

Animal Source Foods to Improve Micronutrient Nutrition and Human Function in Developing Countries

Rising Consumption of Meat and Milk in Developing Countries Has Created a New Food Revolution^{1,2}

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ABSTRACT People in developing countries currently consume on average one-third the meat and one-quarter of the milk products per capita compared to the richer North, but this is changing rapidly. The amount of meat consumed in developing countries over the past has grown three times as much as it did in the developed countries. The Livestock Revolution is primarily driven by demand. Poor people everywhere are eating more animal products as their incomes rise above poverty level and as they become urbanized. By 2020, the share of developing countries in total world meat consumption will expand from 52% currently to 63%. By 2020, developing countries will consume 107 million metric tons (mmt) more meat and 177 mmt more milk than they did in 1996/1998, dwarfing developed-country increases of 19 mmt for meat and 32 mmt for milk. The projected increase in livestock production will require annual feed consumption of cereals to rise by nearly 300 mmt by 2020. Nonetheless, the inflation-adjusted prices of livestock and feed commodities are expected to fall marginally by 2020, compared to precipitous declines in the past 20 y. Structural change in the diets of billions of people is a primal force not easily reversed by governments. The incomes and nutrition of millions of rural poor in developing countries are improving. Yet in many cases these dietary changes also create serious environmental and health problems that require active policy involvement to prevent irreversible consequences. *J. Nutr.* 133: 3907S–3910S, 2003.

KEY WORDS: • meat • milk • food consumption • developing countries • 2020

From the beginning of the 1970s to the mid 1990s, consumption of meat in developing countries increased by 70 million metric tons (mmt)⁴, almost triple the increase in developed countries, and consumption of milk by 105 mmt of liquid milk equivalents (LME), more than twice the increase

that occurred in developed countries. The market value of that increase in meat and milk consumption totaled ~\$155 billion (1990 U.S. dollars), more than twice the market value of increased cereals consumption under the better-known Green Revolution in wheat, rice and maize. The population growth, urbanization and income growth that fueled the increase in meat and milk consumption are expected to continue well into the new millennium, creating a veritable Livestock Revolution. As these events unfold, many people's diets will change, some for the better, but others for the worse, especially if food contamination is not controlled. Farm income could rise dramatically, but whether that gain will be shared by poor smallholders and landless agricultural workers who need it most is still undetermined. The environmental, nutritional and public health impacts of rapidly rising livestock production in close proximity to population centers also needs attention (2,3).

The Livestock Revolution

The Livestock Revolution is propelled by demand. People in developing countries are increasing their consumption from the very low levels of the past, and they have a long way to go before coming near developed country averages. In developing countries, people consumed an annual average in 1996–1998 of 25 kg/capita meat and 44 kg/capita milk, one-third the meat and one-fifth the milk consumed by people in developed countries. Nevertheless, the caloric contribution per capita of meat, milk and eggs in developing countries in the late 1990s

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² This article is drawn from a much longer version written with Mark Rosegrant and Siet Meijer of the International Food Policy Research Institute (IFPRI), which focused on trade implications and was presented at the conference on International Trade in Livestock Products organized by the International Agricultural Trade Research Consortium (IATRC), Auckland, New Zealand, January 18–19, 2001 (1). This present article focuses primarily on consumption issues and is updated with new projections to 2020 from a substantially updated version (July 2002) of IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) Global Food Model, kindly supplied by Mark Rosegrant. Funding from the European Commission and IFPRI's other core donors is gratefully acknowledged.

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⁴ Abbreviations used: ASF, animal source foods; IFPRI, International Food Policy Research Institute; IMPACT, International Model for Policy Analysis of Agricultural Commodities and Trade; LME, liquid milk equivalents; mmt, million metric tons.

was still only a quarter that of the same absolute figure for developed countries and, at 10%, accounted for only half the share of energy from animal source foods (ASF) observed in the developed countries, as shown in **Table 1**.

Per capita consumption is rising fastest in regions where urbanization and rapid income growth result in people adding variety to their diets. Across countries, per capita consumption is significantly determined by average capita income (4). Aggregate consumption grows fastest where rapid population growth augments income and urban growth (5,6). Since the early 1980s, total meat and milk consumption grew at 6 and 4% per y respectively throughout the developing world. In East and Southeast Asia—where income grew at 4–8% per y between the early 1980s and 1998, population at 2–3% per y and urbanization at 4–6% per y—meat consumption grew between 4 and 8% per y.

