As new

technologies come to play an increasingly important role in aid and development strategies, patents will also become a critical part of the international development and humanitarian aid equation. In the 1986-1994 Uruguay rounds, the World Trade Organization (WTO) formed The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). TRIPS lead to the expansion and stronger protection of patents on the international level. Essentially, under the TRIPS agreement the intellectual property rights and patents held in one WTO member country have to be respected in all WTO member countries (WTO 2010). The World Trade Organization and proponents of stronger intellectual property rights protection state that allowing and respecting patents put on new technologies is necessary for encouraging new innovation and funds for new research and development. With patents, researchers can be assured that they will have control over any new technologies they create and that their invention will not be replicated elsewhere for profit without their approval. This guaranteed control, and potential monetary gain, is believed to provide the incentive for researchers to put the time, money, and effort into developing groundbreaking new technologies (WTO 2010).

Since the TRIPS agreement, as patents have gained a prominent position on the international stage, they have also begun to impact the international development and humanitarian aid industries. Through international patents, private companies can control technologies that have the potential to alleviate human suffering in the developing world. This creates controversy when the rights of inventors, creators, and private corporations seemingly have priority over the needs and rights of vulnerable consumers in the poorest sections of low-income countries. This thesis will explore this controversy and evaluate the impact that patents have on technologies used for humanitarian aid.

Technological Fixes and the Western Medical Model:

An additional criticism of technological fixes involves their placement within the Western medical model. Here, the "West" refers to the developed nations of Europe and North America. This medical model puts an emphasis on technology, promoted by Western doctors, as the means to cure diseases and improve health. The emphasis for funding is on larger, urban-based hospitals. This is the model that has dominated international development and humanitarian aid policy in most of the developing nations since decolonization (Werner and Sanders 1997).

The promotion of the Western medical model has been criticized because it focuses on treatment rather than prevention. The model focuses narrowly on specific diseases without addressing the underlying social, economic, political, and structural causes of poor health in developing nations. Therefore, it often cannot implement long-term and sustainable solutions to the health problems. Additionally, the model promotes the use of often expensive, imported technology, which is often too costly for the local populations involved. Lastly, since the focus is on large, higher-tech urban hospitals, many rural populations are left out (Werner and Sanders 1997).

Alternative perspectives emphasize community-based approaches. This method promotes the spread of many small health clinics with local health workers. It emphasizes health education and preventative measures that try to utilize low-cost and local resources whenever possible. Community-based approaches believe that creating local knowledge, control, and emphasizing prevention will lead to the best long-term health improvements in developing countries (Werner and Sanders 1997).

In addition to studying the patents on technological fixes, this thesis will examine

whether technological fixes are limited by their place in the Western medical model.

Research Purpose and Questions:

This thesis is an initial, qualitative exploratory study. Its purpose is to understand the value of technological fixes used for improving child health in developing countries. These questions are important because to make long-term improvements to child health in impoverished nations the value of proposed solutions must be fully understood. Additionally, this research speaks to the larger question of whether technological fixes are an effective method of humanitarian aid and international development assistance. Specifically, this thesis will seek to answer two questions:

1. In what way do patents influence the effectiveness of technologies used to address child health in developing nations?
2. Are there limitations to using imposed technological fixes as the method of humanitarian aid and development assistance aimed at child health?

Research Methods:

The two main questions of this paper will be addressed by a qualitative comparative analysis of three technologies: Plumpy'nut, Golden Rice, and Oral Rehydration Therapy. All of these products were developed to improve the health status of children in developing nations. Two products address nutrition and one addresses diarrhea. Lastly, two possess patents while the third is unpatented. Plumpy'nut will be the main technology to which Golden Rice and Oral Rehydration Therapy are compared. This is because Plumpy'nut is a more recent, and lesser-studied, successful product in fighting malnutrition. Additionally, its formula is simple, which challenges justifications for patents that claim patents are needed to promote complicated, costly scientific research. Golden Rice is genetically engineered rice used to combat Vitamin A

Deficiency in children and represents the scientifically complex, patented comparison to Plumpy'nut. Oral Rehydration Therapy is a formula used to cure dehydration due to diarrhea in children and will be used as a simple, non-patented comparison to Plumpy'nut.

The distinction between the studied technologies can be seen below in Figure 1.

Figure 1. Typology of technical solutions to global health problems

	Patented	Unpatented
Low-tech	Plumpy'nut (fortified food product to treat malnutrition)	Oral Rehydration Therapy (salt-based solution to treat diarrhea and dehydration)
High-tech	Golden Rice (bioengineered food crop to fight Vitamin A Deficiency)	N/A for this study

This thesis is primarily informed by secondary sources. The range of secondary sources used includes: academic journals and books, private company information, multi-national organizations' websites and statistics, and published material by a range of non-profit organizations engaged in the field.

Additionally, the case study on Plumpy'nut is complemented by primary source, key informant interviews. These interviews were conducted in Niamey, Niger in the offices of different aid organizations. Prior to conducting the interviews, Cornell Institutional Review Board (IRB) Human Subject Testing approval was obtained. The interviews were conducted with practitioners working for different organizations involved with the distribution of Plumpy'nut. Potential interview subjects were identified from a list of employees for organizations that supply or distribute Plumpy'nut in Niger. This list was obtained from Helen Keller International. Once initial contact was made with organizations, specific contact information for nutritionists or program directors was obtained. These contacts were called or emailed with information regarding the study and

a request to conduct an interview. Those individuals who responded and agreed to participate were subsequently interviewed.

Over the course of 4 months in Niger, four interview subjects responded, agreed to be interviewed, and were available to meet in Niamey during the time period I was also in Niamey. These included the following:

1. Chief Nutritionist at Helen Keller International: The Chief Nutritionist at Helen Keller International is a Nigerien national and a licensed doctor. He has worked at Helen Keller International for five years, prior to which he worked as a physician at the National Hospital in Niamey.
2. Nutrition Specialist at the United Nations Children's Fund (UNICEF): The nutrition specialist at UNICEF is a Canadian national who has worked in international nutrition for the past decade. She has worked for UNICEF in Niger for approximately two years, prior to which she worked for UNICEF in Senegal.
3. Vice President of Mercy Corps-Niger: The Vice President of Mercy Corps in Niger has worked at Mercy Corps for about five years. She is from the United States, but has worked in project management throughout West Africa for over ten years.
4. Nutritionist at the International Red Cross, Consultant for Société de Transformation Alimentaire, and former UNICEF nutritionist: The nutritionist at the International Red Cross is a French national who has worked in international nutrition for over ten years. She is also a nutritional product development and marketing consultant for the Société de Transformation Alimentaire, which is a local Plumpy'nut producer. Prior to working for the International Red Cross, she worked as a nutritionist for UNICEF in Niger.

The specific interviews were conducted in both French and English with responses paraphrased and written down in English. The interviews were based around a series of questions shown in Appendix A. The transcripts from these interviews were later analyzed for relevant information regarding the supply, distribution, cost, and use of Plumpy'nut.

By comparing both Golden Rice and Oral Rehydration Therapy to Plumpy'nut, I hope to begin to dissect the role that patents, and technologies, have in the international aid and development industry, especially when it comes to improving the health status of children. Comparative analysis of the three representative technologies helps to illuminate the specific costs and benefits of Plumpy'nut, as a patented form of humanitarian aid, as well as to consider the relationship of these technologies to broader theoretical issues surrounding the controversy in the development field over patented technologies. The costs and benefits are evaluated from the perspective of what will most effectively meet the immediate and long-term needs of vulnerable target populations. The controversy posited in this study is one that has been addressed through prior case studies. One example of this is the research that has been conducted on the case of patented anti-retroviral (ARV) drugs used to combat HIV/AIDS (Castro and Westerhaus 2006). However, this thesis moves beyond the single case study analysis to a three case comparative analysis that allows broader conclusions regarding the use of foreign technologies as a method of humanitarian intervention, based on a close examination of the claims and counterclaims of each technology. Such broader conclusions include raising questions about the efficacy of foreign aid over developing locally-based preventative methods of addressing nutritional deficiency.

Potential Research Limitations:

This study faces several potential limitations. In regard to the key informant interviews, there are limitations caused by the small number of interviews conducted. Ideally, interviews would have been conducted with aid workers from every Plumpy'nut distributing organization in Niger, with managing staff at the French Nutriset factory (where Plumpy'nut was developed), and with the director of the local Plumpy'nut producer Société de Transformation Alimentaire (STA). Emails were sent and phone calls were made to Nutriset employees, staff at the STA factory, and additional aid organizations like Doctors Without Borders and CARE. However, only four interview subjects responded in time and were available and willing to be interviewed. This was in part due to the limited time frame available, four months, and the constraint on available time to pursue interviews due to the additional academic and programmatic responsibilities of a study abroad program. Additionally, the interviews are limited by the use of paraphrase over direct quotation. Since the interviews were paraphrased, direct quotations are not available and this may limit some of the accuracy of the interview data.

It is as a result of these limitations that the key informant interviews are used as supplementary sources of information in addition to a more comprehensive evaluation of secondary sources. However, despite their limitations, the interviews are still able to provide insight into common issues faced by Plumpy'nut distributors in Niger. Additionally, one of the four interviews was completed with a nutritionist from the United Nations Children's Fund (UNICEF), which is the largest distributor of Plumpy'nut in Niger. UNICEF provides Plumpy'nut to the majority of Niger's aid organizations, so the experience of UNICEF would likely contain commonalities with

that of many other Nigerien humanitarian aid agencies.

