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ENERGY CROPS: SUSTAINABLE SOURCE OF BIO-FUELS

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Short Profile

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ABSTRACT:
Population explosion leading to excessive fuel utilization from various non- renewable sources quickly decline fossil fuel resources and in turn creates adverse global environmental changes. Identification and developing sustainable methodologies for growth and development of Bio-energy crops play a vital role in preservation of fossil fuels for future generations which in turn reduce GHG emission augmented environmental problems. The major problems encountered with increased use of fossil fuels can be overcome through cultivation and efficient utilization of high potential Bio-energy crop plants on marginal soils which not only generates additional work opportunities to the economically deprived sector but also significantly reduce fossil fuel imports.

KEYWORDS
Bio-energy crops, Fossil fuels.

1.INTRODUCTION

Energy is the major driving force of the world's economies. In the recent past, growing population and expectations of enhanced standards of living are accelerating the demand for energy. The mounting energy demand in India would lead to a further increase in the use of fossil fuels. This will not only lead to increasing Green House Gases (GHG) emissions and augmented environmental problems, but will also result in enormous social problems such as inequalities between rural and urban populations, health-related disorders, and other community-level issues.

The need of the hour today is the search for sustainable energy. If we have to maintain or improve our living standards and of future generations, sustainable and secure energy resources are very important. When environment protection is at stake due to increasing use of fossil oils, renewable energy sources have become vital. One form of renewable energy is Bio-energy. Biomass and Bio-fuels have been at the center of intense interest, discussion, and debate in recent years.

Both Bio-mass and Bio-fuels can be derived from dedicated energy crops, agricultural co-products or waste materials. Traditionally Biomass was primarily used for cooking and heating representing about 13 per cent and is growing slowly or even declining in some regions as Biomass is used more efficiently or replaced by more modern energy forms. According to some of the recent forecasts, Biomass energy is likely to make up one third of the total world energy mix by 2050. In comparison with wind and solar energy, Biomass plants are able to provide vital, reliable base load generation. Biomass plants provide fuel diversity, which protects communities from unpredictable fossil fuels. Another perspective is that as Biomass energy uses domestically-produced fuels, Biomass power greatly reduces our reliance on foreign energy sources and increases national energy security.

IMPORTANCE OF BIO-ENERGY CROPS:

Bio-energy crop plants function as solar energy collectors and thermo-chemical energy storage systems. These crops have capacity to produce large volume of Biomass, high energy potential and can be grown in marginal soils. These crops contribute to the decline of green house gas emissions and thus the slowing of climate change and its negative repercussions. Bio-energy can be used to produce fuel for the transport sector or through Biomass combustion to produce heat and/or power. Bio-fuels have emerged to be the most feasible low carbon transport fuel option in the short to medium term. With growing energy costs and uncertainty of fossil fuel reserves, it's significant to watch over cheaper, safer, and more renewable forms of Bio-energy. Bio-energy crops could play an important role as environmentally safe and economically profitable. Energy crops take up an equal amount of carbon dioxide that was released when burnt – therefore theoretically yielding no net carbon dioxide emissions from their combustion.

BIO-FUELS IN INDIA:

In India, interest in Bio-fuels has grown dramatically over the last few years, prompted by concerns over energy security. Bio-fuels present an opportunity to promote sustainable development while offsetting rising demand for conventional energy sources. While the primary objective in blending Bio-fuels with fossil fuels is to reduce the financial cost of the national oil import bill, the other significant advantages of Bio-fuels include environmental and air quality benefits, the greening of wastelands, and the creation of new employment opportunities. Food security, in particular is a national priority for India. Consequently, India cannot afford to promote the use of cereal grains for ethanol production and the use of edible oil for biodiesel production. India is one of the world's leading importers of vegetable oil, and food grain production. Therefore, bio-fuel policies target the use of waste and non-edible feed stocks for bio-fuel production.

