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India: Biomasses for the Masses

“Namaste.” This is a typical greeting in India. India is a beautiful country that is home to the Taj Mahal, tigers, and towers of grain in storage. It is also home to more than 350 million poor, many of whom go hungry each night. India is a land of diversity and mystery. It is also a land burgeoning with people. It is a land that biofuel technology can greatly benefit or harm.

India is one of the largest countries in the world with an area of 1,269,338 square feet. This total area is a little more than one-third the size of the United States. The capital of this southern Asia country is New Delhi. Much of the country is a peninsula extending south into the Indian Ocean. There is great contrast and variety between the different regions of the country. The world’s tallest mountain system borders the north. The desert is in the west. Eastern India has the highest rainfall in the world. While India is composed of 25 states and 7 union territories, it has three main land regions: the Himalayas, the northern plains, and the Deccan (southern) Plateau. The Himalayas are the world’s highest mountain chain. The Northern Plains lie between the Himalayas and the Deccan Plateau. The plains are the largest alluvial (made by rivers) plains in the world and are the heartland of India. The plains are very fertile, and are therefore home to the majority of Indians. The northern plains are also home to the Thar Desert in the western part of the plains. The Deccan Plateau takes up most of the room in India’s southernmost tip, and it is home to most of the mineral wealth in India. The plateau is home to mountains as well as plains and is mostly farmland, with some forests. About one-fourth of India is forest - full of pine, oak, bamboo, teak, rosewood, and mahogany trees. India has 15,000 varieties of flowers, 500 species of mammals, 2,100 species of birds, and 30,000 species of insects.

India has three main seasons: cool, hot, and rainy. The cool season typically lasts from October to February. During the cool season, the foothills of the Himalayas get lots of snow (the peaks are covered year round), while the plains move through a wide range of temperatures; it is usually warm during the day, but cool or cold at night. Even during the cool season, the temperature never freezes on the Deccan Plateau. The hot season usually takes place from March to June. During this time, the plains are about 115 degrees; the desert is about 125 degrees, and the Deccan area reaches 90 to 100 hundred degrees. The rainy season occurs during June to September. The monsoon winds pick up moisture over the Indian Ocean and release heavy downpours over the land. The rainy season accounts for most of India’s rainfall and the monsoons are an important part of India’s agriculture and economy. If rains come late, or don’t rain enough, the crops will dry up; if there is too much rain, the crops are destroyed and the villages are flooded and washed away. During the rainy season, northeast areas of India get an average of 450 inches of rain, while the Thar Desert gets only ten inches of rain during the entire year. If monsoons do not bring enough rain, the water reserves get used up, the hydroelectric plants close down, and the farmers are left with no electricity to run pumps for wells.

India is ranked as the second largest country in the world in population, second only to China. The most current population figure stands at 1.1 billion people. This makes India one of the most densely populated countries with over 824 people per square mile of land. Seventy-four percent of the population is rural, leaving only twenty-six percent urban. The population is growing at a fast rate: 1.45 percent per year. Over 40% of the population is under the age of 14. Because India has a fairly young population, and these young people will marry and create new families, India’s population is expected to overtake China before the year 2030.

Life is not easy for many in India. Many people live in poverty. Many Indians live in extended families. Grandparents, aunts and uncles, nieces and nephews, parents, and brothers and sisters all live together or near each other. For many, food is not plentiful. Food varies by region, but the typical foods are rice, wheat, pulses (seeds of pod vegetables), lentils, beans, and chickpeas. Little meat is consumed by Indians, since chicken and mutton are expensive, while beef and pork are not eaten for religious reasons. Hindus, a large part of the population, do not eat cattle, and Muslims do not eat pork. Many Indians are vegetarians. There are over 550,000 villages throughout India. Most of these villages have fewer than 1,000 people. Homes in these villages are made of mud and straw. These homes typically have one or two rooms. Wealthy Indians live in concrete or brick houses. Villagers work in nearby fields and factories. Villagers own very little, usually a few brass pots or clay storage vessels. Most of the water comes from wells or ponds. Kerosene is used when a village does not have electricity. Half of India's villages have access to electricity, but individual homes may not have it. Cities in India have a growing middle class. The cities are becoming more crowded. There are many manual labor, vending, factory and peddling jobs. India has large numbers of scientist and engineers, fueling the growth of the middle class. India is also a major manufacturing country. Migration from rural areas to urban areas has strained urban resources. Calcutta alone has a population density of 79,000 people per square mile. Water and electric supplies are not adequate for city populations. Many people are crammed into slums or live on the streets.

