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Economic Development and Food Demand Changes:  
Production and Management Implications

by Norman Rask and Kolleen Rask

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# Economic Development and Food Demand Changes: Production and Management Implications

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# Objectives

Document the economic development process

- Changes in food demand
- Production adjustments
- Single resource-based factor measure

Cereal Equivalents (CE)

# Data

- 159 countries (97% of world population in 2002)
- FAOSTAT database 1961-2002
- World Bank 1975-2002

# Measures and Concepts, 1

- **Economic Development:  $GDP_{PC}$  (PPP)**

*Gross domestic product per capita  
adjusted for purchasing power parity*

- **Food Demand (consumption) and  
Production: CE**

*Tons of cereal equivalents per capita  
per year*

# Measures and Concepts, 2

## Cereal Equivalents

*a resource-based measure*

- **Crop based foods:** caloric content relative to caloric content of an equal weight of cereals
- **Livestock foods:** Cereal (grain) equivalents of feed necessary to produce final livestock product.

# Table 1: Sample Cereal Equivalent (CE) Coefficients\* for Crop and Livestock Products

Crop Products		Livestock Products	
Cereals	1.00	Beef	19.8
Fruits	0.15	Pork	8.5
Pulses	1.08	Chicken	4.7
Starchy Roots	0.26	Milk	1.2
Sugar, Sweeteners	1.10		
Treenuts	0.83		
Vegetable Oils	2.76		
Vegetables	0.07		



# Measures and Concepts, 3

## Land Equivalent

*Total summation (in hectares) of:*

arable land

+ land in permanent crops

+ 1/3 of permanent pasture

---

= *land equivalent*

# Measures and Concepts, 4

Demand (consumption) changes during economic development

Two factors:

- **Population Growth** – *familiar*
- **Diet Upgrade** – *shift to livestock products; most significant and dynamic*

# World and Regional Food Demand Changes 1961-2002

Region	Total	Population Growth	Diet Upgrade
<i>(percentage change in CEs)</i>			
World	154	102	52
Developing	311	133	178
Developed	56	35	21
Africa	205	193	12
Asia	363	122	241
S. America	195	134	61

# Per Capita Income-Consumption Relationship (diet upgrade)

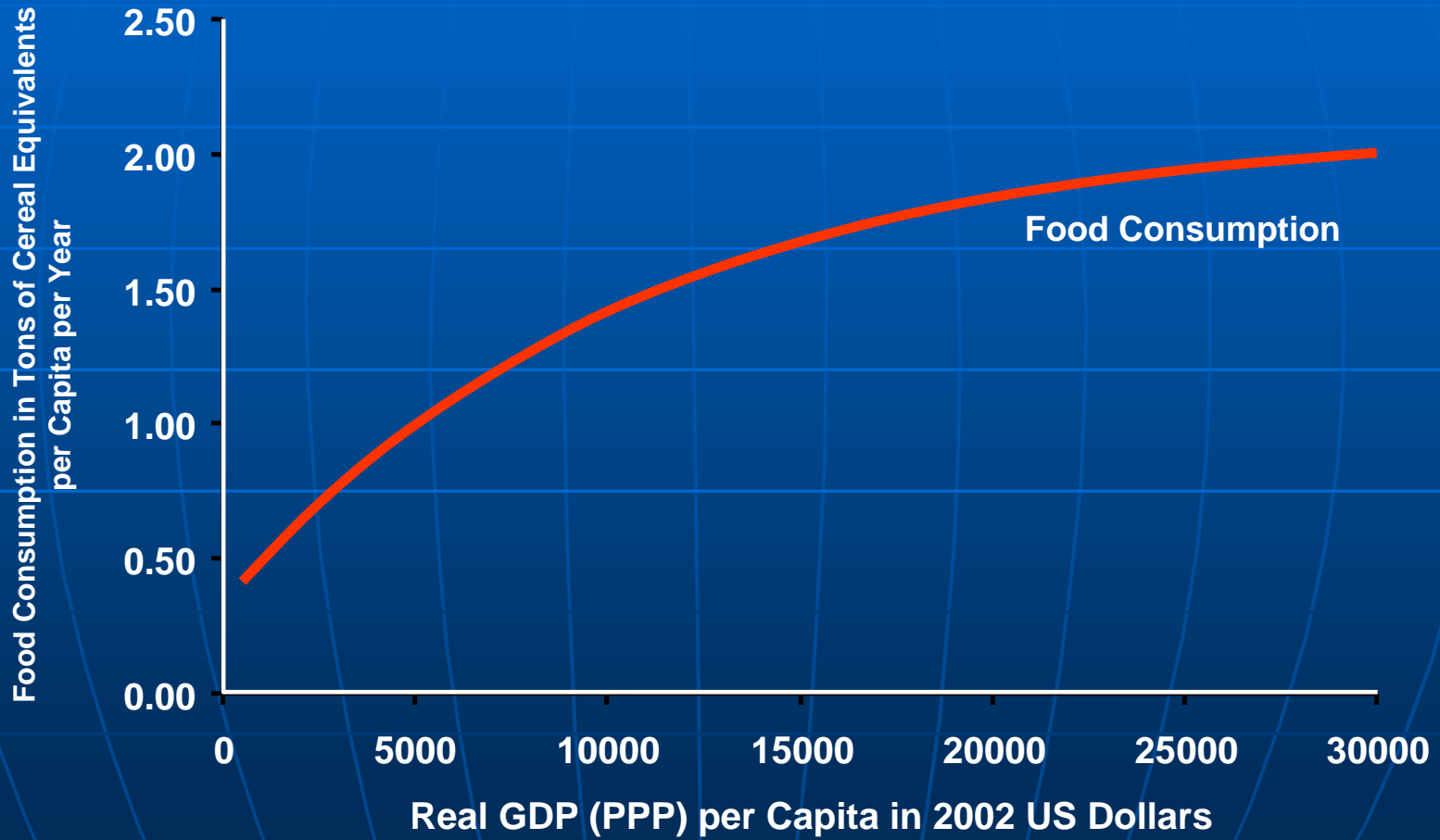
Income range:

\$500 - \$25,000 GDP<sub>PC</sub> (PPP)

