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FEEDING THE FUTURE'S CHANGING DIETS

IMPLICATIONS FOR AGRICULTURE MARKETS, NUTRITION, AND POLICY

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Feeding the Future's Changing Diets

Implications for Agriculture Markets, Nutrition, and Policy

SIWA MSANGI AND MARK W. ROSEGRANT

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Siwa Msangi is a senior research fellow in the Environment and Production Technology Division (EPTD) of the International Food Policy Research Institute, Washington, DC. **Mark W. Rosegrant** is the director of EPTD.

Abstract

This paper explores the nature of several key drivers of change in food systems and examines a number possible entry points for policy intervention to determine their effect on food prices and other market-driven outcomes. Among the drivers of change discussed are those of diet change, which is an important demand-side driver for the longer-term evolution of agricultural market dynamics. We demonstrate the nutrition-enhancing effects that occur when meat consumption, production, and feed demand is decreased, and argue that further benefits ensue when this is supplemented with higher intakes of pulses fruits and vegetables under a "healthier" diet regime. We use a global supply, demand, and trade model to simulate these effects out to 2030 to illustrate the implications for various world regions embodying different rates of socioeconomic and demographic change. We also discuss the implications of our scenarios within the policy design context, and contrast the ability of policy to handle shorter-term issues through direct intervention against those pathways that might be effective in promoting longer-term health and safety outcomes for consumers.

Feeding the Future's Changing Diets

Implications for Agriculture Markets, Nutrition, and Policy

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1. Setting the stage

ECONOMIC GROWTH IN DEVELOPING COUNTRIES (INCLUDING LATIN AMERICA AND the Caribbean, Sub-Saharan Africa, West Asia and North Africa (WANA), Asian developing countries, and the remaining "nondeveloped" countries of the world) is driving fundamental changes in the global structure of food demand. Rising incomes and rapid urbanization in these regions, particularly Asia, are creating changes in the composition of food demand. Direct per capita food consumption of maize and coarse grains is declining; with increasing incomes, consumers shift to wheat and rice. When incomes rise even further and lifestyles change with urbanization, a secondary shift from rice to wheat takes place.

Income growth in developing countries is driving strong growth in per capita and total meat consumption, leading to strong growth in the feed consumption of cereals, particularly maize. At the same time, growth in per capita meat and cereal consumption in developed countries (including Australia, Canada, Eastern Europe, EU, other Western European countries, the former Soviet Union, Israel, Japan, New Zealand, South Africa, and the United States) has slowed dramatically as these countries have reached very high levels of meat consumption in the past decades. Food consumption growth (and related requirements for animal feed) largely determines the pace at which supply growth has to also evolve to keep up with the domestic and export demand for agricultural goods. Little research has been conducted on the impact of changing consumption patterns over time on the future outlook of the world agricultural economy, and the implications of these consumption changes on nutrition and food security.