India may have rich, fertile farmland, but poverty is rampant and one-third of its population goes hungry. People cannot afford food and women especially don't get proper nutrition because the men and children typically eat first; women get whatever is left, if anything. There is a major lack of sanitation, hygiene, and nutrition. These account for many of the diseases people have. "Deficiency diseases" such as goiter, rickets, and beriberi, are caused by malnutrition. Malnutrition and a lack of protein claim many lives, especially those of children. Indoor pollution caused by cooking over charcoal or dung fires has increased the number of incidents of lung diseases. A large part of the population is illiterate. The literacy rate for men is 69%, but the literacy rate for women is only 46%. Most children start school, but half have dropped out by age ten in order to work in the fields or factories to provide their family with money. Many rural areas have no supplier of electricity or communications networks.

India's governments have established a vast social welfare system. Included in the welfare system are nutrition programs for pregnant women and small children, immunizations, vocational training for youth, women's adult education programs, and services for the handicapped. Special programs are available for juvenile delinquents, prostitutes, and convicts. Women are considered inferior to men. Laws that are designed to protect women are frequently ignored. Child prostitution is illegal but widespread. The government has not adequately enforced many of its laws that address basic needs, such as health care, sanitation, education, and housing. There are an increasing number of hospitals and doctors in rural areas, but the average doctor has over 2500 patients. The infant mortality rate is 58 deaths per every 1,000 births. Some states have achieved literacy rates of 100 % due in part to a 1988 push for literacy, but many are illiterate. There is free and compulsory education at the elementary level. Although school is compulsory for ages six to fourteen, the facilities are inadequate. Almost 100% of school age children start, but over 40%, especially girls, drop out. Only 20% of school age children graduate from secondary (high) school. Less than 10% of the population attends higher education.

Although a beautiful land, India has environmental problems as well. The most serious are land damage, water shortages, and air and water pollution. Flooding is also a major problem; flood control methods are not working. Sixty percent of land where crops could be grown has been damaged by overgrazing, timber industry, and agricultural chemical overuse. Seventy percent of surface water is polluted due to uncontrolled dumping of chemicals and industrial waste, fertilizers, and pesticides. Air pollution is severe in urban areas is caused by burning of wood and charcoal; it is also caused by dung in rural areas. Dust from wind erosion is a major problem in rural areas. Acids from industrial air pollutions

threaten historical treasures such as the Taj Mahal in Agra. Due to pollution thirty nine species of mammals, seventy two bird species, and 1,336 plants species are considered endangered.

India's infrastructure is dated. India has a highly developed rail system. The rails are a major means of long distance transportation. India has the longest rail system in Asia, and the fourth largest in the world. The rail system currently has 38,812 miles of track stretching across India. India also has a national state road network consisting of 320,000 miles of hard-surfaced paved roads with 695,900 miles of road total. Roads in rural areas are frequently unpaved and impassable during heavy rains and high water. There are 10,070 miles of inland waterways, and 2,250 miles of the waterways can be navigated by large vessels. There are four international airports in India. Most experts believe that in order to develop economically, India has to improve its infrastructure and specifically its access to rural areas by road.

India has large economy based on Gross Domestic Product, which is the value of all the goods and services produced in a country in one year. The large population means the GDP per person is very low. India's per capita income is \$380, compared to the United States' per capita income of \$28,000. Because of a low GDP, India is considered a developing and poor nation. India is a primarily agricultural nation. Agriculture provides livelihood for 67% of the population and produces 30% of the GDP. India is rich in minerals, forests, and power resources. India has a large supply of iron ore and coal, which provides a substantial base for heavy industry. Industry is dominated by textile production, such as cotton, wool, silk, and rayon. Other important aspects of the economy are the manufacturing of finished steel, vehicles, computers, and other electronic goods. The labor force includes over 375 million people. Twenty percent of the labor force is unemployed, and there are over 17 million child laborers. To develop its industrial growth, India must develop its natural resources. India is at a disadvantage in that it must import large quantities of oil. India produces some oil on offshore oilrigs, but not enough to meet its needs. India's high-tech industries lead the way for the rest of the country's industrial growth.

