The Bioeconomy & Circular Economy in Southern Arizona: Profile, Economic Baseline, & Prospects

George Frisvold
Department of Agricultural & Resource Economics.
University of Arizona

MAP Talk: Arizona’s Bioeconomy
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Collaborative Effort

• Department of Agricultural & Resource Economics

• Department of Biosystems Engineering

• Other Contributors throughout the UA College of Agriculture, Life & Environmental Sciences
<table>
<thead>
<tr>
<th>Contributors</th>
<th>IMPLAN Group, LLC</th>
<th>Agricultural &amp; Resource Economics</th>
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<tbody>
<tr>
<td>Ashley Kerna Bickel</td>
<td>Joel L. Cuello</td>
<td>Kamel Didan</td>
<td>Kathryn Farrell-Poe</td>
</tr>
<tr>
<td>Dari Duval</td>
<td>Biosystems Engineering</td>
<td>Biosystems Engineering</td>
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<tr>
<td>George Frisvold</td>
<td>Gene Giacomelli</td>
<td>Haiquan Li</td>
<td>Murat Kacira</td>
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<tr>
<td>Biosystems Engineering</td>
<td>Joseph Blankinship</td>
<td>Diaa Eldin Elshikha</td>
<td>Tanya Hodges</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>Environmental Science</td>
<td>Biosystems Engineering</td>
<td>Agricultural Education, Technology, &amp; Innovation</td>
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<tr>
<td>Shelby Hoglund</td>
<td>Shelby Hoglund</td>
<td>Baleshka Brenes Mayorga</td>
<td>Barry Pryor</td>
</tr>
<tr>
<td>Desert Cedar Consulting, LLC</td>
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<td>Agricultural Education, Technology, &amp; Innovation</td>
<td>Plant Sciences / BIO 5 Institute</td>
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<tr>
<td>Matthew Recsetar</td>
<td>Matthew Recsetar</td>
<td>Dennis Ray</td>
<td>Peter Weller</td>
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<tr>
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Southern Arizona Bioeconomy

• Agricultural industries (mostly in Yuma) directly accounted for
  • 80% of bioeconomy jobs
  • 75% of the value added
  • 60% of sales

• Including multiplier effects, total contribution
  • $6.5 billion in sales
  • 36,400 jobs
Southern Arizona Circular Economy

• Including multiplier effects, total contribution
  • $1.3 billion in sales
  • 12,600 jobs

• Circular economic activity concentrated in Pima County
Southern Arizona Circular Economy & Bioeconomy

• Total contribution of the bioeconomy and circular economy to Southern Arizona in 2019 was
• $7.9 billion in sales
• 49,000 jobs
• $3.8 billion of Southern Arizona Gross Regional Product
Questions

• What do we mean by “the bioeconomy?“

• What do we mean by “the circular economy?“

• What do we mean by “the circular bioeconomy?“
Circular Bioeconomy

• >50 countries have developed formal strategies to promote their bioeconomies

• No universally accepted definition or agreement about what economic activities to include

• >100 definitions of the circular economy
Defining the Bioeconomy

“A revolution in the life sciences will also go way beyond medicine into agriculture, chemical production, environmental sciences, micro-electronics. Biotechnology will be creating jobs that we don’t even have names for yet. And they will be high-paying, high-demand jobs—and intellectually satisfying ones. New industries will emerge that will be a growing source of national economic strength and world leadership. Some have gone so far as to suggest that the twenty-first century will be based on a bioeconomy”

Dr. Bernadine Healy
Director of the National Institutes of Health (NIH)
1994 commencement address at Vassar College
“The objective of the life science company is no longer to generate breakthroughs in a single area such as medicine, chemicals, or food but to become a dominant player in all of these.”
“The U.S. bioeconomy is economic activity that is driven by research innovation in the life sciences and biotechnology, that is enabled by technological advances in engineering and in computing information sciences.”
Different approaches to defining the bioeconomy landscape

North America (narrow)

- Biotechnology focus
- Medical / pharmaceutical applications
- Bio-cybersecurity & medical / genetic databases
- Narrower ag focus on biofuels & GM crops
- NASEM report includes intangible assets

EU (broad)

- Includes all agriculture, forestry, fisheries
- Includes non-energy biobased production (food processing, wood & paper products)
- Less emphasis on medical applications, GM crops
- De-emphasis of biotech R&D
### Southern Arizona Bioeconomy Jobs

<table>
<thead>
<tr>
<th>Activity</th>
<th>So. AZ</th>
<th>Cochise</th>
<th>Pima</th>
<th>Santa Cruz</th>
<th>Yuma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of Biomass (crops)</td>
<td>14,069</td>
<td>958</td>
<td>572</td>
<td>0</td>
<td>12,539</td>
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<tr>
<td>Food &amp; Fiber System</td>
<td>2,136</td>
<td>104</td>
<td>1,437</td>
<td>50</td>
<td>545</td>
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<tr>
<td>Bioenergy</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industrial</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Health Biosciences</td>
<td>235</td>
<td>0</td>
<td>235</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Research &amp; Development</td>
<td>1,093</td>
<td>39</td>
<td>1,001</td>
<td>0</td>
<td>53</td>
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<tr>
<td>Total</td>
<td>17,533</td>
<td>1,101</td>
<td>3,245</td>
<td>50</td>
<td>13,137</td>
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Linear vs. Circular Economy

