Should Humans Eat Meat?

What can and should be done about human carnivory? Vaclav Smil answers in this excerpt from his new book

By Vaclav Smil | July 19, 2013

There is no doubt that human evolution has been linked to meat in many fundamental ways. Our digestive tract is not one of obligatory herbivores; our enzymes evolved to digest meat whose consumption aided higher encephalization and better physical growth. Cooperative hunting promoted the development of language and socialization; the evolution of Old World societies was, to a significant extent, based on domestication of animals; in traditional societies, meat eating, more than the consumption of any other category of foodstuffs, has led to fascinating preferences, bans and diverse foodways; and modern Western agricultures are obviously heavily meat-oriented. In nutritional terms, the links range from satiety afforded by eating fatty megaherbivores to meat as a prestige food throughout the millennia of preindustrial history to high-quality protein supplied by mass-scale production of red meat and poultry in affluent economies.

But is it possible to come up with a comprehensive appraisal in order to contrast the positive effects of meat consumption with the negative consequences of meat production and to answer a simple question: are the benefits (health and otherwise) of eating meat greater than the undesirable cost, multitude of environmental burdens in particular, of producing it?
Killing animals and eating meat have been significant components of human evolution that had a synergistic relationship with other key attributes that have made us human, with larger brains, smaller guts, bipedalism and language. Larger brains benefited from consuming high-quality proteins in meat-containing diets, and, in turn, hunting and killing of large animals, butchering of carcasses and sharing of meat have inevitably contributed to the evolution of human intelligence in general and to the development of language and of capacities for planning, cooperation and socializing in particular. Even if the trade-off between smaller guts and larger brains has not been as strong as is claimed by the expensive-tissue hypothesis, there is no doubt that the human digestive tract has clearly evolved for omnivory, not for purely plant-based diets. And the role of scavenging, and later hunting, in the evolution of bipedalism and the mastery of endurance running cannot be underestimated, and neither can the impact of planned, coordinated hunting on non-verbal communication and the evolution of language.

_Homo sapiens_ is thus a perfect example of an omnivorous species with a high degree of natural preferences for meat consumption, and only later environmental constraints (need to support relatively high densities of population by progressively more intensive versions of sedentary cropping) accompanied by cultural adaptations (meat-eating restrictions and taboos, usually embedded in religious commandments) have turned meat into a relatively rare foodstuff for majorities of populations (but not for their rulers) in traditional agricultural societies. Return to more frequent meat eating has been a key component of a worldwide dietary transition that began in Europe and North America with accelerating industrialization and urbanization during the latter half of the 19th century. In affluent economies, this transition was accomplished during the post-WW II decades, at a time when it began to unfold, often very rapidly, in modernizing countries of Asia and Latin America. As a result, global meat production rose from less than 50 t in 1950 to about 110 t in 1975; it doubled during the next 25 years, and by 2010 it was about 275 t, prorating to some 40 g/capita, with the highest levels (in the US, Spain and Brazil) in excess of 100 g/capita. This increased demand was met by a combination of expanded traditional meat production in mixed farming operations (above all in the EU and China), extensive conversion of tropical forests to new pastures (Brazil being the leader) and the rise of concentrated animal feeding facilities (for beef mostly in North America, for pork and chicken in all densely populated countries).
This, in turn, led to a rise of modern mass-scale feed industry that relies primarily on grains (mainly corn) and legumes (with soybeans dominant, fed as a meal after expressing edible oil) combined with tubers, food-processing residues and many additives to produce a variety of balanced feedstuffs containing optimal shares of carbohydrates, proteins, lipids and micronutrients (and added antibiotics). But it has also led to a widespread adoption of practices that create unnatural and stressful conditions for animals and that have greatly impaired their welfare even as they raised their productivity to unprecedented levels (with broilers ready for slaughter in just six to seven weeks and pigs killed less than six months after weaning).

Meat is undoubtedly an environmentally expensive food. Large animals have inherently low efficiency of converting feed to muscle, and only modern broilers can be produced with less than two units of feed per unit of meat. This translates into relatively large demands for cropland (to grow concentrates and forages), water, fertilizers and other agrochemicals, and other major environmental impacts are created by gaseous emissions from livestock and its wastes; water pollution (above all nitrates) from fertilizers and manure is also a major factor in the intensifying human interference in the global nitrogen cycle.