India's farmers depend on seasonal rains. India has two growing seasons: kharif is the main summer cultivation period, and the rabi, which is the secondary winter season. Food production in India has increased due to the Green Revolution. India's major agricultural exports are wheat and rice. Agriculture provides the main source of income for the majority of the population. Farms cover over one-half of the land area. In addition to growing rice and wheat, farmers also grow corn, sorghum, and millet. Rice is the leading crop in terms of land area; only China produces more. Other crops grown include tea, jute, mangos, sesame seeds, bananas, cabbage, coffee, cotton, rubber, fruits, and spices. India is somewhat self-sufficient in terms of food production. Improved farming techniques, more mechanization, and more irrigation have lead to greater agricultural output. Many rural development programs make credit and machinery available. The Punjab area is called "India's breadbasket," and produces food for sale. Most farms are subsistence farms, meaning they grow food to feed the family. This means there is little left over for sale to others. Eighty percent of the farmland is used to grow grains and pulses. Two-thirds of farmers own the land where they work. Farms are very small; the average farm is two-and-a-half acres or one hectare. There are very few farms that are larger than twenty-five acres. Inheritance customs of land being divided among sons makes parcels of land smaller and smaller. Some states have now set limits on how much farms can be divided. India has the world's largest cattle population, but there are no beef farms, because Hindus don't eat beef. India has more cattle than any other country. The cattle are used for plowing and working in the fields. Dairy farms are very important, providing milk to the nation. Cowhide is used for leather purposes. India also produces over twenty-five million tons of oilseed and is the second leading producer of sugarcane, second only to Brazil. In recent years, the government has introduced new varieties of seeds, new ways to use fertilizer, and modern irrigation systems. India has some grain surpluses; the problem is that many people are too poor to buy the grain produced.

Biofuels offer India a chance to improve its future for its citizens. Biofuels are fuels with a biological and renewable origin such as fuelwood, charcoal, livestock manure, biogas, biohydrogen,

agricultural wastes and by-products. Sources of bioenergy include agricultural residues and waste, purpose-grown crops, and wild vegetation. Liquid biofuels included bioethanol and biodiesel. First generation technology uses crops that are typically grown for food and relies on the fermenting of sugars. Second generation technology uses crops grown specifically for fuel. Second generation technology also turns cellulose-rich biomass into energy forms. Second generation technology is about ten to fifteen years away from being commercially viable.

Biomass - the biological “stuff” from which biofuels are made - can be produced in almost every country. Biomasses currently account for 10% of the world’s energy supply, and they account for 33% of energy use in developing countries, along with 4% of energy in industrial countries. Industrial countries convert it into electricity and heat in industrial plants. Biomasses in developing countries are usually burned in rural households as energy for cooking and heating and are a main source of household energy for two to three billion people worldwide. Liquid biofuels are relatively minor energy resources, with Brazil and the United States leading the way with a combined 90% of the total produced. Ethanol has replaced 40% of gasoline used in Brazil, but has only replaced 3% of gasoline used in the United States. Brazil uses sugarcane for its ethanol, while the United States use corn. India is starting to produce biofuels by using traditional crops, crop residues and wastes, energy-dedicated crops, grasses, trees, manure, and organic parts of human-produced garbage. Currently in India, the poor rely on inefficient biomass for energy, mainly burning wood, agricultural residue, and dung for cooking and heat. This does produce pollution, mostly inhaled by women and children, with severe health consequences, including respiratory illnesses and premature death. The burning of inefficient biofuels currently results in more than 1.6 million deaths globally per year, and most of the victims are women and children. Traditional sources of biomass are associated with degradation of forest and woodland resources and soil erosion. Energy crops include switchgrass, miscanthus, fast-growing trees, jatropha (found in India) and castor oil. In general, the poorer the country, the more it uses traditional biomass resources for household energy.

The total global energy consumption is 400 EJ, or exajoules, per year. The total global energy consumption is expected to increase by 50% by 2025. Most of this increase is coming from China and India. They generate the equivalent of about 100 EJ from crop residue, and they could generate an additional 180 EJ from energy-dedicated crops such as grasses and trees. There is a link between access to energy services and alleviation of poverty. Each day, the world consumes 21 million barrels of gasoline and 21 million barrels of diesel. Ethanol production in Brazil, using sugarcane, is economically viable when oil costs over thirty-five dollars a barrel, and is economically viable in the United States, using corn, when oil is over fifty dollars a barrel.

