Dietary & Food Security Metrics for Climate Modeling: Spatial Scales for Different Populations

Jess Fanzo PhD
Bloomberg Distinguished Professor of Ethics, and Global Food and Agriculture
Effects of Diet Type on Climate Change but what about the other way around?

Production and Supply at the Global Scale: Species and Nutrition Diversity

Remans et al. 2014 Global Food Security Journal
Nutritional Content Declines in Global Cereal Supply with Increased Production

(A) Fraction of DRI provided by 100 g dry weight from a mix of eight cereals (barley, oats, maize, millet, rice, rye, sorghum, and wheat) from 1961 to 2011 for macronutrients (energy and protein) and micronutrients (iron and zinc). Values were calculated from production quantity (excluding cereals used for livestock feed) and nutritional composition for each cereal crop. DRI does not account for differences among cereals in bioavailability or refining, both of which would further reduce DRI values.

(B) Nutritional yields (number of adults who can obtain 100% of annual DRI from 1 ha per year) of eight cereals for energy, protein, iron, and zinc for global supply in 2013

DeFries et al 2015 Science
Landscape and Farm Level Scale: Multi-functionality

Water ponds: used for washing, drinking and irrigation, malaria flies breeding areas.

Livestock: products for consumption and sale, manure for fertilizer, close animal-human living relationship.

Crop and tree diversity: products for consumption and sale; pest control and pollination.

Vegetation along river: filtration of run-off, biodiversity habitat.

Barotse Floodplain in Zambia

Remans and Fanzo
Inclusion of Human Health and Diet Indicators into Landscapes

Dietary quality (DDS, IYCF)

Food safety (Aflatoxin)

Morbidity (Malaria, diarrhea, URI)

Nutrition (anthropometrics, blood pressure, enteropathy)

Initial links to existing model components

Diversity & productivity in agricultural and natural ecosystems, and access at markets

Agronomic and post-harvest practices, landscape risk elements

Water management and quality, landscape risk elements

Landscape integrated development and risk elements

Climate and seasonality

Remans and Fanzo
“Data from smallholder farm households in Indonesia, Kenya, Ethiopia, and Malawi were examined. Higher farm production diversity significantly contributes to dietary diversity in some situations, but not in all. Improving small farmers’ access to markets seems to be a more effective strategy to improve nutrition than promoting production diversity on subsistence farms.” Sibhatu et al PNAS 2015
Household Scale:
Food Availability & Access Diet Metrics

• Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access
• Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access
• Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access

Increasingly collected in national level surveys (DHS etc)

USAID and FANTA 2010
Examples of Food Security & Diet Metrics

Months of Adequate Household Food Provisioning (MAHFP)

Household Dietary Diversity Score (HDDS)

* p<0.05  ** p<0.01
Individual Scale: Diet Metrics

- Women’s Dietary Diversity Score (FANTA, USAID, IFPRI)
- Infant’s Minimum Acceptable Diet (WHO and UNICEF)
- Optifood (Linear programming model)
- Cost of Diets (Save the Children)

Not systematically collected at the national level
## Women’s Dietary Diversity: Key Vulnerable Population

<table>
<thead>
<tr>
<th>WDD food groups</th>
<th>Isiolo</th>
<th>Marsabit</th>
<th>Turkana</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% consuming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grains, roots and tubers</td>
<td>96</td>
<td>95</td>
<td>99</td>
</tr>
<tr>
<td>Legumes and nuts</td>
<td>44</td>
<td>71</td>
<td>56</td>
</tr>
<tr>
<td>Dairy products including milk, yogurt, cheese</td>
<td>80</td>
<td>97</td>
<td>38</td>
</tr>
<tr>
<td>Organ meat</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Eggs</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Flesh foods</td>
<td>9</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin A dark green leafy vegetables</td>
<td>36</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>Other vitamin A rich fruits and vegetables</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Other fruits and vegetables</td>
<td>56</td>
<td>41</td>
<td>23</td>
</tr>
<tr>
<td>Mean number of food groups</td>
<td>3.4</td>
<td>3.3</td>
<td>2.7</td>
</tr>
</tbody>
</table>

GAIN 2014; Hotz et al
Minimum Acceptable Diet: First 1000 days

• This indicator is the percentage of children aged 6-23 months who receive a minimum acceptable diet
• The composite indicator the proportion of who had at least the minimum dietary diversity and the minimum meal frequency during the previous day
Optifood Programming: Key Nutrient Gaps from Local Foods