Linear Economy – take-make-use-dispose

Circular Economy – 4Rs: reduce, reuse, repair, recycle
Linear vs. Circular Economy

- Energy and material input
- Production
- Distribution
- Use
- Disposal
- Waste and emission leakage

Recycling
Remanufacturing
Refurbishing
Reuse
Waste Management Hierarchy

- Prevent
- Reduce
- Reuse
- Recycle
- Recover
- Dispose
Circular industries vs. circular activities

Most industries are engaged in circular activities (e.g. recycling, reusing)

Our study only measured industries specializing in circular activities
Southern Arizona Circular Economy Components
# Southern Arizona Circular Economy Jobs

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<tr>
<th>Industry</th>
<th>So. AZ</th>
<th>Cochise</th>
<th>Pima</th>
<th>Santa Cruz</th>
<th>Yuma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair and Maintenance</td>
<td>3,995</td>
<td>191</td>
<td>3,096</td>
<td>57</td>
<td>651</td>
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<tr>
<td>Reuse</td>
<td>2,028</td>
<td>141</td>
<td>1,798</td>
<td>0</td>
<td>89</td>
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<tr>
<td>Recycling and Remediation</td>
<td>152</td>
<td>0</td>
<td>152</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>6,175</td>
<td>332</td>
<td>5,046</td>
<td>57</td>
<td>740</td>
</tr>
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Bioeconomy

Production of Biological Resources
Production of renewable biological resources
- Agriculture, Forestry, Fishing

Processing of Biological Resources
Conversion of renewable biological resources into value-added products
- Food & Fiber System
- Industrial*
- Bioenergy & Biofuels

Health Biosciences
Use of biological products and processes for health-related outcomes
- Drugs, Pharmaceuticals, & Diagnostics
- Medical Devices & Equipment

Bio-based Research & Development
Private-sector research and development in biotechnology and physical, engineering, and life sciences

Circular Economy

Repair & Maintenance
Extend the life of existing products and materials for one user

Reuse
Extend the life of existing products and materials through resale

Recycling & Remediation
Recover specific materials for reuse and reduce amount and toxicity of waste

Bioeconomy Innovation System*
Technological advancements enabled by R&D in biological sciences, information and communication, engineering and others
- Biotechnology and genetic engineering
- Precision agriculture
- Alternative biobased chemicals, plastics, fibers, and textiles
- Precision medicine, biomarkers, and bioinformatics
- Molecular diagnostics

* Not included in economic contribution analysis due to limited data availability
CIRCULAR ECONOMY AS THE INTERSECTION OF BIOECONOMY & CIRCULAR ACTIVITIES

Circular bioeconomy includes:
- Bio-based products
- Share, reuse, remanufacture, recycling
- Cascading use
- Utilization of organic waste streams
- Resource-efficient value chains
- Organic recycling, nutrient cycling
Circular Bioeconomy Case Studies

• Reviving Guayule in Southern Arizona
• Biochar for Irrigated Desert Croplands
• Urban and Peri-Urban Vertical Farming
• Leafy greens and mushroom production integrated CEA system
• The Circular Bioeconomy of Decoupled Aquaponics
Circular Bioeconomy Case Studies

• Underground Vertical Farming in Southern Arizona as Inspired by Underground Vertical Farming on the Moon and Mars
• Bioregenerative Life Support for Space Habitats and Earth Applications of Controlled Environment Agriculture
• Microalgae for High-Value Bioproducts
• Phyto-mediated Wastewater Treatment for Removing Contaminants from Wastewater Effluent
• Yuma "Growing Our Own" Initiative
The University of Arizona Links Tucson & Yuma: The 2 Hubs of the Southern Arizona Circular Bioeconomy
New Policy Developments

- 2022 Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy
- Department of Commerce developing satellite accounts for the bioeconomy
- States introduce right-to-repair legislation
- 2021 Executive Order on Promoting Competition in the American Economy encourages FTC chair to, “exercise … statutory rulemaking authority … in areas such as … restrictions on third-party repair or self-repair of items
- American Farm Bureau and John Deere Sign Memorandum of Understanding Addressing Right to Repair
Future Research

• Opportunities to shift purchases from out-of-region suppliers to local Southern Arizona suppliers; more dollars could stay in Southern Arizona

• Multipliers for local (circular) services vs. imported manufactured goods

• Role of the U of A in the bioeconomy innovation ecosystem
  • Interactions with private sector
  • Injection of federal R&D funding into local economy

• Role of state and local public sectors in the circular economy