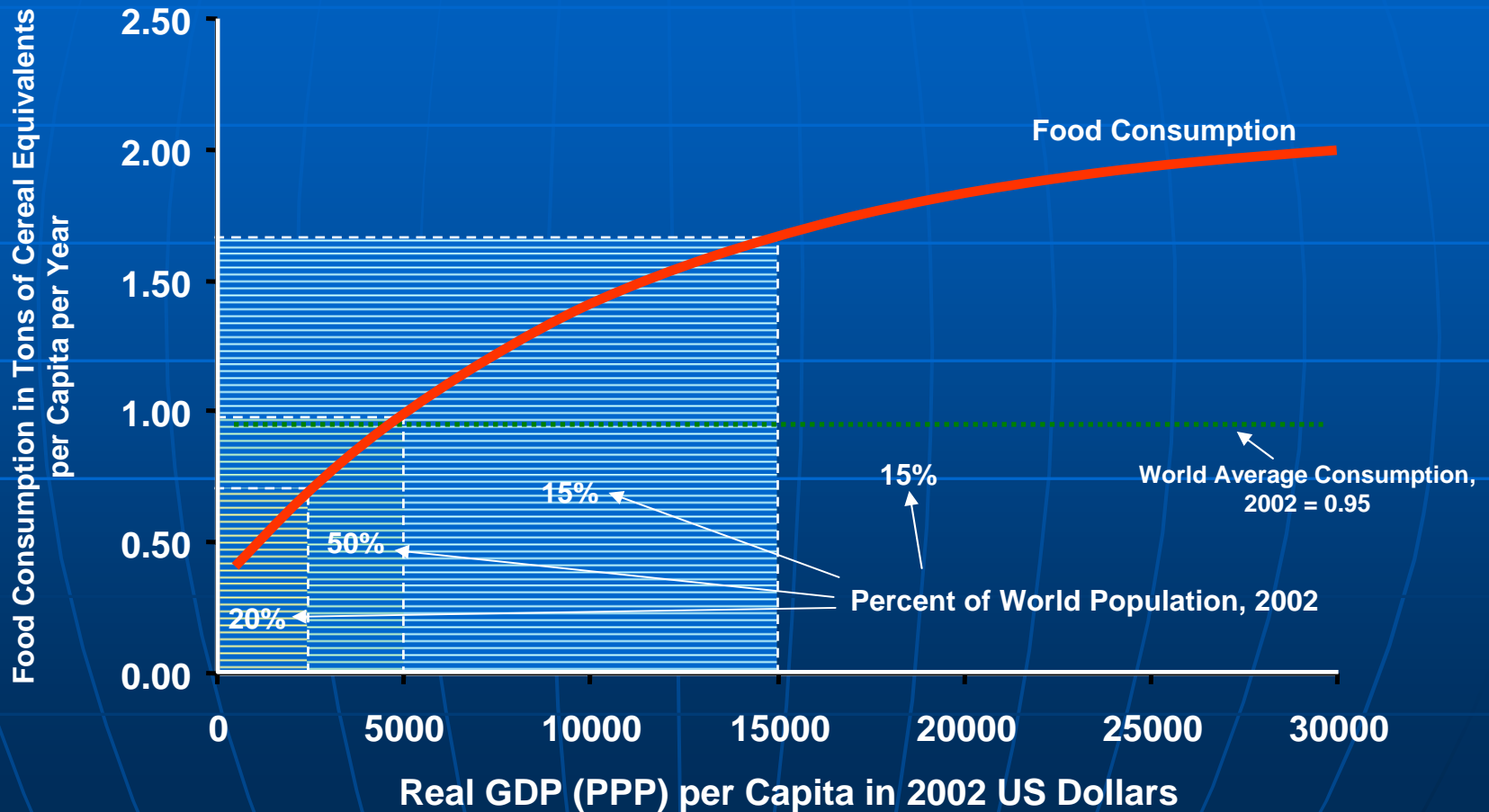
Increase in per capita resource use:

*five to seven-fold*

**Figure 1. Total per Capita Food Consumption as a Function of Income, (159 Countries) 1975-2002**



**Figure 2. Total per Capita Food Consumption as a Function of Income, (159 Countries) 1975-2002: Distribution of World Population by Income Groups 2002**



# Per Capita Crop Product Consumption Changes

Income Range: \$1,500 - \$25,000

*Total crop products – no change*

**Cereals** – slight decrease

*Rice – decrease*

*Wheat – increase*

**Sweeteners** – increase

**Vegetable Oils** - increase

# Per Capita Livestock Product Consumption Increases

Income Range: \$1,500 - \$25,000

Beef 4-fold

Dairy 8-fold

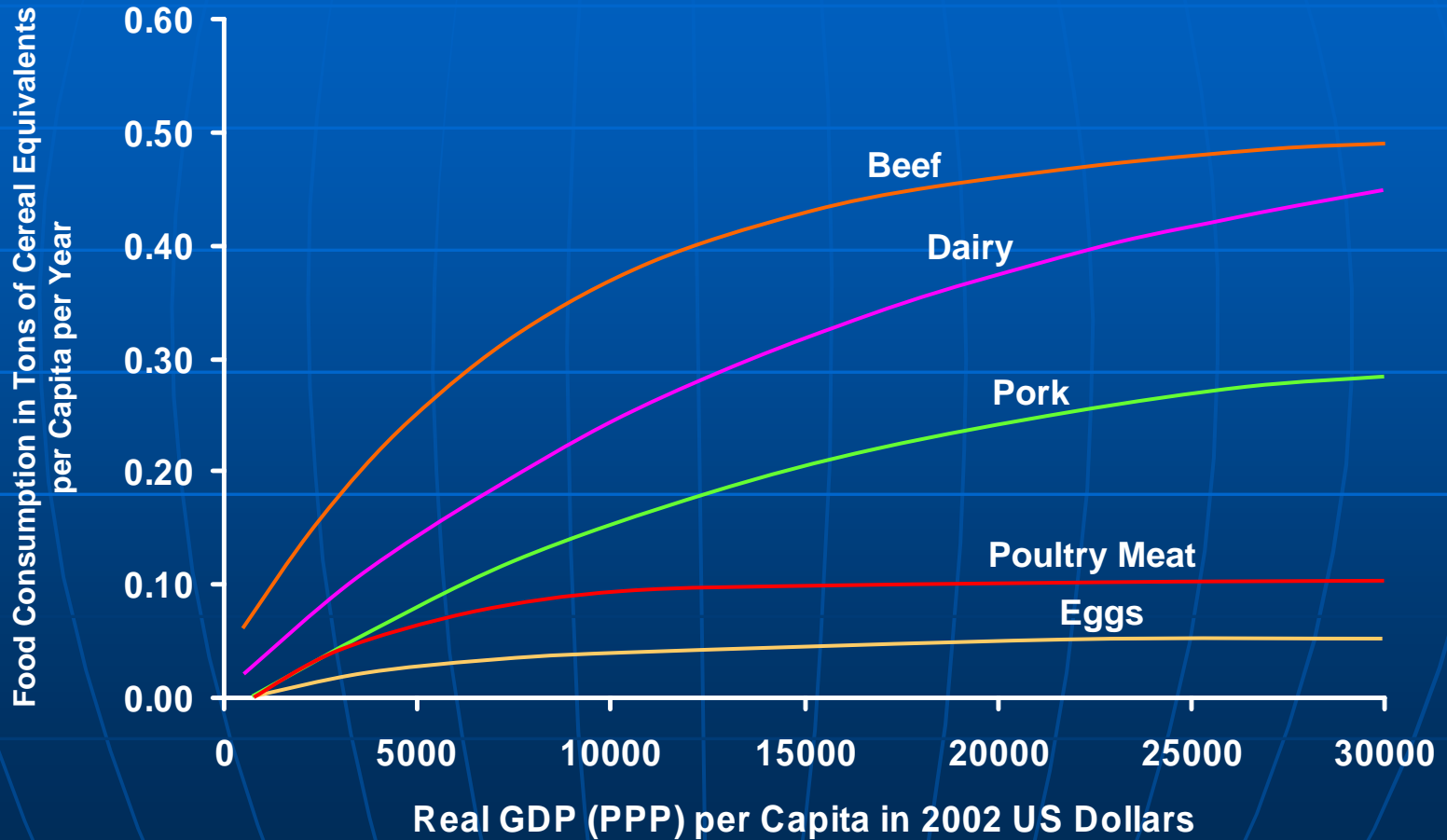
Pork 13-fold

Poultry meat 10-fold

Beef and Dairy: *command the majority of production resources, at all income and land availability levels*



