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Combating Poor Nutrition in India

Poor nutrition is arguably the greatest cause of human suffering in the modern age. Poor nutrition is an imbalance of one type of nutrient relative to other variables such as other nutrients consumed and the exercise levels of the consumer. Poor nutrition manifests itself as malnutrition and over-nutrition. In today's world, over three billion people, nearly half of the world's population, are chronically malnourished. Between one and two billion suffer from iron deficiency alone (Prakash). Malnutrition is caused by a lack or imbalance of certain types of nutrients necessary for a healthy life. In this paper, malnutrition is defined as a deficiency in one or more nutrients essential for health. Usually the nutrients lacking are micronutrients such as vitamin A, vitamin C, iron, calcium and zinc; or amino acids: the building blocks of proteins. Malnutrition results in a reduced ability to work and increased susceptibility to disease, and depending on the nutrients lacking: anemia, blindness, mental retardation, or death. The monetary costs of malnutrition may amount to as much as 5% of the GDP of some third-world countries.

At the same time, the number of over-nourished people is 1.7 billion and rising (Mascarenhas). Over-nutrition in this paper is defined as the consumption of too many calories relative to activity levels. Over time, over-nutrition leads to obesity, in which a person carries a dangerous amount of body fat. Obesity can lead to chronic and life threatening conditions such as diabetes, hypertension, and heart disease. While obesity is currently most prevalent in industrialized countries, it is increasing in frequency in many third world countries as well.

India is a country historically plagued by malnutrition. Even today, sixty-four hundred million Indians, 64% of the population of India are chronically malnourished (Kurtz). At the same time, 11% of the Indian population is over-nourished. While malnourishment is prevalent throughout India, over-nutrition is most prevalent in the cities. In fact, some city dwellers are both malnourished and over-nourished. This is possible because over-nutrition results from an excess of calories consumed whereas malnutrition is caused by a lack of quality in the food consumed.

India is a land of contrasts. The north is bordered by the Himalayas, the west by deserts. Much of the southern portion consists of the Deccan plateau with conditions ranging from moist to semi-arid. The richest farmland lies along the Ganges alluvial plain, also the area of highest population density. India is home to well over a billion people, of which 25% lie below its poverty line (India). India's median age is 24.66 years, and 31.2% of its population is under the age of fourteen. Only 59.5% of India's population is literate (India).

There are two types of Indian families that suffer from the ill effects of poor nutrition. One is the rural farm family. The rural farm family suffers primarily from malnutrition due to the inferior quality and variety of foods that they are able to grow on their land. The farm family in India owns only 1.7 hectares of land (Chopra). While India's average fertility rate is 2.78 children born per mother (India), the typical farm family must support many more than three children. Part of the reason for this is socio-economic: husbands typically want more children to work in the fields and to bring them social standing (Kurtz). The result is more mouths to feed and more people who have to share the same plot of land after the deaths of the parents. This not only contributes to small farm size, it also fuels the migration of people into the cities. For these families, it is important to increase the quality and the quantity of food farmed. Solutions must be feasible for families with little money or land on which to farm.

The second type of Indian family which suffers from the effects of poor nutrition is the urban family. While malnutrition in rural families tends to result from a lack of land and food, malnutrition in urban families results from a lack of jobs and money with which to buy food (Lochmann). For Indian families that live below the poverty line, an average of 70% of their daily income is used to purchase food (Swaminathan). This leads the urban family to buy the cheapest food available, usually food high in “filler” calories and low in micronutrients essential for health. The lack of micronutrients not only causes the family to buy more food, leading to obesity for some, it can also lead to malnutrition. Thus, solutions for these families need to focus on improving the quality of food imported into the cities from the countryside, and on increasing the income of the urban poor.

Many advances have been made in India over the past several decades. The Green Revolution has been successfully implemented to allow India to produce almost all of the staple grains its people need (Swaminathan). The problem of malnutrition however, is based in the quality of food instead of the quantity.

