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HUNGER AND THE EXTERNALITIES OF DIETARY PREFERENCES: DEMAND-SIDE CONSIDERATIONS OF THE CURRENT DIETARY PARADIGM

ANASTASIA PSEIRIDIS*
University of Central Greece

Abstract
World hunger and the latest increases in global food prices are mainly dealt with by measures aimed at boosting supply and allowing markets to function more effectively. Motivated by the persistence of world hunger, we do not intend to contribute to either theory or empirical analysis in economics; we rather aim to show that current research and policies are locked in a sort of scientific paradigm which takes as given our dietary preferences, which are in fact fundamental in creating resource shortages and thus are correlated with world hunger. We bring together current scientific knowledge on nutrition, economics, and environmental studies, to illustrate that our dietary pattern poses large negative externalities to the aims of hunger reduction and food security. It follows that measures to combat world hunger should also address the negative effects this pattern has on the cost and long-run availability of food. Thus more effort and resources should be expended by governments in re-shaping demand towards choices that minimize these negative externalities. An interesting finding is that combating hunger is neither geographically focused nor based on pecuniary contributions only; individuals not directly affected by hunger and food insecurity can make positive contributions through their everyday food choices. Following this, implications and challenges for research and policy are discussed.

JEL Classification: D62, D11, Q01, Q56, Q57
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**Corresponding address:* Anastasia Pseiridis, Assistant Professor, Department of Regional Economic Development, University of Central Greece, e-mail: pseiridis@ucg.gr

Introduction

Hunger is a global problem that represents a moral challenge to the "better-off". Governments, individuals, and a plethora of NGOs expend resources to combat it; however, despite motivation and resources, and despite increases in the global per capita production of food, hunger persists. During the last twenty years, our progress towards the elimination of hunger can be viewed as at best mediocre. After a fall until the mid 90s, the number of hungry people started rising towards 850 million, while the percentage of hungry people fell from 16% to 13% (see Table 1). One in seven people is going to sleep undernourished. Based on these data, it can be argued that the elimination of hunger seems to be a lost battle.

It is interesting to highlight some statements associated with the effort to reduce hunger. The first statement was made in November 1996, with 791.5 million hungry people (accounting for 14% of the world's population), when world leaders agreed to fight poverty, hunger, and malnutrition numbers at the World Food Summit in Rome[1]:

> "We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the *number* of undernourished people to half their present level no later than 2015." (emphasis added)

The second statement was made four years later, at the September 2000 Millennium Summit where 189 heads of states signed the Millennium Development Declaration. The resolution in Paragraph 19 aimed to

> "halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and *the proportion of people who suffer from hunger* and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water." (emphasis added)

One would expect that the shift of focus towards percentages rather than numbers would produce a less elusive goal. Nonetheless, ten years following the Summit, on May 11th 2010, the FAO launched an anti-hunger protest campaign entitled "1 billion hungry and I am mad as hell". With a world population of 6.8 billion, and a rate of population increase between 2000 and 2010 at 12.5% (World Bank Indicators data), there was a total of 925 million undernourished people in 2010 (about 13.5%).

The third statement is from the press release of the protest, where the FAO recognized that the Millennium Development Goal of halving (the percentage of) hunger by 2015 cannot be met at the current pace of hunger reduction and estimated that

1. 1996 World Food Summit http://www.fao.org/wfs/index_en.htm

> "global agricultural production needs to grow by 70 percent if the estimated 9 billion people that will inhabit the planet in 2050 are to be fed".

Indeed the percentage of undernourished people did not seem to be declining at the expected rate. According to the most recent available FAO data, the percentage of undernourishment fell from 14% in 1995-1997 to 13% in 2006-8, as shown in Table 1. According to the same source, the number of undernourished people has even increased compared to 1995-97.

Table 1. Undernourishment in the world

	1969-71	1979-81	1990-92	1995-97	2000-2	2006-8
Prevalence of undernourishment in total population (%)	26	21	16	14	14	13
Number of undernourished persons (millions)*	878 (3,706.6)	853 (4,453.8)	848.4 (5,363.4)	791.5 (5,779.6)	836.2 (6,178.5)	850.0 (6,652.5)

*Population (in millions) in parentheses.

