Consequential Life Cycle Assessment of pisco production in the Ica Valley, Peru

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Presentation layout

1. Pisco production as a case study
2. Methods and model development
3. Results
4. Conclusions and discussion
Pisco is an alcoholic beverage produced with grapes harvested from southern coastal Peru.
Viticulture was identified as a very intensive stage in terms of climate change in most wineries.

Contribution of stages in GHG emissions per liter of pisco

<table>
<thead>
<tr>
<th>Stage</th>
<th>CO₂ eq per liter of pisco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viticulture</td>
<td>1.97</td>
</tr>
<tr>
<td>Vinification</td>
<td>2.99</td>
</tr>
</tbody>
</table>

It is reasonable to expect an increase in the demand of pisco for the following years with BAU conditions.
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What are the possible environmental consequences?

PISCO PRODUCTION 2000-2014

\[ y = 0.5178x + 0.7925 \]

\[ R^2 = 0.9909 \]

BAU: Business as usual
The objective is to understand the environmental consequences of the upcoming increase in pisco demand in terms of GWP.

**H 1:** Profit of grape increases during time and is always higher than for certain crops.

**H 2:** A given farmer will always choose the most profitable crop.

**H 3:** There are certain crops for which profit remains constant or decreases through time.

- **Increase in demand of pisco**
  - Focusing only on agriculture stage

- **Increase in demand of grapes**
  - **Replacement**
  - **Expansion**
  - **Intensification** (Fertilization and water use may alter grape quality)
  - **Imports** (It is not replaceable due to its denomination of origin)

**Profit of grape increases during time and is always higher than for certain crops**
Replacement and expansion scenarios can be explained by proposing plausible economic conditions.

\[
\begin{align*}
\text{max} Z &= (u - u_1)X_1 + (u - u_2)X_2 + (u - u_3)X_3 \\
\text{max} Z &= u(X_1 + X_2 + X_3) - (u_1X_1 + u_2X_2 + u_3X_3) \\
\text{max} Z &= uY - (u_1X_1 + u_2X_2 + u_3X_3) \\
\text{max} Z &= -(u_1X_1 + u_2X_2 + u_3X_3) \\
\text{min} Z &= u_1X_1 + u_2X_2 + u_3X_3
\end{align*}
\]

Selection criteria for marginal producers:
- National Agriculture Census 2012 and National Production Database
- Seasonal crops
- Domestic sales
- Low profit products

Producer perspective:
- Total arable land > 3 ha
- Arable land for grapes > 3 ha
- Access to water sources

Financial perspective:
A Stochastic Technology Choice Model was selected to analyze the interaction among crops in the Ica and Pisco valleys.

Linear programming model:

\[
\min \quad Z = P'Fs \\
\text{s.t.} \quad As = Y \quad \quad sj \geq 0 \quad \quad Fs \leq C
\]
There is an increase in the net GHG emissions per liter of pisco in both scenarios due to crop replacement.
A profit variability simulation shows that emissions per FU converge to a value and net emissions do not differ.

**GHG emissions in 2025**

Ica – with or without annual variability: 38.4 Mg CO$_2$eq
It is possible to satisfy the projected pisco demand in the Region of Ica, if land and water are used efficiently

It is plausible for farmers to change to more profitable and less water demanding crops (grapes)

The Valley of Pisco can potentially fulfill current and future pisco grapes demand and minimize crop replacement

Fallow land is so abundant that a possible agricultural expansion is unlikely to occur
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