Opportunities for higher efficiency can be found all along the meat production–consumption chain. Agronomic improvements – above all reduced tillage and varieties of precision cropping (including optimized irrigation) – can reduce both the overall demand for natural resources and energy inputs required for feed production while, at the same time, improving yields, reducing soil erosion, increasing biodiversity and minimizing nitrogen leakage (Merrington et al. 2002). Many improvements can lower energy used in livestock operations (Nguyen et al. 2010), reduce the specific consumption of feed (Reynolds et al. 2011) and minimize environmental impacts of large landless livestock facilities (IST 2002). Considerable energy savings can also be realized by using better slaughter and meat processing methods (Fritzson and Berntsson 2006).

Rational meat eating is definitely a viable option.

**Toward Rational Meat Eating**
We could produce globally several hundred millions of tons of meat without ever-larger
confined animal feeding operations (CAFOs), without turning any herbivores into
cannibalistic carnivores, without devoting large shares of arable land to monocropping
that produces animal feed and without subjecting many grasslands to damaging
overgrazing – and a single hamburger patty does not have to contain meat from several
countries, not just from several cows. And there is definitely nothing desirable to aim for
ever higher meat intakes: we could secure adequate meat supply for all of today’s
humanity with production methods whose energy and feed costs and whose
environmental impacts would be only a fraction of today’s consequences.

Meat consumption is a part of our evolutionary heritage; meat production has been a
major component of modern food systems; carnivory should remain, within limits, an
important component of a civilization that finally must learn how to maintain the
integrity of its only biosphere.

The most obvious path toward more rational meat production is to improve efficiencies
of many of its constituent processes and hence reduce waste and minimize many
undesirable environmental impacts. As any large-scale human endeavor, meat
production is accompanied by a great deal of waste and inefficiency, and while he have
come close to optimizing some aspects of the modern meat industry, we have a long way
to go before making the entire enterprise more acceptable. And, unlike in other forms of
food production, there is an added imperative: because meat production involves
breeding, confinement, feeding, transportation and killing of highly evolved living
organisms able to experience pain and fear, it is also accompanied by a great deal of
unnecessary suffering that should be eliminated as much as possible.

Opportunities to do better on all of these counts abound, and some are neither costly
nor complicated: excellent examples range from preventing the stocking densities of
pastured animals from surpassing grassland’s long-term carrying capacity to better
designs for moving cattle around slaughterhouses without fear and panic. There is no
shortage of prescriptions to increase global agricultural production with the
maintenance of well-functioning biosphere or, as many of my colleagues would say, to
develop sustainable food production while freezing agriculture’s environmental
footprint of food (Clay 2011) – or even shrinking it dramatically (Foley et al. 2011).

The two key components in the category of improvements are the effort to close yield
gaps due to poor management rather than to inferior environmental limitations and to
maximize the efficiency with which the key resources are used in agricultural production. Claims regarding the closing of the yield gaps must be handled very carefully as there are simply too many technical, managerial, social and political obstacles in the way of replicating Iowa corn yield throughout Asia, to say nothing about most of sub-Saharan Africa, during the coming generations. Africa’s average corn yield rose by 40% between 1985 and 2010 to 2.1 /ha, far behind the European mean of 6.1 and the US average of 9.6 /ha, but even if it were double during the next 25 years to 4.2 /ha, the continent’s continuing rapid growth would reduce it to no more than about 35% gain in per capita terms. Asian prospects for boosting the yields are better, but in many densely populated parts of that continent, such yields might be greatly reduced, even negated by the loss of arable land to continuing rapid urbanization and industrialization.

At the same time, there does not appear to be anything in the foreseeable future that could fundamentally change today’s practices of growing livestock for meat. Indeed, many arguments can be made that after half a century of focused breeding, accelerated maturation of animals and improvements in feed conversion, these advances have gone too far and are now detrimental to the well-being of animals and to the quality of the food chain and have raised environmental burdens of meat production to an unprecedented level that should not be tolerated in the future. And neither the expanded aquaculture nor plant-based meat imitations will claim large shares of the global market anytime soon, and cultured meat will remain (for a variety of reasons) an oddity for a long time to come.