**Figure 3. Per Capita Livestock Product Consumption as a Function of Income, (159 Countries) 1975-2002**



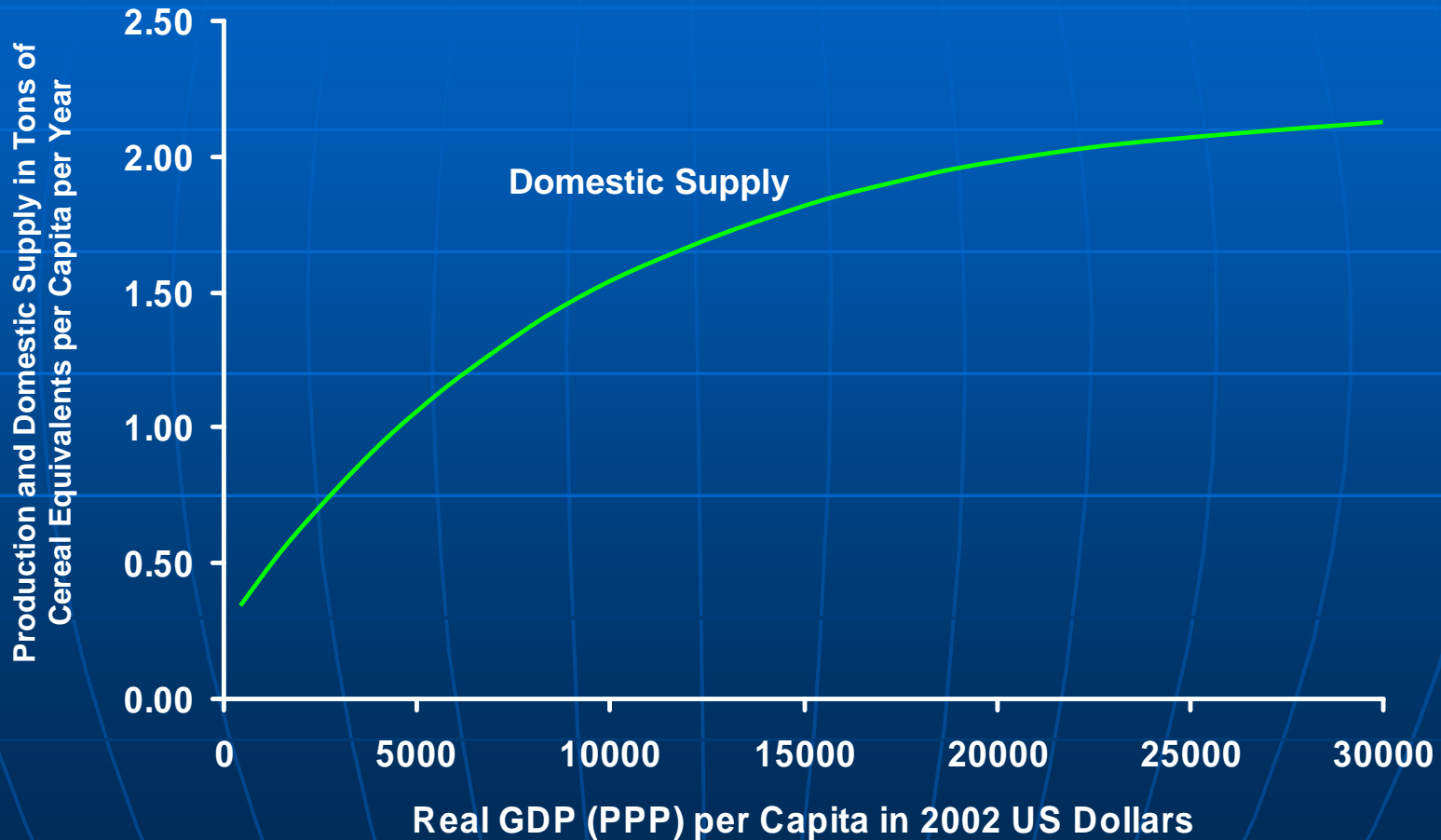
# Economic Development and Agricultural Self-Sufficiency

Low income *self-sufficient*

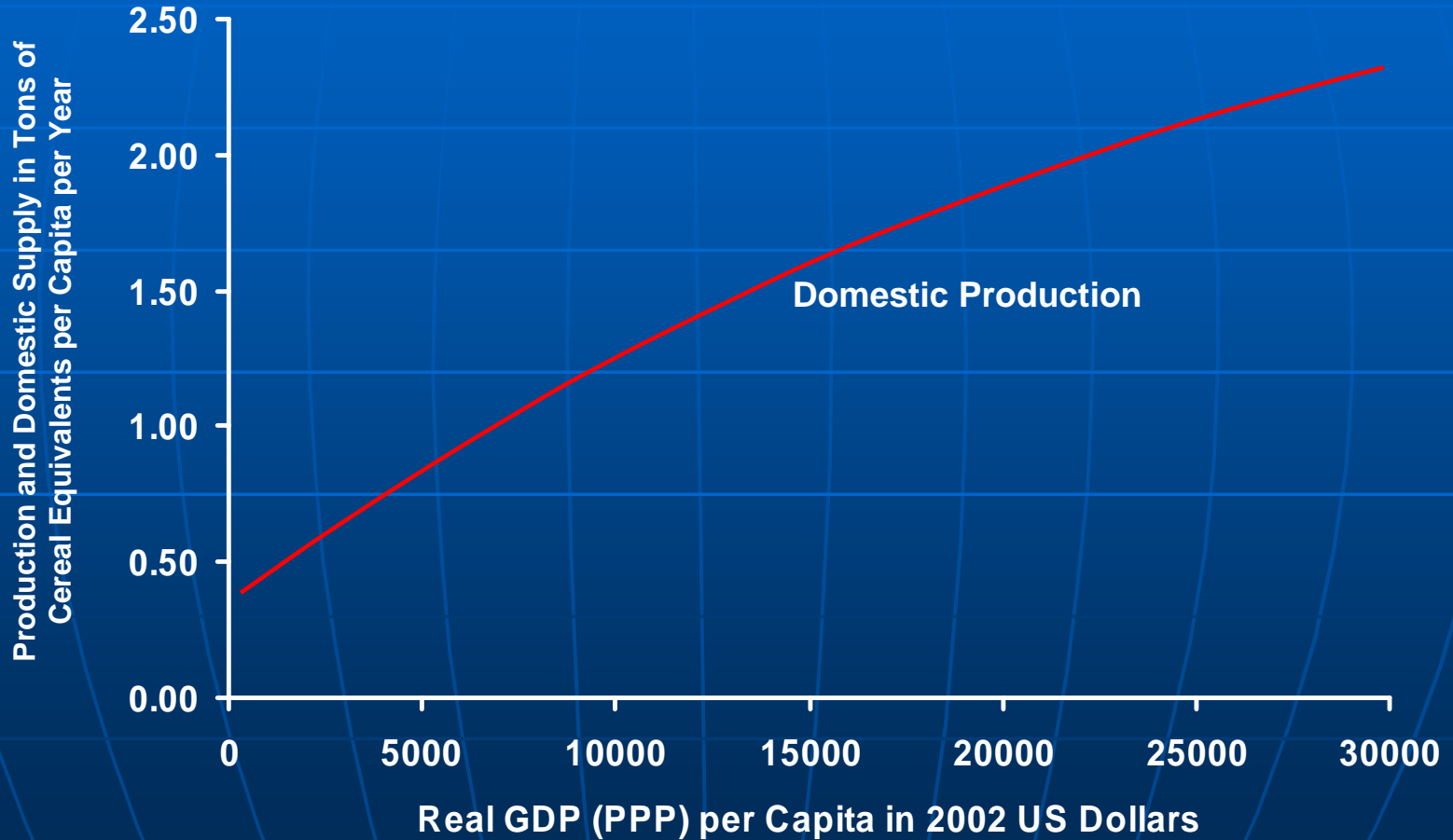
Middle income *declining self-sufficiency*