Historically, the development of new strains of popular grains has been one of the forces allowing for better nutrition. In the past, the only way to create a better grain was through hybridization, in which genes from one plant were transferred to another. Recently however, bioengineering has emerged as a more accurate method of transferring genes to plants, which are then labeled “transgenic.” Bioengineering can transfer genes to target plants not only from other plants but from almost any organism in existence. Recently, bioengineering has been used to impart insect and herbicide resistance in crops such as maize, cotton, and rice. It is being used to aid the growth of commonly cultivated crops in hot or dry environments where they would normally yield less. Even more recently, bioengineering has been used to directly increase the delivery of micronutrients to the consumer by increasing the amounts of micronutrients that crops incorporate into their tissues.

There are two obvious ways in which bioengineering can improve the diet of the malnourished. First, bioengineering can be used to directly improve the micronutrient content of an already cultivated food crop through careful manipulation of the genome of the plant. Secondly, bioengineering can be used to increase the desirability of a variety of highly nutritious crops that either don't grow well locally or have fallen out of favor due to the vast improvements made to cereals during the Green Revolution.

An example of the promise of bioengineering to aid the world's malnourished through directly improving food micronutrient comes from the genetically fortified “Iron Rice.” In 1997, two Japanese scientists: Toshihiro Yoshihara and Fumiyuki Goto, were able to create a strain of rice with vastly increased iron content (Prakash). They did so by inserting a gene from the fungus *Aspergillus niger* into the rice plant. The gene works by coding for the creation of Phytase: an enzyme which counters the Phytate in the endosperm of the rice seed, thereby suppressing the pathway through which a rice plant destroys its own iron reserves (Prakash). An independently working Swiss group has inserted a gene from *Aspergillus fumigatus* which produces a heat stable form of Phytase that can survive boiling and counter the Phytate that a person might ingest from other sources (Prakash). In addition to having increased iron content, the rice contains elevated amounts of calcium, zinc, and other mineral micronutrients.

Another way the use of bioengineering directly improves food micronutrient content comes in the promising, yet controversial form of golden rice. This rice, so named for its golden color, has been genetically engineered to produce and store beta-carotene in its seeds. It has been observed that each gram of golden rice contains 1.6 milligrams of beta-carotene (Bouis). Thus, if a person consumed 400 grams of rice a day, he or she would receive 107 retinal equivalents in that day. This would not be enough vitamin A for some people, but it would go a long way towards eliminating the blindness that, worldwide, strikes between 250 and 500 thousand young children every year (Bouis). Unfortunately, much of the world's

supply of golden rice is kept locked away under level four bio-security greenhouses in the Philippines, unable to be used in the fight against malnutrition.

An example of the use of bioengineering to increase the desirability of an already grown crop that doesn't grow well in a certain area is the bioengineering of transgenic chickpeas. Chickpeas are legumes, and as such are high in many of the amino acids that are not attainable from cereals. The high grain diets of the Indian poor often benefit from the complimentary amino acids found in chickpeas (Manning). Unfortunately, chickpeas have fallen out of favor with farmers due to their susceptibility to an insect *Helicoverpa*, which consumes their seeds from the inside out. In bad years, up to 100% of a farmer's chickpea crop can be lost (Manning).

In response to this problem, Indian scientists under the direction of Kiran Sharma have inserted a gene from the bacteria *Bacillus thuringiensis* (Bt) into the chickpea plant (Randerson). This allows the plant to produce its own insecticide, which kills many of the *Helicoverpa* larvae, saving most of the seeds (Randerson). When this strain of chickpeas, known as Bt chickpeas, is ready for distribution, chickpea yields among India's farmers should increase dramatically.