Consequently, it is very unlikely that the undoubted, continuing (and possibly even slightly accelerating) positive impact of the combination of higher productivities, reduced waste, better management and alternative protein supplies would make up for additional negative impacts engendered by rising meat production and that there would be discernible net worldwide improvement: the circle of reduced environmental impacts cannot be squared solely by more efficient production. At the same time, the notion that an ideal form of food production operating with a minimal environmental impact should exclude meat – nothing less than enacting “vegetarian imperative” (Saxena 2011) on a global scale – does not make sense.
This is because both grasslands and croplands produce plenty of phytomass that is not digestible by humans and that would be, if not regularly harvested, simply wasted and left to decay. In addition, processing of crops to produce milled grains, plant oils and other widely consumed foodstuffs generates a large volume of by-products that make (as described in Chapter 4) perfect animal feeds. Rice milling strips typically 30% of the grain’s outermost layers, wheat milling takes away about 15%: what would we do with about 300 Mt of these grain milling residues, with roughly the same mass of protein-rich oil cakes left after extraction of oil (in most species accounts for only 20–25% of oilseed phytomass), and also with the by-products of ethanol (distillers grain) and dairy industries (whey), waste from fruit and vegetable canning (leaves, peels), and citrus rinds and pulp?

They would have to be incinerated, composted or simply left to rot if they were not converted to meat (or milk, eggs and aquacultured seafood). Not tapping these resources is also costly, particularly in the case of porcine omnivory that has been used for millennia as an efficient and rewarding way of organic garbage disposal. Unfortunately, in 2001, the EU regulations banned the use of pig swill for feeding, and Stuart (2009) estimated that this resulted in an economic loss of €15 billion a year even when not counting the costs of alternative food waste disposal from processors, restaurants and institutions. Moreover, the ban has increased CO₂ emissions as the swill must be replaced by cultivated feed.

At the same time, given the widespread environmental degradation caused by overgrazing, the pasture-based production should be curtailed in order to avoid further soil and plant cover degradation. Similarly, not all crop residues that could be digested by animals can be removed from fields, and some of those that can be have other competing uses or do not make excellent feed choices, and not all food processing residues can be converted to meat. This means that a realistic quantification of meat production potential based on phytomass that does not require any cultivation of feed crops on arable land cannot be done without assumptions regarding their final uses, and it also requires choices of average feed conversion ratios. As a result, all such calculations could be only rough approximations of likely global totals, and all of my assumptions (clearly spelled out) err on a conservative side.

Because most of the world’s grasslands are already degraded, I will assume that the pasture-based meat production in low-income countries of Asia, Africa and Latin
America should be reduced by as much as 25%, that there will be absolutely no further conversion of forests to grasslands throughout Latin America or in parts of Africa, and that (in order to minimize pasture degradation in arid regions and nitrogen losses from improved pastures in humid areas) grazing in affluent countries should be reduced by at least 10%. These measures would lower pasture-based global beef output to about 30 t/year and mutton and goat meat production to about 5 t.

Another way to calculate a minimum production derived from grasslands is to assume that as much as 25% of the total area (the most overgrazed pastures) should be taken out of production and that the remaining 2.5 ha would support only an equivalent of about half a livestock unit (roughly 250 g of cattle live weight) per hectare (for comparison, since 1998 the EU limits the grazing densities to 2 U/ha, Brazil’s grasslands typically support 1 U/ha and 0.5 U is common in sub-Saharan Africa). Assuming average annual 10% off-take rate and 0.6 conversion rate from live to carcass weight, global meat production from grazing would be close to 40 t/year, an excellent confirmation of the previous total derived by different means.

At the same time, all efforts should be made to feed available crop residues to the greatest extent possible. Where yields are low and where the cultivated land is prone to erosion, crop residues should be recycled in order to limit soil losses, retain soil moisture and enrich soil organic matter. But even with much reduced harvest ratios of modern cultivars (typically a unit of straw per unit of grain), high yields result in annual production of 4–8 of straw or corn stover per hectare, and a very large part of that phytomass could be safely removed from fields and used as ruminant feed. The annual production of crop residues (dominated by cereal straws) now amounts to roughly 3 Gt of dry phytomass.

