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Abstract

Per capita food consumption and production changes during economic development are analyzed using a resource-based cereal equivalent measure. Diet up-grades to livestock products during economic development contribute to an increase in per capita food resource use by a factor of five or more. Food consumption changes are generally consistent across countries and are only marginally affected by a country's food production resource base (land). Food consumption increases tend to exceed food production increases in early stages of development, leading to food import needs. In later stages of development, per capita food consumption stabilizes. Continued increases in production allow the closing of the consumption-production gap for some countries at high income levels. Consumption of pork and poultry meat show the largest percentage increase during economic development; however, beef and dairy products are less efficient in resource use and therefore command a majority of the productive resources for livestock production at all income levels.

JEL Classification Codes: O13, Q18

Keywords: economic development, food consumption, agricultural self-sufficiency

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ECONOMIC DEVELOPMENT AND FOOD DEMAND CHANGES: PRODUCTION AND MANAGEMENT IMPLICATIONS

Invited paper presented at the 15th IFMA Congress, "Developing Entrepreneurship Abilities to Feed the World in a Sustainable Way," Campinas, Brasil, August 14-19, 2005.

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Abstract

Per capita food consumption and production changes during economic development are analyzed using a resource-based cereal equivalent measure. Diet up-grades to livestock products during economic development contribute to an increase in per capita food resource use by a factor of five or more. Food consumption changes are generally consistent across countries and are only marginally affected by a country's food production resource base (land). Food consumption increases tend to exceed food production increases in early stages of development, leading to food import needs. In later stages of development, per capita food consumption stabilizes. Continued increases in production allow the closing of the consumption-production gap for some countries at high income levels. Consumption of pork and poultry meat show the largest percentage increase during economic development; however, beef and dairy products are less efficient in resource use and therefore command a majority of the productive resources for livestock production at all income levels.

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Introduction

In keeping with the conference focus on meeting food needs in a sustainable manner, this paper documents and provides estimates of the dimensions of individual country and aggregate world food needs caused by both population increases and diet upgrades. Further, the demonstrated ability of countries to meet these dynamic needs throughout the development process is addressed. Within this context emerges the challenge to managers of agricultural resources to provide the needed food production increases against a relatively stable but declining per capita productive land base.

Per capita food needs and a country's production capability to meet these needs are significantly different across stages of economic development[1]. Poor countries typically commit a significant percentage of income as well as a major share of the active work force to the procurement of food. Despite this effort, levels of per capita food consumption remain quite low. Production technology and supporting infrastructure are often limited, leading to low levels of agricultural productivity. Low income levels also constrain the ability to import food. Hence, most poor countries are of necessity relatively self-sufficient in the production of food.

As economic development proceeds (incomes grow), the patterns of food consumption (and related production resources) change dramatically. The major change is a diet shift from consumption of crop based products to livestock based products. The production resources necessary to support a livestock based diet are considerably greater than for a crop based diet. In fact, we estimate that a stable per capita diet at high income levels requires 5-7 times more agricultural resources to produce than does a predominantly crop based diet at low income levels. Thus, as continued population growth is combined with rapid diet change, many countries in the middle income levels of development are no longer able to maintain food self-sufficiency from domestic agriculture and must import a growing portion of their food needs.

At higher levels of development, the diet shift to livestock products is largely complete. The increasing expenditures on food at this point reflect a demand for non-agricultural resources such as processing, packaging and away-from-home eating. At this level of development, per capita food resource needs stabilize and agricultural productivity growth needs only to match population growth to supply a country's growing food needs. With continued growth in productivity, some countries at this level of development are able to close the production-consumption gap, and a few countries with substantial agricultural resources become major food exporters.

Within these broad generalizations, individual countries follow divergent routes along the development path. Time frames can be dramatically different as some economies grow rapidly, others stagnate or even retreat, and populations continue to increase. Further complications

[1] The following analysis is further developed in Rask and Rask (2004a).

arise from the non-market incentives promulgated by countries setting food self-sufficiency as a policy objective.

Clearly, food production levels vary greatly across countries due to differences in the quantity and quality of productive resources, levels of technology employed, population numbers, and agricultural policies. However, on the demand side, the food *consumption* response to economic growth, while dynamic in nature, is remarkably consistent across countries regardless of the underlying production resource base. This consistent pattern allows us to define a common consumption path that rises during development and stabilizes at higher incomes.

