Land Use Effects of Various Diet Patterns

A Food Forum Workshop on
Sustainable Diets: Food for Healthy People and a Healthy Planet
with the Roundtable on Environmental Health Sciences, Research, and Medicine

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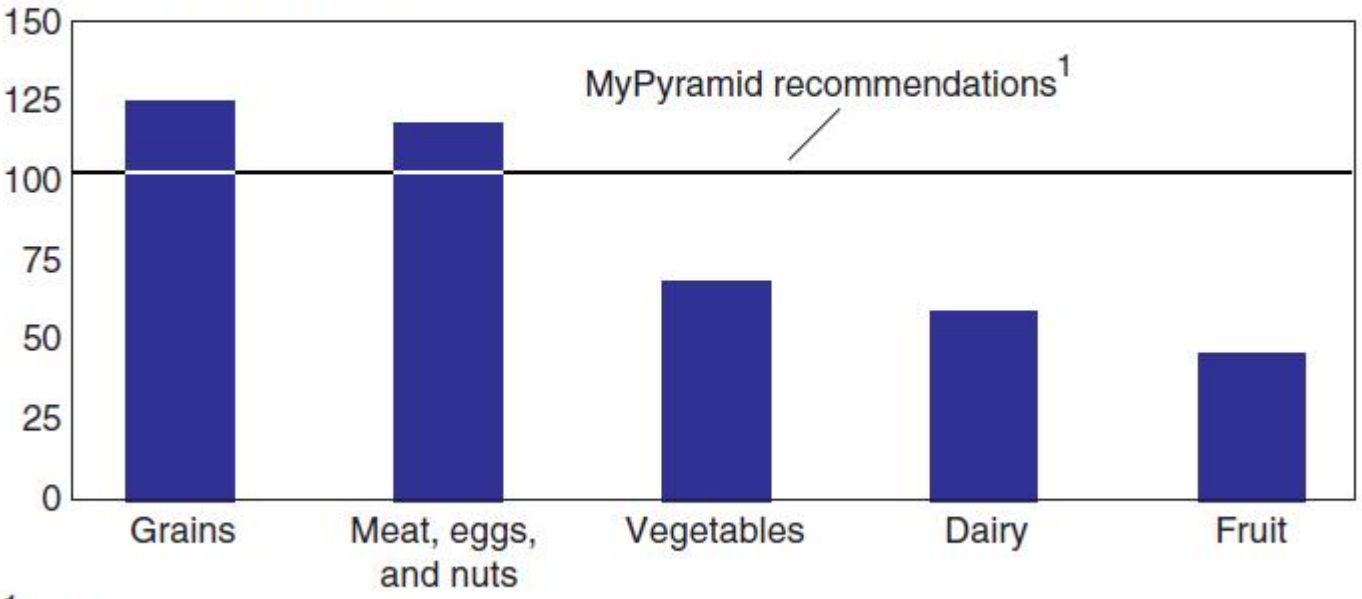
Five questions

1. Land use impacts of healthier diets
2. Projecting, tracking, and evaluating land use
3. Influence on dietary guidelines
4. Indicators to measure environmental impacts
5. Evaluating impacts, balancing tradeoffs

Assessment of U.S. food supply

Figure 1

Loss-adjusted per capita food availabiity out of balance with dietary recommendations



[1]2005 data based on a 2,000-calorie diet.

Source: USDA, ERS Food Availability (Per Capita) Data System.

Wells, H.F. and Buzby, J.C. 2008. (p. 4). Dietary Assessment of Major Trends in U.S. Food Consumption, 1970-2005 [EIB-33]. USDA Economic Research Service, Washington, D.C.

Land impacts of healthier eating

Maximum crop acreage adjustments implied by full adoption of select recommendations from the 2005 *Dietary Guidelines for Americans*[1]

Crop	Average harvested area, 1999-2003	Adjustments in acreage	Acreage needed to meet *Guidelines*
		Million acres	
Fruit	3.5	4.1	7.6
Vegetables:	6.5	8.9	15.3
Dark green	0.3	0.5	0.8
Orange	0.2	0.4	0.6
Legumes	2.0	8.8	10.8
Starchy	2.3	-0.8	1.5
Other	1.7	--	1.7
Wheat (example for whole grains)	22.6	-5.6[2]	17.04
Dairy[3]	NA	NA	NA
Total[4]	32.6	7.4	39.9

Buzby, J.C. Wells, H.F., and Vocke, G. 2006. Possible Implications for U.S. Agriculture from Adoption of Select Dietary Guidelines. USDA Economic Research Service, Economic Research Report No. 31.