Depending on crops, soils and climate, recycling should return 30–60% of all residues to soil, and not all of the remaining phytomass is available for feeding: crop residues are also used for animal bedding; for many poor rural families in low-income countries, they are the only inexpensive household fuel; and in many regions (in both rich and poor countries) farmers still prefer to burn cereal straw in the fields – this recycles mineral nutrients but it also generates air pollution. Moreover, while oat and barley straws and stalks and leaves of leguminous crops are fairly, or highly, palatable, ruminants should not be fed solely by wheat or rice straw; rice straw in particular is very
high in silica (often in excess of 10%), and its overall mineral content may be as high as 17%, more than twice that of alfalfa. As a result, the best use of cereal straws in feeding is to replace a large share (30–60%) of high-quality forages.

These forages should be cultivated preferably as leguminous cover crops (alfalfa, clovers, vetch) in order to enhance the soil’s reserves of organic matter and nitrogen. If only 10% of the world’s arable land (or about 130 ha) were planted annually with these forage crops (rotated with cereals and tubers), then even with a low yield of no more than 3 /ha of dry phytomass, there would be some 420 t of phytomass available for feeding, either as fresh cuttings or as silage or hay. Matching this phytomass with crop residues would be quite realistic as 420 t would be only about 15% of the global residual phytomass produced in 2010. Feeding 840 t of combined forage and residue phytomass would, even with a very conservative ratio of 20 g of dry matter/kg of meat (carcass weight), produce at least 40 t of ruminant meat.

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Unlike in the case of crop residues, most of the food processing residues are already used for feeding, and the following approximations quantify meat production based on their conversion. Grain milling residues (dominated by rice and wheat) added up to at least 270 t in 2010, and extraction of oil yielded about 310 t of oil cakes. However, most of the latter total was soybean cake whose output was so large because the crop is now grown in such quantity (about 260 t in 2010) primarily not to produce food (be it as whole grains, fermented products including soy sauce and bean curd, and cooking oil) but as a protein-rich feed.

When assuming that soybean output would match the production of the most popular oilseed grown for food (rapeseed, at about 60 t/year), the worldwide output of oil cakes would be about 160 t/year. After adding less important processing by-products (from sugar and tuber, and from vegetable and fruit canning and freezing industries), the total dry mass of highly nutritious residues would be about 450 t/year of which some 400 t would be available as animal feed. When splitting this mass between broilers and pigs, and when assuming feed : live weight conversion ratios at, respectively, 2 : 1 and 3 : 1
and carcass weights of 70% and 60% of live weight, feeding of all crop processing residues would yield about 70 t of chicken meat and 40 t of pork.

The grand total of meat production that would come from grazing practiced with greatly reduced pasture degradation (roughly 40 t of beef and small ruminant meat), from feeding forages and crop residues (40 t of ruminant meat) and from converting highly nutritious crop processing residues (70 t chicken meat and 40 t pork) would thus amount to about 190 t/year. This output would require no further conversions of forests to pastures, no arable land for growing feed crops, no additional applications of fertilizers and pesticides with all the ensuing environmental problems. And it would be equal to almost exactly two-thirds of some 290 t of meat produced in 2010 – but that production causes extensive overgrazing and pasture degradation, and it requires feeding of about 750 t of grain and almost 200 t of other feed crops cultivated on arable land predicated on large inputs of agrochemicals and energy.

And the gap between what I call rational production and the actual 2010 meat output could be narrowed. As I have used very conservative assumptions, every component of my broad estimate could be easily increased by 5% or even 10%. Specifically, this could be achieved by a combination of slightly higher planting of leguminous forages rotated with cereals, by treatment of straws with ammonia to increase its nutrition and palatability, by a slightly more efficient use of food processing by-products and also by elimination of some of the existing post-production meat waste. Consequently, the total of 200 t/year can be taken as an unassailably realistic total of global meat output that could be achieved without any further conversion of natural ecosystems to grazing land, with conservative pasture management, and without any direct feeding of grains (corn, sorghum, barley), tubers or vegetables, that is, without any direct competition with food produced on arable land.