Therefore, given the limitations of fieldwork, this thesis is not based on extensive field-based empirical research. Instead, it brings data gathered in Niger into relation with data gleaned form secondary source literatures to form preliminary conclusions about the impact of patents on technologies and the broader effectiveness of technologies used for humanitarian aid purposes.

Plumpy'nut: A Case Study

Plumpy'nut: A Success Story in Treating Malnutrition:

Severe malnutrition is the leading cause of child deaths in the developing world and is the culprit in one third of all deaths to children under five (WHO 2010). Therefore, any program or policy that wishes to improve child health in, and the overall welfare of, developing countries will need to address severe malnutrition in children.

Traditionally, severe malnutrition in children has been treated using therapeutic milk. Using this method, patients are hooked up to an IV drip, which provides them with vitamin enriched milk formulas, for a few weeks in a clinic. Once the patient is released from the clinic, his or her mother has to continue to supplement the child's diet with milk formulas. This method is problematic because of the lack of access to clinics by many impoverished rural communities, the absence of space in most clinics, and the potential for dirty water in the home administered milk formulas that can lead to other deadly diseases like diarrhea (Clayton 2005).

In 1997, a new type of product, in the form of a Ready-to-use-Therapeutic Food (RUTF) (which refers to any pre-made, vitamin rich paste or biscuit that can be administered at home for malnutrition) began to be developed by a French scientist, Andre Briend. In 2000 that product, Plumpy'nut, was first used to treat severe

malnutrition (Bhandari and Tiplady 2005). Plumpy'nut is essentially a vitamin enriched peanut butter paste that provides children suffering from acute malnutrition a mix of vitamins, minerals, calories, and high energy protein that allow them to gain weight and recover quickly, adding 2.2 lbs per week to a child's weight (Clayton 2005). Plumpy'nut improves upon therapeutic milk for several reasons: 1) It tastes good and children want to eat it 2) It can be administered at home and doesn't require long stays in a clinic 3) It does not require water and therefore eliminates the risk of waterborne diseases 4) It has a long shelf life and can be kept without refrigeration in unforgiving climates (Wines 2005).

The World Health Organization promotes the use of Ready-To-Use-Therapeutic-Foods, like Plumpy'nut, as a major component of its strategy to combat malnutrition in children (Prudhon et al 2006). Of the Ready-to-Use-Therapeutic-Foods, Plumpy'nut has become the preferred treatment for severe malnutrition by the World Health Organization (WHO) and other important aid agencies working throughout the developing world, like UNICEF and Doctors Without Borders (Bhandari and Tiplady 2005).

Nutriset and the Patent on Plumpy'nut:

Although Plumpy'nut is used exclusively by humanitarian aid agencies, and its only consumer base is severely malnourished children in the developing world, it is controlled via patent by a private, for-profit company called Nutriset, located in France. Nutriset's research, development, and production are based solely on products used for child health in low-income countries. They sell a wide range of products including: therapeutic milk (which was used primarily for treating malnutrition before Plumpy'nut), infant milk formulas, a food formula to prevent vitamin deficiencies, a formula to prevent dehydration in malnourished children, and more (Nutriset 2010). Although Nutriset was doing well before it developed Plumpy'nut, the success of Plumpy'nut has doubled their

sales revenue. In 2004, Nutriset brought in $15 million in sales. Much of this came from the sale of Plumpy'nut, which is sold for about 35 cents a packet, with 90 packets needed to treat a child, coming to a total of about $30 per child for a full course of Plumpy'nut (Bhandari and Tiplady 2005).

When Nutriset developed Plumpy'nut in 1997, it was registered under patent in France (Nutriset 2010). In 2002, the United States Patent and Trademark Office granted a patent to Nutriset for the Plumpy'nut formula (USPTO 2009). Under the TRIPS agreement, these French and United States patents can be applied in all WTO member countries (WTO 2010). Nutriset makes it clear on its website that it controls the rights to produce Plumpy'nut, stating: "Any manufacture, marketing or use of Plumpy'nut® type products in any country where a patent applies, without the prior agreement of Nutriset, therefore constitutes an infringement of Nutriset's intellectual property rights. Nutriset is then within its right to initiate legal proceedings" (Nutriset 2010). The company has followed through with this warning and has threatened legal action against a company, Compact, which has been providing a generic form of Plumpy'nut to Kenya without Nutriset's approval (Schön-Angerer November 2009).

Although Nutriset continues to exercise its patent rights over Plumpy'nut, It has made some concessions to allow other companies to produce Plumpy'nut. In response to the high demand for Plumpy'nut by the aid industry, the lack of capacity by Nutriset's facility in France to meet that demand, and in response to pressures to allow local production of Plumpy'nut, Nutriset began a licensing and franchise system called Plumpyfield. Through this system, Nutriset grants a license for local companies to produce Plumpy'nut and monitors the production to make sure the product meets quality standards. Additionally, these licensed companies pay back royalties to Nutriset, which

Nutriset says are used to sponsor further research and development (Nutriset 2010).

Currently, Nutriset had granted licenses to 10 companies in 10 different countries. These licenses were awarded in Ethiopia, Malawi, the Democratic Republic of Congo, Mozambique, Niger, Madagascar, Tanzania, India, the Dominican Republic, and the United States. All of these companies combined can produce 21,440 metric tons of Plumpy'nut per year. This total capacity of all licensed companies remains one third less than the total production capacity of Nutriset, which is 33,000 metric tons per year (Nutriset 2010). Therefore, the companies licensed to produce Plumpy'nut produce a relatively small amount of the product. For example, despite the existence of local producers, the main procurer of Plumpy'nut, UNICEF, obtains 89% of its total Plumpy'nut from Nutriset's French factory (UNICEF 2009). This percentage is most likely lower in countries where Plumpy'nut is produced locally, but globally UNICEF continues to purchase Plumpy'nut almost exclusively from the single Nutriset factory in France. Because of the heavy reliance on one producer, the supply of Plumpy'nut is fragile since a problem in the French factory, like mechanical failures or worker strikes, would decimate the global supply of Plumpy'nut (UNICEF 2009).

Despite their licensing system, Nutriset continues to face criticism regarding its patent. One of the main distributors of Plumpy'nut, Médecins San Frontières (Doctors WIthout Borders), has been vocal in criticizing Nutriset's patent. They have asked Nutriset to be more flexible with its patent and to make it easier for more interested producers to begin the production of Plumpy'nut. MSF believes the patent and current licensing system discourage or prevent many producers from manufacturing Plumpy'nut, which could decrease the price as well as increase the supply of Plumpy'nut. With the current demand for Plumpy'nut, MSF believes relying almost exclusively on Nutriset is

not effective in obtaining the needed supply of Plumpy'nut (Schön-Angerer March 2009). The strain on Nutriset's capacity to meet the demand for Plumpy'nut will likely increase in the future as a result of a new method by the World Health Organization, introduced in 2006, for measuring severe malnutrition in children. The new measurement system has increased the number of children who fall in the category of severely malnourished by eight times (Isanaka 2009). Therefore, the adoption of the new WHO measurement system will possibly increase the demand for Plumpy'nut by a similar proportion.

Most recently in the Nutriset patent debate, two US companies (Breedlove Foods Inc and the Mama Cares Foundation) are filing a lawsuit against Nutriset for its patent on Plumpy'nut. The companies both want to produce a nut-based nutrition product like Plumpy'nut and believe Nutriset's patent is too broad to be legitimate because it is not specific and covers almost any vitamin-enriched nut-paste. Nutriset defends itself by saying it needs the patent on Plumpy'nut to both turn a profit that will go into further research and development as well as to control the quality of the companies that it licenses to produce Plumpy'nut in the developing world (Mercer 2010).

Overall, Nutriset's patent on Plumpy'nut has caused conflict in three key areas: limiting the supply, inflating the price (via the lack of producer competition), and limiting the development and production of similar, simple, nut-based products. In response to these criticisms, Nutriset's main compromise has been to grant Plumpy'nut production licenses to certain locally based factories in the developing world (with the exception of one license for a U.S. based company), but the company continues to defend and justify its patent by arguing that the patent facilitates quality control and the revenue needed for further research and development of new life-saving products.

Interviews with Plumpy'nut Distributors in Niger:

In order to further explore the debate over the Nutriset patent, I conducted field interviews with aid workers working in the impoverished nation of Niger. The country of Niger is located in the dry landscape of both the Sahel and Sahara Desert in West Africa. It is one of the world's poorest countries, ranked at the bottom of the United Nations Human Development Index (UNDP 2009). Niger provides a good case in which to study Plumpy'nut for several reasons. To start, it is one of the countries with the highest rates of child mortality and child malnutrition in the world. In 2007, the child mortality rate in Niger was 176 under-five child deaths per 1,000 live births (UNICEF 2010). Malnutrition is a major cause of poor child health in Niger, with 44% of children underweight (UNDP 2009). The most lethal form of malnutrition, acute malnutrition, afflicts more than 15% of children in the country (UNICEF 2010).

Additionally, Niger is one of the countries where Plumpy'nut is most widely used. Plumpy'nut proved its worth to Niger and to the world in the 2005 famine when it saved thousands of children from dying of malnutrition (UNICEF 2010). Between 2005 and 2008, Niger received on average 13% of the Plumpy'nut produced by Nutriset (UNICEF 2009). Lastly, Niger is one of the 10 countries where Nutriset has granted a license to locally produce Plumpy'nut. The company Société de Transformation Alimentaire (STA) has been producing Plumpy'nut in the capital city, Niamey, since 2005 (Nutriset 2010).