Our purpose in this paper is three-fold: 1. to specify the overall food demand changes associated with economic development, 2. to identify the changing role of individual major agricultural commodities, and 3. to measure the production response relative to the changing food demands throughout the development process.

Data

Our agricultural, food, and population data are from the FAOSTAT-Agriculture database and include most countries of the world over the 1961-2002 period of data availability. Detailed consumption, domestic supply, and production data is transformed into per capita cereal equivalent (CE) factor values to more adequately reflect the resource requirements of specific diet levels and to give a consistent single valuation for comparing varying diets. The derivation of the CE value is detailed in Rask and Rask (2004a) and summarized below. The land resource is measured at two levels, hectares of arable land per capita and a computed value, hectares of land equivalent per capita, which includes a summation of arable land, land in permanent crops, and one third of land in permanent pasture (permanent pasture is estimated to be one-third as productive as arable land).

Levels of economic development are defined by per capita gross domestic product adjusted for purchasing power parity in constant 2002 US dollars for the 1975-2002 period as determined by the World Bank. Income data is not available for all countries and all years. Complete or partial time period data exist for 159 countries yielding a total of 3788 data points for estimating food consumption and production changes during the development process. For 1975, the data set includes countries representing 75 percent of the world's population. This rises to 97 percent for the year 2002.

CE Factor Values

Since cereals are both an important direct food item and an important indirect food item (feed) we use CEs to define diets across all stages of development, expressed in tons of CEs per capita per year. For individual food commodities, CE coefficients are developed in the following manner. CE values for crop products consumed in vegetable form (cereals, root crops, fruits,

vegetables) are calculated based on their caloric content relative to the caloric content of an equal weight of cereals.

Animal product CEs are calculated based on the CEs of feeds consumed by specific types of livestock relative to production of specific consumable livestock products. In this calculation we begin by assigning grains or cereals a CE factor value equal to 1. Specific types of production livestock and/or livestock products are then converted to CE factor values based on the amount of feed CEs embedded in their production. This live weight measure includes all forms of feed such as grains, protein supplements, forages (including pasture), and other feeds, and includes consumption by breeding herds. This live weight calculation is then adjusted for dressing weight percentage to give a final CE value for consumable product. The livestock product CE coefficients were developed from USDA (1975) data on US feed consumption, feed conversion ratios, and livestock production for all forms of livestock for the 10-year period 1964-1973. A sample of CE coefficients is shown in Table 1.

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

Crop Products[1]		Livestock Products[2]	
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		

**Cereal Equivalent Coefficient* refers to number of tons of cereals that is equivalent to one ton of crop or livestock product. See text for further explanation.

Sources: [1] Calculations based on world averages from 1999 - 2002 FAO Food Balance Sheet data. Coefficient values for individual countries will vary slightly.

[2] Developed from Rask (1991). The livestock CE coefficients were developed from USDA data on US feed consumption, feed conversion ratios, and livestock production for all forms of livestock for the ten year period 1964-1973 (USDA).

Global and Regional Food Consumption Changes 1961-2002

As noted, food consumption increases derive from both population growth and diet upgrades. The impact of diet change on food requirements can thus be treated as a residual after the population effect has been deducted. Over the 42 year period 1961-2002, world food consumption measured in CEs increased 154 percent (Table 2). Population doubled over this

time period, accounting for about two-thirds of the increase in food consumption, with the remainder due to diet change.

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
			(% change from 1961 to 2002)					
Total Food*	**154**	**311**	**56**	**205**	**363**	**195**	**52**	**70**
Crops*	**146**	**201**	**51**	**242**	**189**	**176**	**36**	**127**
Livestock*	**152**	**404**	**55**	**172**	**638**	**198**	**54**	**61**
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
Population	**102**	**133**	**35**	**193**	**122**	**134**	**20**	**55**

Source: FAO
*Measured in cereal equivalents.

There are, however, significant differences among country groups both in the level of increase in food consumption and in the relative contribution of population growth and diet change to this increase. For example, food consumption in developing countries as a group has increased more than 300 percent, with approximately equal effects from population growth and diet change. On the other hand, developed countries have more stable diets, with population being the major contributor to their (smaller) consumption growth, as predicted.