In exploring the use of biofuels, the debate of food vs. fuel frequently comes up. However, this debate does not have to happen to the detriment of the poor. In fact, there are many advantages to using biofuels. Countries with tropical climates may have an advantage over more temperate locations – such as the U.S. They may be able to use areas that are drought-prone or less fertile for energy production and therefore fuel needs won’t compete with food needs. Energy crops such as grasses and trees can be grown on land too poor to grow food crops. Competition between land used for food and land used for fuelstock can be minimized if poorer land is used for energy crops. Many agricultural commodities have a surplus. Diverting some resources to bioenergy production helps maintain higher prices paid to farmers for their crops. The poor gain from cheaper energy being available. Rural poor might also benefit from more employment opportunities and higher income in biofuel production. Biofuel production can increase wages in poor areas and can generate additional economic activity in rural areas. Some countries could develop new exports, while others could diversify their fuel imports. Oilseed crops, such as palm, soybeans, and jatropha, can be converted to biodiesel fuels to extend or substitute for fossil-derived fuels. This could help establish developing countries as biodiesel manufacturers and reduce their need for fossil fuels. Biofuels can produce systems suited to a particular area, contribute to improving the environment, protect watersheds, provide animal habitat, and contribute to rural life. Crop wastes, such as sisal waste,

coffee husks, rice husks, corn husks and cobs, and banana leaves, could be used. These wastes are generated during agricultural processing and not returned to the field. They won't hurt soil nutrition or food production. Production facilities can also use the agricultural wastes to generate their own heat and electricity, as well as for sale. Biogas production provides clean energy and, as a by-product, rich organic manure to be used in fields, therefore reducing the need for chemical fertilizer. Community-managed energy plantations and co-ops may allow farmers to band together to get large-scale farming advantages and may create jobs in the area. Urban poor would see lower energy costs and increased employment for urban-based bioenergy processing plants. By producing their own fuel, rural residents might not need costly fossil fuels to take products to market. The biofuels export market could become a booming one, because developing countries would export lots of biofuels. Longer growing seasons and better climate conditions should enable poor farmers in developing nations to produce more biomass than farmers in more temperate regions of the world. Incomes would increase as agricultural production, for both food and fuel crops, increases. Biofuel technology would provide jobs for those who do not choose to farm. Biofuels may use less and fewer chemical fertilizers and pesticides. Farmers, even very small-scale farmers, may be able to diversify crop production by adding other crops into their rotation or getting a second or third planting out of some of their fields.

Bioenergy uses resources of land, water, and labor that compete with food and feed production. This can lead to higher food prices worldwide and may especially hurt the poor. Technology currently requires fossil fuels to grow, transport, and process the feedstock, and for refining and distributing the biofuel. Higher prices for farmers for biofuel crops may lead to higher prices for the poor for food as the poor typically spend more of their budgets on food than on energy. A country may end up with a biomass production system that is fossil-fuel dependent, which exhausts the nutrients in the soil, causes erosion, damages the water resources, displaces wildlife and threatens the health and lives of nearby residents. Countries must watch against the spread of plant diseases from purpose-grown crops to wild vegetation. Energy plantations might displace small-scale landowners. Residents might see higher prices for food if competition for land between fuel and food crops isn't resolved.

