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Farming of bioenergy crops could cause water stress: NUS-led study

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With the search for climate-friendly energy sources heating up, more attention is being paid to a potential solution that involves growing crops for fuel, and then capturing the gases released when they are burned.

But scientists at the National University of Singapore (NUS) say such bioenergy and carbon capture and storage (BECCS) solutions – which are not yet widely used – must be thoroughly considered and weighed against other options before they are used.

In a new study, researchers from NUS and other institutions in the United States found that BECCS could have negative implications on water quality, as growing large expanses of bioenergy crops like switchgrass requires fertiliser that can leach into groundwater.

Razing existing forests for the large-scale cultivation of bioenergy crops could also cause more emissions to be released overall, the researchers found.

The study was published last Wednesday in the journal Science Advances.

The lead author of the study, Dr Cheng Yanyan from NUS' Department of Industrial Systems Engineering and Management, said the research team wanted to provide a clearer picture of the effectiveness of BECCS in removing greenhouse gases from the atmosphere when compared with other strategies that bank on nature to achieve this.

Nature-based solutions are gaining prominence globally, with the United Nations' top climate science body saying in a report last month that agriculture, forestry and other land uses can provide large-scale emissions reductions, and also remove and store carbon dioxide (CO_2) at scale.

CO_2 is the main greenhouse gas driving climate change.

Human activity like the burning of fossil fuels for energy belches out CO_2, which accumulate in the atmosphere like a blanket.

The study compared BECCS with reforestation, which refers to planting trees in a dwindling forest, and afforestation, a process that entails planting new trees or sowing seeds in bare areas.

BECCS, reforestation and afforestation all rely on the ability of plants to take in CO_2 from the atmosphere through photosynthesis. Reforestation and afforestation efforts aim to keep the trees standing so that the vegetation continuously takes in CO_2, storing the carbon in tree trunks, roots and in the soil.

In BECCS, however, the crops are used as replacements for fossil fuels, and are felled and burned for energy. The emissions released from the burning are then captured using carbon capture technology – which is still nascent – and stored underground or converted to other substances.

The study, which focused on the potential of BECCS in the US, found that by the end of the century, this method could remove between 11.4 billion and 31.2 billion tonnes of CO_2 from the atmosphere.

This is of similar magnitude to the 19.6 billion to 30.2 billion tonnes of CO_2 removal in the scenario where reforestation and afforestation are the main methods used to reduce emissions. The range accounts for the fact that some natural vegetation will be converted to bioenergy crop fields, even in this scenario, Dr Cheng said.

For context, 36.3 billion tonnes of CO_2 was released into the atmosphere last year.

But the researchers said hitting the bioenergy-based strategy's high end of the range would depend on future bioenergy crop yields, technology advancement, and the effectiveness of carbon capture and storage technologies.

"These factors are important because they determine the amount of fossil fuels that bioenergy crops can replace, and carbon captured via BECCS," said Dr Cheng.

The study also found that nearly one-fourth of land areas in the US will suffer severe water stress by 2100 due to either reduced availability or deteriorated quality.

NUS assistant professor He Xiaogang, another lead author of the study, said that while the study had focused on the impacts of BECCS in the US, their findings could apply to other regions of the world as well. Other studies have shown that bioenergy crop expansion in the region could grow at a rate twice of that in the US, he added.

More studies will need to be done to examine the impacts of BECCS in South-east Asia.

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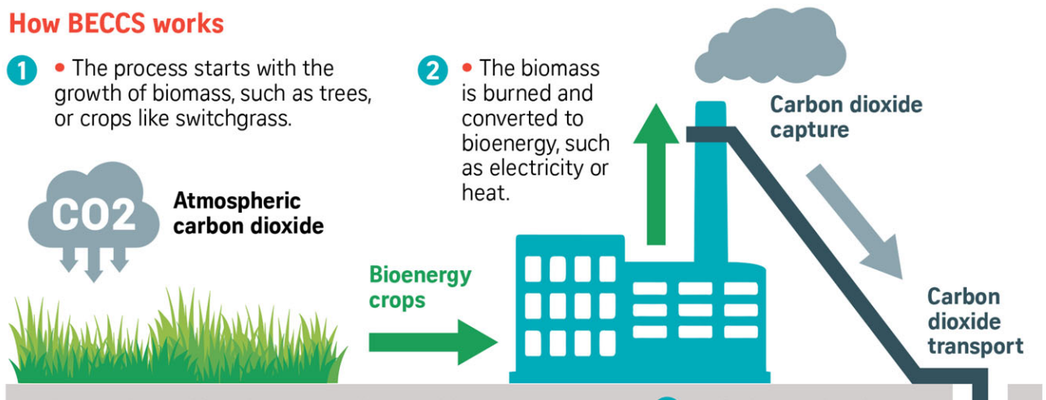
Potential pitfalls of growing energy

Bioenergy with carbon capture and storage, or BECCS, is a technique that is increasingly being discussed among climate scientists as a solution for tackling climate change. But a research team led by scientists at the National University of Singapore has found that, when compared with reforestation, using plots of land for the intensive growing of bioenergy crops could have adverse consequences. This includes reduced water availability or the deterioration of water quality.

How BECCS works



BECCS	Reforestation
Usually monocultures of plant species that can grow quickly. Carbon is released into the atmosphere if forests are cleared for bioenergy cultivation.	Diversity of plant species that can support greater variety of wildlife
Requires the application of fertiliser, which can affect water quality.	
Can be grown on degraded land unsuitable for agriculture.	Does not require fertilisation
Effectiveness depends on advancements in carbon capture technology, which is presently still nascent	

Sources: CHENG ET AL (2022), PRINCETON STRAITS TIMES GRAPHICS