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Efficiency analysis of bioenergy potential on winter fallow fields: A case study of rape

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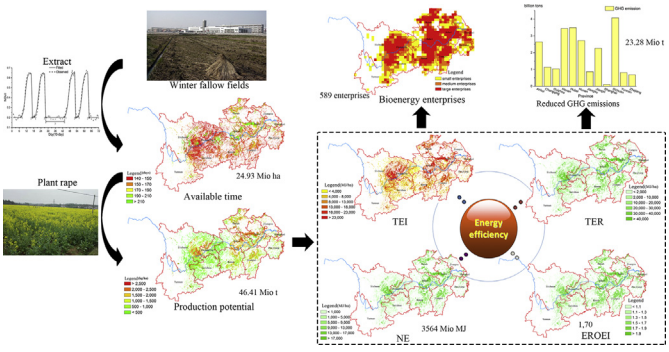
HIGHLIGHTS

- Available winter fallow fields accounts for 34.2% of cultivated land in the Yangtze River from 2010 to 2015
- Net energy is up to 3564 million MJ and EROEI was1.52-1.84, with an average of 1.70
- Reduced GHG emissions amount reached as much as 23.28 million tons.
- The number of bio-energy potential enterprises reached 589.
- Hubei, Henan, Anhui and Jiangxi should be prioritized for generating biofuels from rapeseed planted on winter fallow fields.

GRAPHICAL ABSTRACT



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ABSTRACT

Rape is a non-grain feedstock with several characteristics that make it suitable for biofuel production, such as high oil yields and low environmental impact. Planting rape on winter fallow fields could allow for seasonal rotation between the bioenergy production and agricultural production. In the present study, the Global Agro-Ecological Zones model was used to estimate the production potential of rapeseed on winter fallow fields in the Yangtze River region from 2010 to 2015. Life cycle assessment was then conducted to calculate energy efficiency and greenhouse gas emissions from the entire energy-producing process and to estimate the number of bioenergy enterprises and their spatial distribution. The results indicated that the total area available of winter fallow fields in the Yangtze River region was 24.93 million ha, accounting for 34.2% of the total cultivated land area. The total yield of winter rapeseed was up to 46.41 million tons (an average yield of 1.86 tons/ha). Thus, the study area could potentially produce net energy of up to 3564 million MJ with energy return on energy investment (EROEI) as high as 1.52–1.84. The total reduction of greenhouse gas emissions may be up to 23.28 million tons, and the total number of bioenergy enterprises could be 589, from which the total biodiesel output could be 167.5 million tons. Hubei, Henan, Anhui and Jiangxi should be prioritized for generating biofuels from rapeseed planted on winter fallow fields.

1. Introduction

The increasing demand for energy has become a major challenge for modern society, as energy is the driving force of social development and

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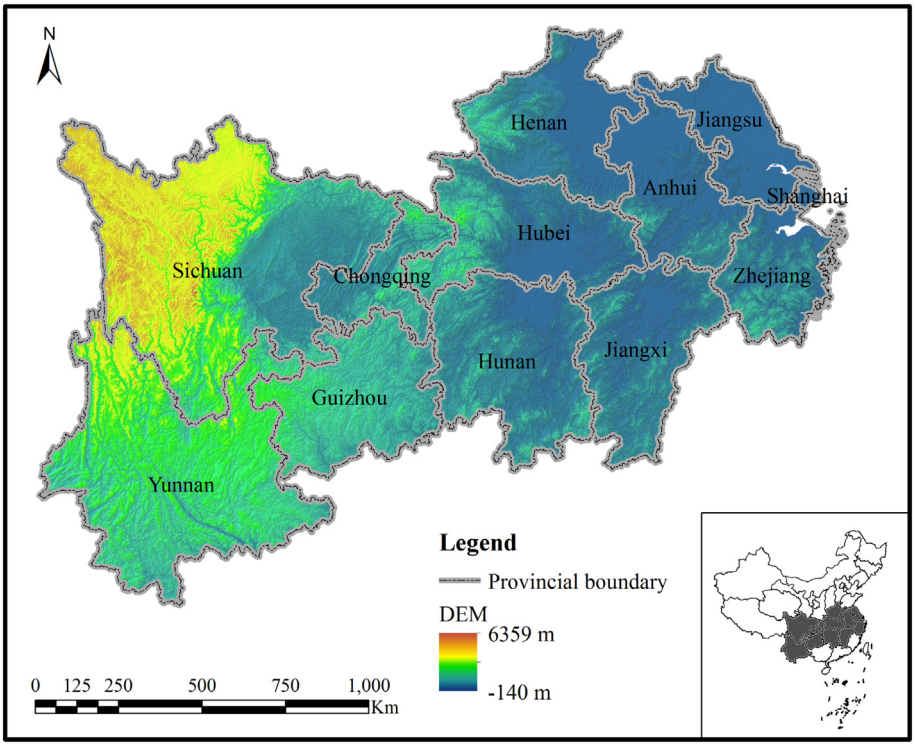

