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An Independent India

Indira Gandhi was the first politician and only woman to hold the position Prime Minister of India for three consecutive terms. She once wrote "A nation's strength ultimately consists in what it can do on its own, and not in what it can borrow from others" (Planning Commission) Indira Gandhi wrote this in the preface of India's Fourth Five Year Plan, which focused extensively on improving India's industry and agricultural techniques. But today, Indira Gandhi's quote is applicable to a variety of challenging issues facing India today: overpopulation, poverty, the hunger crisis, and energy demands. India can not continue to rely heavily upon foreign aid and energy, as it has for the past fifty years. If India is to improve its current conditions, it must look within itself for a resource that is stable, cheap, and economically beneficial. Biofuels offer a glimmer of hope for a nation aspiring to become a world leader in agriculture and energy independence. Biofuels are liquid or gaseous fuel derived from biomass. The biofuels ethanol and biodiesel are the primary biofuels used commercially in India. Ethanol is produced by converting the carbohydrates in biomass into sugar, and then fermenting the sugar into ethanol. Biodiesel is produced through transesterification of organic oils, usually vegetable oil, but India has chosen to use oil from the *Jatropha Curcas* to produce biodiesel. Biofuels will play a crucial role in meeting India's energy demands in the near future. The current price for producing and manufacturing biofuels in India is about \$0.46 per liter, equal to the current price of gasoline or diesel. Biofuels will not only help India to become an energy independent nation, but will also eliminate their dependence upon oil imports from unstable nations. The economic investment to create a new job in the petroleum industry is considerably more than the cost to create a job in the biofuels industry. The expansion of the biofuels industry in India would create new jobs, specifically in rural India where poverty and malnourishment are prevalent. New jobs, along with more accessible agricultural technologies will help to deliver India from malnutrition, poverty, and food insecurity. When considering the increasing prices of petroleum, biofuels appear to be a more stable, cheaper, and eco-friendly fuel source for India, while showing promises of increasing food security.

Geographically India's size is slightly larger than one third of the contiguous forty-eight United States, and accounts for only 2.4 percent of the world's land. Over half the land in India is suitable for sustaining crops, 2.8 percent of the land is used for permanent crop usage while over 48.8 percent is arable land, capable of producing crops. India faces the crisis of overpopulation; as of July 2007 the population of India was 1.13 billion and constituted 17 percent of the worldwide population. India has a fertility rate of 2.8; each woman was having an average of 2.8 children during her life time, well above the 2.1 replacement value needed to keep a population stable (CIA World Fact book). Fifty-four percent of the Indian population lives in the rural regions, while 46 percent live in urbanized areas (Nystrom). By the year 2040 India's population will exceed China's, making India the most populous nation on earth. Globally, India has emerged as an economic leader with the fourth highest gross domestic product (GDP) of any nation, but India's economic advancements are overshadowed by the millions who are unable to escape the horrors of poverty. There are 222 million Indians living in poverty (Rural Poverty Portal). Poverty has different meanings in different locations. In India poverty can be defined when a person is unable to satisfy the basic needs of life. Poverty in India often brings food insecurity, a lack of water, malnutrition, and illness. In 2003, 35 percent of Indians earned less than one dollar a day, and 80 percent earned two dollars or less a day (Rural Poverty Portal). Poverty rates were 53.1, 38.9, and 29 percent in the years 1977-78, 1987-88, and 2007 (Economy Watch). Eradicating poverty has been a major objective of the Indian government since its formation as an independent nation in 1950. Main causes of rural poverty in India are high levels of illiteracy, inadequate healthcare, a lack of financial resources to invest, limited technology, archaic agricultural practices, and limited accessibility to social services. The average

Indian per capita income is 450 dollars while the average farm per capita is 300 dollars. Farming in India generates less income simply because most farmers are subsistence farmers, who raise crops for the sole purpose of feeding their families. The government of India discourages subsistence farming, and encourages cash crop farming instead. Cash crop farming brings several benefits to the average family. Instead of a family depending solely upon their crops to supply them with food, food can be purchased. This will bring the poverty stricken families of India food security. Often, severe weather, whether it be in the form of droughts, flooding, or irregular monsoons, strike India and destroy the crops that are raised by subsistence farmers. For millions of poor, rural families in India their crops are their only food source, and if the crops do not survive then millions would go malnourished. A typical rural, farming family in India lives in a one room home made of mud and bricks, lacking electricity, running water, and furniture. Families often include grandparents, parents, and their children.

