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Focali Brief: 2015:02

Can India's wasteland be used for biomass plantations?

How much of India's vast wasteland can be used for growing plants such as eucalyptus and Jatropha? As land demands have increased, the sustainable use of marginal lands has become increasingly important. In India about 47 million hectares, or 15 percent of the total geographical area, is classified as wastelands. Here we assess the climate and land quality requirements of eucalyptus, a commonly used plantation tree, and Jatropha, a much-discussed biodiesel crop. We find that roughly half of the degraded lands are suitable for growing eucalyptus and/or Jatropha.

LAND is a finite resource and has increased in demand at a global level. Degraded or marginal lands have repeatedly been proposed as an option for biomass production for bioenergy and other bioproducts such as building material. It is also commonly proposed that such production can improve the productivity of soils. The use of degraded lands is considered an option for biomass production that avoids/mitigates competition for higher quality lands suitable for the cultivation of food crops.

According to the Indian 2010 Wasteland Atlas about 47 million hectare are assessed as belonging to one of the 23 different categories of wasteland that exist in India. This corresponds to 15 percent of India's total geographical area. Wasteland is described as 'degraded land which can be brought under vegetative cover with reasonable effort…'. implying that the land could be managed to increase production and to adapt to natural circumstances, such as a changing climate.

According to research, Indian wastelands are under-utilized, with current biomass production on average less than 20 percent of the potential production level. In India, as elsewhere, one often-discussed strategy for making better use of wastelands is to produce biomass for bioenergy, or other bioproducts. Eucalyptus and Jatropha are among the plants that have received most attention as suitable for cultivation on wastelands.

Biophysical potential for eucalyptus and Jatropha

Eucalyptus (*E. tereticornis, E. globulus*) is a fast-growing species presently grown in plantations covering about 20 million hectares globally. Despite controversy, especially around the water requirements, eucalyptus is favored in plantation systems in Asia, South Africa and in several Latin American countries.

Figure 1 is subject to revision.

The map will be uploaded shortly.

Jatropha (*Jartropha curcas L.*) received much attention as a potential bioenergy crop in the early 2000s due to its multipurpose and drought-resistant character and particularly for its toxic seeds, which contain 30-40 percent inedible oil suitable for biodiesel production. Jatropha's suitability for cultivation on lands less suitable for food production was the source of much hope, but this has yet to be realised for reasons related to expected yields, implementation techniques and markets. The fact that Jatropha seeds are inedible is also a drawback from a food security point of view, allthough it has been put forward as a benefit in pro-biofuel rethoric promoting simplistic views on the mechanisms behind food-fuel competition.

Land suitable for eucalyptus and Jatropha

The maps show the districts that are suitable or unsuitable for hosting eucalyptus and Jatropha on the wasteland that is available in the district (figure 1) according to our assessment.

In the eucalyptus case, 22 million hectares of wasteland (47 percent of the total wasteland area), distributed across 446 districts, were assessed as suitable. Districts with rainfall below 400 mm/year, over 1600 mm/year and temperatures below 4 °C were omitted. The most important limiting factor was the rainfall limit of 400 mm/year.

For Jatropha, 25 million hectares of wasteland (52 percent of the total wasteland area), distributed over 393 districts, were assessed as suitable after omitting areas with rainfall below 200 mm/year more than two years in a row, rainfall over 1300 mm/year and temperatures below 0°C. The most important limiting factor was the upper rainfall limit of not more than 1300 mm/year, which was exceeded in many coastal areas.

The future

It becomes increasingly important to rehabilitate degraded lands and to promote more resilient and productive uses of this resource as demands for food, bioenergy and other products increase and climate change brings new challenges for agriculture and forestry. With this as a backdrop and given the results presented in this brief, we believe that the following issues deserve further consideration in the future.

i) Under conditions of dense population and extreme poverty it is unlikely that land will be under-utilized. Data based on the notion that land is unutilized must therefore be used and assessed carefully to avoid unintended effects such as exclusion of people causing negative social and economic impacts and possibly indirect land use change.

ii) In our assessment we only used rainfall and temperature as climatic parameters. For further analysis, evapotranspiration will be added which is likely to further limit potential plantation areas.

iii) Planting extensive wasteland areas can cause changes in evapotranspiration and other water flows, and hence affect hydrological flows. The change in vegetation cover may also cause changes to albedo and local/regional climate. These effects will also need to be accounted for in analyses of the potential of wastelands for Jatropha and eucalyptus.

This brief can be referenced as:
Ostwald. M, Tiwari. R, Pettersson. K, Murthy. I, Berndes. G, Ravindranath. N.H, Karlson. M. Can India's wasteland be used for biomass plantation? Focali Brief 2015:02, Gothenburg

Photo of wasteland in India. Photo courtesy Rakesh Tiwari.

The model

Data on the 23 wasteland types from the 585 districts were collected from the Wasteland Atlas and imported to GIS for further analysis. Ten of the 23 wasteland categories were considered unsuitable for biomass production, leaving the model with 13 categories. After omitting the 10 unsuitable wasteland categories about 31 million hectares (66 percent of the total wasteland area) remained for analysis.

Information on climate and soil quality requirements of eucalyptus and Jatropha was collected from scientific literature and used as the determining factors for biomass growth.

Climate data (rainfall and temperature) covering the period 1961 to 2012 was collected from the Climate Research Unit's (CRU) database.

For this assessment, an optimistic view on plant productivity and resilience was adopted. For example if the plant needed a certain amount of rainfall per year to survive, a year with too little rainfall was still considered suitable if the surrounding years had enough rain.

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