Global Ecology and Conservation 11 (2017) 158–164

Contents lists available at ScienceDirect

Global Ecology and Conservation

journal homepage: http://www.elsevier.com/locate/gecco

Original Research Article

Estimation of carbon emissions/savings incurred by wasteland and abandoned cropland-conversion from plantation of biofuel producing perennial tree species - Case study of India

Namita Pragya [a,*], Navin Sharma [b], Asha E. Devnekar [c]

[a] World Agroforestry Centre (ICRAF), NASC Complex, New Delhi, India
[b] Amity University, Noida, New Delhi, India
[c] Sphere Thoughts, Bangalore, India

ARTICLE INFO

Article history:
Received 19 December 2016
Received in revised form 10 June 2017
Accepted 17 June 2017
Available online 23 June 2017

Keywords:
Carbon sequestration
Emission
Oil bearing
Perennial tree species
Degraded wasteland
Degraded cropland

ABSTRACT

Growing concerns of energy security and climate change mitigation have led to new policy initiatives by many countries in the area of renewable energy. In the same direction, India's National Policy on Biofuels has now allowed producers to directly sell biofuel to consumers. This is to ensure the minimum supply of biofuels in the domestic market and meet an "indicative target" of 20% blending for biofuels. This policy change will raise concerns about greenhouse gas emissions from land-use changes (LUC) that would be incurred by accelerated production of the biofuel feedstock. Efficacy of biofuel should be assessed by accounting for its potential LUC emissions. The conversion of land from its original state to an altered state for production of biofuels feedstocks, has been shown to emit direct greenhouse gases. Perennial tree species sequester carbon dioxide (CO_2) and certain oil seed bearing perennial tree species can be grown on degraded wasteland and degraded cropland and can also be used to produce biofuels. Carbon dioxide emissions/saving potential from plantations of perennial tree species on degraded wasteland and degraded cropland were studied and results showed that these tree species had huge net CO_2 sequestration potential.

1. Introduction

Global concerns over energy security and climate change mitigation have led to increased interest in renewable fuels for substituting fossil fuels (Ravindranath et al., 2009). This increasing demand for renewable fuels has led to large scale production of biofuel feedstocks. The food crops like corn, soybean, sugarcane and palm have been used to produce biofuels (Fargione et al., 2008). Moreover, the land which was earlier used to produce food crops has now been diverted to produce biofuel feedstocks, which leads to land use change (LUC) (Gibbs et al., 2008). LUC is one of the major cause for global environmental change and an important source of increased greenhouse gas (GHG) emissions (Harris et al., 2015).

* Corresponding author. World Agroforestry Centre (ICRAF), Biofuel Department, 1st Floor, C Block, NASC Complex, Dev Prakash Shastri Marg Pusa Campus, New Delhi, 110012, India.

E-mail address: namitapragya21@gmail.com (N. Pragya).

http://dx.doi.org/10.1016/j.gecco.2017.06.002
2351-9894/

Greenhouse gas (GHG) emissions from this induced land use change can offset the climate benefits of biofuel use (Gibbs et al., 2008). Moreover, LUC may also cause altered soil organic carbon (SOC) and changes in many ecosystem services (Harris et al., 2015).

Soils and plant biomass are storehouses of terrestrial carbon. They together store ~2.7 times more carbon than the atmosphere (Fargione et al., 2008). And these terrestrial ecological systems play vital role in global carbon cycle. Respiration, photosynthesis, and decomposition are a few processes through which natural exchange of carbon takes place between these systems. However, certain human activities like land use and land use change lead to substantial release of this carbon stock into the atmosphere (Watson et al., 2000). Conversion of native habitats to croplands involves fire to clear land and also leads to microbial decomposition of the plant biomass releasing the stored organic carbon in them (Fargione et al., 2008). Apart from this the other significant factor which releases GHG is use of fossil energy for cultivation (for production of fertilizers and pesticides), harvesting and production of biofuels (Campbell et al., 2008).

Therefore, whether biofuels mitigate climate change and offer carbon savings depends largely on the way they are produced. Converting original ecosystems like rainforests, savannas, peat lands, or grasslands to an altered state to produce food crop-based biofuel release 17 to 420 times more carbon dioxide than they would help to reduce by displacing fossil fuels and thus create a "biofuel carbon debt". On the contrary, biofuel made from perennial feedstock grown on degraded and abandoned agricultural land incurs little or no carbon debt and can offer immediate and sustained GHG advantages (Fargione et al., 2008). These lands do not compete with food production and nor do they require clearing of native ecosystems, and emit less GHG than natural ecosystem. Moreover, if cultivated in ways compatible with wildlife, it may also maintain or increase habitat (Campbell et al., 2008).

Many countries across the globe have set mandatory biofuel targets for substituting petroleum fuels with biofuels (Fargione et al., 2010). The Government of India had approved the National Policy on Biofuels in December 2009. This policy encouraged the use of renewable energy resources for biofuels to supplement the existing transport fuels (petrol and diesel for vehicles) and had proposed a target of 20% biofuel blending (both bio-diesel and bio-ethanol) by 2017 (National Policy on Biofuels, 2009). Though this was a very ambitious target as India has not been able to achieve it till date, yet Ministry of India sees this industry to rise close to ₹1.25 lakh crore by 2040, and has assured that it will provide all the necessary policy support to the manufacturers who procure the feedstock for biofuel production from India (Biofuel, 2016). Adding to the challenge is the national policy's requirement that biofuels must avoid conflict with food production. It requires that crops for biofuel feedstock be grown in India on degraded or wasteland not suitable for food production.

Considering the above-mentioned concerns, University of Agricultural Sciences of Bangalore, based in Karnataka, set up a pilot site, where it has grown perennial tree species for biodiesel production. As these tree species can grow on degraded land they do not compete with food crop for fertile land. Oil from their seeds is used to produce biodiesel. But as mentioned earlier, we also need to take land use change into account, in order to realize the full mitigation potential of biodiesel production and use from these tree species. In the same context this study aims to assess the CO_2 emissions/saving potential arising due to land use change from these perennial tree species grown on degraded and abandoned agricultural land for the fulfilment of India's biofuel production targets.

2. Land use change assessment

2.1. Methodology

Mitigation potential was calculated using the Tool for Afforestation and Reforestation Approved Methodologies (TARAM) model developed by the World Bank under Clean Development Mechanism (CDM). The study is based on IPCC good practice guidance Land use, Land use change and forestry (Good Practice Guidance for Land Use, 2003). The required data for the study was taken from the pilot site based at Hassan district, Karnataka, India. The data from this pilot site was then extrapolated to degraded land available on pan-India level.

Like most of the countries India's policy does not allow conversion of forest land for food crop nor for biofuel crop production. And since food production cannot be put aside for rapidly growing population at the cost of biofuel production, so arable land cannot be used to produce biofuel feedstock. Therefore, for pan-India study, the study assumed the plantations to take place on degraded waste land and degraded cropland/agricultural land. They include following:

- Degraded wasteland – the barren land and completely fallow land are considered in this category where there is no pre-existing biomass/vegetation happening and therefore no grazing.
- Degraded cropland/agricultural land – only 10% of current fallow land is considered in this category. Cultural wasteland, land under miscellaneous tree crops and groves have not been considered.

2.2. Method of data collection

The pilot site considered for the current study is based in the Hassan district in the state of Karnataka, India. Since this site is on degraded land, the plantations do not compete with food crops for fertile land. The plantations include six tree species,