High income *rising self-sufficiency*

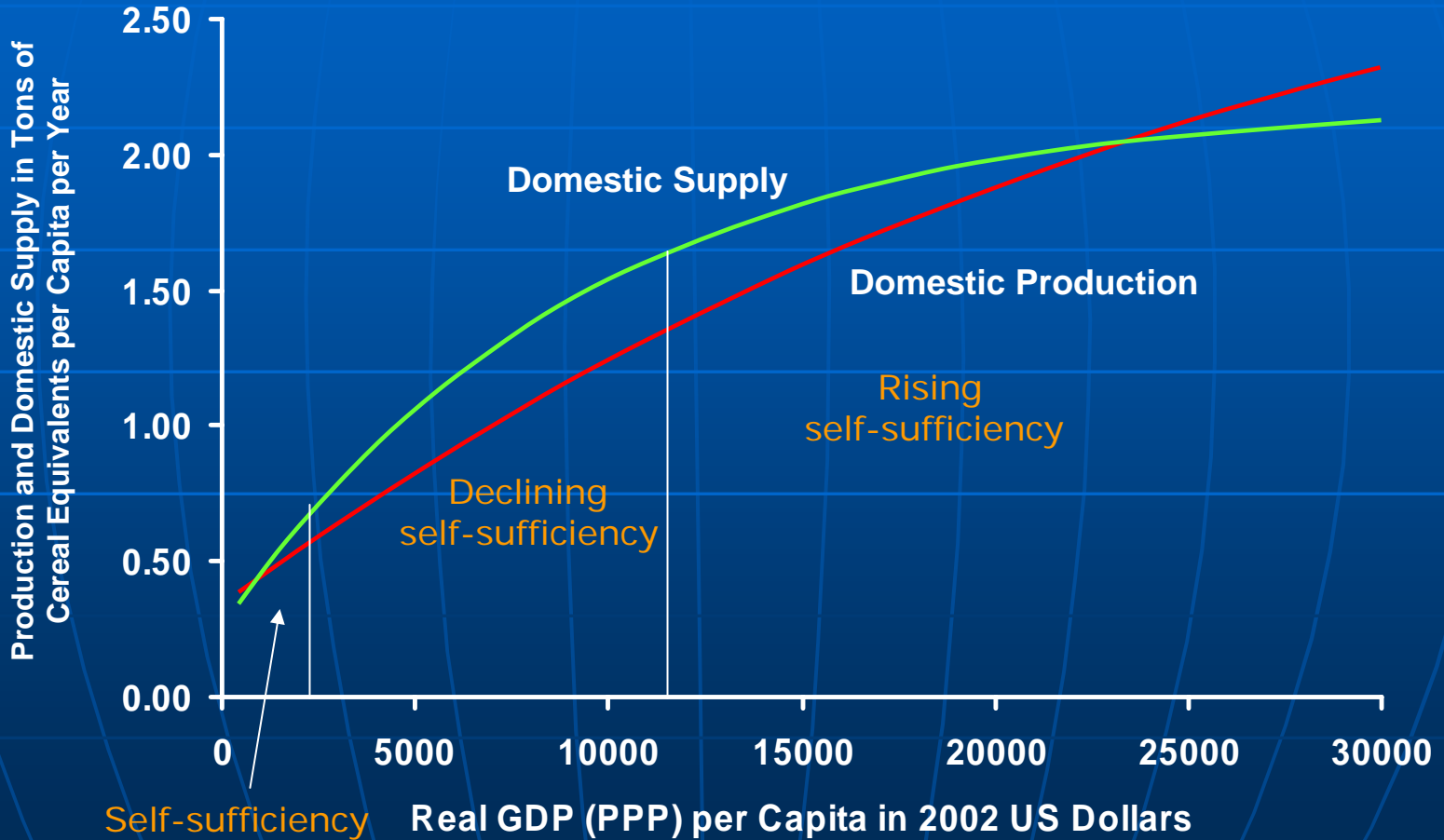
# Per Capita Agricultural Production and Domestic Supply as Functions of Income



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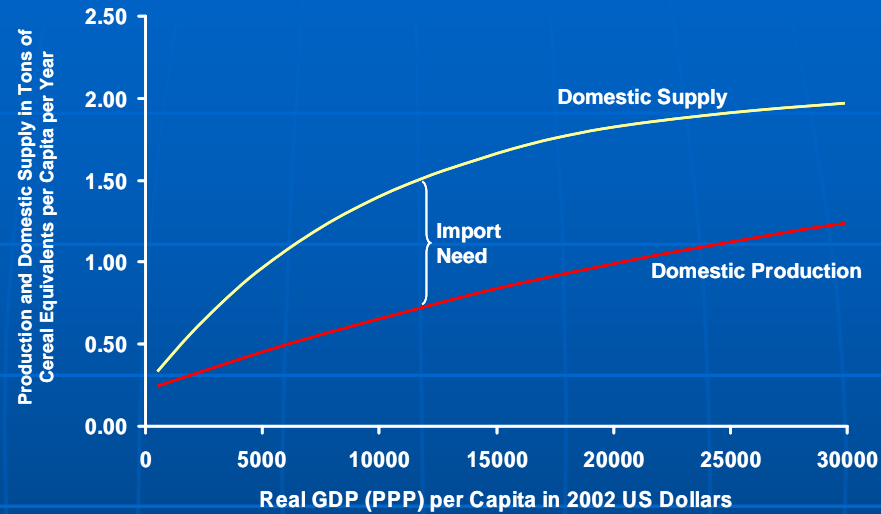
# Agricultural Self-Sufficiency and Land Availability

Four levels of land equivalent availability – hectares per capita, 2002

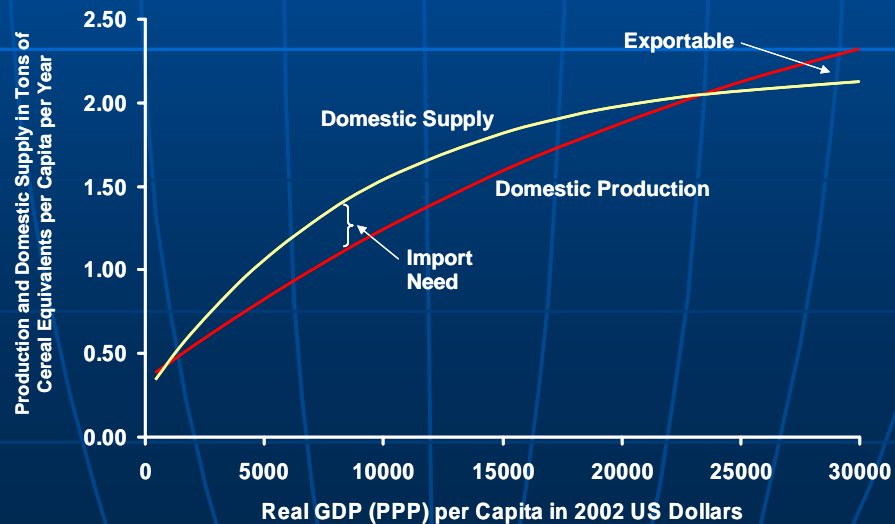
	<i>Number of countries</i>	<i>% of world population</i>
<0.15	22	10
0.15 – 0.49	73	67
0.50 – 0.99	33	16
1.00 +	24	7