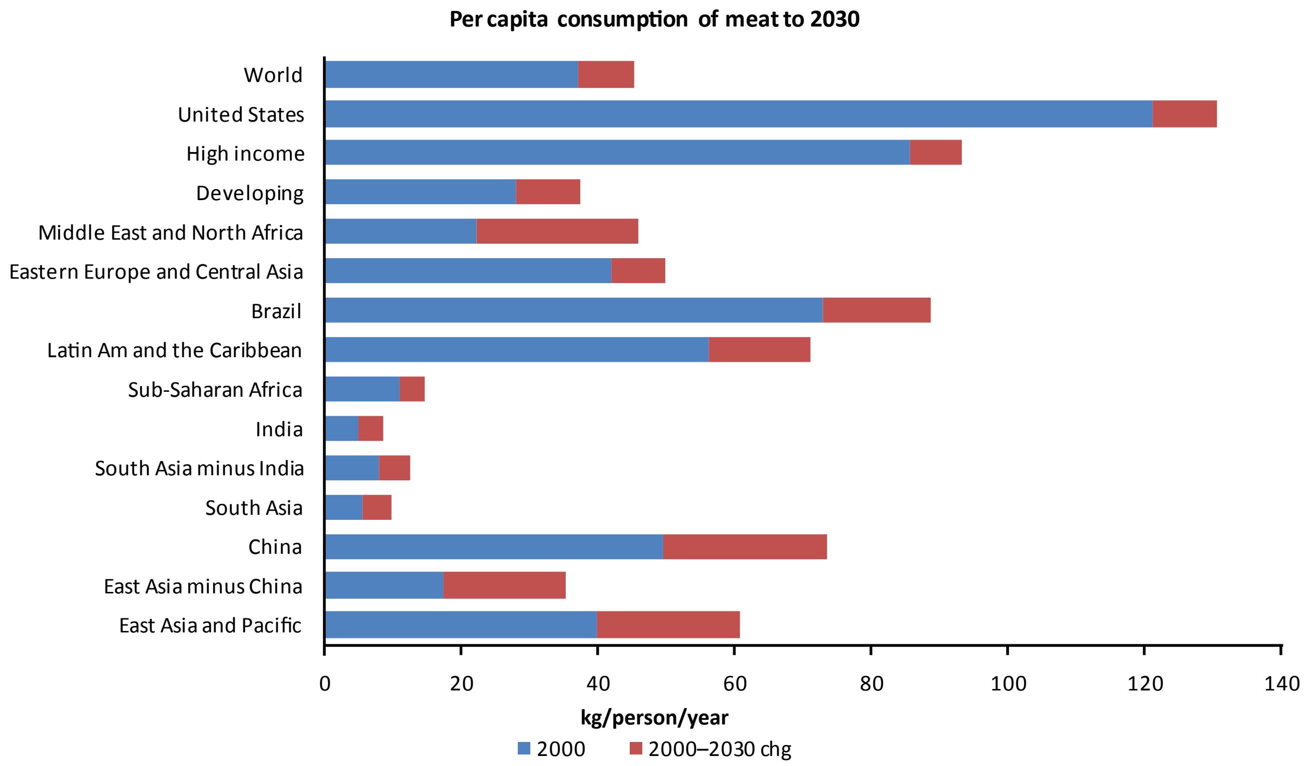
In this paper, we address this knowledge gap by closely looking at changing food consumption patterns and what they imply for market prices, food security, and nutrition. We use a model-based approach to illustrate the implications of tendencies toward less meat-intensive and more "healthy" and balanced diets, and what kind of shift in market outcomes might arise from that. Based on this analysis, we conclude with some final recommendations for both policy intervention and further research.

2. The future of food to 2030

To illustrate how socioeconomic and demographic changes play out in the medium- to long-term evolution of food consumption for key commodity groups, we draw on results from IFPRI's IMPACT model (Rosegrant et al. 2001, 2002).[1] We look at both the baseline set of projections to 2030 and an alternative set of scenarios that illustrate the implications of changes toward healthier and less meat-intensive diets on market dynamics and nutritional outcomes.