Malnutrition and famine are problems that have plagued India for hundreds of years, taking millions of lives. The Food and Agricultural Organization (FAO) defines food security as a state which "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. In 2006 there was an estimated 854 million undernourished people worldwide, 220 million of these people live in India (Rural Poverty Portal). The malnourishment of workers in India causes an estimated annual loss of ten billion dollars. Forty-seven percent of children under three are undernourished (World Bank). Malnutrition has been estimated to be linked with half of all child deaths in India, and more than half of child deaths from serious diseases and illness. Malnutrition has been linked to a reduced learning capacity and less years of schooling. Malnutrition during any stage of childhood affects educational development and can lower the lifetime earnings potential of a child. Under nutrition in India declined during the 1990s, but lagged far behind other nations with sharing similar economic growth rates. Nutritional inequalities differ by state; the poorest sections of India are Chhattisgarh, Bihar, Jharkhand, Madhya Pradesh, Orissa, Rajasthan Uttar Pradesh, and West Bengal. These are all semi-arid tropical regions that are often plagued by droughts that hinder the successful agricultural practices that the Green Revolution has brought to other regions of India. Severe flooding also troubles numerous regions in India, hindering agricultural development.

India's energy demands are projected to grow at an annual rate of 4.8 percent over the next several decades. Currently a majority of India's energy requirements are met with fossil fuels. The domestic production of petroleum only meets 25-30 percent of India's energy requirements. The bill for crude oil imported into India for 2006-2007 would be \$61.74 billion, roughly 10 per cent of the nation's GDP, and with the rising cost in petroleum, biofuels appear to be a cheaper source of fuel (UNCTAD). India uses sugarcane to produce ethanol. The cost of ethanol can decline if the Indian government makes new irrigation techniques available to poor farmers, end archaic farming practices, and implements a variety of new technologies to the cultivation of biofuel producing crops. India is the fourth largest producer of ethanol behind the United States, Brazil, and China. India generates 1.9 billion liters of ethanol a year, and has a distillation capacity of 2.9 billion liters of ethanol each year. On January 1, 2003, India mandated that the nine major sugarcane producing states of India must have a five percent ethanol blend in all gasoline sold in within them. If India were to add a 5 percent ethanol blend in all gasoline for 2006-2007, 640 million liters of ethanol would be required, about one third of the ethanol that India produces annually and for 2011-2012 810 million liters would be required to meet 5/95 ethanol/petroleum blend (UNCTAD). India's current ethanol production should be stable enough to meet this energy demands for the future. India is the world's largest consumer of sugar, which stresses the ethanol industry. The price of sugar and ethanol production in India, are directly related. The remaining states will slowly convert to the five percent ethanol mandate within the next several years. To improve the cultivation of sugar, there needs to be alternate feedstock crops such as the tropical sugar beet. In India ethanol is produced from molasses, which is a by product of sugar production. Since India has such a high demand for sugarcane, the need for sugar stresses the ethanol industry because sugarcane has traditionally been a food crop. Fortunately other cost-effective sources have been discovered to replace sugarcane,

such as the tropical sugar beet. New research reveals that the tropical sugar beet can yield as much sugar as sugarcane. The tropical sugar beet could potentially replace the need for sugarcane in the ethanol industry, thus easing the demand for sugarcane. Sugarcane produces 2.5-4.8 tons of sugar per acre, while the tropical sugar beet produces 4.5-7.2 tons. The amount of ethanol that can be produced from one acre of the tropical sugar beet is between 2800-4100 liters, while sugarcane can only produce 1700-2700 liters of ethanol per acre (UNCTAD). The tropical sugar requires less management, is easier to harvest, has a shorter growing season, and requires 40-60 percent less water than sugarcane. The ethanol industry of India uses the fermentation of molasses (a by product of sugar production) to produce ethanol, and if there is a shortfall in the sugar cultivation of India, then molasses must be imported.