The Livestock Revolution has been most evident in East Asia, as illustrated by the per capita figures for China in **Table 2**. The significance of the per capita figures is more striking when these are multiplied by population, because four-fifths of the latter is in developing countries, and their share is growing (7). Using current FAO estimates of Chinese consumption in 1982/1984 and 1996/1998, the share of the world's meat consumed in developing countries rose from 37 to 48%, and their share of the world's milk rose from 34 to 44%. Pork and poultry accounted for 76% of the large net consumption increase of meat in developing countries from 1982/1984 to 1996/1998. Conversely, both per capita and

TABLE 1

Annual per capita human food consumption (kg) and percent of calories from selected livestock products, 1973 and 1997¹

Commodity	Developed countries		Developing countries	
	1973	1997	1973	1997
Beef (kg)	26	23	4	6
(% of calories from beef)	(3%)	(3%)	(1%)	(1%)
Mutton and goat (kg)	3	2	1	2
(% of calories from mutton and goat)	(1%)	(0+%)	(0%)	(0+%)
Pork (kg)	26	28	4	10
(% of calories from pork)	(4%)	(5%)	(2%)	(4%)
Poultry (kg)	11	22	2	7
(% of calories from poultry)	(1%)	(3%)	(0%)	(1%)
Eggs (kg)	13	12	2	6
(% of calories from eggs)	(2%)	(1%)	(0%)	(1%)
Milk and products excluding butter (kg)	188	194	29	43
(% of calories from milk)	(9%)	(9%)	(2%)	(3%)
Four meats (kg)	67	75	11	25
(% of calories from four meats)	(10%)	(10%)	(3%)	(6%)
Four meats, eggs, and milk (kg)	268	283	42	74
(% of calories)	(20%)	(20%)	(6%)	(10%)

Source: Calculated from data in the United Nations Food and Agriculture Organization (FAO) database, 2002 (11). 1997 is the annual average of 1996–1998.

¹“Four meats” includes beef, pork, mutton and goat, and poultry. Percentages of total food calories consumed directly by humans accounted for by the item and location shown are given in parentheses. Values are 3-y moving averages centered on the year shown; percentages are calculated from 3-y moving averages. Throughout this report the term “food” will be used to distinguish direct food consumption by humans from uses of animal products as feed, fuel, cosmetics or coverings.

TABLE 2

Per capita meat and milk consumption by region, 1983 and 1997

Region	Meat		Milk	
	1983	1997	1983	1997
	(kg)			
China	16	43	3	8
Other East Asia	22	31	15	19
India	4	4	46	62
Other South Asia	6	9	47	63
Southeast Asia	11	18	10	12
Latin America	40	54	93	112
WANA	20	21	86	73
Sub-Saharan Africa	10	10	32	30
Developing world	14	25	35	43
Developed world	74	75	195	194
United States	107	120	237	257
World	30	36	76	77

Source: Values are 3-y moving averages centered on the year shown, calculated from data in the United Nations Food and Agriculture Organization (FAO) database, 2002 (11).

aggregate milk and meat consumption stagnated in the developed world, where saturation levels of consumption have been reached and population growth is small. Nine-tenths of the small net increase in meat consumption that occurred in developed countries over the same period was from poultry.

China and Brazil play a dominant role in the meat part of the Livestock Revolution. However, the near doubling of aggregate milk consumption as food in India between the early 1980s and the late 1990s suggests that the Livestock Revolution goes beyond just meat and beyond China and Brazil. At 60 mm of LME in 1996/1998 (a figure from FAO considered low by many Indian dairy analysts), Indian milk consumption amounted to 13% of the world's total and 31% of milk consumption in all developing countries. The high milk consumption of Latin America in 1996/1998, at 112 kg/capita, is halfway between the developing world as a whole (44 kg/capita) and the developed countries (195 kg/capita), because of the very high level (75%) of urbanization in Latin America (Table 2).

The share of the developing countries in world use of cereals for feed went from 21% in 1982/1984 to 36% in 1996/1998. This salient fact has inspired many observers to wonder if the rise of production of pork, poultry, eggs and milk for the urban middle class would jack up the price of cereals to the poor in both rural and urban areas of developing countries. Furthermore, others wondered whether the trends portrayed above could possibly continue far into the future, without resource scarcities or import constraints raising prices to the point that the growth in consumption would peter out.

Whether these trends will continue was explored in 1998 with the International Food Policy Research Institute's (IFPRI's) International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), a global food model first reported by Rosegrant et al. (8). Results were put into the context of growing concern about livestock issues by Delgado et al. (2) and have recently been updated using new more recent data and new insights.⁵

⁵ This article reports results from a substantially updated version of IMPACT run in July 2002 that incorporates many refinements. Details of the IMPACT model are discussed in Mark Rosegrant's many publications on the subject [see Rosegrant et al. (9)].

Rising consumption of meat and milk to 2020

For the 1996/1998–2020 period, IMPACT projects developing country aggregate consumption growth rates of meat and milk separately to be 3.0 and 2.9%/y, respectively, compared to 0.8 and 0.6%, respectively, in the developed countries. Aggregate meat consumption in developing countries is projected to grow by 106 mmt between the late 1990s and 2020, whereas the corresponding figure for developed countries is 19 mmt (Table 3). Similarly, additional milk consumption in the developed countries of 32 mmt of LME will be dwarfed by the additional consumption in developing countries of 177 mmt.