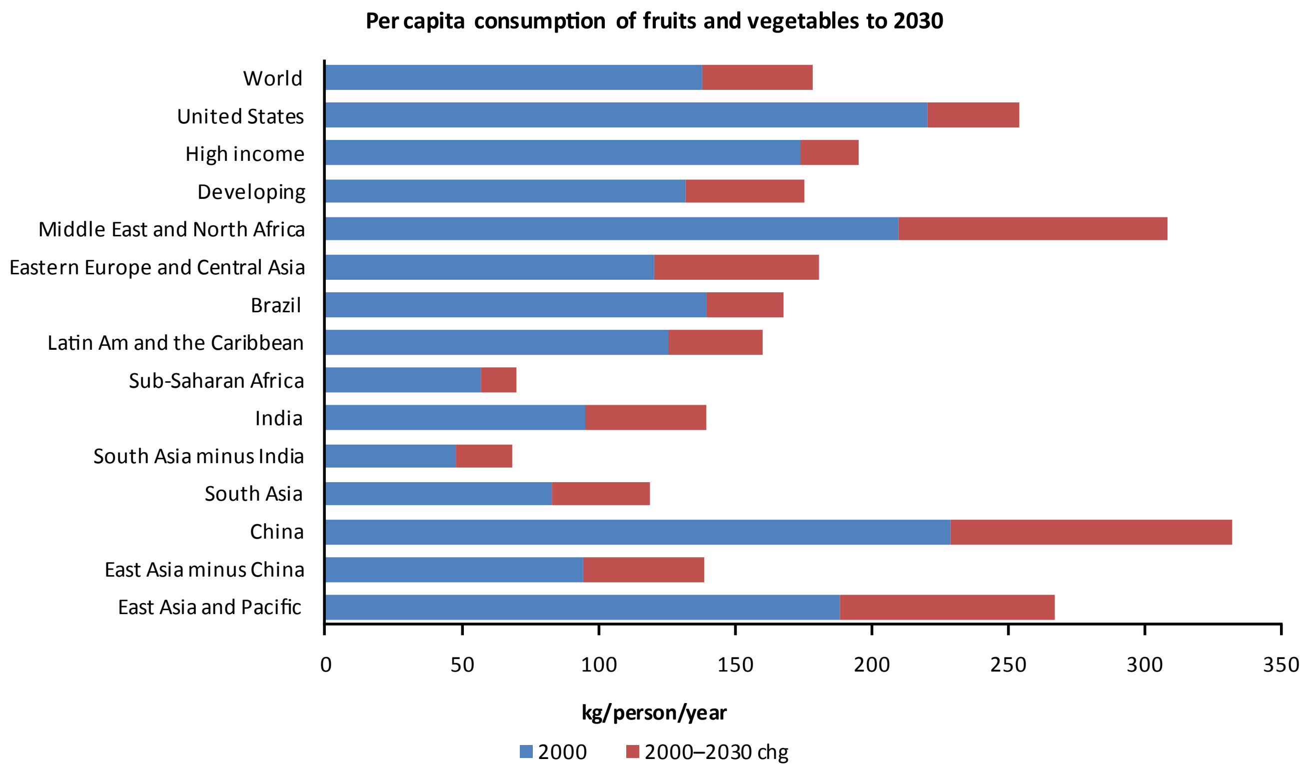
[1] IMPACT (**I**nternational **M**odel for **P**olicy analysis of **A**gricultural **C**ommodities and **T**rade) was developed to project global food supply, food demand and food security to year 2020 and beyond (Rosegrant *et al.* 2001). The IMPACT model is a partial equilibrium agricultural model for crop and livestock commodities, including cereals, soybeans, roots and tubers, meats, milk, eggs, oilseeds, oilcakes/meals, sugar/sweeteners, and fruits and vegetables.