India has been operating an ethanol program for a number of years. In India, ethanol is produced from sugar molasses. The industry is encouraged to supplement the production of ethanol from molasses by producing ethanol directly from sugarcane juice in areas with surplus sugarcane.

Biodiesel production is focused on using non-edible oils from plants, particularly J*atropha curcus, Pongamia pinnata*, and other tree-borne oilseeds (such as karanj), and animal fats like fish oil. The goal is to encourage the use of wastelands, non-forest, and other unproductive land for the cultivation of relatively hardy bio-fuel crops. As bio-fuel crop production is very labor intensive, its cultivation will also provide additional employment opportunities.

BIO-ENERGY POTENTIAL FROM CROP RESIDUE BIOMASS IN INDIA:

Overall, India produces 686 MT gross crop residue Biomass on annual basis, of which 234 MT (34% of gross) are estimated as surplus for Bio-energy generation. At state level, Uttar Pradesh topped the highest amount of crop residue amongst all the 28 states. In the midst of all the crops, it was found that sugarcane produces the highest amount of surplus residue followed by rice. The estimated annual Bio-energy potential from the surplus crop residue Biomass is 4.15 EJ, equivalent to 17% of India's total primary energy consumption. There exists variation from 679 MJ (West Bengal) to 16,840 MJ (Punjab) of per capita crop residue Bio-energy potential amongst the states of India (Hiloidhari, et al., 2014).

BIO-ENERGY PLANTS:

Biomass produced from fields consists of residues (straw tops) and specifically cultivated crops including *Miscanthus, Poplar, Willow, Reed canary grass, Rape seed* and *Maize.* Not all residues are available for Bio-energy production because they are needed for livestock feed, litter and to maintain soil fertility. Biomass is a heterogeneous aggregation of different feedstock's, conversion technologies, and endues with different traditional and connotations in different parts of the world.

Traditional Biomass provides 38±10 EJ/yr as fuel wood, manure, and other forms (Smeets et al., 2007). Conventional grain and oilseed crops and crop residues, perennial herbaceous and woody crops, halophytes, and algae are candidate Bio-energy crops and are expected to combat Global climate change (Eisenbies et al., 2009).

TRADITIONAL BIO-ENERGY CROPS:

Traditional Bio-fuels derived from natural vegetation or from crop residues. Such Bio-fuels still are the main energy source in number of countries (e.g., Bhutan 86%, Nepal 97%) but they are not sustainable.

FIRST GENERATION BIO-ENERGY CROPS (FGECS):

Bio-fuels derived from FGECs rely on fermentation of sugars to produce ethanol or on trans-esterification of plant oils to produce biodiesel. The vast majority of current liquid Bio-fuels production is based on FGECs. FGECs are used for food and dependence on these crops pose deficit of food resources due to their raw materials compete for fertile land and inputs. Ex: Corn, Sugarcane, Oil palm and Rapeseed.

In general, technology improvements for other first generation crops are possible along the production chain: yields, harvesting, storage, transport, fuel preparation, and processing. Process technologies could also benefit from improvements in dealing with variable quantities and qualities of Biomass feed stocks. Cost reductions may also come from increases in plant sizes. Intensifying production through improved use of fertilizers and other agricultural best practices on existing areas could play a significant role in meeting increased demand for Bio-fuels in the coming years. Despite significant gains in crop yields in many regions and globally, yields continue to lag in several developing countries suggesting that considerable scope remains for increased production on existing lands. By 2017, crop breeding and agronomic developments are expected to increase yields in corn and soybeans by 149-173 and 43-46 bushels per acre respectively and sugarcane by 20-25 tons per acre.