In India, mass transportation requires diesel fuel, which in turn, makes the demand for diesel fuel in India is five times greater than the demand for gasoline. India will have to rely upon the bold National Biodiesel Mission to supply the nation with biodiesel in the future. Biodiesel, unlike ethanol, contains no petroleum and is capable of being blended with any level of petroleum diesel to create a biodiesel combination. Biodiesel is very similar to petroleum diesel. Both can be used in compression ignition engine which requires minimal, or no engine. The Indian government has formulated the National Biodiesel Mission, in hopes of meeting their lofty goal of replacing 20 percent of the nation's diesel requirements with biodiesel by 2011-2012. India's biodiesel program currently uses the transesterification of vegetable oil to create biodiesel. Biodiesel is traditionally made from vegetable oil, but since the high demand for edible oil exceeds the national supply, the Indian government has chosen to use the non-edible, toxic oil from the *Jatropha Curcas*. The oil of the *Jatropha Curcas* is toxic because it contains curcin (a toxic protein) and phorbol esters. Other than this, the *Jatropha Curcas* has a variety of excellent qualities that make it the perfect choice for a feedstock in the biodiesel industry. The *Jatropha Curcas* nuts have an extremely high percentage of oil when compared to other plants used for biodiesel. The nuts are composed of 38-40 percent oil and the oil is produced is non edible. The oil yield per hectare for *Jatropha Curcas* is among the highest for tree-borne oil seeds. Many Indian crops are too dependent upon often intermittent and irregular monsoons. The *Jatropha Curcas* is a drought resistant shrub which can grow in areas that receive as little as 250 millimeters of rainfall annually. *Jatropha Curcas* is very versatile, while preferring the hot temperatures of the tropics the *Jatropha Curcas* can thrive in mild climates and even survive a light frost. *Jatropha Curcas* there requires minimal or no insecticide. Additionally the plant has insecticide like properties in its leaves, oil, and nuts. The oil and nuts can be used to develop a natural pesticide for farmers who can not afford the cost of manufactured pesticides. India has taken the initial steps toward commercial production of *Jatropha Curcas*. Thus far India has developed high-yielding varieties of *Jatropha Curcas*, construction of *Jatropha Curcas* nurseries, development for pilot plants that manufacture biodiesel, and testing biodiesel in public transport, specifically locomotives and buses.

Since currently there is no commercial production of biodiesel and India may find it challenging to produce even a 5 percent biodiesel/diesel blend by 2011-2012, yet alone their goal of 20 percent (UNCTAD). The largest problem facing the biodiesel industry of India is the struggle to start the large scale cultivation of *Jatropha Curcas*. Farmers do not consider the cultivation of *Jatropha Curcas* rewarding enough; since *Jatropha Curcas* nuts are non-edible, Indian farmers do not see the value in raising a plant that can not be eaten. The Indian government needs to establish a minimum support price for *Jatropha Curcas*, and offer a timely payment method; once these requirements are met the biodiesel industry of India can embark upon its rapid growth. There are numerous agricultural practices that need to be utilized in order to maximize crop yields; these include using water irrigation techniques that maximizes the usage of water, bio-fertilizer, using better seed quality, and using machinery to plant and harvest crops. The biodiesel industry of India is currently in the incubation stage of development. While the biodiesel industry of India is waiting upon the large scale cultivation of *Jatropha Curcas*, India needs to prepare for oil collection and oil extraction, and the finish the construction of multiple transesterification plants. It would be very beneficial for the Indian government to invest more money toward researching techniques that could convert non-edible oils, such as oil from the *Jatropha Curcas*, into edible oil. If a conversion for

Jatropha Curcas is to be discovered the oil from the Jatropha Curcas would have dual functions, serving as biodiesel and oil for domesticated cooking. In addition to this, an oil converting process could be developed for Jatropha Curcas oil, farmers would have more incentive to raise the plants, and therefore the Indian government would not need to establish a minimum support price for the crop. Jatropha Curcas desperately needs multiple uses to increase the demand for the plant; this would generate a major increase in the average Jatropha Curcas farmer's income.