Figure 2—Growth in per capita meat consumption to 2030



Source: IMPACT model projections

Figure 3—Growth in per capita fruit and vegetable consumption to 2030

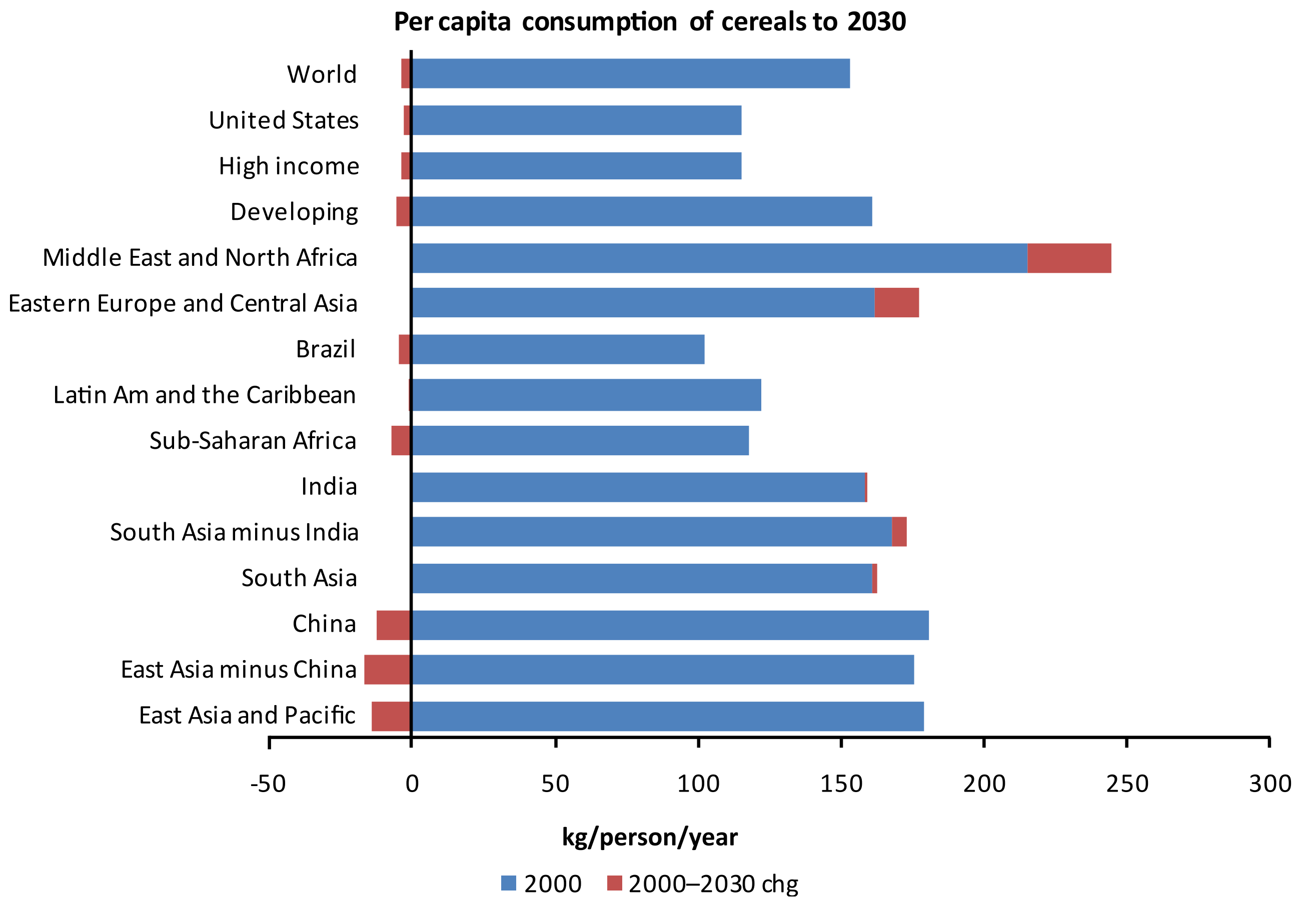


Source: IMPACT model projections

2.1 Baseline outcomes

The exogenous trajectories of socioeconomic change, described above, lead to changes in food consumption patterns in various world regions, which vary according to the relationship between income growth and per-capita consumption levels. For most regions, the per capita levels of meat and milk consumption rise with additional per capita income, while consumption of cereals decreases. Figure 1 shows how changes in per capita consumption of cereals are expected to change by 2030 as a result of these socioeconomic drivers.

Figure 1—Growth in per capita cereal consumption to 2030



Source: IMPACT model projections

We see, on average, a worldwide decline in per capita cereal consumption, with the strongest decreases in the developing world (which starts out with a higher initial level of per capita consumption in 2000 compared to high-income countries). Looking more closely at the regional level, however, we also see a wide range of variation within this pattern; with future socioeconomic growth, the Middle East and North Africa (MENA) region sees continuing increases in per capita cereal consumption levels (mostly from wheat), whereas areas of the East Asia region see relatively strong declines in the consumption of cereals.

Meat consumption reveals an even more dynamic picture of behavioral change over the medium to long term. Figure 2 shows increasing growth in per capita consumption of meat in high-income countries that already approach or exceed 80 kg/cap/yr in year 2000, such as the United States and Brazil. Though the MENA region starts from a much lower level in year 2000, the consumption of meat is projected to almost double by 2030.

The booming East Asian economies such as China show remarkable growth in meat consumption over the 2000-2030 period, though the projected levels of per capita consumption remain below Latin America's 2030 levels. By comparison, the total per capita consumption levels and growth in the Sub-Saharan Africa and South Asia regions are relatively small. A projection of how fruit and vegetable consumption changes over time (Figure 3) shows that, within this commodity group, East Asia and the MENA region have the strongest tendencies toward future growth in intake of the nutrient-rich foods within this category.

2.2 Alternative diet scenarios

Now we contrast the baseline trajectory of food consumption in the IMPACT model with three alternative scenarios in which the pathway of consumption toward key food commodities is altered in order to reflect the evolution toward "healthier" diets in high-income countries. In the first scenario variant ("Low Meat"—LM), the per capita intake of red (beef, lamb) and white (poultry, pork) meats is decreased by half in high-income countries[2] over the projection period to reflect a change in consumer preferences toward "greener" diets with a lower environmental impact. We then extend this scenario design to Brazil and China in order to create an additional low-meat variant (LMBC). We supplement these two low-meat scenarios with an additional variant ("LowMeat/HighFruitVeg"—LMHFV), which applies to just the high-income regions and compensates for the calorie and protein loss of lower meat intakes with a (20 percent) higher per capita intake of fruits, vegetables, and pulses in just the high-income regions. The time period for diet adjustments are implemented such that changes begin in 2010 and are complete by 2015. While we do not try to explain the details of policy mechanisms that would lead consumers in these countries to adopt alternative diets, we highlight their implications in a way that is relevant to policymakers.