# Figures 4a, 4b. Low and Moderate per Capita Land Equivalents (0 – 0.15 and 0.15 – 0.5)

Low

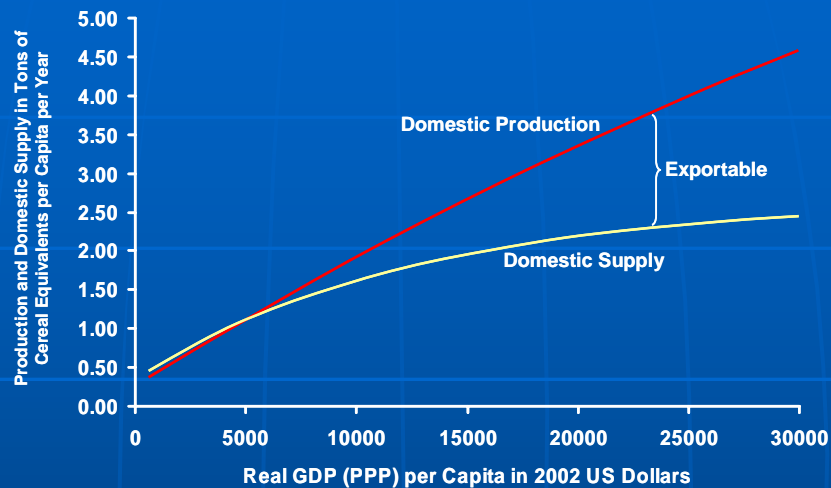


Moderate

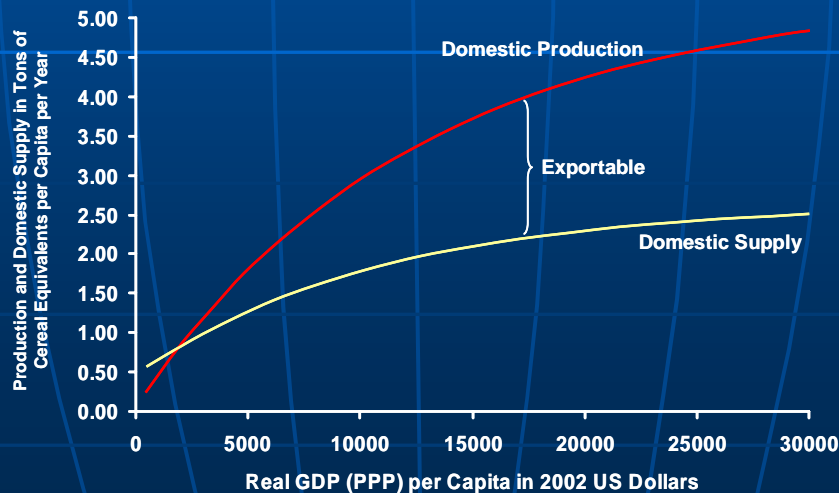


# Figures 4c, 4d. High and Very High per Capita Land Equivalents (0.5 – 1.0 and 1.0 +)

High



Very High





# Summary, 1

- **Economic development** income range \$500 - \$25,000 (70% below \$5,000)
- **Diet upgrade** to livestock products requires 5-7 fold increase in per capita resource use
- **Pork and poultry** show largest % change
- **Beef and dairy** are largest users of resources
- **Demand changes consistent** across income and resource levels

# Summary, 2

## Agricultural Self-Sufficiency

Low income *self-sufficient*

Middle income *declining self-sufficiency*

High income *rising self-sufficiency*

**Figure 2a. Total per Capita Food Consumption as a Function of Income, (159 Countries) 1975-2002: Distribution of World Population by Income Groups 2002, and Income-Consumption Levels for Selected Countries**

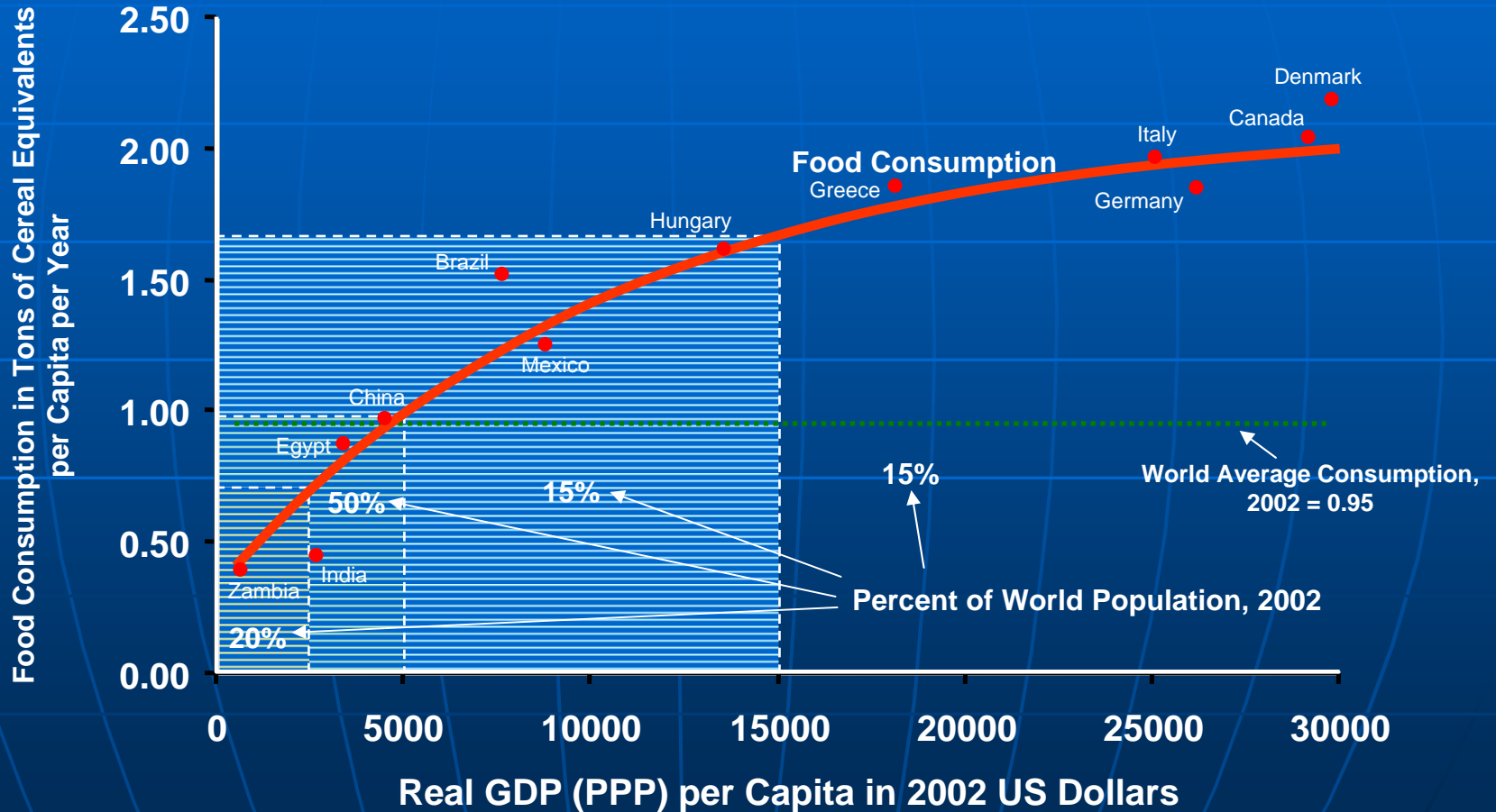


Figure 4a. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with Low per Capita Hectares of Land Equivalents (Less than .15)