This amounts to almost 70% of the actual meat output of about 290 t in the year 2010: it would not be difficult to adjust the existing system in the described ways, eliminate all cultivation of feed crops on arable land (save for the beneficial rotation with leguminous forages) and still average eating only a third less meat than we eat today.

A key question to ask then is how the annual total of some 200 t of meat would compare with what I would term a rational consumption of meat rather than with the existing
level. Making assumptions about rational levels of average per capita meat consumption is done best by considering actual meat intakes and their consequences. A slight majority of people in France, the country considered to be a paragon of classic meat-based cuisine, now eat no more than about 16 g of meat a year per capita, and the average in Japan, the nation with the longest life expectancy, is now about 28 g of meat (both rates are for edible weight). Consequently, I will round these two rates and take the per capita values of 15–30 g/year as the range of rational meat consumption. For seven billion people in 2012, this would translate to between 105 and 210 Mt/year – or, assuming 20/30/50 beef/pork/chicken shares, between 140 and 280 Mt in carcass weight. The latter total is almost equal to the actual global meat output in 2010, with the obvious difference being that the consumption of today’s output is very unevenly distributed.

If we could produce 200 t/year without any competition with food crops, then the next step is to inquire how much concentrate feed we would need to grow if we were to equal current output of roughly 300 t with the lowest possible environmental impact. Assuming that the additional 100 t meat a year would come from a combination of 10 t of beef fed from expanded cultivation of leguminous forages, 10 t of herbivorous fish (conversion ratio 1 : 1) and 80 t of chicken meat (conversion ratio 2 : 1), its output would require about 170 t of concentrate feed, that is, less than a fifth of all feed now produced on arable land. Moreover, a significant share of this feed could come from extensive (low-yield and hence low-impact) cultivation of corn and soybeans on currently idle farmland.

Roques et al. (2011) estimated that in 2007 there were 19–48 Mha of idle land (an equivalent of 1.3–3.3% of the world’s arable area), that is, land cultivated previously that can be planted again, most of it in North America and Asia. Using 20 ha of this land would produce at least an additional 60 t of feed. And when factoring in increasing crop yields, regular rotations with leguminous forages (producing excellent ruminant feed while reducing inputs of nitrogen fertilizers) and, eventually, slightly higher feed conversion efficiencies, it is realistic to expect that the share of the existing farmland used to grow feed crops could be reduced from the current share of about 33% to less than 10% of the total. Consequently, there is no doubt that we could match recent global meat output of about 300 t meat a year without overgrazing, with realistically estimated
feeding of residues and by-products, and with only a small claim on arable land, a combination that would greatly limit livestock’s environmental impact.

**Prospects for Change**

Many years ago, I decided not to speculate about the course and intensity of any truly long-term developments: all that is needed to show a near-complete futility of these efforts is to look back and see to what extent would have any forecast made in 1985 captured the realities of 2010 – and that would be looking just a single generation ahead, while forecasts looking half a century into the future are now quite common. Forecasting demand for meat – a commodity whose production depends on so many environmental, technical and economic variables and whose future level of consumption will be, as in the past, determined by a complex interaction of population and economic growth, disposable income, cultural preferences, social norms and health concerns – thus amounts to a guessing game with a fairly wide range of outcomes. But FAO’s latest long-range forecast gives just single global values (accurate to 1 t) not just for 2030 (374 t) but also for 2050 (455 t) and 2080 (524 t). Compared to 2010, the demand in 2030 would be nearly 30%, and in 2050 about 55% higher. When subdivided between developing and developed countries, the forecast has the latter group producing in 2080 only a third as much as the former. These estimates imply slow but continuing growth of average per capita meat consumption in affluent countries (more than 20% higher in 2080 than in 2007) and 70% higher per capita meat supply in the rest of the world.