Asia (dominated by China) leads in food consumption increases, up 363 percent, principally from diet change. The major diet changes are reflected in increases in consumption of livestock products, up over six-fold in Asia, with the principal increases from pork and poultry exceeding 17- and 16-fold increases respectively. At the other extreme, low levels of food consumption in Africa have barely kept pace with population growth. While both pork and poultry consumption have shown significant increases in Africa (albeit from a low initial base), beef consumption has not kept pace with population growth. Within the developed countries of Western Europe and North America, marginal increases in consumption of beef and pork, along with significant increases in poultry consumption, have been recorded over this time period.

The land base supporting these increases in food consumption has remained relatively constant with both arable land and land equivalent measures increasing marginally on an absolute basis but falling significantly on a per capita basis. The land constraint in Asia is particularly acute with hectares of arable land per capita in 2002 (0.14) significantly less than the world average (0.23).

Consumption Dynamics of Diet Upgrades in the Economic Development Process

The Income-Food Consumption Relationship Using CE: The Model

The relationship between food consumption and income is generally expressed in this way: food expenditures rise as income increases, but at a decreasing rate.

$$C_{ce} = f(GDP_{PC}),\ f' > 0,\ f'' < 0$$

Here we use consumption expressed in cereal equivalents per capita as the dependent variable and real GDP per capita as the independent variable. The regression uses the following functional form:

$$y = A_1 - A_2 e^{-kx},$$

which yields the expected rise in CE consumption for early stages of development, tapering off at higher income levels[2]. Regression results are shown in Table 3, and the graph of this curve for world data appears in Figure 1.

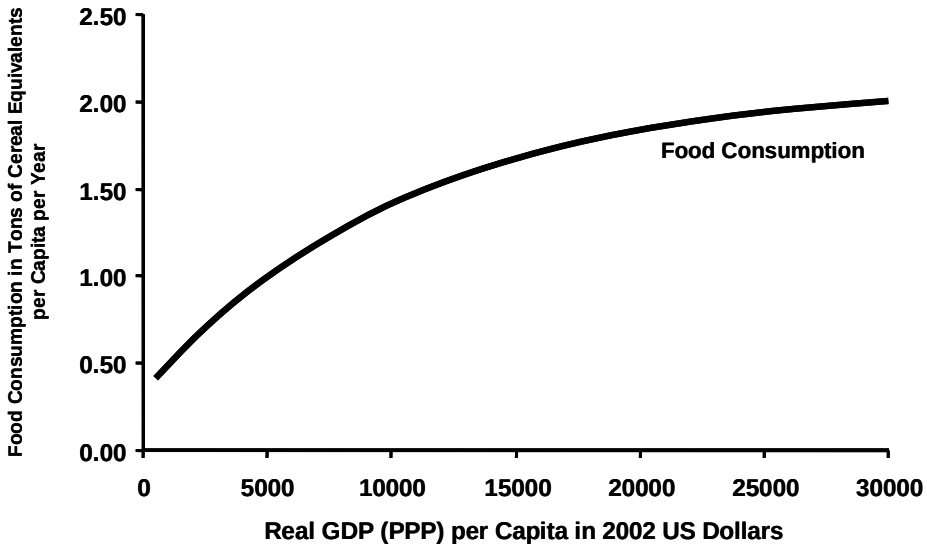
Table 3: Regression Results, (159 Countries) 1975-2002

	Estimate	Asymptotic Standard Error
A_1	2.1153	.0265
A_2	1.7821	3.8x10-6
k	9.2x10-5	.0308

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

[2] For more discussion of the use of this form in this context, see Rask and Rask (2004a).