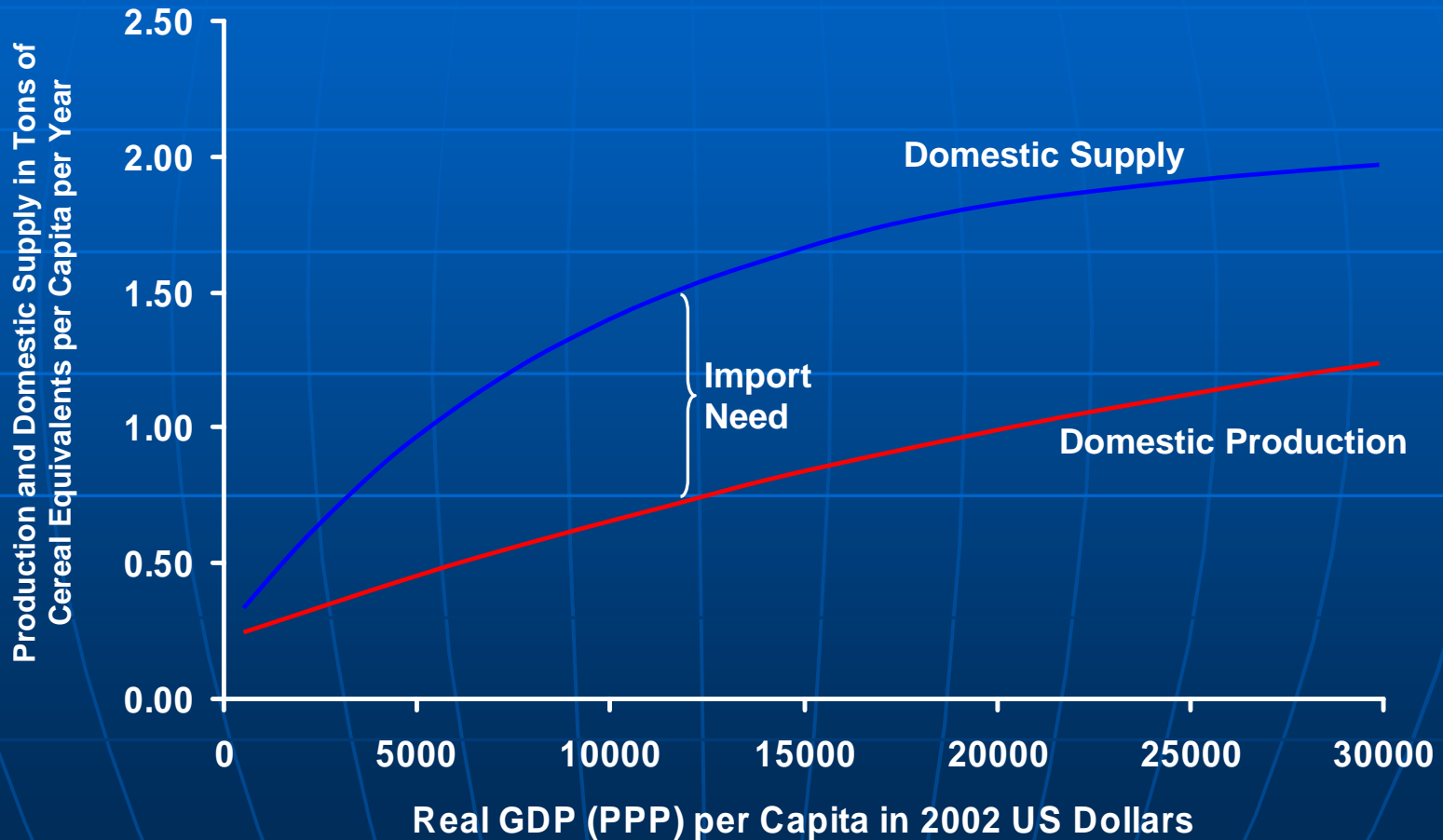


Figure 4b. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with Moderate per Capita Hectares of Land Equivalents (Between .15 and 0.5)

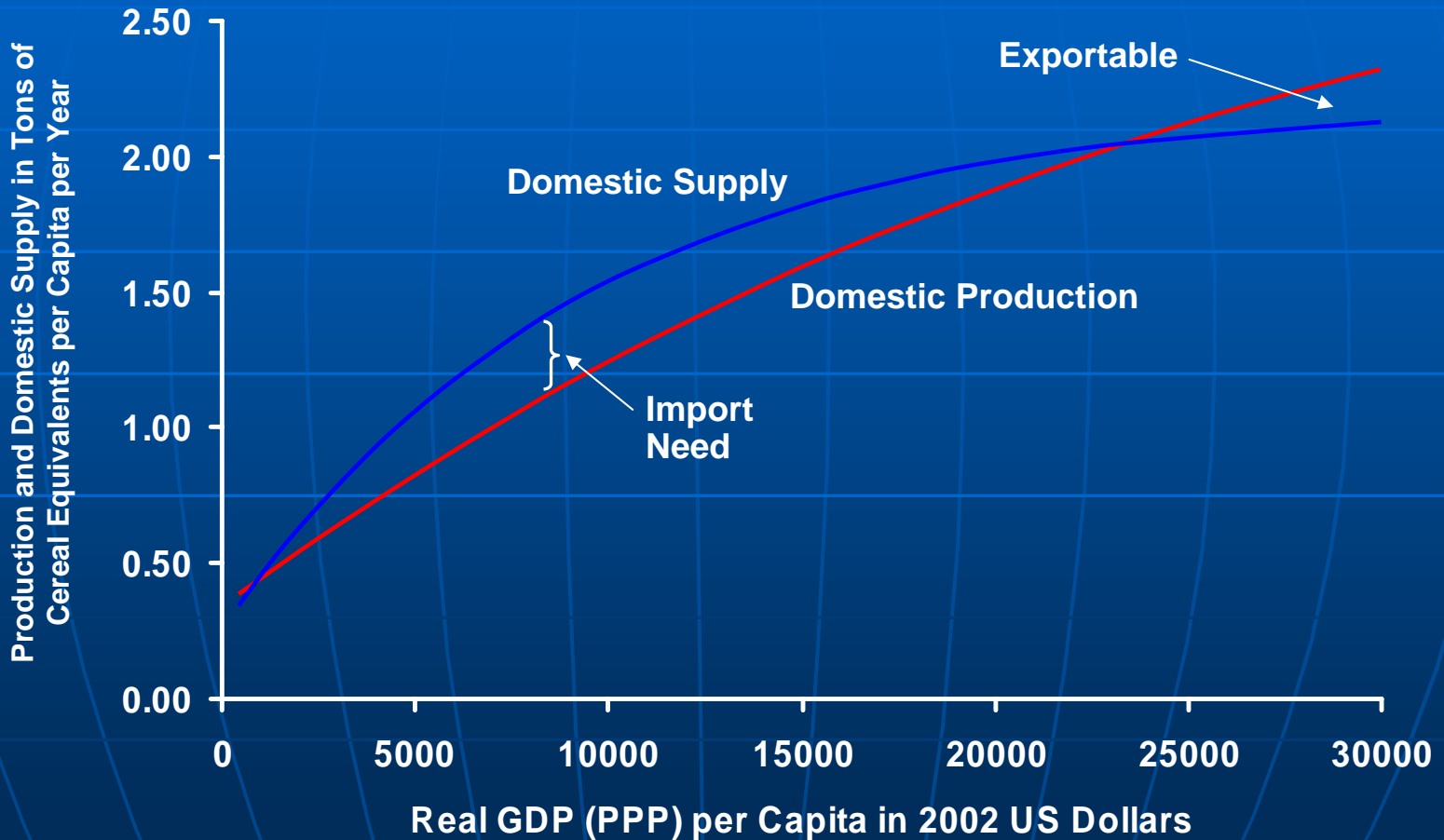


Figure 4c. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with High per Capita Hectares of Land Equivalents (between 0.5 and 1.0)