By conducting these interviews in Niger, I hoped to test some of the criticisms against Nutriset and gain a first-hand perspective from field workers about a) whether currently they were restricted in their use of Plumpy'nut by price and supply and b) whether the existence of a locally licensed factory had a positive impact on the use of Plumpy'nut in the country. Following is a summary of these interviews conducted in Niamey, Niger from January-May, 2009.

Interview 1: Nutritionist at Helen Keller International

Helen Keller International is one of the distributors of Plumpy'nut in Niger. They do not buy Plumpy'nut directly from Nutriset, but instead they buy their supply from UNICEF, which procures Plumpy'nut directly from the supplier. With the exception of Doctors Without Borders, all the NGOs (non-governmental organizations) working in Niger obtain their Plumpy'nut from UNICEF. In 2008, Helen Keller International distributed 280,200 packets of Plumpy'nut to severely malnourished children in Niger. Helen Keller International provides 20 packets per week to each child for a total of four weeks. Therefore, they were able to reach about 3,500 afflicted children. This cost Helen Keller International $101,040 for the year. The nutritionist at Helen Keller International stated that ideally, the organization would have reached 17,000 malnourished children. Therefore, they only reached 20% of the children they hoped to help.

When I asked why Helen Keller International was unable to reach enough children, I was told that the largest setback to the NGO's procurement and distribution of the adequate amount of Plumpy'nut was supply. UNICEF allocated Helen Keller International less Plumpy'nut than they would have liked to purchase and distribute.

Since Nutriset gave a license in Niger to STA for the local production of Plumpy'nut, I asked if the existence of a local supplier helped with the supply flow. I was informed that the STA factory didn't produce nearly enough Plumpy'nut for Niger's domestic demands. The majority of Helen Keller International's Plumpy'nut is imported from Nutriset's factory in France. In fact, when I was brought to the Plumpy'nut storage facility, only one packet of locally produced Plumpy'nut could be found among hundreds of imported packets. Overall, from the Helen Keller International perspective, the local production of Plumpy'nut in Niger under license from Nutriset didn't have a noticeable

impact on their ability to obtain the adequate amount of Plumpy'nut to meet their organization's needs and targets.

Interview 2: Nutritionist at UNICEF

The United Nations Children's Fund (UNICEF) is the main procurer and distributor of Plumpy'nut in Niger. UNICEF estimates their need for Plumpy'nut and orders a quantity from a combination of Nutriset and STA. They then sell and distribute this Plumpy'nut to the many NGOs working with Plumpy'nut in Niger, with the exception of Doctors Without Borders. While UNICEF does purchase from STA, UNICEF purchases the majority of its Plumpy'nut from Nutriset in France.

Although UNICEF attempts to estimate how much Plumpy'nut they will need in Niger, they never reach 100% of their target groups. In the coming years, even more Plumpy'nut will be needed as the new World Health Organization (WHO) standards have increased the number of children who fall into the severely malnourished category.

The UNICEF nutritionist said that the main limiting factor in reaching all target groups in Niger is health infrastructure, both physically and in regards to knowledge. There is a lack of infrastructure in Niger to distribute Plumpy'nut to many target populations who live in remote areas. Additionally, lack of health knowledge can limit the effectiveness of Plumpy'nut in the country. I was informed that even if UNICEF were able to purchase the exact amount needed for all malnourished children, they wouldn't be able to reach all the children because of these infrastructure constraints.

Another factor that limits UNICEF's ability to reach all malnourished children in Niger is the price of Plumpy'nut. In 2006, UNICEF in Niger had to pay prices as high as $1.30 per packet of Plumpy'nut, compared to the average price given by Nutriset of 30 cents. The high price of Plumpy'nut inhibits the use of Plumpy'nut for children that fall

in the moderately malnourished category. Plumpy'nut has been used for moderately malnourished cases instead of the traditional porridge mixtures, but it is not cost-effective and UNICEF in Niger has chosen to pay for, and use, Plumpy'nut exclusively for the direst cases of severe malnutrition.

Interview 3: Vice President of Mercy Corps-Niger

Although not one of the consistent Plumpy'nut distributors, Mercy Corps helps to implement Plumpy'nut distribution during times of food crisis as an umbrella organization under UNICEF. In the coming years, Mercy Corps anticipates needing more Plumpy'nut as the new World Health Organization (WHO) standard for defining malnutrition has increased the number of children considered to be severely malnourished in Niger.

The majority of the Plumpy'nut used by Mercy Corps comes from France. The practitioner at Mercy Corps stated that this was a result not only of a lower production capacity of STA in Niger but also the higher price of Plumpy'nut produced at the local factory. According to the Mercy Corps practitioner this higher price is due to higher production costs that come from the lower industrial capacity in Niger and make it expensive for a small factory like STA to operate.

Interview 4: Nutritionist at the Red Cross, Consultant with STA, and former nutritionist at UNICEF

Both UNICEF and the Red Cross buy and distribute Plumpy'nut in Niger. In the case of both organizations, the majority of Plumpy'nut is purchased from Nutriset in France and not from the local STA factory.

One reason that less Plumpy'nut is purchased from STA is that the factory has a lower production capacity than the Nutriset factory in France. Additionally, the STA

factory is less reliable in its production than Nutriset. For example, while working with UNICEF, the nutritionist I spoke with had coordinated the procurement of Plumpy'nut for UNICEF. During the 2005 famine in Niger, there was a shortage of Plumpy'nut in the country and the local factory, STA, was not able to produce fast enough the quantity of Plumpy'nut that was ordered by UNICEF and this detracted from the ability of UNICEF to address the nutrition crisis caused by the famine.

Additionally, both the Red Cross and UNICEF purchase less Plumpy'nut from STA because the cost of STA produced Plumpy'nut is higher than that produced by UNICEF. As a consultant for STA, the Red Cross nutritionist I spoke with had insight into why the cost of locally produced Plumpy'nut was higher than that imported from France. One reason comes from the small-scale nature of the factory which makes it hard to compete with the lower prices set by the larger factory in France. Another reason for the higher price is that in order to meet the quality requirements set by Nutriset for the licensed factory, STA had to import almost all components of Plumpy'nut. This includes costly milk imported from South America and the CMV (complexe minerale vitamine) imported from Nutriset in France. The Plumpy'nut formula requires a vitamin mixture that was created and produced by Nutriset. Therefore, even though STA has a license to produce Plumpy'nut locally, they must import the vitamin mixture necessary to make Plumpy'nut from Nutriset. The only component of Plumpy'nut that isn't imported is peanuts; which are grown by and purchased from Nigerien farmers.

Although the price for Plumpy'nut set by Nutriset is lower than the price set by the local STA, the price remains a limiting factor that prevents the Red Cross, along with UNICEF, from using Plumpy'nut for moderate malnutrition and severe malnutrition prevention. In general, it is only cost-effective to be used in emergency, life or death,

crisis situations.

The Impact of Nutriset's Plumpy'nut Patent in Niger:

In three of the four interviews, the organizations confirmed that they were restricted in their use of Plumpy'nut by price, supply, or both. The nutritionist at Helen Keller International stated that supply was the limiting factor, as they were only able to obtain 20% of the Plumpy'nut they wanted to distribute. The current nutritionist at UNICEF did not say that Plumpy'nut supply was currently a major problem. However, the current UNICEF nutritionist did mention that the price of Plumpy'nut limited UNICEF's ability to use the product more widely and restricted its use to only life-threatening scenarios despite the fact that Plumpy'nut is also effective as a preventative tool in more moderate cases of malnutrition. Additionally, the current UNICEF nutritionist mentioned the volatility of Plumpy'nut's price, which has the potential to get high enough, as in 2006, one year after the Nigerien famine, that it can limit how much UNICEF is able purchase. The Red Cross nutritionist also mentioned that the high price of Plumpy'nut limits the use of the product for any cases outside of severe malnutrition, despite the fact that Plumpy'nut could be used to aid with more moderate malnutrition and preventative measures against the onset of severe malnutrition.

In all four of the interviews, the interviewees expressed that despite the existence of a local Plumpy'nut producer, their organizations relied primarily on Plumpy'nut imported from France. This was explained as both a result of the low production capacity of the STA factory and the higher price set by the STA factory. The nutritionist at Helen Keller International explained that the lack of locally produced Plumpy'nut in their storeroom was a result of STA's small output of Plumpy'nut, which is 3,600 metric tons per year compared to Nutriset's 33,000 metric tons per year (Nutriset 2010). The Vice

President of Mercy Corps-Niger explained that the primary reliance on Nutriset was a result of both the lower output of STA and the higher costs of their product, which the vice president stated came from the smaller nature and lower industrial capacity of the STA factory. The Red Cross nutritionist attributed the continued dependence on Nutriset to two causes. First, the STA factory has historically been less reliable than Nutriset, leading to shortages during the 2005 famine. Second, the price of locally produced Plumpy'nut is higher than imported Plumpy'nut. This can be attributed both to the small size of the STA factory, which can't compete with Nutriset's larger factory, and the cost of imports to produce Plumpy'nut. In fact, STA must buy the "complexe minerale vitamine" from Nutriset in order to make local Plumpy'nut and this contributes to the higher cost experienced.