Looking at the outcomes of these scenarios for per capita meat consumption levels (Table 1), we see that the per capita consumption of high-income countries is halved by 2030 relative to the baseline, whereas the levels of consumption in developing countries is seen to rise, on average, by more than 10 percent, to slightly over 41 kg per capita per year. When we also reduce meat consumption in China and Brazil, the consumption levels for Africa and India each increase by another 30 percent, bringing the average per capita value for all developing countries (minus China and Brazil) up by 7 kg/capita/yr.

Table 1—Per capita meat consumption under baseline and alternative scenarios for high-income (HIC) countries, Brazil and China (kg per capita per year)

	2000	2030 baseline	2030 HIC Low-Meat	% chg from baseline in 2030	2030 HIC+BrzCh Low-Meat	% chg from baseline in 2030
USA	121.3	130.7	64.7	*-50%*	64.7	*-50.5%*
China	49.4	73.5	83.6	*14%*	36.3	*-50.7%*
India	4.8	8.6	9.9	*15%*	12.9	*48.9%*
Brazil	73.0	88.8	103.3	*16%*	43.7	*-50.8%*
E. Europe & C. Asia	41.9	49.8	41.1	*-17%*	48.7	*-2.1%*
High Income countries	85.7	93.3	46.7	*-50%*	47.0	*-49.6%*
Sub-Saharan Africa	10.9	14.5	16.6	*15%*	21.2	*46.7%*
Rest of Developing*	18.2	25.3	27.2	*7.5%*	34.0	*34.5%*
World	37.1	45.2	42.1	*-7%*	36.5	*-19.2%*

Note: "Rest of Developing" excludes China and Brazil.
Source: IMPACT model projections

The price changes that accompany these changes in per capita consumption are seen in Table 2, which show the percentage decreases to be doubled when we also extend the diet change to Brazil and China.

Livestock commodities show the strongest decrease in prices since scenarios were focusing on decreasing meat consumption. But cereal prices (especially those for coarse grains, like maize) are also seen to decrease appreciably under both "low-meat" scenario variants due to the decreased demand for livestock feed that would be expected when herd sizes are reduced in response to lower livestock product prices. This effect on livestock feed demand is seen in Table 3, where a notable drop in tonnage of feed is noted for most regions, especially for the livestock-intensive Latin America region.

The effect that less meat demand has in "releasing" grain for food use is offset by the increase in cereals consumption under the two low-meat scenarios. However, there is not much overlap in food and feed uses for coarse grains like sorghum and maize outside of Sub-Saharan Africa and other developing regions. Table 4 shows that the strongest increase in per capita cereal consumption for both low-meat variants occurs in Sub-Saharan Africa.

[2] 'High-income' countries refers to all OECD countries, as well as other high-income defined in the World Bank classifications of regions and economies (see pg 333 World Bank, 2007)

Table 2—World prices of key commodities under baseline and alternative diet scenario for high-income (HIC) countries, Brazil and China (US$/mt)

	2000	2030 baseline	2030 HIC Low-Meat	% chg from baseline in 2030	2030 HIC+BrzCh Low-Meat	% chg from baseline in 2030
beef	1971	2031	1646	*-19%*	1245	*-39%*
pork	899	848	649	*-24%*	345	*-59%*
lamb/goat	2831	2875	2538	*-12%*	1905	*-34%*
poultry	1245	1174	910	*-22%*	536	*-54%*
eggs	764	716	703	*-2%*	665	*-7%*
milk	308	338	340	*0%*	340	*0%*
rice	208	252	252	*0%*	251	*0%*
wheat	115	135	132	*-2%*	125	*-7%*
maize	89	119	111	*-7%*	96	*-19%*
other coarse grains	68	91	84	*-8%*	73	*-20%*
soybeans	203	310	310	*0%*	309	*0%*
potatoes	213	272	269	*-1%*	264	*-3%*
sw potatoes & yams	476	421	406	*-3%*	379	*-10%*
cassava	64	74	72	*-2%*	69	*-6%*
meal	189	360	331	*-8%*	282	*-22%*