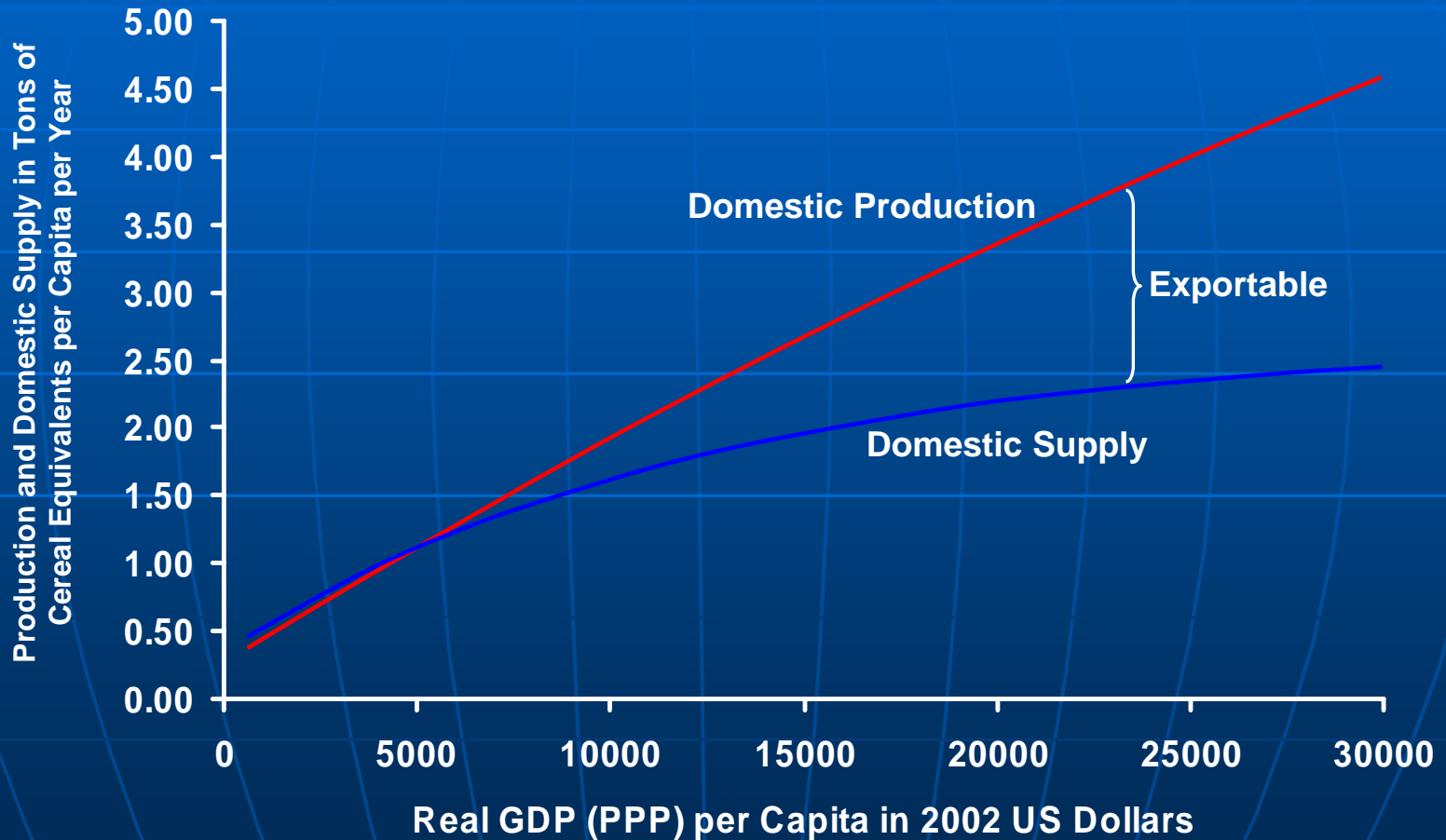
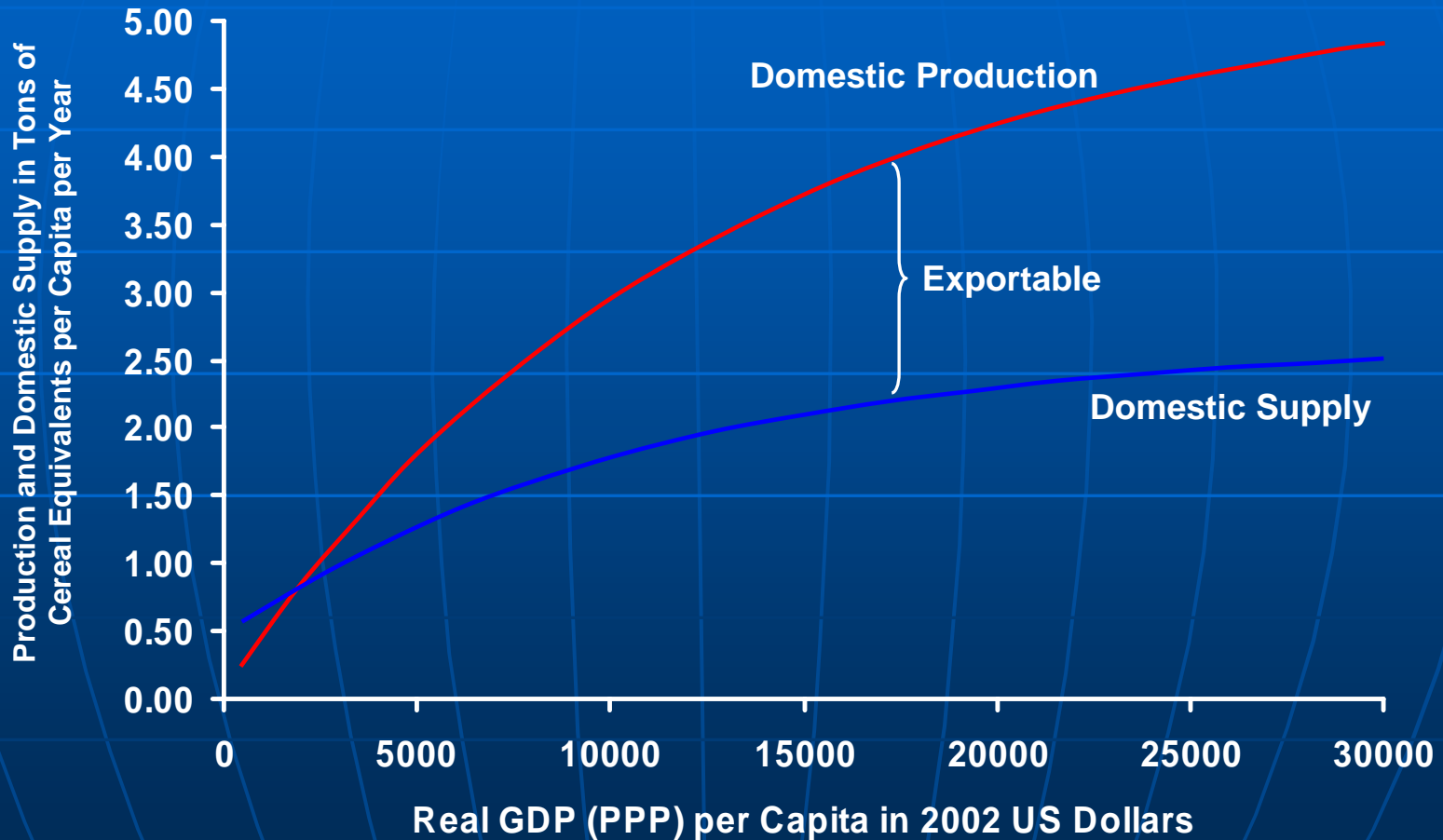