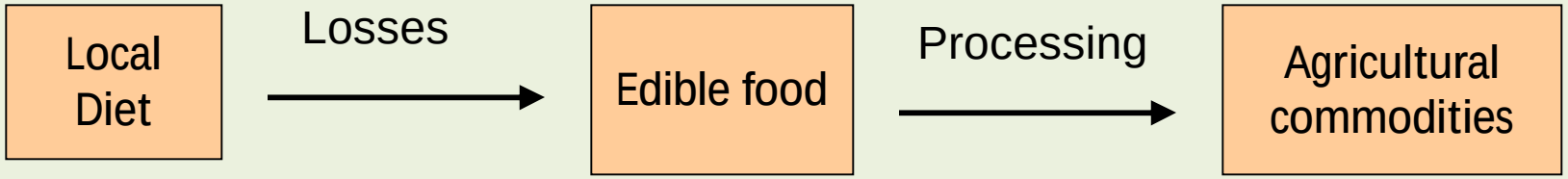
What about the other food groups?

Sweeteners	Meat and added fats
• Straightforward • Sweeteners decrease by 5.3 million acres (67%) • Would effect sugar cane, sugar beet, and corn sweeteners	• Complex • Lean meat requires more animals • Feed grains should increase • Soybean a dual use crop • Livestock support demand for soybean • Trade resolves mismatch between demand for lean meat and less oil

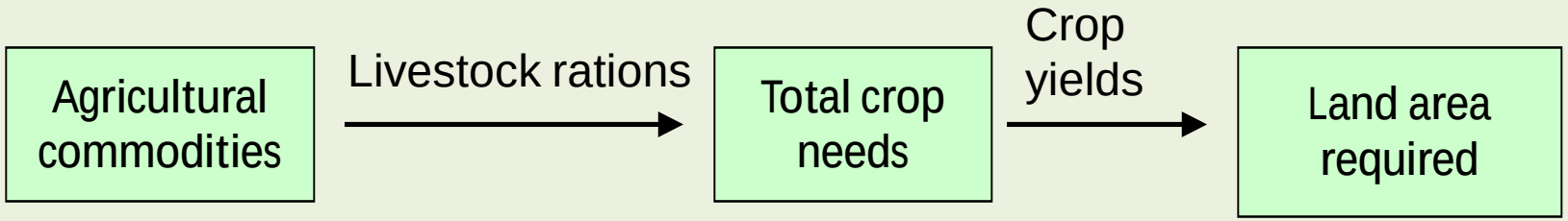
Young, C.E. and L.S. Kantor. 1999. Moving Toward the Food Guide Pyramid: Implications for U.S. Agriculture. p. 403-423 *In* E. Frazao (ed.) America's Eating Habits: Changes and Consequences (AIB-750). USDA-Economic Research Service, Washington, D.C.

