Plants as solutions to global warming?

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A mature redwood tree can contain the equivalent of 800 tons of CO$_2$.

That is 16 times the amount released into the atmosphere annually by an average US household.
Plants take up CO$_2$ (and produce it, too…)

Some of the energy fixed by plants is used to maintain and repair plant tissues and their functions. That energy is used through respiration:  

\[ \text{CH}_2\text{O} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy} \]
Photosynthesis takes place in chloroplasts, mostly in leaves.
Absorption spectrum of photosynthetic pigments.
Carbon accumulation takes time and trees

- It would take 300 25-year-old pine trees to offset a typical US household’s 50 t CO$_2$ carbon footprint.

1 house, 300 pine trees
… and trees use water …

Change in annual runoff

… and can have other effects on the environment, …

…such as soil salinization by redistribution of saline groundwater to the surface soil. This was observed under *Eucalyptus* plantations in Argentina.

Carbon sequestration vs. plants as bioenergy

- Using trees for carbon sequestration (= carbon offsets)
  - requires a lot of trees,
  - requires water,
  - takes a long time,
  - may have adverse environmental impacts,
  - and requires certainty that carbon stays in the trees and their ecosystems for a long time (e.g., no fires!).

- Using plants as bioenergy to replace fossil fuels has a much more immediate impact on carbon emissions.
Bioenergy crops

<table>
<thead>
<tr>
<th>Platforms</th>
<th>Feedstock</th>
<th>NEB(^b) GJ/ha/yr</th>
<th>NER(^b)</th>
<th>CO(_2) balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol from starch or sucrose</td>
<td>Maize</td>
<td>10–80</td>
<td>1.5–3.0</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Sugarcane</td>
<td>55–80</td>
<td>3.0–4.0</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Sugar beet</td>
<td>40–100</td>
<td>2.5–3.5</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Sweet sorghum</td>
<td>85–300</td>
<td>5–10</td>
<td>Positive</td>
</tr>
<tr>
<td>Ethanol from lignocellulosic feedstocks</td>
<td>Miscanthus</td>
<td>250–550</td>
<td>15–70</td>
<td>Possibly negative</td>
</tr>
<tr>
<td></td>
<td>Switchgrass</td>
<td>150–500</td>
<td>10–50</td>
<td>Possibly negative</td>
</tr>
<tr>
<td></td>
<td>Poplar</td>
<td>150–250</td>
<td>10–20</td>
<td>Possibly negative</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Soybean</td>
<td>–20–10</td>
<td>0.2–0.6</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Canola</td>
<td>–5–2</td>
<td>0.7–1.0</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Sunflower</td>
<td>–10–0</td>
<td>0.3–0.9</td>
<td>Positive</td>
</tr>
</tbody>
</table>

NEB = net energy balance, NER = ratio of energy output to energy input

Possibly also sequester carbon
Miscanthus

Source: University of Arkansas: http://dailyheadlines.uark.edu/
Where to plant bioenergy crops?

- Lands now occupied by natural vegetation.
  - This would result in a net CO₂ release.

- Agricultural lands now used for food production:
  - A terrible idea that has already caused food shortages and resulted in rising food prices globally (Gallagher Review 2008, UK Renewable Fuels Agency).

- Abandoned agricultural lands.
  - The area of such lands worldwide is limited.
Abandoned agricultural lands

(a) Abandoned area

(b) Abandoned NPP

Plant growth on these areas could offset ~5% of global energy consumption (Field et al. 2008. TREE 23:65-72).
So how can plants help us?

- Carbon sequestration in trees and bioenergy cannot be the only solutions to global warming,
- … but they can be solutions if we reduce our carbon footprints!
- Remember the 300 pine trees needed to offset a current US household’s annual carbon footprint?
- How about reducing our households’ carbon footprints to 5 t CO$_2$ and using 30 pine trees to offset that whole footprint?
Calculate your carbon footprint

One of the best carbon footprint calculators is at:
http://www.coolcalifornia.org/calculator.html
What can you do?

- Help to **plant trees** now so that they can become part of a future solution as they grow.
  - Support the UNEP “Billion Tree Campaign”

- **Urban trees** sequester carbon and can reduce air-conditioning bills by shading buildings.
  - Calculate your carbon savings with the CUFR Tree Carbon Calculator at: http://www.fs.fed.us/ccrc/topics/urban-forests/

- **Biodiesel** is no global solution, but using biodiesel from used vegetable oil can be a solution for individuals like you.
The solution to global warming

Drawing: Antoine de Saint-Exupéry’s “The little prince”.