Overall, the insight gained from these interviews in Niger paint a picture that fits in line with that of Nutriset's critics. Both the current supply and price of Plumpy'nut can put limitations on organizations working to alleviate malnutrition in the field. As was mentioned in both the interview at UNICEF and at Mercy Corps, application of the new WHO standards for calculating malnutrition will increase the number of children who qualify as "severely malnourished" and will subsequently lead to an increase in demand for Plumpy'nut by the organizations that distribute the product. Therefore, any constraints on the supply of Plumpy'nut today will likely increase in the future as these new WHO malnutrition standards become institutionalized.

Additionally, Nutriset's "Plumpyfield" initiative has not done enough to alleviate the problems of price and supply in Niger. While the STA factory no doubt contributes to local employment and the support of local peanut production, it does not provide a sufficient or reliable supply of Plumpy'nut for Niger and in fact puts a higher price on

Plumpy'nut, partially as a result of the payments it must make to Nutriset for Plumpy'nut's vitamin mixture. The "quality control" that Nutriset has over STA appears to force importation of components (like the vitamin mixture and milk), which lead to higher prices. Additionally, while the local production of Plumpy'nut is good, as it stands now all licensed factories have a low level of Plumpy'nut output. Currently, the highest output is that of STA in Niger and Hilina in Ethiopia, at 3,600 metric tons per year, and the lowest output is that of JAM in Madagascar and AMWILI in the Democratic Republic of Congo at 540 metric tons per year (Nutriset 2010). If STA in Niger, with the highest level of local production, only contributes minimally to the supply of Plumpy'nut used in Niger, then it is safe to assume that the story is similar in the other countries with local producers. With the current licensing system, it is clear there is no real competitor to Nutriset and for there to be a more substantial impact on the global supply and price of Plumpy'nut, larger companies and factories would have to enter the market. This appears to be exactly what Nutriset is trying to prevent with its previous lawsuit against COMPACT supplying to Kenya and with its current fight with U.S. based Breedlove Foods Inc and the Mama Cares Foundation.

Beyond the Patent: the Limits to Plumpy'nut's Use as a Foreign-Supplied Technology

While the interviews with Plumpy'nut distributors in Niger gave important insight into the implications of Nutriset's patent and licensing system, the interview at UNICEF raised important questions about the limitations to Plumpy'nut's use as a technology. The nutritionist at that organization stated that the biggest limitation to UNICEF's effective distribution of Plumpy'nut was local infrastructure. The nutritionist stated that there was a lack of health knowledge to ensure Plumpy'nut was being utilized properly and also insufficient transportation infrastructure to reach all of the needy populations. Even when

sufficient quantities of Plumpy'nut did exist, UNICEF could not reach all the malnourished children in Niger.

While Plumpy'nut has had enormous success in treating severe malnutrition, its distribution does not address the root of the problem, which is why are children starving in the first place? Plumpy'nut is a "band-aid" solution, which serves to temporarily fix the results of a deep-rooted problem without getting to the problem's source and causes. The same lack of knowledge and poor infrastructure that make it impossible for UNICEF to reach all of the children it targets likely also contribute to the initial hunger and poor health of those same children. If the distribution of Plumpy'nut is not coupled with strategies to improve infrastructure, from roads to clinics, and programs to increase health education and knowledge, Plumpy'nut will not reach its optimal level of effectiveness.

In criticism of the focus on Plumpy'nut as a main method to combat hunger, Marion Nestle, a nutrition professor at New York University, said: "Over the long haul items such as Plumpy'nut can teach children that food only comes in a shiny wrapper from a faraway place. If you want to solve nutrition problems, you need to go into a society and show people how to grow foods" (Mercer 2010). This criticism, and the previous limitations observed from poor infrastructure and a lack of health knowledge, tie into the problems with the Western medical model. Plumpy'nut is distributed as a medicine by foreign aid agencies. While it is an important technology that has the potential to save millions of lives, it should not be viewed as the cure-all to child malnutrition. Rather, Plumpy'nut should be viewed as a temporary fix that needs to be coupled with long-term strategies aimed at improving the cultivation and consumption of locally available nutritious foods and with education campaigns that show communities the nutritional reasons behind why Plumpy'nut works.

Comparative Case I: Golden Rice

Vitamin A Deficiencies and Golden Rice:

In the developing world, micronutrient deficiencies cause numerous health problems in children. One of the three most important micronutrients is Vitamin A (the other two being iodine and iron) (WHO 2010). Vitamin A is obtained from the consumption of specific animal products (eggs, milk, liver), fruits (apricots, peaches, mangoes), and vegetables (carrots, spinach). When populations lack access to these foods, Vitamin A Deficiency (VAD) occurs (WHO 2009). In developing countries, VAD is common and is the leading cause of preventable blindness (referred to as "night blindness) in children. Children deficient in Vitamin A are also at a higher risk for deadly diseases like diarrhea and measles and are more likely to suffer from anemia. Around 250 million children are Vitamin A deficient before reaching school age. Of the Vitamin A deficient children, 250,000-500,000 of them become blind annually from the deficiency, with half of those blind children dying within a year (WHO 2010). Globally, 33.3% of children under the age of 5 are Vitamin A deficient and .9% of children suffer from night blindness as a result (WHO 2009).

A lack of access to animal products, fruit, and vegetables is the main cause of Vitamin A Deficiency in the developing world. In many poor communities, families rely on the consumption of grains, like rice and sorghum, that are a source of carbohydrates but lack many essential nutrients (Golden Rice Project 2010). This issue has led researchers to develop a new technology, Golden Rice. Golden Rice is a genetically modified rice grain that has been developed to contain higher levels of Vitamin A than what normally occur in rice. In naturally occurring rice, beta-carotene (the precursor to Vitamin A found in vegetables) occurs in the plant's vegetative tissue, but not in the

grain. Through biotechnology, the endosperm (which is the edible part of the rice grain) of Golden Rice has been genetically modified to allow for beta-carotene accumulation. This allows Golden Rice to serve as a larger source of Vitamin A for consumers (Golden Rice Project 2010).

In countries where more than 400 grams of rice are consumed per day, like Bangladesh and Cambodia, Golden Rice researchers claim that the introduction of Golden Rice will keep Vitamin A at the appropriate and healthy level in populations. Proponents of Golden Rice believe that the technology acts as an alternative solution to communities that depend on rice, which includes about 3 billion people globally, and are unable to access animal products, fruit, and vegetables either because of their geographical location or economic situation (Golden Rice Project 2010). Proponents argue that Golden Rice is a sustainable solution because Golden Rice seeds require the same inputs as un-modified seeds and provides the same rice yields. Additionally, once farmers obtain the first Golden Rice seed, they can obtain new seeds from the Golden Rice plant for future cultivation (Potrykus 2004).

Plumpy'nut and Golden Rice: Similarities and Differences

Plumpy'nut and Golden Rice are both technologies developed to help alleviate nutrition-based disorders in children. Both technologies deal with an issue that is caused by food insecurity in developing countries. Both severe malnutrition and VAD are caused by a lack of access to an adequate food supply. Neither technology seeks to change the pattern of agricultural distribution in the developing world. Plumpy'nut provides a food-based cure after malnutrition has set in and Golden Rice seeks to change the quality of the rice that is already being consumed without altering global consumption patterns or changing the allocation of different types of agricultural products.

Another similarity between the technologies is their control by private company patents. Plumpy'nut is fully controlled via an international patent by a private French company Nutriset. Golden Rice has been developed through a partnership of different researchers, institutions, and companies. However, the rights to the final product are held by the multi-national agribusiness Syngenta (Golden Rice Project 2010). Like Nutriset, Syngenta and the Golden Rice Project state that it did not the develop its technology for profit and it outlines the ways in which it will grant licenses for research institutions in developing countries to develop different strands of Golden Rice using local rice varieties. Syngenta also states that it will allow "free licenses for humanitarian use" which will allow farmers to obtain seeds at no additional charge (i.e. the same cost as unmodified seeds) if they have an annual income of below US $10,000 (Golden Rice Project 2010). Nutriset and Syngenta each defend its acquisition of patents for humanitarian products and state that while it hold the intellectual property rights to Plumpy'nut and Golden Rice, its primary goal is not profit and it is dedicated to making its products accessible for humanitarian use.

Although Plumpy'nut and Golden Rice tackle a similar child health issue and are both controlled by private company patents that claim to hold no profit-based motivation, the two products possess several differences. To start, the utilization of the technologies has been vastly different. Plumpy'nut is widely used and has become the method of malnutrition alleviation promoted by international organizations like the WHO and UNICEF. Plumpy'nut has proven to be effective and has saved million of lives already since its debut in the late 1990s (Bhandari and Tiplady 2005).

Golden Rice, on the other hand, has yet to be widely used. Because the grain is a genetically modified organism (GMO), there have been many restrictions to its distribution (Portrykus 2004). Globally, there exist numerous concerns regarding GMOs. One major

concern is that genetically modified organisms have the potential for horizontal gene transfer in which the modified gene from the GMO is spread to neighboring plants, causing unintended consequences (Shiva 2000). Another worry is that GMOs may contain unknown health risks and cause allergic reactions because of their genetic mutation (Shiva 1997). A major criticism of genetically modified seeds is that many GMOs don't have the ability to reproduce and farmers must buy new seeds every year, creating dependence on the corporations that produce the seeds (Shiva 1997). Lastly, critics worry that the expansion of genetically modified seeds will lead to diminished biodiversity, loss of local agricultural knowledge, and increased reliance on single varieties of seeds controlled by companies rather than farmers (Shiva 2000). Because of these global concerns regarding GMOs, there have been many barriers to the proliferation of Golden Rice. Golden rice faces many regulatory hurdles and must meet the biosafety and environmental requirements of the countries where it wishes to be utilized. This means that Golden Rice has still only been used in experimental trials and it has not yet reached its target farmers and communities. It won't be until 2011 that Golden Rice can be distributed in its first country (Golden Rice Project 2010). This is a significant difference from Plumpy'nut, which has faced no regulatory issues and has been distributed widely; already proving it's effectiveness as a product.