In the developing countries, 71% of the additions to meat consumption are from pork and poultry; in the developed countries, the comparable figure is 74%. Poultry consumption in developing countries is projected to grow at 3.9% per annum through 2020, followed by beef at 2.9% and pork at 2.4%. In the developed countries, poultry consumption is projected to grow at 1.5% per annum through 2020, with other meats growing at 0.5% or less (Table 3). As the growth rates in Table 4 suggest, high growth in consumption is spread throughout the developing world and in no way limited to China, India and Brazil, although the sheer size and vigor of those countries will mean that they will continue to increase their dominance of world markets for livestock products. Experience for individual commodities will vary widely among different parts of the developing world, with China leading the way on meat with a near doubling of the total quantity consumed; the increments are primarily poultry and pork. India and the other South Asian countries will drive a large increase in total milk consumption.

Because so much of the expansion in meat consumption, and thus production, comes from monogastric livestock such

TABLE 3

Projected food consumption trends of various livestock products to the year 2020¹

Region	Projected growth of consumption 1997–2020	Total consumption		Percent of world total 2020	Per capita consumption	
		1997	2020		1997	2020
	(%/y)	(million metric tons)		(%)	(kg)	
Developed world						
Beef	0.5	30	34	40	23	25
Pork	0.4	36	39	33	28	29
Poultry	1.5	28	39	36	22	29
Meat	0.8	98	117	35	75	87
Milk	0.6	251	286	43	194	210
Developing world						
Beef	2.9	27	52	61	6	9
Pork	2.4	47	81	67	10	13
Poultry	3.9	29	70	64	7	11
Meat	3.0	111	217	65	25	36
Milk	2.9	194	375	57	43	62

Sources: Total and per capita consumption for 1997 are calculated from the United Nations Food and Agriculture Organization database (FAO), 2002 (11) and are 3-y moving averages centered on 1997. The 2020 projections are from the July 2002 version of the IMPACT model.

¹Consumption is direct use as food, uncooked weight bone-in. Meat includes beef, pork, mutton and goat, and poultry. Milk is milk and milk products in liquid milk equivalents. Metric tons and kilograms are 3-y moving averages centered on the year shown. WANA is Western Asia and North Africa.

TABLE 4

Projected food consumption trends of meat and milk, 1997–2020¹

Region	Projected annual growth 1997–2020		Total consumption in 2020		Per capita consumption in 2020	
	Meat	Milk	Meat	Milk	Meat	Milk
	(%/y)		(million metric tons)		(kg)	
China	3.1	3.8	107	24	73	16
India	3.5	3.5	10	133	8	105
Other East Asia	3.2	2.5	5	2	54	29
Other South Asia	3.5	3.1	7	42	13	82
Southeast Asia	3.4	3.0	19	12	30	19
Latin America	2.5	1.9	46	85	70	130
of which is Brazil only	2.4	1.8	20	30	94	145
WANA	2.7	2.3	13	42	26	82
Sub-Saharan Africa	3.2	3.3	11	35	12	37
Developing world	3.0	2.9	217	375	36	62
Developed world	0.8	0.6	117	286	86	210
World	2.1	1.7	334	660	45	89

Sources: Total and per capita meat consumption for 1997 are annual averages of 1996–1998 values, calculated from the United Nations Food and Agriculture Organization database (FAO), 2002 (11). Projections are from the July 2002 version of IMPACT.

¹Consumption is direct use as food, uncooked weight bone-in. Meat includes beef, pork, mutton and goat, and poultry. Milk is milk and milk products in liquid milk equivalents. Metric tons and kilograms are 3-y moving averages centered on the year shown. WANA is Western Asia and North Africa.

as pigs and poultry, effective demand for concentrate feeds in developing countries will continue to increase. IMPACT projects a worldwide expansion of an additional 295 mmt of cereals used as feed per year by 2020, compared to the 1996/1998 annual average. This can be compared to an average annual U.S. maize (corn) crop of ~200 mmt in the 1990s. Developing countries accounted for 36% of cereals feed use in 1996/1998, but are projected to account for 46% in 2020. On a human per capita basis, cereals feed use in 2020 in developed countries is projected to be 375 kg, compared to 72 kg in developing countries.

With these large increases in animal food product consumption and cereals use as feed, it is interesting to review inflation-adjusted prices of livestock and feed commodities to 2020. Real prices for these items fell sharply from the early 1970s to the early 1990s, stabilized in the mid-1990s in most cases and fell again thereafter (1). Real maize prices did not fall over the 1990s, reflecting perhaps high demand for feed under the Livestock Revolution. By contrast, real beef prices fell by a factor of 3 from 1970/1972 to 1996/1998.