While bioengineered crops such as iron rice, golden rice, and Bt chickpeas can improve nutrition in many developing countries, they hold a particular promise for India. One of the reasons for this is that Indians are predominately vegetarians. This is because the population of India is 81.3 % Hindu, a religion which traditionally prohibits the eating of meat (India). Because of their vegetarian tendencies, the majority of Indians must receive their protein, iron, and micronutrients through plants. Thus, even a minor increase in the nutrient content of plants will have a major impact on the health of the Indian people. While the majority of the health benefits gained through the increasing use of transgenic crops will be through the reduction in malnutrition among rural families, over-nourished people stand to benefit as well. With higher quality food being produced, people would not need to consume as many calories in order to obtain their micronutrients, reducing the dietary imbalance that often leads to over-nutrition among India's poor.

In addition to bioengineering, the industrial fortification of food provides an important tool in the battle against malnutrition and over-nutrition. Through fortification, small quantities of essential micronutrients are added to a food product after harvesting and before it is sold to the consumer. This includes the addition of iodine to salt and the addition of small quantities of iron, zinc, folic acid, and vitamin B to processed grain. Fortification of food is routine practice in industrialized countries (Lochmann), and it would accomplish much for India's urban poor. Because the urban poor generally eat processed foods anyway, the fortification of food would not involve a change in eating habits, likely leading to widespread acceptance. As food fortification would cut down on consumption of empty calories, it is probable that it would reduce the incidences of obesity as well as malnutrition.

In fact, food fortification is already underway in parts of India (Darnton-Hill). There is, for example, a successful program to fortify cow's milk with vitamin A underway in parts of the country (Eighteen Nations Fortify Foods). Other attempts to fortify foods with micronutrients have not been so successful, including one to create vitamin A fortified tea (Darnton-Hill). Programs in Venezuela have succeeded in fortifying wheat and corn with iron and vitamin A (Eighteen Nations Fortify Foods), and there is little reason to doubt that they could work in India as well. This would be especially true in areas where wheat products are already popular among the city-dwellers.

The wealthy children of India's cities face many of the same lifestyle problems that plague American children. These include a lack of exercise--many city children no longer have to walk to school--and a shift in the Indian diet. The shift in diet towards more processed foods affect all urban Indians, however the affluent face a special problem--fast food. Now that the fast food companies have

markets established in industrialized countries, many are turning their attention towards the developing world (Mascarenhas). Companies such as Coca-cola are working to “stimulate impulse purchasing behavior” in a global market (Mascarenhas). Unfortunately, the affluent people who are targeted for advertising are also among the least active. As the fast food industry expands, India is threatened with an increasing incidence of obesity. In order to curb this rising threat to its health care system, India should look into banning the advertising of fast food to children. This may prevent young people from forming the bad eating habits that lead to obesity and can last a lifetime. In many ways the banning of advertising fast food products to Indian children would be similar to banning cigarette advertising directed at American children; both are instances of government intervention designed to improve the health of citizens while saving government money.

In order to relieve malnutrition and prevent obesity, India’s government must continue taking an active role in the affairs of its citizens. The benefits of the eradication of malnutrition would be enormous, not only in terms of the alleviation of human suffering, but in financial terms as well. The decreased ability to work resulting from malnutrition alone can result in up to a 5% loss of gross domestic product (Bouis), and gaining back this productivity would boost India’s economy substantially. In addition, some of the 70% of the income of the poor that goes towards food (Swaminithan) could potentially be spent on other goods and services, creating new domestic markets for Indian products. It is estimated that an efficient solution to malnutrition would cost a country only a third of a percent of GDP (Bouis), which would be more than made up for by the 5% regained in lost labor. The problem then is not a lack of long term profit, but a lack of strategy and starting capital.

For a micronutrient supplement program to be successful, it must target the poorly nourished in both rural and urban areas. At least initially, it should focus on women and children; who suffer the most from debilitating malnutrition (Swaminithan). In rural areas, the strategy should focus on quality farm production; in urban areas it should focus on food fortification and control of fast foods.