The second difference between Plumpy'nut and Golden Rice regards the complexity of the product's development and design. Dr. Andre Briend, the inventor of Plumpy'nut, began developing the Ready-To-Use-Therapeutic-Food in 1997. Within three years, Plumpy'nut was being produced and distributed around the globe (Bhandari and Tiplady 2005). Plumpy'nut is a very simple product and made by combining commonly available products into a paste.

In contrast, the development of Golden Rice has been lengthy and complex. Led by Dr. Ingo Potrykus, the development of Golden Rice began in 1980. In the 1980s, the technology to transfer new genes to rice was developed. In the 1990s, the gene for Vitamin A synthesis was introduced into the rice seed. Finally, in 2004 two types of Golden Rice seeds were finalized and deemed ready for use. Currently, the Golden Rice Project is working on creating Golden Rice seeds based on local rice varieties found in target countries and they anticipate that the first distribution to farmers will occur in 2011 (Golden Rice Project 2010). This whole process from conception to implementation will have taken over 30 years by the time any poor farmers in the developing world can actually obtain the technology. Additionally, while a single patent and a single company, Nutriset, exclusively control Plumpy'nut, the creation of Golden Rice involved multiple patents and the cooperation of multiple companies and research institutions. Researchers at the University of Freiburg and ETH-Zurich developed the initial patented technology and technique for creating Golden Rice. To recreate Golden Rice on a larger scale, the researchers needed access to a package of technologies that allow traits to be engineered into rice. The researchers obtained a license to these patented technologies through a partnership with Syngenta that had obtained licensing approval from four other Agriculture and Biotech companies: Bayer AG, Monsanto Co, Orynova BV, and Zeneca Mogen BV. As a result of Syngenta's cooperation with the Golden Rice inventors, the commercial rights and patent to Golden Rice were given to Syngenta, which now has the control over the final Golden Rice technology (Golden Rice Project 2010). Overall, the final Golden Rice product, held by Syngenta, is formulated from methods and technologies that are held by seventy different patents (Kryder et al 2000).

The Implications of the Patent on Golden Rice:

Because Golden Rice has not yet been openly distributed on the international market, it is too early to tell if the control of Golden Rice by Syngenta will have an impact on the supply and price of Golden Rice similar to that of Nutriset's patent on Plumpy'nut. Until now, pre-existing patents have slowed the development of the Golden Rice technology. Seventy different patents hold the rights to the technologies and techniques used to produce Golden Rice. These include technologies like plant transformation vectors (a technology that allows the transfer of genes), agrobacterium transformation (the technique used to transfer genes), rice generation technologies, and more (Kryder et al 2000). Syngenta had to coordinate the approval of all seventy patent-holders, stemming from a wide range of research institutions and corporations, to produce the final Golden Rice technology (Golden Rice Project 2010). This coordination of patents no doubt contributed to the slow development of Golden Rice over the past thirty years.

The Golden Rice case shows that when complex biotechnology is being developed to treat dire health issues in developing countries, patents may complicate and slow down the process. Creating biotechnology for the world's poor is a lot different than creating a simple, Ready-To-Use-Therapeutic-Food like Plumpy'nut. Plumpy'nut was created from scratch, with no pre-existing patents on peanuts, milk, or vitamins. However, new biotechnology depends on previous scientific developments that are almost undoubtedly patent controlled. By using biotechnology for humanitarian use, potential complications can arise not only from the corporation that produces the final product, but also from all the previously patented technologies that go into making the technology for humanitarian use. Although Nutriset didn't face this problem with Plumpy'nut, allowing a patent for

Plumpy'nut sets precedent for future improvements on the technology to be slowed and limited by pre-existing patents, similar to the experience of Golden Rice.

In regard to the supply and price of Golden Rice, only hypothetical predictions can be made at this time. If Syngenta follows through on its promise that Golden Rice seeds will be sold to poor farmers (i.e. those making under US $10,000/year) at the same price as traditional seeds, then Syngenta's patent shouldn't cause the cost of Golden Rice seeds to be overpriced. However, currently most small, poor farmers don't buy seeds but rather cultivate new seeds from their existing plants (Shiva 2000). Therefore, investing in a new variety of seeds may prove to be too costly for them even if the price is the same as traditional varieties and the venture might appear risky since farmers have no previous experience cultivating Golden Rice. As a result, putting any price on Golden Rice seeds may inhibit farmers from purchasing them. Hypothetically, if, as they claim they will, Syngenta allows licensing of Golden Rice production to local breeding institutions that will create Golden Rice using local rice varieties, the supply should be readily available at the local level (Golden Rice Project 2010). However, as shown with the Plumpy'nut case, in the previous section, local licensing does not mean a steady supply. Even with the existence of local Plumpy'nut producers, the supply of Plumpy'nut was not sufficient and was unstable. In the case of Golden Rice, licensing will be a complex process involving a biosafety assessment that will be too costly to many breeding institutions in developing countries. However, under Syngenta's licensing agreement, no export of Golden Rice is allowed and production can only be utilized for domestic consumers (Golden Rice Project 2010). This means that no breeding institutions in developed countries, where they are more likely able to finance a biosafety assessment, will be able to produce Golden Rice for export to developing countries. Therefore, it appears that like with Nutriset, Syngenta will

allow local production where capacity is lacking and will disallow production in developed countries where institutions have greater finances and facilities. This may lead to the same problem of restricted local supply that is seen with Plumpy'nut.

The Limitation to Golden Rice as a Technology:

Once biosafety assessments are carried out and local breeding institutions are able to produce Golden Rice, we will be able to see whether the technology is successful at alleviating Vitamin A Deficiency. However, Golden Rice faces many potential limitations as an effective technology for improving child health in developing countries. Golden Rice is a complex piece of biotechnology created as a solution in the laboratories of developed nations. Over the past thirty years, 100 million dollars have been spent on the development of Golden Rice (Ho 2000). These are funds spent before Golden Rice was ever used in developing countries to prove its effectiveness. Additionally, it is still uncertain whether farmers will want to adopt Golden Rice on their land. Already, many governments have expressed concern that their populations will be reluctant to start cultivating a foreign-looking gold-colored variety of rice (Fessenden 2009). This limitation differs slightly from Plumpy'nut. Although Plumpy'nut is currently too expensive for most needy populations to afford, its development was not particularly costly and given the success of Plumpy'nut in treating severe malnutrition, no one has seriously questioned the allocation of resources used to develop the technology.

Enormous amounts of time and money have been spent to develop a new Vitamin A rich crop. However, why not spend that money and time to promote the existence of pre-existing and naturally occurring sources of Vitamin A? There are many cheaper sources of Vitamin A that could be encouraged instead of Golden Rice, like green vegetables, carrots, or unpolished rice (Ho 2000). The entire reason that Golden Rice was developed was

because white rice consumed in developing countries did not contain Vitamin A. However, this only occurs in unpolished rice. The aleurone layer (i.e. the outside layer) of rice contains many vitamins, and is a source of Vitamin A. However, the aleurone layer can spoil in storage, so it is usually removed to create "polished rice" that no longer provides Vitamin A. Polished rice has been encouraged for export production, because it doesn't spoil. However, unpolished rice could be promoted for home and local consumption and would provide a natural form of Vitamin A (Ho 2000). Additionally, biofortification has been successful at increasing Vitamin A content in sweet potatoes. Using natural plant breeding methods, orange-fleshed sweet potatoes were developed to contain a higher level of beta-carotene (the precursor to Vitamin A) than the traditional white-fleshed sweet potatoes. By consuming orange-fleshed sweet potatoes instead of the white-fleshed variety, Vitamin A Deficiency can be prevented in populations (Low et al 2001). Biofortified orange-fleshed sweet potatoes were easier to develop than Golden Rice and did not face the same biosafety restrictions of Golden Rice. As a result of this, orange-fleshed sweet potatoes have already been adopted in parts of Sub-Saharan Africa (Fessenden 2009). A similar effort to breed improved existing rice varieties might have been technically feasible and more cost effective than the Golden Rice project.

For a technology that has taken up so much time and money, Golden Rice neglects a large percentage of the global population with Vitamin A Deficiency. Syngenta and the Golden Rice Project wish for Golden Rice to be distributed in the regions of the world where rice is grown as a primary staple crop and rice already constitutes a large share of the diet (Golden Rice Project 2010). The countries where the highest quantity of rice is consumed lie predominantly in Asia. These countries, where more than 400 grams of rice are consumed per day, are Bangladesh, Cambodia, Indonesia, Laos, Myanmar, and

Vietnam. For countries that consume more than 200 grams per day, there are some African and Latin American countries, like Burkina Faso, Senegal, Madagascar, Guinea, Suriname, and Guyana. However, the majority of countries where Golden Rice will be promoted are in Asia (Golden Rice Project 2010). This leaves out a large number of children afflicted with Vitamin A Deficiency. For example, in Africa 44.4% of children are affected by Vitamin A Deficiency, totaling 56.4 million children (WHO 2009). Since rice is not the staple crop in many African countries, and Golden Rice therefore won't be targeted at them, many of these Vitamin A deficient children will not see any benefits from Golden Rice. This differs from Plumpy'nut, which can be distributed wherever the need exists, and hinders the global impact that Golden Rice can have on Vitamin A Deficiency.

