Fruit and Vegetable Food Systems

Overview from CSIRO - Australia

Jessica Bogard | Nutrition Systems Scientist
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Our business units and focus areas

- Agriculture and Food
- Energy
- Health and Biosecurity
- Land and Water
- Manufacturing
- Mineral Resources
- Oceans and Atmosphere
- Astronomy and Space Science
- Australian Animal Health Laboratory
- Data61
- Marine National Facility
- National Computing Infrastructure
- National Research Collections of Australia
Global Food and Nutrition Security team

- Multi-disciplinary team who partners to deliver outcomes for a sustainable, food secure world

https://research.csiro.au/foodglobalsecurity/
What does CSIRO contribute to the F&V space?

Value chain analysis

Systems analysis – Global Food and Nutrition Security team
Plant breeding and farm management

- Improved selection tools — genetic markers, phenomics and selection of elite lines
  - Wine and table grapes, almonds, avocado (wheat, sugarcane, canola)

- New varieties with resistance to major pathogens, improved quality and differentiated products
  - Wine, table and dried grapes, citrus, mango, lychee, macadamia (soybean, sugarcane)

- New rootstocks with improved resistance to root pests and tolerance to salinity and drought
  - Wine, table and dried grapes, almonds

- Improved management techniques to manipulate flowering, ripening and quality attributes
  - Wine, table and dried grapes, almonds, avocado, apple

- Improved modelling of plant/crop and gene-to-phenome

Processing technologies for increased shelf life, reduced seasonality, retained/enhanced nutritional quality:

- Extrusion
- High pressure processing (HPP)
- Modified atmosphere packaging
- Separation and stabilisation

Advanced capability in sensory and consumer science
Program on food loss:
Aim → to divert and transform edible food loss, using novel processing methods to add value and enhance sustainability

- Extrusion → snacks or powder from broccoli, carrot, apple and other F&V (utilising imperfect produce that would otherwise be wasted)
  - Snacks can be eaten as is
  - Powders can be added to smoothies, dips, sauces, spreads, pasta, noodles or bakery items
- Vision that growers/groups of growers could generate a secondary income from imperfect produce/waste material

CSIRO's TraNSIT tool analyses transport and logistics options for agriculture to identify potential cost savings.

- Used by industry to inform logistics/decision making
- Used in decision making around infrastructure investment
Increasing demand – VegEze App

• <5% of Australians eat recommended # vegetable serves
• CSIRO developed an app that challenges people to eat 3 serves of veg at dinner over 21 days
• The ‘challenge’ period helps to establish new habits
• The app gives info on portion sizes and prompts with easy ways of increasing intake
• Impact: Average serves of vegetables increased by 0.6 serves at 21 days, and 0.7 serves at 90 days

Increasing demand: Vegetable education resource for primary schools

**A 5-week Classroom Based Program:**

- Aimed at changing children’s knowledge, attitudes & receptivity to consuming vegetables
- Aligned to the curriculum
- Suitable for teachers’ needs to facilitate adoption

**Written resources**

- 5 x 1hr lessons
- Aimed at each of three age stages (ages 5-8, 8-10, and 10-12 years) of Australian primary schools.

**Theoretical Framework of Exposure & Sensory Education**

- Vegetable tasting
- Development of the senses
- Hands-on learning

**Cross-Curricular**

- Science
- Physical Health & Education (but no explicit health messages)
CSIRO value chain capability

Value chains for the future

- Life cycle analysis
- Carbon & water footprinting
- Adaptive value chains
- Predictive analytics
- Supply chain indices
- Nutrition-sensitive agriculture
- Equitable
- Resilient
- Competitive
- Low impact

Optimisation
TraNSIT
Block chains
Social network analysis

https://adaptivevaluechains.com/info/

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Systems analysis from local to global scales—Global F&N Security team

Methods and data:
- Scenarios and projections
- Agricultural systems analysis and modelling
  - Dynamic simulation modelling for land use, food production and economics
  - Crop modelling
  - Statistical modelling
- Spatial analysis
- Environmental impact assessment
- National agricultural censuses and surveys
- Food composition data bases

Nutrition-sensitive agriculture and aquaculture systems
- Carbon sequestration
- Land use and environmental management
- Climate impacts, adaptation and mitigation
- Stochastic frontier analysis

Agricultural and Development Economics
- Value Chains
- Agricultural Policies

Environmental Science

Animal Science
- Sustainable and profitable livestock systems

Data Science/Statistics

Nutrition and Health Science
Example 1 - systems modelling

- Modelling approaches to map value addition throughout the chain (methods applied to Cassava in this case, but applicable to any value chain)