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Isiolo 6-8 mo</th>
<th>9-11 mo</th>
<th>12-23 mo</th>
<th>Marsabit 6-8 mo</th>
<th>9-11 mo</th>
<th>12-23 mo</th>
<th>Turkana 6-8 mo</th>
<th>9-11 mo</th>
<th>12-23 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folate</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Niacin</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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</tr>
<tr>
<td>Riboflavin</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Thiamine</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Vitamin A RE</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<td>✅</td>
</tr>
<tr>
<td>Vitamin B-12</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Vitamin B-6</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Vitamin C</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<td>✅</td>
</tr>
<tr>
<td>Calcium</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
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<tr>
<td>Iron</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Zinc</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
</tbody>
</table>

- ✅: Nutrient requirements could be met with local foods
- 🔴: Nutrient requirements cannot be met with any combination of local foods
- 🟡: Nutrient requirements could be met but may require too many changes to food patterns or may affect other nutrient requirements

GAIN 2014; Hotz et al
Cost of Diets: Income and Diet Links

The graph shows the cost of diet per day and income per day for different countries. The countries compared are Ethiopia, Myanmar (Burma), Tanzania, and the UK.

- **Ethiopia**: The cost of diet per day is around $1.20, and the income per day is around $1.00.
- **Myanmar (Burma)**: The cost of diet per day is around $1.00, and the income per day is around $1.20.
- **Tanzania**: The cost of diet per day is around $0.80, and the income per day is around $1.00.
- **UK**: The cost of diet per day is around $0.40, and the income per day is around $1.50.

The graph indicates a general trend where the cost of diet is lower than the income across all countries.
Data Sources

The following websites contain survey data that can include information on anthropometry, biochemical status and dietary intake:

- WHO NLIIS
  [http://apps.who.int/nutrition/landscape/report.aspx]
- WHO child growth database
  ([http://www.who.int/nutgrowthdb/en/](http://www.who.int/nutgrowthdb/en/))
- WHO BMI database
  ([http://apps.who.int/bmi/index.jsp](http://apps.who.int/bmi/index.jsp))
- Global Nutrition Report
- Demographic and Health (DHS) surveys
  ([http://www.measuredhs.com](http://www.measuredhs.com))
- Multiple Indicator Cluster (MICS) surveys
- WHO surveys
- Global Disease Burden Project
  [http://www.healthdata.org/gbd](http://www.healthdata.org/gbd)
- Lives Saved Tool
- UNICEF ChildInfo
- UNICEF NutriDash

- Food balance sheets
  ([http://faostat.fao.org/site/368/default.aspx# ancor](http://faostat.fao.org/site/368/default.aspx# ancor))
- Functional Diversity Database
  [https://sites.google.com/site/functionaldiversity/downloads](https://sites.google.com/site/functionaldiversity/downloads)
- FAO Stat
- Nut Val
- USDA food composition tables
- European food information resource
  ([http://www.eurofir.net](http://www.eurofir.net))
- International Network of Food Data Systems (INFOODS)
- FAO/INFOODS e-Learning Course on Food Composition Data
- IFPRI Global Hunger Index
  [https://www.ifpri.org/topic/global-hunger-index](https://www.ifpri.org/topic/global-hunger-index)
- Food and Nutrition Technical Assistance
- Cost of Diet
  [http://www.heawebsite.org/home](http://www.heawebsite.org/home)
Thank you!

- AgMIP group for the invitation
- Roseline Remans, Cheryl Palm, Madeleine Thomson and Ruth DeFries at Columbia University
- Lawrence Haddad at IFPRI
Agenda for Ethics and Global Food Security

2015 GLOBAL NUTRITION REPORT

ACTIONS AND ACCOUNTABILITY TO ADVANCE NUTRITION & SUSTAINABLE DEVELOPMENT
Other Considerations
The Shannon production diversity index is a mathematical measure of species diversity (in this case, food item diversity) in a community (in this case, national food production or supply). The size of the bubbles represents the percentage of the population with access to improved drinking water.

Global Nutrition Report 2015 (Nugent et al)
Nutritional Status and Seasonality

Extreme events including droughts and floods have significant impacts on year to year (or even month to month) variability of nutritional status.
Food Acquisition Changes with Seasons

“Lean season”

Isiolo

“Plentiful season”

Marsabit

Turkana

GAIN 2014; Hotz et al
If the color is red (MUAC below 115 mm), then the child is severely malnourished.

If the color is yellow (MUAC between 115 mm and 125 mm), then the child is moderately malnourished.

Green color (MUAC above 125 mm) means that the child is healthy and not malnourished.