Figure 4d. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with Very High per Capita Hectares of Land Equivalents (1.0 and greater)



**Table 2. Percent Change in Food Consumed by World Region and Food Commodity (1961-2002)**

Region	World	Developing Countries	Developed Countries	Africa	Asia	South America	Western Europe	North America, Developed
<i>(% change from 1961 to 2002)</i>								
<b>Total Food*</b>	<b>154</b>	<b>311</b>	<b>56</b>	<b>205</b>	<b>363</b>	<b>195</b>	<b>52</b>	<b>70</b>
<b>Crops*</b>	<b>146</b>	<b>201</b>	<b>51</b>	<b>242</b>	<b>189</b>	<b>176</b>	<b>36</b>	<b>127</b>
<b>Livestock*</b>	<b>152</b>	<b>404</b>	<b>55</b>	<b>172</b>	<b>638</b>	<b>198</b>	<b>54</b>	<b>61</b>
Beef	111	242	50	137	469	169	22	60
Dairy	93	290	37	222	336	204	41	37
Pork	287	1201	88	318	1766	250	130	68
Poultry Meat	715	1768	410	891	1601	2778	354	365
Eggs	277	951	60	412	948	301	36	27
<b>Population</b>	<b>102</b>	<b>133</b>	<b>35</b>	<b>193</b>	<b>122</b>	<b>134</b>	<b>20</b>	<b>55</b>

Source: FAO

\*Measured in cereal equivalents.



**Table 3: Regression Results:  
159 Countries 1975-2002**

	<u>Estimate</u>	<u>Asymptotic Standard Error</u>
$A_1$	2.1153	.0265
$A_2$	1.7821	$3.8 \times 10^{-6}$
k	$9.2 \times 10^{-5}$	.0308

$R^2 = .71, n = 3788$

**Table 4. Estimated per Capita Food Consumption by Food Item and Income Level, in Tons of Cereal Equivalents per Capita per Year**

<b>Real Income*</b>	<b>\$1,500</b>	<b>\$5,000</b>	<b>\$15,000</b>	<b>\$25,000</b>
	<i>(tons of cereal equivalents /capita /year)</i>			
<b>All Food</b>	<b>0.56</b>	<b>0.99</b>	<b>1.67</b>	<b>1.94</b>
<b>Crops</b>	<b>0.23</b>	<b>0.25</b>	<b>0.25</b>	<b>0.25</b>
Cereals	0.13	0.13	0.11	0.10
<i>Rice</i>	<i>0.04</i>	<i>0.03</i>	<i>0.02</i>	<i>0.01</i>
<i>Wheat</i>	<i>0.05</i>	<i>0.07</i>	<i>0.07</i>	<i>0.07</i>
<i>Other Cereals</i>	<i>0.04</i>	<i>0.03</i>	<i>0.02</i>	<i>0.02</i>
Root Crops	0.02	0.02	0.01	0.01
Vegetable Oils	0.02	0.03	0.04	0.04
Sweeteners	0.03	0.04	0.05	0.05
Other	0.03	0.03	0.04	0.05
<b>Livestock</b>	<b>0.30</b>	<b>0.69</b>	<b>1.32</b>	<b>1.59</b>
Beef	0.12	0.25	0.43	0.48
Dairy	0.05	0.14	0.31	0.41
Pork	0.02	0.08	0.20	0.26
Poultry Meat	0.01	0.06	0.10	0.10
Eggs	0.01	0.02	0.04	0.05
Other	0.09	0.14	0.24	0.29
<b>Fish</b>	<b>0.03</b>	<b>0.05</b>	<b>0.10</b>	<b>0.10</b>

Source: Based on regression results, FAO and World Bank data from 159 countries (1975-2002).

\*Real GDP (PPP) in 2002 US dollars.

**Table 5. Estimated per Capita Livestock Product Consumption Under Varying Land Resource Availability and Income Level\***

Income	Land Equivalent Levels**	Less than	Between	Between	1.0 or
		0.15	0.15 and 0.5	0.5 and 1.0	Greater
		..... (tons of cereal equivalents/capita/year) .....			
<b>\$1,500 GDP (PPP) per Capita</b>	<b>Livestock</b>	<b>0.17</b>	<b>0.22</b>	<b>0.30</b>	<b>0.48</b>
	Beef	0.03	0.09	0.13	0.19
	Dairy	0.05	0.04	0.05	0.07
	Pork	0.01	0.01	0.01	0.02
	Poultry	0.01	0.02	0.01	0.01
	Eggs	0.01	0.01	0.01	0.01
<b>\$5,000 GDP (PPP) per Capita</b>	<b>Livestock</b>	<b>0.57</b>	<b>0.61</b>	<b>0.70</b>	<b>0.92</b>
	Beef	0.18	0.19	0.23	0.44
	Dairy	0.11	0.14	0.16	0.14
	Pork	0.07	0.09	0.10	0.04
	Poultry	0.10	0.07	0.04	0.03
	Eggs	0.02	0.02	0.03	0.02
<b>\$15,000 GDP (PPP) per Capita</b>	<b>Livestock</b>	<b>1.17</b>	<b>1.28</b>	<b>1.36</b>	<b>1.61</b>
	Beef	0.37	0.36	0.38	0.68
	Dairy	0.25	0.35	0.35	0.30
	Pork	0.16	0.24	0.27	0.11
	Poultry	0.12	0.09	0.09	0.08
	Eggs	0.04	0.04	0.05	0.03
<b>\$25,000 GDP (PPP) per Capita</b>	<b>Livestock</b>	<b>1.38</b>	<b>1.58</b>	<b>1.65</b>	<b>1.88</b>
	Beef	0.42	0.42	0.44	0.71
	Dairy	0.34	0.48	0.42	0.42
	Pork	0.20	0.34	0.36	0.17
	Poultry	0.12	0.09	0.12	0.11
	Eggs	0.05	0.05	0.05	0.04

Source: Based on regression results, FAO and World Bank data from 159 countries (1975-2002).

\*\$US Real GDP (PPP) per capita in 2002 dollars.

\*\*Land equivalents is a summation of arable land, land in permanent crops, and one-third of land in permanent pasture.