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

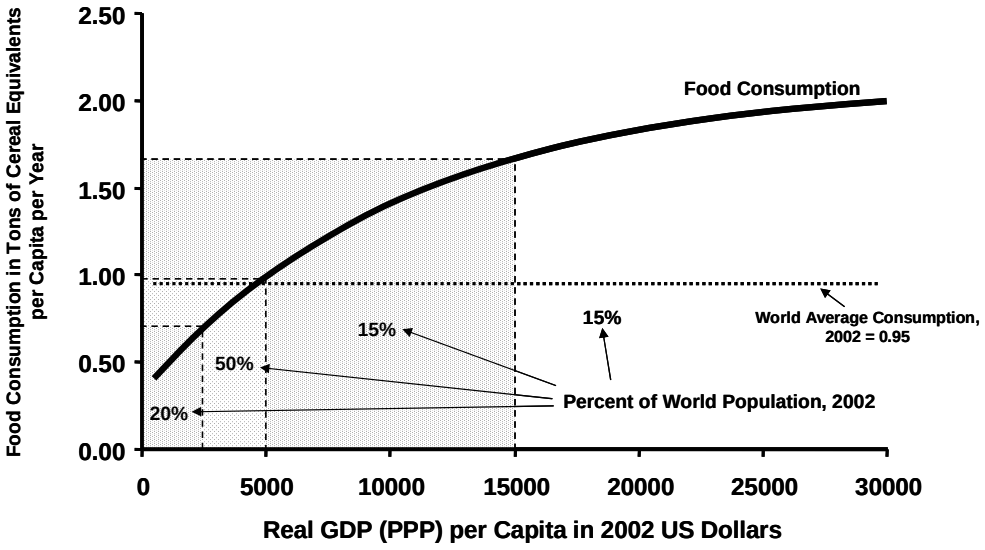


The income-food consumption relationship depicted in Figure 1 demonstrates several important characteristics of the dynamics of food demand changes during the development process. First, per capita consumption measured in tons of CEs per capita per year rises rapidly with income growth at low levels of income, but stabilizes at around $25,000 GDP (PPP) per capita. Over this income range, annual consumption per capita measured in CEs increases about five-fold, from less than 0.4 to about 2.0. People do not eat five times as much food, but in the diet change to more livestock products the cereal or grain equivalents consumed by the livestock account for most of the change.

The average level of food consumption for the world was 0.95 tons of CEs per capita per year in 2002, which corresponds to an income level of about $5000 GDP (PPP) per capita, according to our regression results. Average consumption is therefore currently significantly less than that of a country midway along the path of economic development and therefore midway through the process of diet upgrade (Figure 2). Seventy percent of the world's population resides in countries with average income levels under $5,000. Fifteen percent are in the $5,000 to $15,000 income range, and only 15 percent of the world's population (incomes of $15,000 and above) reside in countries that have or are approaching diet upgrade stability. Thus, the potential increase in food needs from diet upgrade remain substantial and are characterized by a different mix of food items which involves a restructuring of the production resources to meet this

new and increasing demand. We now examine the specific food commodity changes associated with this development.

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



Consumption Changes for Specific Food Commodities Associated with Economic Development

Economic development alters both crop and livestock consumption items. The per capita quantity of crop consumption remains relatively constant across all income levels, with changes primarily involving substitutions among commodities, while substantial increases in per capita consumption of livestock products occur (Table 4). For low income countries, crop based foods account for about 40 percent of the diet and livestock products about 55 percent. At high income levels total per capita food consumption measured in CEs increases five-fold. With only a modest absolute increase, the crop component declines to 13% and livestock products increase to 82%. Fish consumption increases with income but remains at about 5% of the total at each income level.

Per capita consumption of cereals, the principal crop food item, declines marginally at higher income levels. The main substitution within cereals is from rice to wheat. Consumption of sweeteners and vegetable oils more than doubles from low to high income levels.

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

Real Income*	$1,500	$5,000	$15,000	$25,000
		(tons of cereal equivalents /capita /year)		
All Food	**0.56**	**0.99**	**1.67**	**1.94**
Crops	**0.23**	**0.25**	**0.25**	**0.25**
Cereals	0.13	0.13	0.11	0.09
Rice	*0.04*	*0.03*	*0.02*	*0.01*
Wheat	*0.04*	*0.07*	*0.07*	*0.07*
Other Cereals	*0.05*	*0.03*	*0.02*	*0.01*
Root Crops	0.03	0.02	0.01	0.01
Vegetable Oils	0.02	0.03	0.04	0.04
Sweeteners	0.02	0.04	0.05	0.05
Other	0.03	0.03	0.04	0.06
Livestock	**0.30**	**0.69**	**1.32**	**1.59**
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
Fish	**0.03**	**0.05**	**0.08**	**0.10**

Source: Based on regression results, FAO and World Bank data from 159 countries (1975-2002).
*Real GDP (PPP) in 2002 US dollars.