Estimating dietary land requirements

STEP 1: Estimating food needs

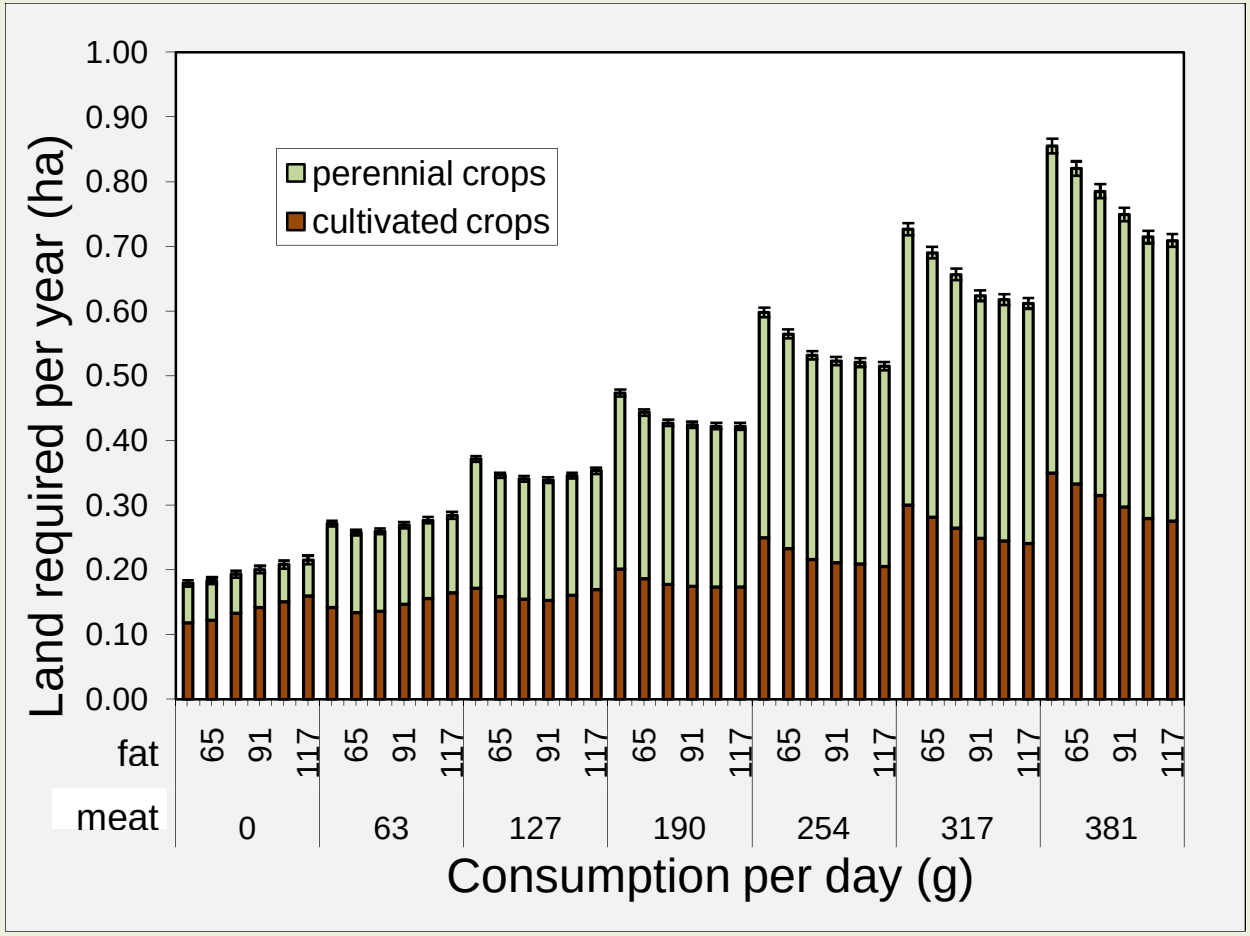


STEP 2: Estimating land needs



Peters, C.J., J.L. Wilkins, and G.W. Fick. 2007. Testing a complete-diet model for estimating the land resource requirements of food consumption and agricultural carrying capacity: The New York State example. *Renewable Agriculture and Food Systems* 22(2): 145-153.