Source: IMPACT model projections

Table 3: Feed demand for coarse grains under baseline and alternative diet scenarios for high-income (HIC) countries, Brazil and China (millions of metric tons)

	2000	2030 baseline	2030 HIC Low-Meat	% chg from baseline in 2030	2030 HIC+BrzCh Low-Meat	% chg from baseline in 2030
E Asia & Pacific	105.7	269.8	257.1	*-4.7%*	230.5	*-14.6%*
E. Asia minus China	16.5	40.1	37.9	*-5.6%*	33.5	*-16.4%*
China	89.2	229.7	219.2	*-4.6%*	197.0	*-14.3%*
S. Asia	3.4	10.8	10.6	*-2.6%*	10.0	*-7.5%*
S. Asia minus India	1.5	4.6	4.4	*-2.8%*	4.2	*-7.9%*
India	1.8	6.3	6.1	*-2.5%*	5.8	*-7.1%*
SS Africa	8.0	19.3	18.6	*-3.2%*	17.5	*-9.3%*
Latin America & Caribbean	65.2	152.5	143.9	*-5.7%*	129.3	*-15.2%*
Brazil	30.6	73.7	69.0	*-6.4%*	61.4	*-16.7%*
E. Europe & C. Asia	109.3	150.2	143.4	*-4.5%*	130.8	*-12.9%*
M. East & N. Africa	21.1	48.5	47.0	*-3.2%*	44.1	*-9.2%*
Rest of Developing	192.8	347.7	332.3	*-4.4%*	303.7	*-12.6%*
High Income	333.6	492.5	466.8	*-5.2%*	420.8	*-14.5%*
USA	166.1	240.6	228.2	*-5.2%*	206.7	*-14.1%*
World	646.2	1143.6	1087.3	*-4.9%*	982.9	*-14.0%*

Source: IMPACT model projections

This effect would of course not apply to a commodity like meal by-products, which are exclusively used for feed and are seen to drop strongly in price under both "low-meat" diet scenarios (Table 2).

2.3 Implications for nutrition and food security

Looking beyond changes in food consumption patterns and commodity price impacts implied in the scenarios described above, we can also consider the possible implications of changes in prices and consumptions across the wider range of food products for food security. Given the above-highlighted supply and demand patterns, the IMPACT model infers a trend in levels of malnourished among the most vulnerable demographic of the population, children aged zero to five. The determinants of malnutrition are derived primarily from four key indicators, which were first established by Smith and Haddad (2000): per capita calorie availability, access to clean drinking water, rates of secondary schooling among females, and the ratio of female-to-male life expectancy. These determinants are consistent with the four-pillared concept of food security underlining FAO's conceptual framework, where availability is only one factor accounting for food security status among vulnerable populations, and must be evaluated along with access, utilization, and stability. The methodology used for tracking child malnutrition in IMPACT is based on this work, and is implemented through an analytical relationship that is parameterized by the statistical coefficients derived by Haddad and Smith's work.

Table 5 shows the changes in per capita calorie availability that are consistent with the changes in per capita consumption that were simulated for both of the low-meat scenarios. It also shows the implications of the additional scenario variant, where the intake of pulses, fruits, and vegetables are increased in the high-income countries.

Table 4—Per capita cereal consumption under baseline and alternative scenarios for high-income (HIC) countries, Brazil and China (kg per capita per year)

	2000	2030 baseline	2030 HIC Low-Meat	% chg from baseline in 2030	2030 HIC+BrzCh Low-Meat	% chg from baseline in 2030
USA	115.2	112.6	111.0	*-1.4%*	111.0	*-1.4%*
China	181.3	169.1	170.4	*0.8%*	167.6	*-0.9%*
India	158.6	159.1	160.4	*0.8%*	163.4	*2.7%*
Brazil	102.9	98.6	99.4	*0.8%*	98.9	*0.4%*
E. Europe & C. Asia	161.9	177.5	178.5	*0.6%*	181.2	*2.1%*
High Income countries	115.5	112.5	111.9	*-0.5%*	111.9	*-0.5%*
Sub-Saharan Africa	118.3	111.3	113.6	*2.1%*	118.4	*6.4%*
Rest of Developing	156.6	155.3	156.9	*1.0%*	160.5	*3.3%*
World	153.7	150.1	151.4	*0.8%*	153.2	2.0%