Fig. 1. Location of the study area.

the lifeblood of the global economy. Since the 19th century, approximately 90% of global energy consumed has been derived from fossil fuels such as petroleum, coal, and natural gas (Petroleum, 2010). However, the sustainability of fossil fuels cannot be ensured, as they are non-renewable (Batchelor et al., 1995; Baka and Roland-Holst, 2009; Ajanovic and Haas, 2010). The conflict between the potentially unstable supply of fossil fuels and the increasing demand for energy has prompted researchers to search for alternative energy sources (Arvidsson et al., 2011). Compared to fossil fuels, these alternative energy sources are often beneficial in terms of their environmental impacts (Bomb et al., 2007; Nanaki and Koroneos, 2012). Biofuels, one type of alternative energy source, could decrease our reliance on fossil fuels and help farmers increase their incomes (Davis et al., 2009; Zah and Ruddy, 2009).

At present, the total global output of biofuels is nearly 80 billion l. The United States, Brazil, the European Union, and Canada are the main producers, accounting for over 90% of the global biofuels output (Surhone and Timpledon, 2010). The production of bioethanol has increased rapidly, from 35.2 million tons to 79.15 million tons over the past decade. In the United States, biofuel comprises the largest share

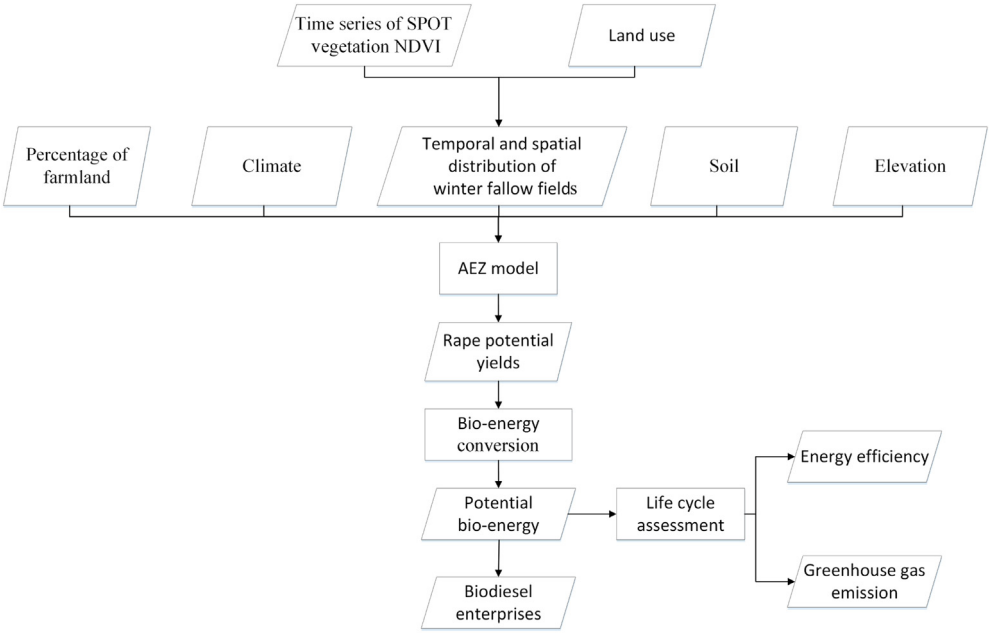

Fig. 2. Technology roadmap.