The food changes (diet upgrades) during economic development which are critical for resource use issues are the significant increases in per capita livestock product consumption. The least efficient converters of feeds to consumable food products (and hence the most resource demanding) are ruminants, predominantly beef and dairy cattle (Table 1). Further, feed requirements for ruminants include a large percentage of forages, which are substantially available only in those countries in which the land and climate resources are uniquely and in some cases *only* suited to forage production. Other countries with very limited land resources find it difficult to dedicate a scarce resource to forage production.

Do these land and climate supply limitations materially affect livestock product food consumption behavior? If so, beef and dairy products would be favored in land rich countries and poultry and pork in land poor countries. Otherwise, consumption might be relatively independent of the underlying production resource conditions. To answer this question, we have divided the sample observations into four categories based on hectares of land equivalents per capita: less than .15, .15 to .49, .50 to .99, and 1.0 and greater (Table 5). In 2002, the category of less than .15 land equivalents per capita included 22 countries comprising 10% of the world's population. The .15 to .49 category included 73 countries and 67% of the world's population. This category includes four of the most populous countries: China, India, Indonesia, and Pakistan. The latter three at .17, .17, and .16 land equivalents per capita respectively are set to move into the lower

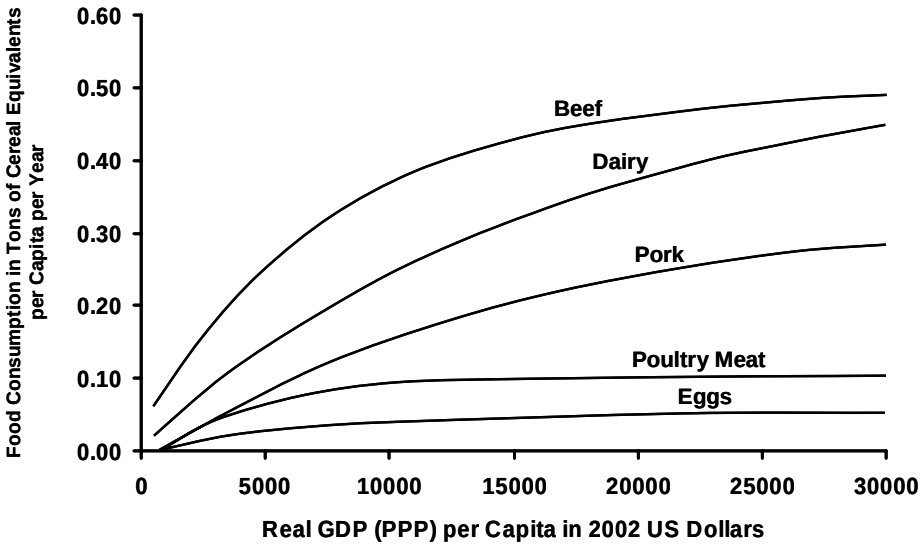
category in several years as population increases against a relatively fixed land base. The .5 to .99 category includes 33 countries and 16% of world population, and the final category holds 24 countries and 7% of world population. Based on these categories, the independence of food consumption behavior compared to productive resource availability depends on the specific food type, as detailed below.

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

Income \ Land Equivalent Levels**		Less than 0.15	Between 0.15 and 0.5	Between 0.5 and 1.0	1.0 or Greater
		(tons of cereal equivalents/capita/year)			
$1,500 GDP (PPP) per Capita	**Livestock**	**0.17**	**0.22**	**0.30**	**0.48**
	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
$5,000 GDP (PPP) per Capita	**Livestock**	**0.57**	**0.61**	**0.70**	**0.92**
	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
$15,000 GDP (PPP) per Capita	**Livestock**	**1.17**	**1.28**	**1.36**	**1.61**
	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
$25,000 GDP (PPP) per Capita	**Livestock**	**1.38**	**1.58**	**1.65**	**1.88**
	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.