Value chain performance ($AUD)  Profit/ton cassava produced

<table>
<thead>
<tr>
<th>Value Chain</th>
<th>Profit/ton cassava produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava Producers profit</td>
<td>23</td>
</tr>
<tr>
<td>CPP + Chip cluster profit</td>
<td>37</td>
</tr>
<tr>
<td>CPP+CCP+ By-products profit</td>
<td>44</td>
</tr>
<tr>
<td>CPP+CCP+BPP+ Labor profit</td>
<td>84</td>
</tr>
<tr>
<td>CPP+CCP+BPP+LB+ Transporters profit</td>
<td>89</td>
</tr>
</tbody>
</table>

Confidential, Kanar Dizyee (unpublished)
Example 2 – mapping global nutrient production

- Small and medium farms produce between 50-75% of the world’s food

Herrero et al. 2017 The Lancet PH
Example 2 – mapping global nutrient production

(A) calcium, (B) folate, (C) iron, (D) protein, (E) vitamin A, (F) vitamin B12 (G) zinc

Collaboration with the IHME

ARTICLE

Mapping child growth failure in Africa between 2000 and 2015

Osgood Zimmerman et al 2018 Nature

Herrero et al. 2017 The Lancet PH
Example 3 - Policy coherence for nutrition?

1. Mapping of key policies which shape the food system
2. Assessment of their coherence with positive nutrition outcomes
The issues – Availability: Need gap

Production and Demand at Farm Gate

Vegetables

Grains

(Ridoutt et al, 2017)
The issues: affordability and availability

• “The consumption of fruit and vegetables is low worldwide, particularly in LICs, and this is associated with low affordability” (Miller, 2016)

• Mean daily F&V consumption was:
  • 2·14 servings in LICs
  • 3·17 servings in LMICs
  • 4·31 servings in UMICs
  • 5·42 servings in HICs
The issues: Cost of F&V relative to unhealthy food

- Price of fruit and vegetables ↑ 55-91% from 1990-2012 whilst many processed foods are getting cheaper
- Consistent with findings in Australia (Harrison, 2010)
- In remote Indigenous communities in Australia, from 1986-2012, affordability of F&V ↑ by 30%, and consumption doubled (Lee, 2016)
- BUT...affordability of discretionary foods also increased and the net result was a decline in overall dietary quality

(Wiggins and Keats, ODI, 2015)
The issues: Global funding environment

FIGURE 6.6: CGIAR research funding allocated to specific crops in 2012 (in US$ million)

- Rice
- Maize
- Wheat
- Livestock and fish
- Cassava
- Bananas & plantains
- Sweet potatoes
- Potatoes
- Yams
- Groundnut
- Chickpea
- Sorghum
- Beans
- Pigeonpea
- Soybean
- Cowpea
- Pearl millet
- Lentil
- Faba bean
- Roots, other
- Finger millet
- Barley

World Vegetable Centre

(Global Panel report on Food Systems and Diets, 2016)
The issues: Australian funding environment

Investment in agricultural R&D by food groups 2010-2015

- Vegetables and fruit, $494 million
- Dairy, $220 million
- Meat, $728 million
- Grains, $947 million
- Discretionary food
  - Sugar: $109 million
  - Wine: $141 million

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# Data gap: Nutrient composition of indigenous varieties

<table>
<thead>
<tr>
<th>Vitamin A content (RE/100 g)</th>
<th>Portion needed to meet RNI for adult woman (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 banana varieties found in Solomon Islands</td>
<td></td>
</tr>
<tr>
<td>Aibwo/Suria</td>
<td>871</td>
</tr>
<tr>
<td>Fagufagu</td>
<td>698</td>
</tr>
<tr>
<td>Saena</td>
<td>16</td>
</tr>
<tr>
<td>Cavendish</td>
<td>6</td>
</tr>
</tbody>
</table>

RNI, recommended nutrient intake WHO/FAO 2004
RE, retinol equivalents

Englberger et al, 2010

Aibwo banana
References

• Englberger, L., Lyons, G., Foley, W., ...Taylor, M. (2010). Carotenoid and riboflavin content of banana cultivars from Makira, Solomon Islands. *Journal of Food Composition and Analysis*, 23(6), 624-632. doi: [http://dx.doi.org/10.1016/j.jfca.2010.03.002](http://dx.doi.org/10.1016/j.jfca.2010.03.002)


Thank you
Jessica.Bogard@csiro.au
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Group website: https://research.csiro.au/foodglobalsecurity/