The development of Golden Rice is no doubt an accomplishment for the advancement of scientific research and biotechnology. However, Golden Rice may not be the most cost-effective and beneficial way to tackle Vitamin A Deficiency given traditional and naturally occurring forms of Vitamin A are cheaper and already exist (Ho 2000). Additionally, simply creating one new form of Vitamin A in a laboratory won't change the fact that the poor populations in developing countries need a more diversified diet (Ho 2000). Even if communities increase their intake of Vitamin A with Golden Rice, they will still be lacking a variety of other nutrients like iodine and iron. Since the degree of Vitamin A absorption is dependent on the overall nutritional status of an individual, increasing Vitamin A consumption without increasing the consumption of other key nutrients will restrict Vitamin A absorption (Ho 2000). Lastly, the promotion Golden Rice in just a few countries means that millions of children suffering from Vitamin A Deficiency in the many countries where rice is not a staple crop will see no improvements to their health from the millions of dollars spent on developing Golden Rice.

Lessons for Plumpy'nut from Golden Rice:

The coordination of patents has no doubt slowed the development of Golden Rice. While Nutriset did not have to gain the approval of prior patents before they developed Plumpy'nut, the Golden Rice case serves as a future warning. If companies want to improve upon the Plumpy'nut formula, they will need to gain Nutriset's permission. Technologies always have the potential to improve and to adapt. However, with the patent on Plumpy'nut being so broad and essentially covering any nut-based foods used to cure malnutrition, new developments of nutrition products may be limited (Mercer 2010). The patent on Plumpy'nut runs the risk of slowing down the development of future Ready-To-Use-Therapeutic-Foods in the same way the formulation of Golden Rice was slowed by prior patents. For Plumpy'nut to be as helpful as possible in the fight against child malnutrition, conditions should be made with Nutriset's patent that allow companies to develop new nut-based technologies that deviate from Plumpy'nut's exact formula.

Comparative Case 2: Oral Rehydration Therapy

Child Diarrhea and Oral Rehydration Therapy:

After malnutrition, diarrhea is the second leading cause of deaths to children under five worldwide. Annually, diarrhea causes 1.5 million child deaths. Most deaths from diarrhea occur throughout the developing world where unsanitary living conditions and contaminated food and water lead to over a billion cases of diarrhea each year. Diarrhea causes severe dehydration, which is usually what ultimately leads to fatality. (WHO 2010)

Although diarrhea remains a leading cause of child deaths, there has been vast improvement in treating the dehydration resulting from diarrhea. In 1968, Richard Cash

and David Nalin, two researchers from the Harvard School of Public Health working in Bangladesh, developed and tested a formula for preventing and treating dehydration caused by diarrhea (Kiewra 2007). The development, Oral Rehydration Therapy (ORT), involves a simple solution of salt, sugar, and water and it works wonders at preventing dehydration in diarrhea patients (Kiewra 2007). The glucose, found in sugar, allows sodium, found in salt, to more effectively cross the semi permeable membrane of the small intestine. Sodium carries water and if it is able to cross the membrane of the small intestine, more water will also cross the membrane and be absorbed by the body. Therefore, the combination of water, salt, and sugar allows for better water retention as patients suffer from diarrhea, subsequently preventing dehydration and death (Quotah 1999). Cash and Nalin showed that ORT worked just as well as the IV solution therapy that was previously used to treat dehydration caused by diarrhea. The IV therapy was more costly than ORT and relied on clinics, which many diarrhea victims did not have access to (Kiewra 2007). With ORT, treatment can be administered at home and therefore ORT can reach rural communities and aid in emergency situations, like refugee camps, where clinic access is restricted (Ruxin 1994). Additionally, ORT eliminates much of the potential for over-hydration caused by intravenous methods where miscalculations by nurses or doctors could cause too much of the hydrating solution to be pumped into patient's blood. With ORT, researchers have proven that patients will drink the solution, which with a salt and sugar mixture allows water to be better absorbed, until they are hydrated, so close monitoring of intake is not needed like with the intravenous solutions (Ruxin 2006).

The discovery and adoption of Oral Rehydration Therapy as a method for treating diarrhea-induced dehydration has had an enormous impact on health in the developing

world. Since 1978, when the World Health Organization implemented the use of ORT in its programs, an estimated 40 million lives have been saved by the formula. Additionally, since 1978, ORT has contributed significantly to lowering the number of annual child deaths due to diarrhea from 5 million to 1.9 million (Kiewra 2007).

Oral Rehydration Therapy and Plumpy'nut: Similarities and Differences

At first glance, Oral Rehydration Therapy and Plumpy'nut are very similar products. The formulas for both Plumpy'nut and ORT were developed to address child health in the developing world. Malnutrition and diarrhea are the two leading causes of child deaths globally (WHO 2010). Plumpy'nut and ORT both seek to prevent deaths from these leading causes through curative means after either malnutrition or diarrhea has set in.

Additionally, both Plumpy'nut and ORT are heralded with being simple solutions that improve on previous clinic-based treatment for common childhood ailments. Plumpy'nut is often referred to as a "simple" formula, made by the combination of a few key ingredients: peanuts, vegetable oil, milk, and vitamins and minerals (George 2005). Plumpy'nut is so simple that its inventor compared it to the common household food Nutella (Wines 2005). Oral Rehydration Therapy is also incredibly simple. The formula is just a mixture of salt, sugar, and water, in specific proportions that can be made and administered by almost anyone (Ruxin 1994).

Both products have revolutionized treatment for their disease and have been idealized by the media. Plumpy'nut has been referred to as a "magic potion" (George 2005). Oral Rehydration Therapy has been called a "magic bullet" (Ruxin 1994). The "revolutionary" aspect of each product has come in part from its movement of treatment from intravenous and clinic based to oral and home based. Before Plumpy'nut,

malnutrition was treated with milk IV drips in clinics. Plumpy'nut, on the other hand, can be administered orally by mothers to their children in the home (Wines 2005). Before ORT, dehydration from diarrhea was also treated by a solution administered by IV drip in clinics. ORT, like Plumpy'nut, allows treatment to be done orally at home (Ruxin 1994). In developing countries, where poor communities have limited clinic access, home-based treatments allow a much larger number of patients to receive treatment. Plumpy'nut and ORT both allow for this.

Despite their many similarities as simple medical technologies used to treat children in the developing world, the administration and production of ORT and Plumpy'nut have been handled very differently. The main difference between the two products is that the ORT formula was never patented by its developers while Plumpy'nut has been under the control of Nutriset's patent since it was originally formulated. When questioned about why he never patented ORT, Richard Nash, one of ORT's developers, responded both that he did not think it was an option for his research team, in 1968, since they were employed by the US Public Health Service and not a private company. He also stated that at the time he had never thought of the possibility of a patent for ORT (Gorman 2007). ORT and Plumpy'nut are very similar products yet about 30 years after ORT was developed and not patented Plumpy'nut was able to receive a patent.

The Outcomes of a Non-patented ORT formula:

As a non-patented technology, the exact formula for Oral Rehydration Therapy is openly available and advertised. WHO and UNICEF have adopted and promoted specific instructions and proportions for manufacturing ORT (Werner and Sanders 1997). This formula involves the following:

Glucose (a simple sugar) 20.0 grams
Sodium chloride (table salt) 3.5 grams

Potassium chloride 1.5 grams
Trisodium citrate, dehydrate (formerly sodium bicarbonate) 2.9 grams
1 liter of water

Many manufacturers have adopted this formula and produce ORT in a range of forms. Using UNICEF/WHO production guidelines, Oral Rehydration Therapy has been produced in packets, pre-mixed with water in cans, with added flavoring, and more. In 1997, 400 million packets of ORS were produced annually with two-thirds of production occurring in 60 developing countries (Werner and Sanders 1997). Production of ORT also occurs throughout the developed world, with companies advertising the sale of Oral Rehydration Therapy products scattered across Europe and North America (Rehydration Project 2009). Online Oral Rehydration Therapy vendors market the solution under various names and prices, including: Chinook Medical Gear at $1.15 per packet, Adventure Medical Kits at $2.65 per packet, and Traveler's Supply, Inc at $1.98 per packet.

Compared to Plumpy'nut, Oral Rehydration Therapy merchandise is produced by a much larger number and wider range of companies. Items are both made locally and imported from developed countries (Werner and Senders 1997). There has been obvious competition between producing companies, who have tried to improve on their version of ORT by creating dissolvable ORT tablets or adding different flavors to be more appealing to taste (Werner and Sanders 1997). The supply of ORT is clearly reliant on a much larger array of suppliers than Plumpy'nut, which is almost completely dependent on Nutriset.

Additionally, the majority of ORT producers have sprung up in the developing world (Werner and Sanders 1997). Nutriset partially justifies its patent by stating that it needs to help licensed factories in developing countries with Plumpy'nut production and

quality control (Nutriset 2010). However, it is clear from the ORT example that local factories will begin to produce aid products that are in high demand without the oversight and assistance of a larger company.