Quality farm production means not only the development of new and better crops through both hybridization and bioengineering, it also involves the distribution of these crops to the farmers and the economic incentive necessary to plant a variety of crops. Improved crop yield is beneficial not only to the farmers, who can make more money off their limited land, but to the environment as well. Greater yield per unit land means that, in the long run, less forest will be converted to agricultural land for the sole reason that there is not enough quality food to go around. Transgenic crops are especially beneficial because many of them do not require as much pesticide or fertilizer as standard crops do, leading to less pollution of the water with agricultural runoff. In addition, improved varieties of traditional crops will make it profitable for the farmers to economically plant crops high in micronutrients; thereby increasing the health and well being of India’s rural population. Thus, India should thoughtfully expand its biotech industry while taking measures to insure the distribution of the resulting technology to the farmers.

Because bio-engineering is not universally accepted in India (Randerson) the government will have to address the concerns of its citizens. Many, such as anti-biotech advocate Suman Sahai feel that “the people are completely excluded from the decision making process,” and that bioengineering is just another attempt for foreign corporate giants to control the Indian economy. Others feel that transgenic crops are not safe or fit for human consumption (Randerson). The best way to address these concerns may be to allow the planting of transgenic crops by farmers and to demonstrate through their successes the right of bioengineered foods to exist. India has already begun to do this, approving the planting of Bt cotton in 2002 and the field testing of Bt chickpeas and transgenic rice with the intent to commercialize not long thereafter (Randerson). In addition to such a demonstration, the government could use billboards and other forms of advertising to gain the confidence of the public.

To alleviate the problems of urban malnutrition and the over-consumption of empty calories, the government of India should continue to explore the possibilities of food fortification. It has already taken the first steps with the fortification of milk with vitamin A and iron, but it needs to continue to explore the fortification of processed grains, especially wheat. The largest problem to overcome would be the lack of existing factories and other buildings necessary to begin a food fortification program, however, an investment here would pay off many fold in the long run. Food fortification would be especially beneficial in conjunction with the farming of increasingly micronutrient-laden foods. The dual targeting of urban and rural malnutrition would work wonders for the health of India's people.

In order for India to succeed in its task of eliminating malnutrition and curbing obesity, the United Nations and the developed world need to lend their support. This support could take the form of partnerships between developed nations' universities and companies with those of India in order to promote food quality and security. In doing this, the developed nations would contribute to India's intellectual and physical capital, providing the initial resources necessary for India to develop its agricultural and food fortification systems. An example of such a relationship is the relationship that currently exists between the McKnight Foundation and the developing world. Since 1995, this group of philanthropists and scientists from the United States has contributed \$12 million to scientists in developing countries, supporting a variety of partnerships between them and the developed world (Manning). In addition to the McKnight Foundation, organizations such as the World Food Prize award money and prestige to individuals and groups who make a difference in the food security of developing countries. Once the initial resources are invested, India is likely to continue moving forward in a manner that is self-sustainable. It is of paramount importance that all partnerships between Indian scientists and companies and those of the developed world are mutually beneficial and non-controlling. Through cooperation, such initiatives will not only prove of immense benefit to India's people, but will yield results in the developed world as well.

In order for malnutrition to cease to plague the Indian people, India's government and private sectors will have to step up their efforts. They should focus on improving the crop yield and quality in the countryside, the fortification of food for urban residents, and the control of habit-forming advertising directed towards children. In order to achieve better nutrition for its citizens, India's government should continue the thoughtful expansion of its biotech industry as well as traditional breeding programs. It should invest in the system necessary for the routine fortification of food, concentrated in the cities. Developed nations should by no means stand idle. It is through partnerships between the scientists and companies of developed nations and their Indian counterparts that India will acquire the needed capital to implement these programs. It is through the world's continued involvement in the affairs of the Indian people that the crippling specter of Indian malnutrition and the rising menace of Indian obesity may at last be eliminated.

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