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



Beef

Measured in CEs, beef is the most important contributor to livestock product consumption at all income levels. (Recall that CEs measure the resource input to consumption items, not the direct quantity of food consumed). At low incomes it accounts for 40% of livestock food consumption. Per capita beef consumption increases four-fold from low to high income, but as a percentage of total livestock products declines gradually to 30% at high income levels (Table 4). Beef consumption for land poor countries is somewhat depressed (less than 20% of livestock products) at low income levels, but is relatively consistent with countries possessing considerably more per capita land resources at middle and upper income levels, an indication that as development proceeds into the middle income ranges, incomes are sufficient to support significant imports of beef products or related feed inputs. In absolute terms, beef consumption continues to increase well into the high income range (Figure 3). As expected, land rich countries consume a larger amount of beef both absolutely and as a percentage of livestock products.

Dairy Products

Dairy product consumption is very consistent across land endowments at all levels of income and therefore relatively independent of resource availability. It is the second most important livestock product in terms of CE consumption, starting at 20% of livestock product consumption at low income levels and rising to 25% at high income levels. Per capita consumption continues to increase well into the high income levels, approaching that of beef at the very high income levels. Over the income ranges reported in Table 4, per capita dairy product consumption increases eight-fold. The combination of beef and dairy products together accounts for a consistent 56% of livestock product consumption at all income levels.

Pork

Pork consumption changes across income levels are the most dramatic, rising 13-fold from low to high income, increasing strongly at all income levels. However, since swine are more than twice as efficient as beef in feed conversion, pork production commands only 16% of productive resource use at high income levels as compared to 25% for dairy products and 30% for beef. As with beef, land poor countries consume slightly less pork than do those with moderate land endowments. Countries with large per capita land endowments consume pork at considerably lower levels, but as noted above are major consumers of beef.

Poultry

Poultry products, both meat and eggs, are the most efficient in terms of resource use (Table 1). Consumption levels are quite consistent across land endowments but show a reversal

for land poor countries: whereas consumption of other livestock products is lower in these countries, poultry consumption levels are marginally higher. While the per capita consumption of eggs continues to increase into high income levels, consumption of poultry meat rises rapidly at initial stages of development but peaks early at about $15,000 GDP (PPP) per capita and continues at this level through middle and high income levels. The cause for this early stabilization in poultry meat consumption as contrasted with other livestock products is not immediately clear and should be the focus of additional study.

Meeting Food Needs during Economic Development: The Food Self-Sufficiency Dilemma

To measure food self-sufficiency throughout the development process we maintain the four-part country-level land endowment divisions and introduce two additional variables, both expressed in CEs: agricultural production and domestic supply. Domestic supply equals production adjusted for imports, exports and changes in stock. Domestic supply is slightly greater but closely related to food consumption. In addition to product used directly for food it includes seeds and waste. The ratio of production to domestic supply is an indicator of overall agricultural self-sufficiency or in graphic terms, when the production curve exceeds the domestic supply curve (see Figures 4), a country is self-sufficient. Where production falls short of supply, in contrast, a country must import a portion of its food needs. These are aggregate measures and do not preclude the import or export of specific commodities as countries respond to comparative advantage in particular commodities (Figures 4a,b,c, and d).

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)

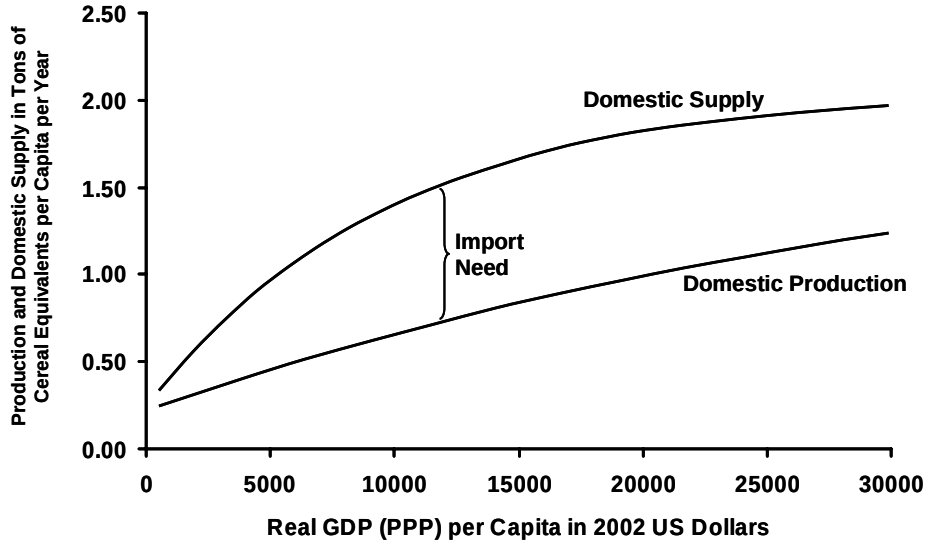


Figure 4b. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with Moderate per Capita Hectares of Land Equivalents (Between .15 and 0.5)