Meat, fat, and land requirements



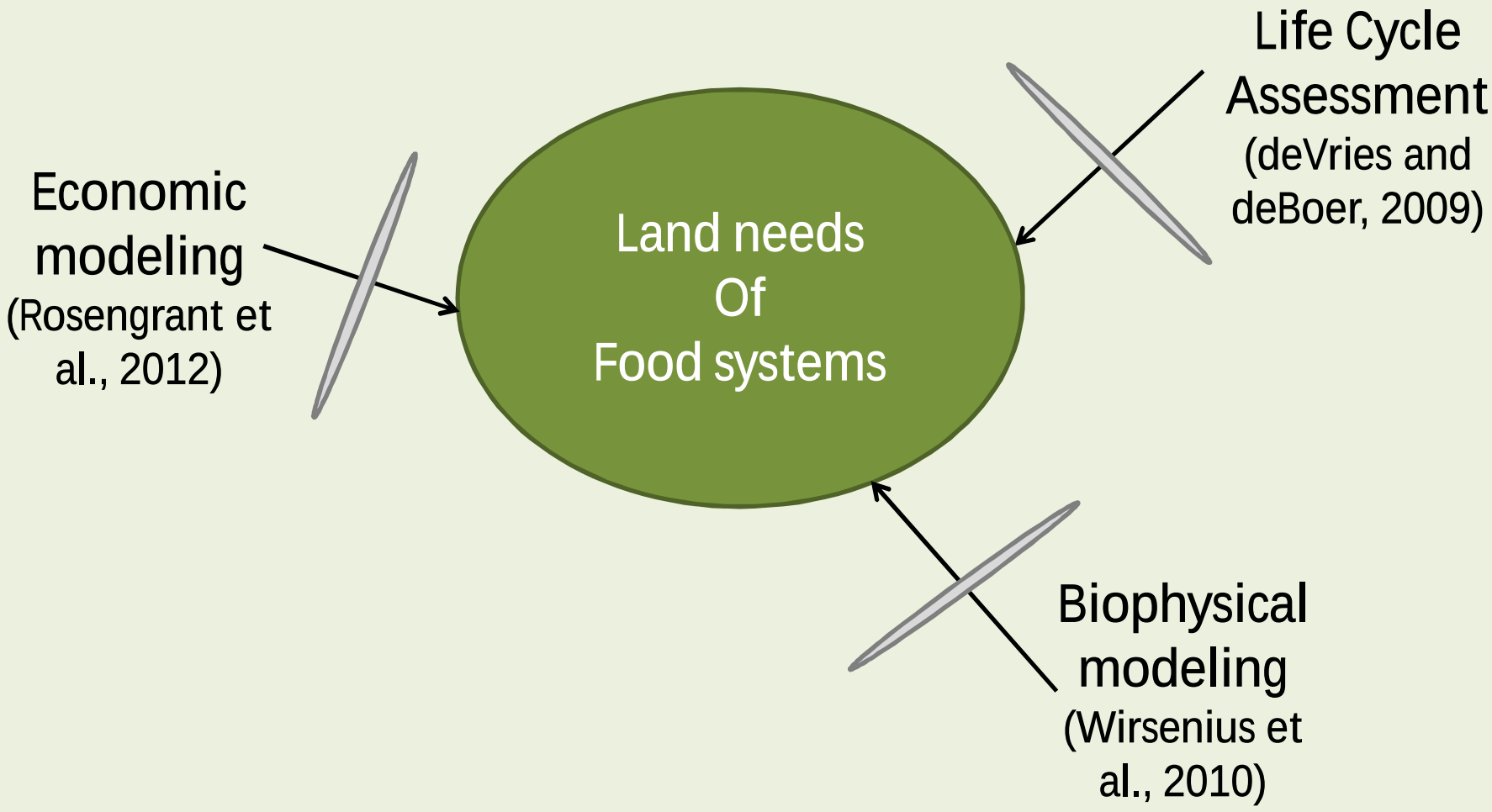
U.S. Diet, 2009

(Meat equivalent ounces)

Meat:	4.67
Eggs:	0.52
Fish:	0.46
Nuts:	0.81
Beans:	0.10
Total:	6.56

Peters, C.J., J.L. Wilkins, and G.W. Fick. 2007. Testing a complete-diet model for estimating the land resource requirements of food consumption and agricultural carrying capacity: The New York State example. *Renewable Agriculture and Food Systems* 22(2): 145-153.

Projecting land use impacts



deVries and deBoer .2009.Livestock Science 128(1):1-11.
Wirsenius et al. 2010. Agricultural Systems 10(3: 621-638.
Rosengrant et al. 2012. International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) Model Description

How is land use tracked?

- Temporal trends:
  - Crop production surveys (USDA-NASS)
  - Census of Agriculture (USDA-NASS)
- Spatial patterns
  - National Land Cover Dataset (MRLC)
  - Cropland Data Layer (USDA-NASS)
- Land use change
  - National Resources Inventory (USDA-NRCS)

How are land use impacts evaluated?

