Defining Whole System Sustainability in Hawai‘i

Carey W. King, Emily Grubert, Michael E. Webber
What is the Ulupono Initiative?

- Ulupono is a Hawai‘i-focused impact investment firm that uses for-profit and non-profit investments to improve the quality of life for island residents in three key areas:

  More Locally Produced Food  More Renewable Energy  Waste Reduction

Founders: Pam & Pierre Omidyar
Objective:
Take a systems approach to understand whether there is enough water to meet society's goals for energy and food self-sufficiency

- Climate change reflecting in the persistent drought raises serious questions about whether we can achieve our food and energy goals while balancing urban, indigenous, and environmental needs
- Understanding water adequacy fundamentally requires a systems approach
- Maui was selected because it is a harbinger for the impending water crisis across the rest of the state
The Problem: The Hydrological System is in Deficit, and Climate Trends Indicate Decreasing Rainfall

Agriculture is the dominant user based on cheap surface water
Where Maui Stands Now: Plantation Economy Mining Its Natural Inheritance

Sugar Cane Scenarios

% of total Maui consumption of each category

- Gross Electricity as Renewables
- Fruit & Vegetables
- Beef
- Liquid Fuels
- Milk

(a)

30K acres, Today - Calibration (sugar)
30K acres, Full Water, EtOH
25K acres, Full Water, EtOH

Net Groundwater Recharge from Irrigation

Calibration Scenario 1 Scenario 2B

- Net Recharge
  = GW recharge from irrigation
  - GW pumped

Dr. Carey W. King 10/23/2013
Where Hawai’i Could Be: More Local Food and Energy While Restoring Natural Capital

System Energy & Food Scenarios

% of total Maui consumption of each category

- Liquid Fuels
- Milk
- Beef
- Fruit & Vegetables
- Gross Electricity as Renewables

Net Groundwater Recharge from Irrigation

<table>
<thead>
<tr>
<th></th>
<th>Billion gallons H₂O per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Cane</td>
<td>3</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2</td>
</tr>
<tr>
<td>Cassava (std.)</td>
<td>1</td>
</tr>
<tr>
<td>Cassava (imp.)</td>
<td>0</td>
</tr>
<tr>
<td>Bangrass</td>
<td>-1</td>
</tr>
</tbody>
</table>

Yield assumptions (fresh weight, with moisture):
- Sugar Cane: 91 tonnes/acre/harvest (2-yr cycle, 50% harvested/yr)
- Sweet Sorghum: 37.4 tonnes/acre/yr over 3 harvests in a year
- Cassava: 20 tonnes/acre/yr ("Standard"), 30 tonnes/acre/yr ("Improved")

Dr. Carey W. King 10/23/2013
What if drought patterns persist?
Cassava can tolerate low-flow years
## Maui Could Triple the Economic Value Derived From Water Use Through an Integrated Food-Fuel Approach

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Efficacy: $/1000 gal. H₂O</th>
<th>Efficacy: $/1000 gal. H₂O (w/RO)</th>
<th>Efficiency: mill. gal. H₂O/acre</th>
<th>% Fuel</th>
<th>% Gross Electricity</th>
<th>% Div. Ag</th>
<th>% Beef</th>
<th>% Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 7: Diversified Ag. (1,000 acres)</td>
<td></td>
<td>$48.2</td>
<td>$48.2</td>
<td>0.50</td>
<td>0%</td>
<td>19%</td>
<td>69%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 8c: Cassava High (ETOH), cattle and div. ag.</td>
<td></td>
<td>$3.38</td>
<td>$4.12</td>
<td>1.31</td>
<td>40%</td>
<td>24%</td>
<td>69%</td>
<td>13%</td>
<td>101%</td>
</tr>
<tr>
<td>Scenario 8c: Cassava Standard (ETOH), cattle and div. ag.</td>
<td></td>
<td>$2.88</td>
<td>$3.74</td>
<td>1.45</td>
<td>40%</td>
<td>24%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 8b: Sweet sorghum (ETOH), cattle and div. ag.</td>
<td></td>
<td>$2.57</td>
<td>$3.06</td>
<td>1.31</td>
<td>26%</td>
<td>22%</td>
<td>69%</td>
<td>13%</td>
<td>101%</td>
</tr>
<tr>
<td>Scenario 8a: Grass-fed beef and dairy (5,850 acres)</td>
<td></td>
<td>$2.01</td>
<td>$2.01</td>
<td>0.91</td>
<td>0%</td>
<td>19%</td>
<td>16%</td>
<td>13%</td>
<td>101%</td>
</tr>
<tr>
<td>Scenario 4: Cassava standard (2,000 acres - ETOH)</td>
<td></td>
<td>$1.92</td>
<td>$2.40</td>
<td>1.45</td>
<td>26%</td>
<td>22%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 6d: Panagras (ETOH), cattle and div. ag.</td>
<td></td>
<td>$1.90</td>
<td>$2.30</td>
<td>2.61</td>
<td>43%</td>
<td>26%</td>
<td>69%</td>
<td>13%</td>
<td>101%</td>
</tr>
<tr>
<td>Scenario 6a: Panagras (2,000 acres - ETOH)</td>
<td></td>
<td>$1.54</td>
<td>$1.98</td>
<td>2.13</td>
<td>43%</td>
<td>26%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 6a: Sugar cane (ETOH), cattle and div. ag.</td>
<td></td>
<td>$1.54</td>
<td>$1.83</td>
<td>2.61</td>
<td>31%</td>
<td>25%</td>
<td>69%</td>
<td>13%</td>
<td>101%</td>
</tr>
<tr>
<td>Scenario 7: Sweet Sorghum (2,000 acres - ETOH)</td>
<td></td>
<td>$1.43</td>
<td>$1.75</td>
<td>1.15</td>
<td>12%</td>
<td>26%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 2: Sugar cane (2,000 acres - sugar)</td>
<td></td>
<td>$1.32</td>
<td>$1.32</td>
<td>3.13</td>
<td>0%</td>
<td>25%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Scenario 2b: Sugar cane (38,000 acres - sugar)</td>
<td></td>
<td>$1.18</td>
<td>$1.18</td>
<td>3.11</td>
<td>0%</td>
<td>26%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Today</strong>: Sugar cane (38,000 acres - sugar)</td>
<td></td>
<td>$1.14</td>
<td>$1.45</td>
<td>3.13</td>
<td>31%</td>
<td>25%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
</tr>
</tbody>
</table>

1 Gross electricity includes current generation from other renewable sources, primarily wind
2 Diversified Ag = cabbage, romaine lettuce, bananas and onions
Implications

- Current course is unsustainable – climate change will only accelerate this, ultimately creating a crisis
- Significant improvement towards self sufficiency is attainable with sustainable water use if we can shift agricultural lands to more productive and profitable approaches
- Investment approach: Partner with major landowners on commercial trials in 2014; shift grass-fed beef initiatives to wetter areas of Maui, convert lands to food production
- Mindset Shift Approach: Use systems framework to launch statewide dialog on sustainable water use
Mahalo!

Dr. Carey W. King

careyking@mail.utexas.edu
careyking.com

Emily Grubert, Michael E. Webber

energy institute

JACKSON

THE UNIVERSITY OF TEXAS AT AUSTIN

SCHOOL OF GEO SCIENCES

Cockrell School of Engineering

Special thanks to
Kyle Datta & Kandice Johns

www.uluponoinitiative.com

ulupono initiative