Lastly, while Plumpy'nut is almost completely distributed by UNICEF, less than 25% of ORT distribution has historically relied on UNICEF (Werner and Sanders 1997). This may be a result of the wider range of autonomous ORT producers who can sell directly to local distributors or other NGOs and organizations besides UNICEF. Although large international institutions, like UNICEF and WHO, have propagated both ORT and Plumpy'nut, ORT has been able to spread beyond the scope and control of these international organizations while Plumpy'nut remains very much a product distributed by the international aid community.

The Limitations to Oral Rehydration Therapy:

Although Oral Rehydration Therapy has been enormously successful, and despite the fact that there has been no patent limiting its production or distribution, there have been limits to the success of ORT as a technology. While the use of ORT has greatly reduced the number of children dying from diarrhea, death from diarrhea remains the second leading cause of child mortality and 1.5 million children are still dying from diarrhea each year despite the fact that ORT is known to be an effective treatment (WHO and UNICEF 2009). In the developing world, currently only 33% of children with diarrhea receive one or more packets of Oral Rehydration Therapy. In rural areas of developing countries, only 31% of diarrhea cases receive ORT and among the poorest sectors of society only 28% receive treatment with ORT (WHO and UNICEF 2009). Therefore, in the poor, rural areas of the developing world, the vast majority of children with diarrhea are not receiving the life saving technology.

Critics of ORT blame the commercialization of the product for the inability of the poorest, most rural families to access and use the therapy. The private sector has been encouraged to produce ORT to increase the availability of the product and in fact the majority of ORT has been produced and distributed by the private sector (Werner and Sanders 1997). Even though private sector competition, versus patent controlled production, should bring the price of ORT down, the cost of the commercial product still remains a burden on poor families worldwide. For many needy communities, a single packet of Oral Rehydration Therapy costs ¼ to ¾ of their daily wages (Werner and Sanders 1997). Currently, 2.7 billion people live on less than 2 dollars a day, amounting to more than 50% of the developing world's population (World Bank 2004). Even when the price of ORT is at its lowest, which has been documented as 5 cents per packet, the cost may be too high for poor families in the developing world. Even if families can afford a packet, they often can't afford enough packets for a full course of treatment and since diarrhea is often a reoccurring problem, continually paying for packets of Oral Rehydration Therapy may not be sustainable or possible for many needy families (Werner and Sanders 1997).

Another major setback to ORT, beyond cost, is access. Although ORT is considered a "home-based" remedy, its use still involves obtaining the packet of ORT, which then can be brought home and mixed with water. Because ORT is such a simple solution, it is possible for the Oral Rehydration Therapy mixture to be made in the home. However, the large aid institutions like UNICEF, USAID, and the WHO have promoted the distribution of pre-packaged ORT over the encouragement of homemade ORT. The justification for this is that pre-packaged ORT ensures the correct doses and proportions of salt, sodium, and glucose that allow ORT to have the maximum effectiveness. These

institutions favor a top down approach and have concerns that mothers will incorrectly make the Oral Rehydration Therapy mixture in the home (Werner and Sanders 1997). However, in many cases obtaining pre-packaged ORT is not feasible, not only because of price, but also because of the distance from clinics or distribution centers. It is clear that rural diarrhea patients receive less access to ORT than more urban patients, with 39% of urban diarrhea patients receiving ORT and only 31% of rural patients receiving ORT (WHO and UNICEF 2009). Another study, conducted in Bangladesh showed that children living five miles away from a clinic were three times more likely to die from diarrhea than children within a five-mile radius of a clinic (Werner and Sanders 1997). In other cases, some mothers who traveled long distances to obtain packets of ORT for their children arrived at clinics too late and their child had already died from diarrhea and dehydration (Werner and Sanders 1997).

In order to improve the use of ORT in isolated communities, mothers can be trained in homemade ORT. When there is not the time or money to gain ORT from a clinic, mothers can make the solution with salt and sugar found in the home. Pamphlets have been developed that show pictures of how much salt and sugar to use by showing a photograph of the approximate amount in a person's hands. Additionally, explaining the reasoning behind ORT, that salts and sugars are needed to help with water absorption, gives communities health knowledge and makes ORT less of a medicine and more of a method. These strategies decrease dependency on outside organizations and put more control into hands of the local community. Although this type of program has been used less often, it has been successful when and where is has been utilized (Werner and Sanders 1997).

Lastly, it is important that ORT work be coupled with prevention measures. Throughout the developing world, poor sanitation and low water quality continue to persist. For example, 1 in 4 people in developing countries must practice open defecation with no latrine or sewage system (WHO and UNICEF 2009). While focus on ORT as a remedy for diarrhea is important, without simultaneous focus on prevention and improved sanitation, children will continue to die from diarrhea.

Lessons for Plumpy'nut from Oral Rehydration Therapy:

The developers of Oral Rehydration Therapy followed a different path from Nutriset and the scientists behind Plumpy'nut. ORT was never patented and as a result its production has spread throughout the globe and beyond the control of international aid organizations like the WHO and UNICEF. ORT is primarily produced locally unlike Plumpy'nut's European-based production. Additionally, the competing manufacturers of ORT have invested in new varieties of the formula (tablet based, flavored, etc) in order to better market their version. Nutriset, on the other hand, limits manufacturers who are trying to produce any Plumpy'nut style formula that can fall under their patent. Therefore, the lack of a patent on ORT seems to have increased the number of producers, increased local production, and encouraged competitive improvements to the formula compared to the patent controlled Plumpy'nut.

However, despite the lack of a patent, the price of ORT continues to be too high for many families in the developing world. Additionally, despite the existence of a wide range of local and international producers, many communities do not have access to clinics or other locations where they can obtain commercially prepared ORT. The issue of access is also important for Plumpy'nut. Aid agencies cannot reach all communities afflicted with malnutrition and it is likely that even if the price of Plumpy'nut were

lowered, most families suffering from a lack of adequate food would still not be able to afford the treatment. Malnourished children continue to be fully dependent on the ability of aid agencies to supply them with Plumpy'nut.

Homemade ORT and knowledge sharing over hydration and sanitation are one way to increase access to the benefits of ORT where prepackaged ORT is unfeasible. Because of the similarities between ORT and Plumpy'nut, it is possible that the benefits of Plumpy'nut could also be obtained through homemade formulas and knowledge sharing. Many parts of the world where Plumpy'nut is most needed are also the areas of the world where peanuts are a major agricultural product. For example in Chad, 31% of children are malnourished (UNICEF 2010). Chad also is the world's 8th largest producer of peanuts (Soyatech 2010). In Mali where 32% of children are malnourished (UNICEF 2010), peanut production is the 19th highest in the world (Soyatech 2010). Although Plumpy'nut is vitamin enriched peanut butter, peanuts alone are very nutritionally rich (Griel et al 2004). Encouraging peanut production and consumption and explaining the nutritional benefits of peanuts to communities may be one way to learn from the success of Plumpy'nut and move beyond viewing the technology as one that has to be produced in a factory, pre-packaged, and distributed to dependent communities.

Similar to Plumpy'nut, ORT is a curative solution that does not get to the root of the problem. Although ORT has contributed significantly to reducing the deaths due to diarrhea, diarrhea remains a prevalent health problem. Many of these cases are caused by poor sanitation and water quality coupled with poor nutrition that makes children even more vulnerable to diarrhea (WHO 2009). These structural factors will continue to cause diarrhea no matter how widespread Oral Rehydration Therapy becomes. The same is true for Plumpy'nut. If communities continue to experience food insecurity, Plumpy'nut will

simply be trying to play catch-up to the cases of malnutrition prevalent throughout the globe. With successful curative technologies, like ORT and Plumpy'nut, it is important not to over-focus on restoring people to health. Resources should be allocated towards preventative changes that will reduce the need for therapeutic technologies.

Conclusion

The Importance of Effective and Sustainable Aid:

The year 2015 is fast approaching and it appears improbable that the targets set by the international community in 2000 via the Millenium Development Goals will be reached by their promised date. The fourth Millenium Development Goal deals with child health and the need for the reduction of child mortality. However, in 2010, child mortality persists and the fact remains that the chance of a child's survival in this world is heavily dependent on the geographic location where they are born. Child survival chances are highly unequal across the globe and in developing countries the majority of child deaths still occur from known, preventable causes.

In response to this problem, there have been many different strategies proposed for improving child health. Since the institutions of the developed world are primarily where policy regarding international development and humanitarian aid is made, it makes sense that technological fixes would be an attractive option for addressing the problems of child health. Under the "Western medical model", the development of precise medicine created in laboratories under the supervision of expert scientists is viewed as the best way to tackle health problems (Werner and Sanders 1997). In the United States, biotechnology is used to ameliorate problems of crops failure and assure that the country will have a stable food supply (Paarlberg 2008). Overall, in the developed world, investment in the advancement of scientific technology is generally heralded as bringing

the solutions to problems. In this context, technological fixes become very appealing as a way to structure humanitarian aid for child health.

While technology can sometimes provide the answer, there are many limitations to technological fixes, especially in the context of child health in the developing world. When the research institutions and corporations of the developed world create new technologies for humanitarian aid purposes, problems come up regarding their effectiveness in achieving sustainable improvements in child health. To start, these technologies arise within the context of international patents that affect and may constrain their use in developing countries. More broadly, these externally introduced technologies are often temporary or expedient solutions that do not address the root causes of poor child health. Therefore, when aid programs place primary focus on technological fixes, they may be failing to reach their full potential for sustainable impact on disadvantaged populations.