Land Sparing Hypothesis

- Increased yields spare land from conversion to agriculture
- Sparing land leaves more undisturbed habitat for biodiversity
- Reducing land in agriculture is generally an environmental good

See for example Ausubel et al. 2013. Peak farmland and the prospect for land sparing. Population and Development Review 38 (Supplement): 221-242.

Land Sharing Hypothesis

- Agricultural systems can accommodate both productive harvest and wildlife
- Intensification of agriculture has many negative social and ecological consequences
- Reduction of land in agriculture may not be an environmental good

See for example Perfecto and Vandermeer. 2010. The agroecological matrix as an alternative to the land-sparing/agriculture intensiifcation model. PNAS 107(13): 5786-5781.

Helpful indicators?
No one measure will suffice

Limit agriculture to current footprint
(see Foley et al., 2011 and Godfray et al., 2010)

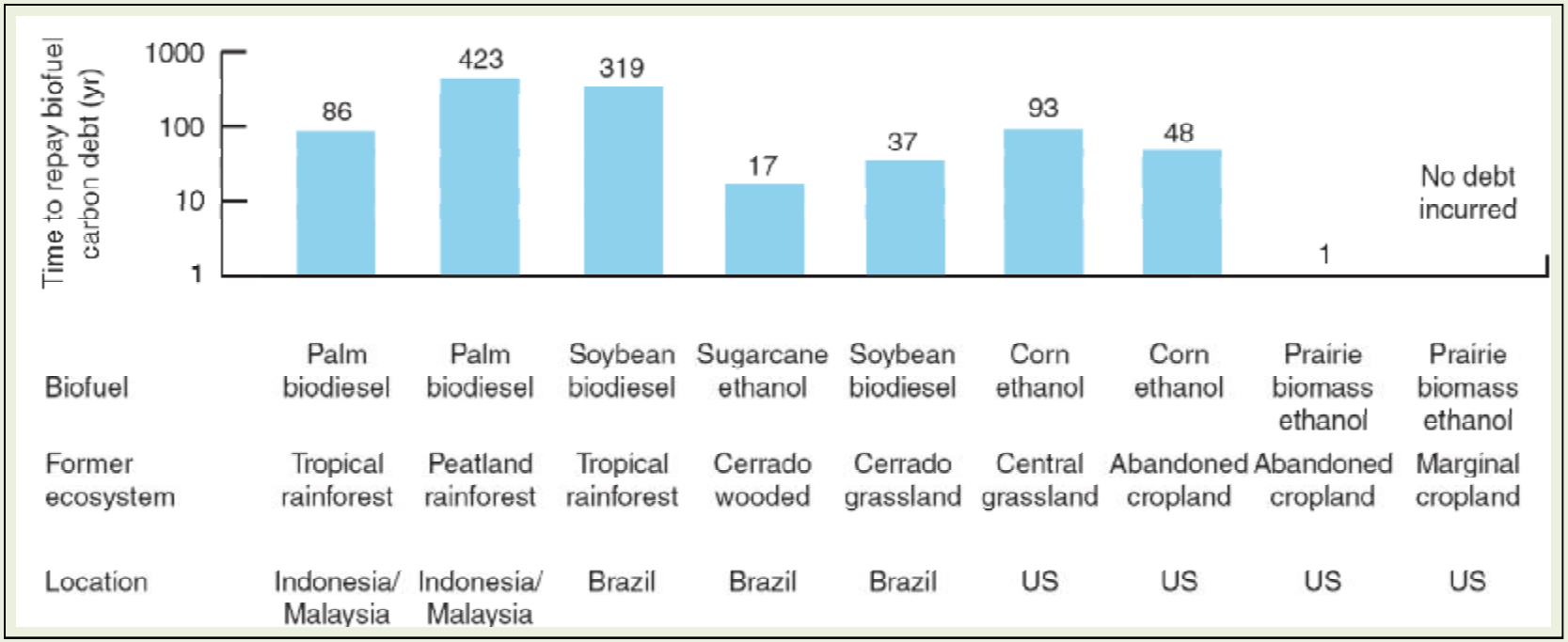
- Land in reserve
- Yield gap

Understand ecological impact of land use

- GHG emissions (CO_2, CH_4, N_2O)
- C storage
- Erosion
- Losses to air and water (Sediment, N, and P)
- Biological diversity

Foley, J.A. et al. 2011. Solutions for a cultivated planet. *Nature* 478: 337-342
Godfray, H.C.J. et al. 2010. Food security: The challenge of feeding 9 billion people. *Science* 327: 812-818.