National and international policies are needed in order to save the country. Policies should be addressed now during the early stages of bioenergy development, rather than trying to change practices once they are established. Opportunities for rural development should be a main focus. Collection and conversion facilities should be set up in rural areas, close to where the feedstock is grown. Small-scale producers should be organized to meet the needed volume and reliability of conversion facilities, and to market crops to large-scale processors. Stakeholders should be involved, as everyone's livelihood will be affected. Brazil, a leader in fuel production from sugarcane, has many effective policies. One requires the auto industry to produce cars that use biofuels. The government is required to subsidize biofuels during market development until the economy allows fair competition with oil products. They must also allow renewable energy-based power producers to compete with traditional utilities in the electricity market and have access to the power grids. Another of the policies that is enforced is to support private ownership of production facilities. Another important policy stimulates rural activities based on biomass energy to increase employment in rural areas. Maybe some of these same policies could work for India. Kamman has said, "Biomass energy programs offer a wide range of benefits, but achieving them require significant public policy guidance." Appropriate regulatory and revenue-sharing programs must be put into place and practice. Efficient systems for collecting, transporting, storing, handling, and fuel preparation are needed. If these are in place, the poor can benefit directly. India needs a well-designed revenue-sharing plan. There needs to be an increase in food production in areas that are already producing food. India needs a legal and regulatory framework that allows for biofuel development and access to the power grid and transport fuel market. The country needs to support scientific endeavors that promote biomass crops that yield higher amounts of energy per acre or unit of water, thereby reducing the resource needs of the crops themselves. There could also be a focus on food crops that generate by-products that are usable for bioenergy. India needs to develop and grow biomass in "sub-prime," dry and less fertile, agricultural

areas and remove barriers to international trade in biofuels. The country needs to promote use of biofuels that require little fossil fuel in their production. Promises of biofuels must be weighed against their costs. Infrastructure needs must be addressed. Rural areas in developing countries frequently have no transportation and/or communication access, which makes it difficult to get crops to markets. Technology is currently moving into this arena, but India's governments need to support these efforts. Many poor countries don't have the wealth to invest in and encourage/support biofuel technology. These countries may lose tax revenue if people switch to biofuels and decrease demand of heavily-taxed fossil fuels. This investment and support may have to come from the global community. International standards and regulations are needed. Tariffs and other trade barriers - for example, the United States places a fifty-four cent tariff on ethanol imports to protect its domestic ethanol industry – would need to be worked out. Most importantly, population growth needs to be limited, as by 2050, the world's population is expected to grow to 9 billion, with most of its growth coming from developing nations. Policies that promote controlled population growth will benefit all. As Dr. Norman Borlaug has said, "Agricultural technology, per se, cannot solve problems of bad governance, such as inadequate investments in rural education, health, and infrastructure. Nor can technology correct unequal land tenure. Nor can agricultural technology compensate for what I call the 'population monster.'"

Biofuels hold promise for the future. By developing policies and programs that discourage competition between foods and fuels, India may be able to increase earnings for its poor, reduce its growing dependence on fossil fuels, and bring a higher standard of living to its people.

Works Cited

- Borlaug, Norman and Chris Dowswell. "Cyberspace Discussion, January 5-9, 2004. Responses to Discussion Questions from Dr. Norman Borlaug and Dr. Chris Dowswell." October 6, 2007. <<http://www.cnr.berkeley.edu/BeahrsELP/Borlaug/3%20Responses%20Borlaug%20and%20Dowswell%2012-30-03.htm>>
- De La Torre Ugrte, Daniel G. "Developing Bioenergy: Economic and Social Issues." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 2 of 12. International Food Policy Research Institute, December 2006.
- Hazell, Peter. "Developing Bioenergy: A Win-Win Approach That Can Serve the Poor and the Environment." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 12 of 12. International Food Policy Research Institute, December 2006.
- Hazell, Peter and R.K. Pachauri. "Overview." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 1 of 12. International Food Policy Research Institute., December 2006.
- "India." Junior Worldmark Encyclopedia of the Nations. Detroit: UL, 1999.
- "India." World Book Encyclopedia of People and Places. Chicago: World Book, Inc., 1993.
- Kamman, Daniel M. "Bioenergy in Developing Countries: Experiences and Prospects." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 10 of 12. International Food Policy Research Institute, December 2006.
- Karkezi, Stephen and Waeni Kithyoma. "Bioenergy and the Poor." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 11 of 12. International Food Policy Research Institute, December 2006.
- Kartha, Sivan. "Environmental Effects of Bioenergy." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 4 of 12. International Food Policy Research Institute, December 2006.
- Lal, Vinay and Anil Lal. "India." World Book Encyclopedia. Chicago: World Book Inc., 2001.
- Laney, Kara. "Biofuels: Promises and Constraints." Bioenergy and Agriculture: Promises and Challenges. International Food Policy Research Institute, December 2006.
- Moreira, Jose Roberto. "Brazil's Experience with Bioenergy." Bioenergy and Agriculture: Promises and Challenges. Focus 14, Brief 8 of 12. International Food Policy Research Institute, December 2006.