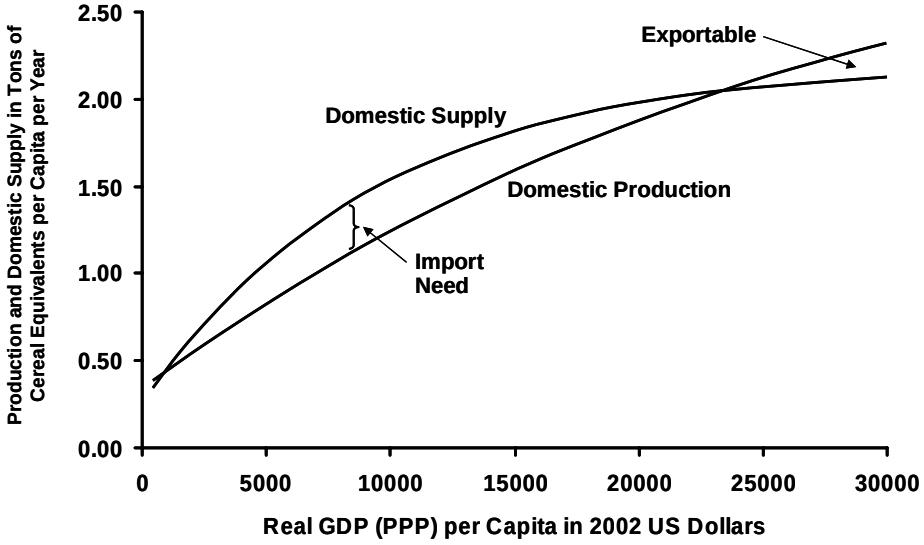


Figure 4c. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with High per Capita Hectares of Land Equivalents (between 0.5 and 1.0)

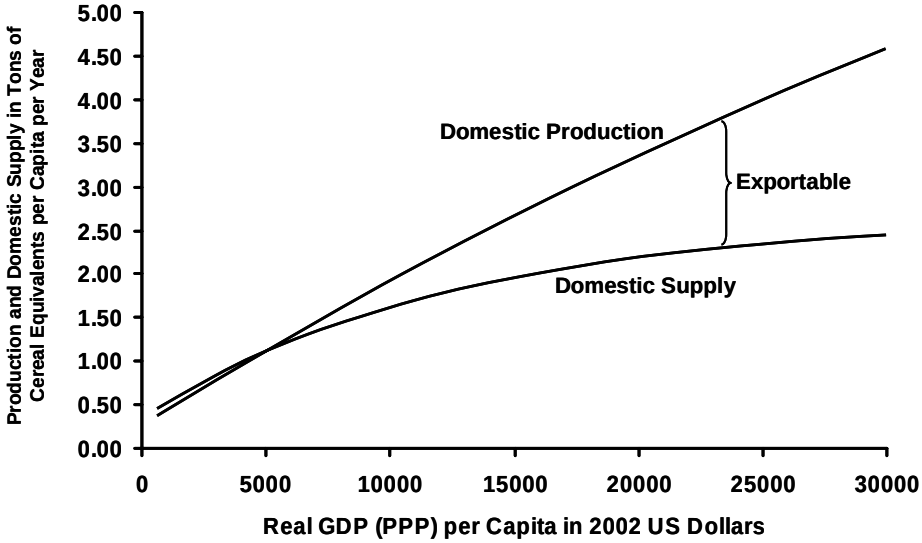
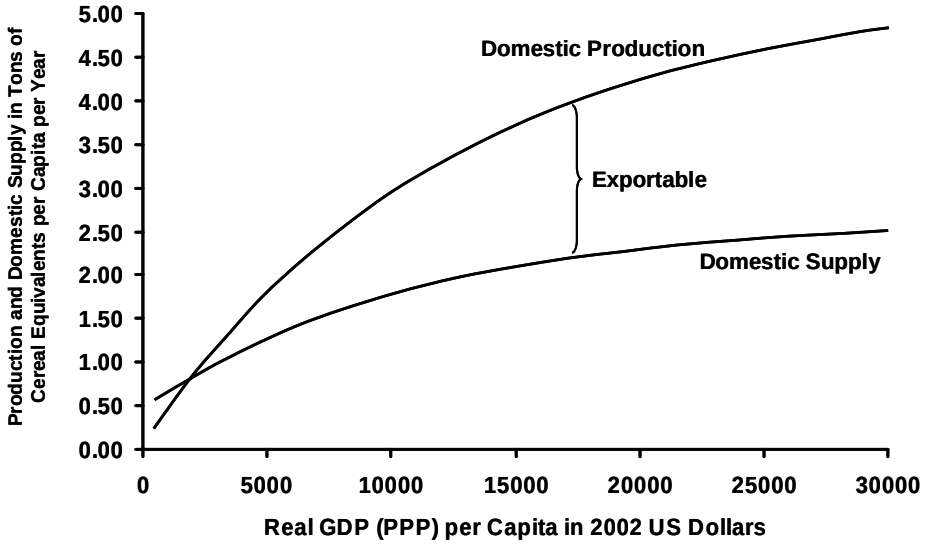