Standard assumptions driving these kinds of forecasts are obvious: either a slow growth or stagnation and decline of affluent population accompanied by a slow increase of average incomes; continuing, albeit slowing, population growth in modernizing countries where progressing urbanization will create not only many new large cities but also megacities, conurbations with more than 20 or 30 million people, and boost average disposable incomes of billions of people; advancing technical improvements that will keep in check the relative cost of essential agricultural inputs (fertilizers, other agrochemicals, field machinery) and that will keep reducing environmental impacts; and all of this powered by a continuing supply of readily available fuels and electricity whose cost per unit of final demand will not depart dramatically from the long-term trend.
Standard assumptions also imply continuation and intensification of existing practices ranging from large-scale cultivation of feed crops on arable land (with all associated environmental burdens) to further worldwide diffusion of massive centralized animal feeding operations for pork and poultry. Undoubtedly, more measures will be taken to improve the lot of mammals and birds in CAFOs. Many of them will be given a bit more space, their feed will not contain some questionable ingredients, an increasing share of them will be dosed less with unnecessary antibiotics and their wastes will be better treated. Some of these changes will be driven by animal welfare considerations, others by public health concerns, new environmental regulations and basic economic realities; all of them will be incremental and uneven. And while they might be cumulatively important, it is unlikely that their aggregate positive impact will be greater than the additional negative impact created by substantial increases in the expected demand for meat: by 2030 or 2050, our carnivory could thus well exact an even higher environmental price than today.

I would strongly argue that there is absolutely no need for higher meat supply in any affluent economy, and I do not think that improved nutrition, better health and increased longevity in the rest of the world is predicated on nearly doubling meat supply in today’s developing countries. Global output of as little as 140 t/year (carcass weight) would guarantee minimum intakes compatible with good health, and production on the order of 200 t of meat a year could be achieved without claiming any additional grazing or arable land and with water and nutrient inputs no higher than those currently used for growing just food crops.

And it could also be done in a manner that would actually improve soil quality and diversify farming income. Moreover, an additional 100 t/year could be produced by using less than a fifth of the existing harvest of concentrate feeds, and it could come from less than a tenth of the farmland that is now under cultivation and that could be used to grow food crops. Even for a global population of eight billion, the output of 300 t/year would prorate to nearly 40 g of meat a year/capita, or well above 50 g a year for adults. This means that the average for the most frequent meat eaters, adolescent and adult men, could be 55 g/year, and the mean for women, children and people over 60 would be between 25 and 30 g/year, rates that are far above the minima needed for adequate nutrition and even above the optima correlated with desirable health
indicators (low obesity rates, low CVD mortality) and with record nationwide longevities.

Global inequalities of all kinds are not going to be eliminated in a generation or two, and hence a realistic goal is not any rapid converging toward an egalitarian consumption mean: that mean would require significant consumption cuts in some of the richest countries (halving today’s average per capita supply) and some substantial increases in the poorest ones (doubling today’s per capita availability). What is desirable and what should be pursued by all possible means is a gradual convergence toward that egalitarian mean combined with continuing efficiency improvements and with practical displacement of some meat consumption by environmentally less demanding animal foodstuffs.

Such a process would be benefiting everybody by improving health and life expectancies of both affluent and low-income populations and by reducing the environmental burdens of meat production. Although the two opposite consumption trends of this great transition have been evident during the past generation, a much less uneven distribution of meat supply could come about only as a result of complex adjustments that will take decades to unfold. In the absence of dietary taboos, average meat intakes can rise fast as disposable incomes go up; in contrast, food preferences are among the most inertial of all behavioral traits and (except as result of a sudden economic hardship) consumption cuts of a similar rapidity are much less likely.

At the same time, modern dietary transition has modified eating habits of most of the humanity in what have been, in historic terms, relative short spans of time, in some cases as brief as a single generation. These dietary changes have been just a part of the general post-WW II shift toward greater affluence, and the two generations of these (only mildly interrupted) gains have created a habit of powerful anticipations of further gains. That may not be the case during the coming two generations because several concatenated trends are creating a world that will be appreciably different from that whose apogee was reached during the last decade of the 20th century.

Aging of Western population and, in many cases, their absolute decline appear to be irreversible processes: fertilities have fallen too far to recover above the replacement level, marriage rates are falling, first births are being postponed while the cost of raising
a family in modern cities has risen considerably. By 2050, roughly two out of five Japanese, Spaniards and Germans will be above 60 years of age; even in China that share will be one-third (compared to just 12% in 2010!), and, together with many smaller countries, Germany, Japan and Russia will have millions (even tens of millions) fewer people than they have today.