SECOND GENERATION BIO-ENERGY CROPS (SGECS):

SGECs are more efficient than FGECs and to provide fuel made from cellulose and non-oxygenated, pure hydrocarbon fuels such as Biomass-to-liquid fuel. Bio-fuels produced biochemically or thermo-chemically from lingo-cellulosic SGECs, have more energy content than most First generation energy crop derived Bio-fuels. Early SGECs include perennial forage crops-*Switchgrass, Phalaris arundinacea L., Medicago sativa L., Pennisetum purpureum, Schumach., and Cynodon species.*

The contribution of non-edible plant oils (*Jatropha curcas L*.:30-50% oil) and Soap nut (*Sapindus mukorossi and S. trifoliatus; 52% oil*), as new sources for biodiesel production have the advantage of not competing with edible oils produced from crop plants.

THIRD GENERATION BIO-ENERGY CROPS (TGECS):

The TGECs include boreal plants species which are resilient and tolerant of cold temperatures, poor soil quality, and fires (Ex. Black and white spruce, balsam fir, jack pine, and tamarack, White birch, Trembling aspen, and Balsam poplar),CAM plants(Agave), Eucalyptus and micro-algae (*Botryococcus, Chlorell, Dunaliella, Gracilaria*). The boreal and CAM plants are potential sources of feed stocks for direct cellulose fermentation. Algae is a potential source of biodiesel. In one study, the US National Renewable Energy Laboratory (NREL) reports that if some key technology challenges are resolved, some 7.5 billion gallons of biodiesel could be produced from algae using 200,000 hectares of desert land avoiding the need for land conversion or use of ecologically sensitive land (Briggs, 2004)..

TGECs tested for biodiesel production: African palm (22% oil), Coconut (55- 60% oil), Grain of Castor bean (45-48% oil), and Peanut (40-43% oil). TEGCs reduce GHG emissions by capturing CO_2 released from power plants or by generating Biomass through photosynthesis.

DEDICATED BIO-ENERGY CROPS (DECS):

DECs and their Genetic resources requirements for biological, chemical or physical pre treatment are more environmentally friendly and will contribute more to GCC mitigation. They include: Cellulosic crops: short rotation trees and shrubs-Ex: E*ucalyptus, poplar, Salix,*, and *Betula spp.*, Perennial grasses such as Giant cane, *Reed canary grass, Switch grass, Elephant grass, Johnson grass* and *Sweet sorghum,, Non-edible oil crops: Castor bean, Physic nut* (Jatropha curcas), Radish (*Raphanus sativus*) and *Pongamia.*

Bio-energy Generation Processes:

Pyrolysis is the precursor to gasification, and takes place as part of both gasification and combustion. It consists of thermal decomposition in the absence of oxygen. It is essentially based on a long established process, being the basis of charcoal burning,

Gasification: A partial oxidation process whereby a carbon source (coal, natural gas or Biomass), is broken down into carbon monoxide (CO) and hydrogen (H2), plus carbon dioxide (CO2) and hydrocarbon molecules such as methane (Ch_4).

Combustion: A process: by which flammable materials are allowed to burn in the presence of air or oxygen with the release of heat.

Challenges of Bio-fuel Industry:

The Indian Bio-fuel industry continues to face challenges resulting from rapid population growth, rising income levels, increasing demand for agricultural products, and lagging government policies which put the country's land and water resources under enormous strain. The growing emphasis on expanding Bio-fuel production capacity, primarily through the augmentation of ethanol output based on irrigated sugarcane, is expected to put further pressure on water resources. It might also lead to the diversion of land from food crops to sugarcane.

CONCLUSION:

Bio-fuels should be produced in a way that economize the use of land, water, fertilizers and fossil energy, and does not aggravate the pollution of air, water, and soil. It is necessary to concentrate on feed stocks that do not vie with food production. This is possible by establishing plantations on land that are not used for food production. Committed measures that encourage involvement of smallholders, fair trade, labor rights and the rights of indigenous people are necessary to ensure equitable outcomes from Bio-fuels expansion. Smart economic subsidies and incentives are required to further reinforce the best practices in existing production systems while paving the way for more efficient feed stocks and technologies.

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