Looking to the future, IMPACT projects the expected change in real prices to 2020 relative to 1996/1998. The overall picture for 2020 is a noticeable real decline for wheat and rice (8 and 11%), a similar decline for milk (8%), more modest decreases for meats (3%) and stability or slight increases for feedgrains (+11 and –4% for maize and soybeans, respectively). The results lend support to the view that the main effect of the Livestock Revolution on agricultural prices is to stem the fall in feedgrain prices, such that maize and soybeans will increase in value over time compared to rice and wheat, whose real prices will fall. The Livestock Revolution will also cushion if not prevent the further fall in real global livestock prices. There

is little support for the view that increased livestock consumption in Asia will run up the food grain prices of the poor there or elsewhere, especially because world maize prices were very significantly higher in real terms in the 1970s and 1980s than they are now or are projected to be in 2020.

Opportunities and perils

The principal conclusion of the most recent projections is to confirm the view that the Livestock Revolution in developing countries will continue at least to 2020 and will increasingly drive world markets for meat, milk and feed grains. Whether it is a good thing is not the issue; it is a phenomenon that will occur. The main trade impact is that developing countries as a whole will increase their already large net imports of cereals to an annual amount in 2020 of about the same magnitude as the annual U.S. corn crop (193 mmt). About half (92 mmt) of these net imports will be maize and cereals other than rice and wheat; most of the coarse grains will probably go to feeding, as may some of the wheat. Meat and milk production increases in developing countries will largely match the big consumption increases, and meat exports from Latin America to Asia will soar.

Yet the Livestock Revolution is not necessarily a threat to the poor through raising cereals prices. The model suggests relative little change in 2020 relative to real price levels in the base y 1996/1998. Principally because of the propping-up effect of net import demand from developing countries, feedgrain prices will remain at ~1996/1998 average levels. Meat prices will fall in the range of 3%, whereas the milk price is projected to fall 8%. These falls would be substantially higher without the Livestock Revolution.

On the positive side, increased consumption of meat and milk under the Livestock Revolution can improve the incomes of poor farmers and food processors in developing countries. Considerable evidence from in-depth field studies of rural households in Africa and Asia shows that the rural poor and landless presently get a higher share of their income from livestock than do better-off rural people (2,10). The exception tends to be in Latin America, where relative rural wealth correlates more clearly with cattle holdings. In most of the developing world, a goat, a pig, some chickens or a milking cow can provide a key income supplement for the landless and otherwise asset-poor.

Some analysts contemplating the Livestock Revolution extend the concern with excess animal product consumption in developed countries to the rise in consumption in developing countries. However, for the large majority of people in developing countries, whose consumption levels are still very low as evidenced by Table 1, little evidence supports this view, especially in rural areas. On the contrary, protein and micro-nutrient deficiencies, which tend to disappear with increased consumption of livestock products, remain widespread in developing countries. There is valid concern that those who most need the added meat and milk will not get it simply from increasing production, and this is a highly valid policy concern.

Rapid industrialization of production of monogastrics under the Livestock Revolution will supply urban supermarkets, but may not bolster rural incomes in a widespread manner unless specific actions are undertaken. There are large economies of scale in processing livestock-origin food products and in input supply but far less in production itself once market distortions favoring powerful producers are removed. Poverty policy can promote vertical integration of small producers with livestock food processors, through contract farming or participatory

producer coops. The alternative might be that the poor are driven out by industrial livestock producers; the one growing market the poor presently supply will be closed to them. Furthermore, the environmental and disease consequences of increasing concentrations of animals and people are very worrisome (2).

On the production side, policy needs to focus on removing the overt distortions that encourage overconcentration of production and produce many of the problems, while promoting institutional change in property rights in commercializing smallholder areas. On the consumption side, governments need to recognize that the rapid rise in aggregate consumption of meat and milk is propelled by (literally) billions of people diversifying primarily starch-based diets into a small amount of milk and meat, and this fundamental structural shift is not likely to be policy-changeable, nor in most cases should it be, at least not for nutritional reasons. Although cases of overweight children in Chinese cities provide a compelling anecdote, they account for only a tiny fraction of the increase in meat and milk consumption in developing countries.

Most importantly, governments and development partners wanting to help the malnourished poor need to follow the Livestock Revolution closely. The rapidly growing demand for livestock products is a rare opportunity for smallholder farmers to benefit from a rapidly growing market and for their families to have a viable source of much-needed micronutrients and dense calories. The worst thing that well-motivated agencies can do is to cease public investments that facilitate economic, sustainable and small-operator forms of market-oriented livestock production. Lack of action will not stop the Livestock Revolution, but it will help ensure that the form it takes is less favorable for poverty alleviation, better nutrition and health and preservation of the environment.

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