We have yet to understand the complex impacts of these fundamental realities, but (judging by the German, Japanese and even Chinese experiences) continuing rise in meat demand will not be one of them. And while the American population will continue to grow, the country’s extraordinarily high rate of overweight and obesity, accompanied by a no less extraordinary waste of food, offer a perfect justification for greatly reduced meat consumption. Beef consumption is already in long-term decline, and the easiest way to achieve gradual lowering of America’s overall per capita meat intakes would not be by appealing to environmental consciousness (or by pointing out exaggerated threats to health) but by paying a price that more accurately reflects meat’s claim on energy, soils, water and the atmosphere.

Meat, of course, is not unique as we do not pay directly for the real cost of any foodstuff we consume or any form of energy that powers the modern civilizations or raw material that makes its complex infrastructures. Meat has become more affordable not only because of the rising productivity of the livestock sector but also because much less has been spent on other foodstuffs. This post-WW II spending shift has been pronounced even in the US where food was already abundant and relatively inexpensive: food expenditures took more than 40% of an average household’s disposable income in 1900; by 1950, the share was about 21%; it fell below 15% in 1966 and below 10% (9.9%) in the year 2000; in 2010, it was 9.4%, with just 5.5% spent on food consumed at home and 3.9% on food eaten away from home (USDA 2012b). The total expenditure was slightly less than spending on recreation and much less than spending on health care. At the same time, the share of overall food and drink spending received by farmers shrank from 14% in 1967 to 5% in 2007, while the share going to restaurants rose from 8% to 14%.

These trends cannot continue, and their arrest and a partial reversal should be a part of the affluent world’s broader return to rational spending after decades of living beyond its means. Unfortunately, such adjustments may not be gradual; while the FAO food
price index stayed fairly steady between 1990 and 2005, the post-2008 spike lifted it to more than double the 2002–2004 mean, and it led to renewed concerns about future food supply and about the chances of recurring, and even higher, price spikes. Increased food prices in affluent countries would undoubtedly reduce the overall meat consumption, but their effect on food security on low-income nations is much less clear. For decades, low international food prices were seen as a major reason for continuing insecurity of their food supply (making it impossible for small-scale farmers to compete), but that conclusion was swiftly reversed with the post-2007 rapid rise of commodity prices that came to be seen as a major factor pushing people into hunger and poverty (Swinnen and Squicciarini 2012).

In any case, it is most unlikely that food prices in populous nations of Asia and Africa will decline to levels now prevailing in the West: China’s share of food spending is still 25% of disposable income, and given the country’s chronic water shortages, declining availability of high-quality farmland and rising feed imports, it is certain that it will not be halved yet again by the 2030s as it was during the past generation. And the food production and supply situation in India, Indonesia, Pakistan, Nigeria or Ethiopia is far behind China’s achievements, and it will put even greater limits on the eventual rise in meat demand. In a rational world, consumers in the rich countries should be willing to pay more for a food in order to lower the environmental impacts of its production, especially when that higher cost and the resulting lower consumption would also improve agriculture’s long-term prospects and benefit the health of the affected population.

So far, modern societies have shown little inclination to follow such a course – but I think that during the coming decades, a combination of economic and environmental realities will hasten such rational changes. Short-term outlook for complex systems is usually more of the same, but (as in the past) unpredictable events (or events whose eventual occurrence is widely anticipated but whose timing is beyond our ken) will eventually lead to some relatively rapid changes. These realities make it impossible to predict the durability of specific trends, but I think that during the next two to four decades, the odds are more than even that many rational adjustments needed to moderate livestock’s environmental impact (changes ranging from higher meat prices and reduced meat intakes to steps leading to lower environmental impacts of livestock
production) will take place – if not by design, then by the force of changing circumstances.

Most nations in the West, as well as Japan, have already seen saturations of per capita meat consumption: inexorably, growth curves have entered the last, plateauing, stage and in some cases have gone beyond it, resulting in actual consumption declines. Most low-income countries are still at various points along the rapidly ascending phase of their consumption growth curves, but some are already approaching the upper bend. There is a high probability that by the middle of the 21st century, global meat production will cease to pose a steadily growing threat to the biosphere’s integrity.

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