Intensification vs land expansion in sugarcane production

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12:00 - 13:30 hr
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Outline

- the increase in sugarcane production in Africa, is it from land expansion and/or improving productivity?

- What is the potential for intensification on existing land?

- What is the implication of intensification on land use and water consumption?
Sugarcane production in Africa

Sugarcane cultivated area by Country in Africa [ha] (FAOSTAT, 2005)

Sugarcane cultivated area by Country in Africa [ha] (FAOSTAT, 2012)
Sugarcane production in Africa

Sugarcane cultivation by Country in Africa [ha] (FAOSTAT, 2005)

1,128,698 ha

Sugarcane cultivation by Country in Africa [ha] (FAOSTAT, 2012)

1,274,127 ha

~13%
Sugarcane production in Africa

Average 61 ton/ha/year

Sugarcane yield by Country in Africa [ton/ha] (FAOSTAT, 2005)

Average 59 ton/ha/year

Sugarcane yield by Country in Africa [ton/ha] (FAOSTAT, 2012)
Is there a scope for intensification

- The case from Xinavane, Mozambique
- The total area considered for this analyses is **10,012 ha** (363 ha irrigated using furrow, 935 ha irrigated using centre pivot and 8,714 ha irrigated using mixed irrigation system).
Methods and data

Seasonal water consumption/production = \sum_{SOS} X_i

WaPOR: FAO portal to monitor Water Productivity through Open access of remotely sensed derived data. [https://wapor.apps.fao.org/home/WAPOR_2/1](https://wapor.apps.fao.org/home/WAPOR_2/1)
**Methods and data**

*Seasonal* water consumption/production = \( \sum_{EOS}^{SOS} X_i \)

**WaPOR:** FAO portal to monitor Water Productivity through Open access of remotely sensed derived data. [https://wapor.apps.fao.org/home/WAPOR_2/1](https://wapor.apps.fao.org/home/WAPOR_2/1)
Methods and data

\[ WP_b = \frac{B}{ET_a} \]

\[ \text{Biomass} = AOT \times f_c \times \frac{NPP \times 22.222}{(1 - MC)} \]

Water and land productivity

Productivity targets

Productivity gaps

Closing productivity gaps

Production projection

Implication on water consumption

Water and land productivity

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Land productivity: biomass

![Graph showing land productivity over different years for various farming methods.](Image)

- Biomass [ton/ha/year]

Legend:
- Furrow (biomass)
- Centre pivot (biomass)
- Xinavane scheme (biomass)
- FAOSTAT - Mozambique (yield)
Land productivity: biomass

![Map of Biomass 2017-10-01 to 2018-09-30]

- Water and land productivity
- Productivity targets
- Productivity gaps
- Closing productivity gaps
- Production projection
- Implication on water consumption
Water productivity: biomass WP

**Biomass WP 2017-10-01 to 2018-09-30**

Legend
- Centre pivot
- Furrow
- Mixed irrigation system

-5.4 to -7.0 biomass water productivity [m³/kg]

**Biomass WP 2017/2018**

- >95 Percentile

- 0 to 350 Biomass WP [kg/m³]

- 4 to 8 Biomass WP [kg/m³]

Water and land productivity  Productivity targets  Productivity gaps  Closing productivity gaps  Production projection  Implication on water consumption
Productivity targets

Water and land productivity  Productivity targets  Productivity gaps  Closing productivity gaps  Production projection  Implication on water consumption
Productivity targets

Biomass vs Biomass WP 2017/2018

- 95 percentile
- Productivity target

Water and land productivity | Productivity targets | Productivity gaps | Closing productivity gaps | Production projection | Implication on water consumption
Productivity targets

Water and land productivity | Productivity targets | Productivity gaps | Closing productivity gaps | Production projection | Implication on water consumption
Productivity gaps

Water and land productivity | Productivity targets | Productivity gaps | Closing productivity gaps | Production projection | Implication on water consumption
Closing productivity gaps

1) Close biomass gaps & WP gaps by increasing $ET_a$
2) Close biomass gaps & $WP_b$ gaps at the same $ET_a$
3) Close biomass gaps & WP gaps by reducing $ET_a$
## Production projection

<table>
<thead>
<tr>
<th>Year</th>
<th>Biomass gap [ton/ha/year]</th>
<th>Biomass WP gap [kg/m³]</th>
<th>Production gap [ton/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>2014/2015</td>
<td>14.7</td>
<td>9.6</td>
<td>0.3</td>
</tr>
<tr>
<td>2015/2016</td>
<td>13.9</td>
<td>9.1</td>
<td>0.7</td>
</tr>
<tr>
<td>2016/2017</td>
<td>13.3</td>
<td>7.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2017/2018</td>
<td>14.3</td>
<td>8.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2018/2019</td>
<td>13.2</td>
<td>8.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Average</td>
<td>13.9</td>
<td></td>
<td>0.42</td>
</tr>
</tbody>
</table>
## Implication on water consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>Area [ha]</th>
<th>Mean [mm]</th>
<th>SD [mm]</th>
<th>ETa Increase [m³/year]</th>
<th>Area [ha]</th>
<th>Mean [mm]</th>
<th>SD [mm]</th>
<th>ETa Reduction [m³/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014/2015</td>
<td>8,442</td>
<td>202</td>
<td>147</td>
<td>17,042,258</td>
<td>1,058</td>
<td>39</td>
<td>301</td>
<td>409,030</td>
</tr>
<tr>
<td>2015/2016</td>
<td>5,710</td>
<td>195</td>
<td>156</td>
<td>11,155,927</td>
<td>3,755</td>
<td>95</td>
<td>70</td>
<td>3,568,423</td>
</tr>
<tr>
<td>2016/2017</td>
<td>8,276</td>
<td>149</td>
<td>105</td>
<td>12,335,516</td>
<td>1,218</td>
<td>38</td>
<td>31</td>
<td>461,342</td>
</tr>
<tr>
<td>2017/2018</td>
<td>7,880</td>
<td>184</td>
<td>122</td>
<td>14,498,279</td>
<td>1,614</td>
<td>54</td>
<td>39</td>
<td>878,183</td>
</tr>
<tr>
<td>2018/2019</td>
<td>7,082</td>
<td>166</td>
<td>126</td>
<td>11,756,116</td>
<td>2,412</td>
<td>68</td>
<td>54</td>
<td>1,642,862</td>
</tr>
<tr>
<td>Average</td>
<td>7,478</td>
<td>179</td>
<td>13.4 M m³</td>
<td>59</td>
<td>1.4 M m³</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• Intensification at Xinavane by closing biomass gaps can increase water productivity as well as production up to 131,826±5,414 ton/year, which is equivalent to harvesting from additional irrigation land of more than ~ 1,437 ha (~14% of the existing crop land).

• The increase in production from existing land comes with additional water consumption (13.4 million m³), which would have been higher if the production gain is from land expansion.

• Subsequent studies, could additionally consider sucrose content of sugarcane as it is the most important indicator of the marketable output (sugar) than biomass.

• WaPOR play an important role in bridging the data gaps, particularly the spatial detail, which are unavailable from the traditional means of data collection (point data). However, validation and accurate interpretation of the results, diagnoses of the productivity gaps and formulation of practical solutions can be made if WaPOR analyses and results are complemented with observed data and local information.
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