Source: IMPACT model projections

Table 5—Per capita calorie availability under baseline and alternative diet scenarios for high-income (HIC) countries, Brazil and China (kCal per capita per day)

	2000	2030 baseline	2030 HIC Low-Meat	2030 HIC+BrzCh Low-Meat	2030 HIC Low Meat + High Pulse FruitVeg
	Total calorie availability		change in calorie availability from baseline		
E. Asia & Pacific	2870	2895	10	-2	4
E. Asia minus China	2660	2605	8	25	4
China	2959	3041	11	-16	5
S. Asia	2401	2502	9	32	6
S. Asia minus India	2334	2459	9	32	7
India	2423	2520	9	32	6
SS Africa	2277	2251	27	81	23
Latin America & Caribbean	2876	2920	15	40	11
Brazil	3031	2963	6	-1	2
E. Europe & C. Asia	3014	3235	6	28	15
M. East & N. Africa	3141	3642	18	61	9
Rest of Developing	2588	2644	14	47	11
High Income	3420	3345	-9	-11	32
USA	3790	3744	-18	-20	28
World	2812	2822	10	26	13

Source: IMPACT model projections

The increase in per capita calorie availability is seen across all regions, except for the regions targeted by the scenarios, and is consistent with what we would expect from lower cereal and meat prices globally. By contrast, the imposition of higher per capita consumption of pulses, fruits, and vegetables in just the high-income countries (under the LMHFV case) causes a slight drop in per capita calorie availability across all regions (except the target region) due to the increase in high-income demand and commodity prices that is seen to accompany this change (Table 6).

The size of price changes from increased pulse, vegetable, and fruit consumption under this last scenario variant is much smaller, though, compared to the decrease in meat commodity prices that accompanied both the "low-meat" scenario variants (Table 2).

3. Implications for Food Security and Policy

Following the quantitative scheme based on the Smith-Haddad relationship, and drawing from the scenario-driven changes in per capita calorie consumption, we see child malnutrition changes (Table 7), demonstrating the "calorie-releasing" effect of reducing livestock consumption, production, and feed demand in both "low-meat" scenario variants.

Table 6—World prices of pulse, fruit and vegetable commodities under baseline and alternative diet scenario for high-income (HIC) countries (US$/mt)

	2000	2030 baseline	2030 HIC Low-Meat, High-Pulse/Fruit/Veg	% chg from baseline in 2030
vegetables	576	533	552	*4%*
(sub)tropical fruits	468	455	470	*3%*
temperate fruits	600	577	604	*5%*
chickpeas	562	599	609	*2%*
pigeonpeas	558	604	602	0%

Source: IMPACT model projections

Table 7—Child malnutrition under baseline and diet scenarios for high-income (HIC) countries, Brazil and China (millions of children aged 0-5)

	2000	2030 baseline	2030 HIC diet change	2030 HIC+BrzCh Low-Meat	2030 HIC Low Meat + High Pulse Fruit/Veg
	Total malnourished children		Total change in malnourishment from baseline		
N. SS Africa	11.3	15.5	-0.1	-0.3	-0.1
W. SS Africa	6.6	10.1	-0.1	-0.4	-0.1
E. SS Africa	3.2	4.5	0	-0.2	0
S. SS Africa	4.6	7.3	-0.1	-0.3	-0.1
All SS Africa	32.1	44.0	-0.5	-1.4	-0.4
W. Asia & N. Africa	6.2	4.3	0	-0.1	-0.1
S. Asia	75.6	62.5	-0.2	-0.6	-0.1
S. Asia minus India	19.2	19.5	-0.1	-0.2	-0.1
S.E. Asia	13.5	11.4	-0.1	-0.2	-0.1
E. Asia	10.7	4.8	-0.1	0.1	0
All of Asia	99.9	78.6	-0.2	-0.5	-0.1
All of Latin America	7.7	6.4	-0.1	-0.2	-0.1
All Developing*	146.5	133.9	-0.8	-2.3	-0.7