Figure 4d. Per Capita Agricultural Production and Domestic Supply as Functions of Income: Countries with Very High per Capita Hectares of Land Equivalents (1.0 and greater)



Several generalizations are apparent in the relationship between production and domestic supply over stages of development (income growth). First, at initial stages of development (low per capita income), per capita production and supply are of necessity in relative balance. Secondly, as development proceeds, domestic supply responds to rapid diet upgrades, growing more rapidly than domestic production and following a curvilinear path until stabilizing at high income levels. In contrast, production growth is slower and more linear than supply growth but continues well after supply has become stable. This differential growth pattern leads to the need at early stages of development to turn to imports to satisfy the demand for diet upgrade (livestock products). This supply-production gap closes quite early for countries with large per capita land endowments. However, for land poor countries it never closes completely, and for most countries production and supply balance only at mature levels of development. Further, these results are from a given point in time, and many countries with limited land supply and growing populations will be moving into lower per capita land equivalent categories over time, exacerbating the need for food imports. Finally, as noted earlier, over one-half of the world's population is consuming at levels consistent with average incomes below $5,000 (GDP (PPP)), an early point in the production-supply gap.

Summary and Conclusions

Food needs during economic development (income growth) are driven by two forces, population growth and diet upgrade (principally to livestock products). Diets rich in livestock products require considerably more agricultural resources to produce than do diets composed primarily of crop products. Using a resource based measure of food consumption (cereal equivalents), we estimate that development-induced diet change alone (from low to high incomes) will increase *per capita* food resource use by a factor of five. Pork and to a lesser extent poultry products demonstrate the largest percentage gains among livestock products. Beef and dairy products show less percentage gain, but because they are less efficient in the use of agricultural resources, together account for over one-half of our cereal equivalent measure (resource use) at all levels of development. Countries with limited land resources demonstrate only moderate reductions in consumption growth of livestock products during development, continuing to consume significant levels of resource inefficient products such as beef and dairy through food or feed imports.

Consumption growth outstrips the production response at early and middle levels of development. Diet upgrade appears to be complete at about $25,000 GDP (PPP) per capita and continued agricultural productivity allows some countries with sufficient land resources to close the production–consumption gap at that point and become relatively self-sufficient in the production of food. Land poor countries, while experiencing some closure, are unable to reach food self-sufficiency at any income level.

The average world diet, measured in tons of cereal equivalents per capita (0.95), has grown less than one-third of the way from low to high income (0.56 to 1.94), indicating that significant further diet upgrade will put continued pressure on world land resources as countries continue to develop. In fact, the changes in diet from an income level of $5000 per capita to the largely stabilized diet of the $25,000 income level requires an increase of about 100% in CE food consumption *per capita.* With seventy percent of the world's population currently living in countries with income levels *below* that $5000 point, critical food supply issues emerge, even before considering population growth. Optimum agricultural resource and technology use will be necessary to meet this growing food demand challenge.

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