The Role of Patents in the Humanitarian Aid Industry:

Through the comparison of Plumpy'nut, Golden Rice, and Oral Rehydration Therapy, several preliminary conclusions about the impact of patents on humanitarian aid products can be made. First, patents have the potential to restrict the supply of valuable aid technologies. Intellectual property rights give patent holders the right to control and restrict the production of their product. If the patent holding company decides to restrict the production of its product, then the supply of that product may not be able to meet its demand. When this limited supply applies to humanitarian aid products, then there can be dire consequences. As I have shown, this is the case with Plumpy'nut. Nutriset only allows specific local producers to manufacture Plumpy'nut and these producers tend to be small with low production capacity. Nutriset remains the primary manufacturer of

Plumpy'nut and actively prevents large, and competitive, companies from producing Plumpy'nut. In a developing country like Niger, with staggering rates of child malnutrition, distributors cannot obtain enough Plumpy'nut to meet the country's needs.

The liberating effect on supply that the absence of a patent can have is seen with Oral Rehydration Therapy. A wide range of producers throughout the world manufactures ORT. More than half of global production occurs in the developing world and companies and factories in developed nations have been free to produce ORT and export to low-income countries (Werner and Sanders 1997). This competition has even fostered improvements to the original ORT formula to increase its effectiveness. If one company had been able to control ORT from the beginning, it is unlikely that the supply of ORT would still come from such a large number of manufacturers all around the globe.

Patents also create gridlock and slow down the process of developing technologies that are needed for immediate humanitarian aid purposes. This can be seen most clearly with the case of Golden Rice. The development of Golden Rice involved the coordination of 70 different patents (Kryder 2000). Each patent-holding company had to approve for the humanitarian use of their technology (Golden Rice Project 2010). This no doubt slowed down the development of Golden Rice, which in the end took about 30 years. When technologies are being developed to help with humanitarian crises, like children dying and being blinded by Vitamin A Deficiency, patents can hinder the speed at which life-saving technologies can be created and distributed. Again, ORT was not faced with this problem and improvements to the formula could be made without waiting for the authorization of patent-holders to grant permission to build off the original formula.

Lastly, patents can inflate the price of a product, making it hard for organizations to purchase the amount needed for humanitarian aid purposes. In Niger, the price of Plumpy'nut has clearly been a limiting factor to distributor procurement of the product. If the price of Plumpy'nut were lower, aid organizations would be able to use Plumpy'nut more widely. Since Plumpy'nut is made of peanuts, oil, milk, and vitamins, it is hard to imagine that it is particularly expensive to produce. However, since the only other Plumpy'nut producers are the small local factories it has licensed, Nutriset does not face any true competition and feels no pressure to lower its prices. If other large companies were allowed to enter the Plumpy'nut market, as they wish to, it is likely that the price of Plumpy'nut would drop with the increase in its supply.

Overall, patents have the potential to limit the supply of products, inflate the price of products, and slow down the development of new products. For non-essential products, this may not be a problem. College students can wait in long lines to get the new Ipod, pay a little extra for that new Ipod, and wait a little longer until a competitor finds a legal loophole that will allow them to produce a similar model. However, limited supply, higher price, and longer wait times can have devastating and deadly ramifications when the technology's consumer base is poverty-stricken children in developing countries suffering from poor health.

The Limitations to Top-down Technological Fixes:

The limitations to technologies used for humanitarian aid goes deeper than the restrictions caused by international patents. The case of Oral Rehydration Therapy exemplifies this point. Although there was no patent on ORT to limit producers from manufacturing the technology, ORT was still unable to access many needy populations and deaths due to diarrhea continue to be a major cause of child mortality.

Outside imposed technological fixes run the risk of being "band aid" technologies. These are technologies that address the symptom of a problem without getting at the cause. This is the case completely with both Plumpy'nut and Oral Rehydration Therapy. Both technologies target children after they are already in the dangerous stages of either malnutrition or diarrhea. Plumpy'nut and ORT are important because they keep children from dying once they are sick. However, neither technology should be the primary solution advocated, because they are unable to change the causal factors that send children desperately to them.

While Golden Rice does act as a preventative technology, by providing children with more Vitamin A before deficiencies occur, the technology still runs the risk of trying to be a quick fix without addressing the structural causes of Vitamin A Deficiency. Golden Rice accepts that communities in developing countries do not have access to a diversified diet and it seeks to change that by improving one component of the rice-based diet that many depend on. However, since Vitamin A absorption relies on an overall healthy nutritional system, simply increasing Vitamin A intake without increasing the intake of other key nutrients limits how effective Golden Rice can be (Ho 2000).

Plumpy'nut, Golden Rice, and Oral Rehydration Therapy are all outside technologies formulated in the developed world for distribution in developing nations. Both Plumpy'nut and Oral Rehydration Therapy are pre-packaged in factories based on precise formulas. Although both Plumpy'nut and ORT are very simple in their design, they are presented as precise medicine to the mothers of children who need them. While when given the option, it is generally better to be precise with medical treatment, in the context of developing nations, focusing on a fixed medical regimen can be detrimental. The case of Oral Rehydration Therapy demonstrates this well. Where access to clinics is

limited, forcing mothers to obtain pre-packaged and Oral Rehydration Therapy from clinics often limited the mother's ability to get ORT to her child in a timely manner. Since ORT is so simple, it can be easily made at home if mothers are shown and trained how to do so (Werner and Sanders 1997). This situation could potentially be applied to Plumpy'nut and advocating for the consumption of peanut butter in the home might allow communities with poor infrastructure and lack of clinic access to mitigate the effects of malnutrition.

Golden Rice is not a pre-packaged medical formula, but it is a seed that is formulated in the laboratories of the developed world. Since many rural farmers in developing nations lack access to infrastructure and capital, it may be difficult for them to access stores where they can buy seeds and they may be unable to purchase them. Since natural sources of Vitamin A exist, encouraging crops like orange-fleshed sweet potatoes and unpolished rice may be a more effective and affordable way to reduce Vitamin A Deficiency.

At the end of the day, developing local capacity will usually be the most sustainable way to improve child health for the long-term. When communities depend on aid organizations for life-saving technologies, they are put in a risky situation. Aid budgets change, countries go into political turmoil, international politics can shift, and aid distributors may be forced to pull out of a country or region. For example, this past year the United States suspended much of their aid to Niger as a symbolic gesture against the unconstitutional continuation of power assumed by Niger's former president Mamadou Tandja (Reuters 2009). Overall, international aid funding is not stable.

Plumpy'nut, Golden Rice, and Oral Rehydration Therapy are all fundamentally based on simple concepts. A high intake of fat and protein will curb malnutrition, eating

food with higher levels of Vitamin A will reduce Vitamin A Deficiency, and consuming salts, sugar, and water will prevent the dehydration due to diarrhea. These principles can be delivered through technology, but they can also be encouraged through increasing local knowledge and finding cheaper, more accessible, and locally appropriate ways for them to be achieved.

Prospects for the Future:

This thesis is an initial exploratory study of the limitations that externally introduced technologies can face in their utilization for humanitarian aid. The purpose of this thesis is not to show that technologies are useless or unimportant for international humanitarian aid and development. Rather, this thesis seeks to challenge the notion of quick fix technologies. While it is an appealing idea, we should be skeptical about "magic bullet" technologies that claim to provide the solution to problems like poor child health in the developing world. By comparing Plumpy'nut to Oral Rehydration Therapy and Golden Rice, lessons can be learned to both improve upon Plumpy'nut and for the development of future technologies. For technologies developed for humanitarian aid, patents should be strongly questioned, as they appear to hold back the spread of important innovations. The use of externally introduced technologies should be coupled with programs that increase knowledge for why certain technologies work and that promote locally available, home made, and community owned solutions whenever possible. Additionally, when technologies focus on the outcome of a problem but not the cause, they must be used in conjunction with strategies to ameliorate causal factors.

Future research is necessary on different technological fixes, patented products, and alternative solutions to problems of poverty and social exclusion. By continuing to compare different technologies, a more concrete set of advisements could be made to

both companies developing technologies and to aid organizations involved with distributing humanitarian aid in the field. These questions are important both because funding is limited and because our global commitment to create long-term improvements in child health in developing countries is important. These questions also go beyond technologies used for child health. Future research could be done on different technologies used for agriculture, sanitation, reproductive and maternal health, and more.

In 2000, the 192 member states of the United Nations signed the Millennium Development Goals and agreed to have them achieved by 2015. This represented a pivotal moment where the international community acknowledged that the extreme inequality and poverty seen across our globe is unacceptable. In order to continue working towards the achievement of those goals, it is critical to ensure that the solutions we promote are both cost-effective and sustainable, with the ultimate goal being that communities will take ownership of the solutions to the problems they face.

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Appendix A: Key-Informant Interview Questions

1. Do you use Plumpy'nut in your nutrition work?

2. If yes, from where do you get Plumpy'nut?

3. If no, why have you decided to not use Plumpy'nut in your work and what products do you use instead?

4. What is the cost of Plumpy'nut for your organization or what would the cost be if you chose to buy it?

5. Do you prefer to use products that are locally grown and produced? If yes, what advantages do you see from local products? If no, what advantages do you see from imported products?

6. Are you aware of the patent on Plumpy'nut? If yes, how do you think the patent affects your organization's ability to use the product?