Soybeans will play a considerably major role in India's agricultural future. Soybeans will help to increase food security while serving as an alternative crop to sugarcane for the production of ethanol. Soybeans first came to India from China and have existed there for hundreds of years. Soybeans have been called a "miracle crop" because of their high protein content and high oil percentage. A lack of knowledge about soybean cultivation has prevented soybeans from becoming a major food crop in India. India has struggled to maximize the potential of soybeans for the following reasons: inadequate high-yielding varieties, ineffective marketing techniques, and unfamiliarity with its consumption. Soybeans can be used to replace paneer (coagulated milk) or substitute meat products. Using soybean products to replace meat products would tremendously benefit India's food supply, because a majority of the Indian population follows a strict vegetarian diet. The largest dilemma facing soybean cultivation is the lack of high-yielding varieties. In order for soybeans to become a major food crop, Indian scientist must develop a soybean plant that will produce higher yields and adapt to the diverse conditions of the Indian climate.

Biofuels are an environmentally friendly alternative to traditional fossil fuels. Emissions from the transportation sector are the leading cause of environmental pollution in India. Minimizing the use of fossil fuel would promote a healthier standard of living for Indians. Biofuels emit virtually no carbon dioxide because the amount of carbon dioxide produced during combustion is equal to the amount of carbon dioxide absorbed during photosynthesis plant growth. Biofuels and biodiesel are by far more beneficial to the environment than gasoline, which releases almost quadruple the greenhouse gases. Biofuels also reduce the emissions of unburnt hydrocarbons and carbon monoxide, while releasing no sulphur into the atmosphere, which in turn, creates acid rain. Biofuels do not produce sulphur oxides, which leads to the formation of acid rain. The sulphur is removed from gasoline and diesel as a result of hydro-desulphurisation. Hydro-desulphurisation of diesel causes a loss in lubricity, which must be corrected by introducing a lubricity enhancing additive. Biodiesel itself has natural lubricity, and lubricates the moving parts of the engine as it travels through, greatly increasing fuel efficiency.

An unfortunate, yet common misconception is that biofuels may cause starvation in developing countries. Expanding the ethanol industry in India would increase food security, because the current choice of ethanol crops in India are edible. Ethanol crops in India can be diverted toward the national food supply during a time of shortage. For India, biofuels bring a cornucopia of benefits. Growth in the biofuels industry of India will create new jobs. The sugar industry employs 45 million farmers, comprising 7.5 percent of the rural population. Another half a million people are employed as laborers in sugarcane cultivation. Every \$11,000 invested into the ethanol industry creates a new job, much less than the \$220,000 for the petroleum industry. The National Biodiesel Mission will create more agriculture related employment opportunities in rural areas, specifically for women. In 2007, the National Biodiesel Mission will generate an estimated 127.6 million person days to plant, 36.8 million person days to gather seeds, and 3,680 person years for running the seed collection and oil extraction centers (UNCTAD). Biofuels will make several social improvements available to millions of rural citizens, such as gaining access to electrical energy services. The use of biofuels in rural areas is strongly linked to a decline in poverty, because better access to energy services can reduce the time spent by women and children spent on performing basic survival activities. Energy services will also bring modern lighting which will increase security at night and expand the amount of time for educational study. The government of India needs to reform their restrictive policies on ethanol production. Banning the inter-state transportation of molasses is essential to expanding ethanol production into poorer states. In addition, ethanol distilleries

should also be permitted to use sugarcane juice instead of molasses for ethanol manufacture. When sugar prices decline, sugarcane farmers could divert some of the sugarcane crop to ethanol production, thus bringing extra income for the farmers. Biofuels will bring a plethora of positive benefits to India. While India has made great strides in their attempts to eradicate poverty, there is still a great distance to go. Biofuels cause a reduction in pollutants, specifically sulphur, carbon monoxide, and greenhouse gases such as carbon dioxide into the atmosphere. For every ton of petrol or diesel substituted by ethanol or biodiesel, the net emitted carbon dioxide is reduced by about 3 tons. Investing in biofuels will bring more stable economy are all brought by using biofuels instead of traditional fossil fuels. India has established highly ambitious goals to get the biofuels industry running. India will be energy secure by having a diversified energy supply ranging from traditional fossil fuels, to alternative, renewable fuel sources. For India the biofuels industry will play a crucial role in meeting the nation's energy needs, while providing a clean, eco-friendly fuel that will help to lower poverty, increase job creation, and eradicate food insecurity.

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