Example: Evaluating land use in light of C emissions and renewable fuel



Fargione, J., Hill, J., Tilman, D., Polasky, S., and Hawthorne, P. 2008. Land clearing and the biofuel carbon debt. Science 319: 1235-1237.

Balancing health and environment

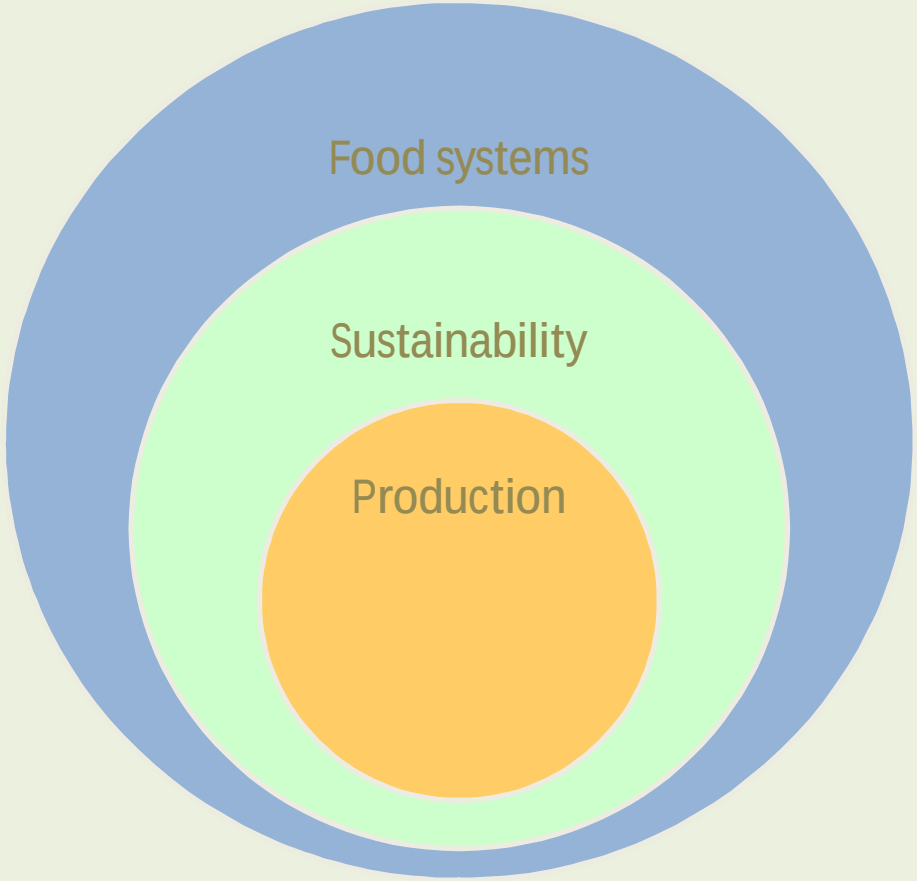
Ethical Synergy

- *Eat more legumes* [+ for health, reduces land relative to other protein]
- *Reduce sugars* [+ for health, reduces land requirement if eliminating excess energy intake]

Ethical Dilemma

- *Increase fish* [health benefits, negative on wild stocks]
- *Increase lean meats* [health benefits, increased land requirements relative to status quo]

Should availability influence dietary guidelines?



Nested Agricultural Paradigms

Agricultural Paradigms

1. Production: output & efficiency
2. Sustainability: ecological impact
3. Food systems: human health

Welch, R.M. and R.D. **Graham**. 1999. A new paradigm for world agriculture: meeting human needs. Field Crops Research 60: 1-10.

Concluding points

- Land use impact of diet
  - Modest overall effect
  - Unless meat consumption changes
- We have the tools we need
  - Projecting impacts of dietary change
  - Tracking changes in land use
- Evaluation of impacts is complex
  - Requires multiple indicators but
  - Land sparing provides helpful rubric
- Dietary guidelines should consider sustainability
  - Within bounds of available evidence
  - Trade offs must be identified