*Note: This includes China and Brazil
Source: IMPACT model projections

Under the "low-meat" scenario that just targets high-income countries, the decrease of child malnutrition in Sub-Saharan Africa is half a million; the inclusion of Brazil and China in the scenario results in an even bigger improvement, increasing the reduction of undernourished children to 1.4 million. Child malnutrition also improves in Asia under both low-meat scenarios, though to a lesser extent (0.2 million for the HIC case, and 0.5 million when China and Brazil are included). In contrast, the LMHFV scenario variant slightly reduces the impact that the low-meat (LM) variant has on malnutrition, relative to the baseline case, for both the Asian and Sub-Saharan regions (reducing malnutrition relative to baseline by 0.1 million children *less* than the LM scenario). This shows the effect of diets in high-income diets shifting away from meat and cereal-feed intensive goods — thereby relieving pressures in those markets — but shifting toward other goods as substitutes, which introduces price pressure elsewhere. On the whole, however, the benefits of releasing grains from livestock production systems through a lowering of meat demand outweighs the countervailing price effects of increasing the consumption of "healthy" foods like pulses and nutrient-laden fruits and vegetables. Also, it should be noted that IMPACT's partial-equilibrium framework does not capture any additional income to farmers generated by pulse fruit and vegetable; this offset the slight increase in simulated malnutrition that we demonstrate Another possible poverty-reducing and (ultimately) nutrition-enhancing benefit not captured by the framework is the availability of micronutrients in these foods, which could be linked to other positive effects on human health and nutrition.

Since halting or altering urbanization, population, and income growth isn't a plausible policy instrument for influencing consumption behavior, the only policy entry point is influencing consumers themselves to diversify away from a meat-intensive regime. Nutrition education, as part of a long-term health education program that strives to target diverse demographics, could be a useful instrument for achieving this. Such a program's influence, however, would only be realized gradually over time, similarly to the patterns seen in other health-oriented education efforts such as AIDS awareness.

A more direct means to exert influence could be through the promotion of healthy diets within government-sponsored feeding programs (for example, through relief efforts or school lunch programs), although it would only be limited to the intervention's target population. Reaching a broader population in a more enduring way could be achieved through the promotion of food health and safety standards that provide guidance to food processors on phytosanitary standards, as well as education about additives/preservatives and proper processing, packing, and storage procedures. Even without going so far as to promote a "less meat" diet, a policy focused on <u>safe</u> meat could help to avoid human illnesses and death. The uniform and diligent implementation of food safety standards could empower consumers with the information they need to come to educated conclusions about which food types pose greater risk to their health. Labels that contain information about nutrition, health, and production methods is another approach that allows consumers to make more informed purchases based on their concerns—be they regarding the humane treatment of animals, the number of calories, or the availability of micronutrients.

4. Conclusions

In this paper, we discuss the nature of several key drivers of change in food systems, and explore in detail dietary change and its effect on the evolution of food prices, consumption, and other future world food markets dynamics. We demonstrate that a strong shift toward more healthy and nutritious diets significantly decreases the price and consumption of livestock products, as well as cereal commodities used for animal feed. An important lesson is that reducing high meat consumption in fast-growing countries such as China has an even bigger impact than reducing meat consumption in OECD countries. However, the shift to less meat and healthier diets leads to only a small enhancement of food security in developing regions; there is little impact on prices of wheat and rice, the main staple foods in most developing countries and, therefore, little gain in consumption of these staples. The overall effect on calorie consumption in developing countries, therefore, is small. Consequently, the projected number of malnourished preschool children in developing countries shows very little reduction relative to the baseline results. The additional benefits of encouraging healthier diets that are richer in pulse-based proteins, fruits, and vegetables are not fully captured in our analysis, but could provide further welfare improvements to developing regions through the additional income from supplying fresh horticultural fruits and vegetables to markets of wealthier countries.

It is crucial to emphasize that changes in the dietary patterns in developed and rapidly growing BRIC countries are not, by themselves, an effective route towards the long-term improvement of food security in developing countries. As was shown by Rosegrant et al. (2009), significant progress on malnutrition in developing countries will require: economic growth that generates employment and reduces inequality and poverty; investments in agricultural and rural development; investments in agricultural research and technologies as well as in health and education; the development of infrastructure such as irrigation, domestic water supply, good roads, communications and effective markets. These things, taken together, will increase agricultural productivity, household incomes, and food security.

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