Source of population data: US Bureau of the Census, last accessed 4 Jan 2012. http://www.npg.org/facts/world_pop_year.htm.

Source of undernourishment data: FAO Statistics Division, last accessed 4 Jan 2012. http://www.fao.org/economic/ess/ess-fs/en/

It is difficult to accept and explain the discrepancy between aims and achievement. In what follows we will outline the strategies used in the fight against hunger by international organizations (Section 2). We will then focus on a key economic variable, world food prices, and the tools used to combat hunger (Section 3). We will then consider the demand side of the food price equation, which is largely ignored by policy makers. To do this, we will synthesize contributions from different disciplines to show that there is so far enough dispersed knowledge to assign to the current western dietary paradigm the status of a good with negative externalities (Section 4). Sections 5, 6, and 7 outline the path for future research and implications for policy making. Section 8 summarizes.

2. What we do to fight hunger

Numerous international organizations and NGOs deal directly or indirectly with hunger. The UN, Unicef, Oxfam, and lately the Bill and Melinda Gates Foundation, are among the best known. These organizations provide both immediate relief and longer-term support for communities and nations in their fight against hunger. Immediate relief is provided, for example, in the form of energy-dense food and other foodstuffs which are procured by the organizations and administered during crises. Longer term

support is provided by projects aimed at increasing local food production and incomes, boosting the nutritive content of produce, and making local and international markets work more effectively (see Von Braun, 2008, for an account).

The rationale behind increasing local supply of foodstuffs is that local people will be able to consume their produce or barter or acquire income to spend on food. Of course, increasing local supply is not enough to provide adequate incomes; the markets should be accessible and freely functioning. Thus the rationale behind removing distortions in the functioning of national and international markets is that local producers will be able to sell their produce at fair market prices. Further, the proper functioning of markets will allow farmers and other producers to respond to market signals by producing more of the crops that yield high prices and less of the others, which will help increase incomes to be spent on food.

What all these measures share is a belief that people and communities suffering from hunger are key to positive change against hunger and poverty, as is most eloquently put by a the statement by Bill Gates: "Poor farmers are not a problem to be solved: they are the solution"[2].

Nevertheless, the hidden side of this belief is that it takes as given the economic behaviour of people who do not live in poverty and hunger. As will be argued in the next section, this implicit assumption may be flawed, or at least may not produce desirable results in the long run.

Further, even if the economic behaviour of wealthy people is not important, it does not make sense to focus on the supply side and the functioning of markets only. A strategy focusing on increasing supply alone will be effective only if it is possible to increase global supply at a rate high enough to dull the effects on prices of increasing demand. Per capita supply growth however is tempered by increasing population, limited supply of resources of the earth, the questionable success of genetically modified seeds, depletion and degradation of land and other natural resources, and global warming, all mainly anthropogenic. There is evidence to suggest that the falling food prices of the pre-2005 period might have been enjoyed at the expense of resources which are needed for the necessary future growth of supply (see below). In effect, the falling prices might have not been real (in terms of showing the full opportunity cost of resources used).

The above hold even if we complement policies aiming at increasing food supply with policies aiming at enhancing proper market functioning. Ensuring proper market functioning does not necessarily translate into incomes allowing adequate nutrition for low-income individuals (in other words, even if we manage to eradicate the numbers of people living on less than a dollar per day, could this dollar buy enough food?). Re-

2. http://www.gatesfoundation.org/agriculturaldevelopment/Pages/default.aspx. Last accessed 5 Jan 2012.

moving distortions in global markets might be able at best to restore prices to around their pre-crisis levels; nevertheless there were hundreds of millions of people not able to afford adequate nutrition even before the recent food price increases.

3. …and what we do not do

Obviously hunger is linked to poverty and both are directly linked to a multitude of economic, political, institutional and social factors. Leaving non-economic factors aside, world food prices are an important determinant of food consumption. Price increases affect food spending decisions of individual and institutional consumers in high-income and low-income countries alike. In low-income countries where the recommended daily calorie intake is barely met by the whole population, an increase in world crop prices brings an increase in the number and proportion of undernourished people. Indicatively, the world food price increases of 2007-8 coincided with a 25% increase in the number of undernourished people (from around 800 million to 1 billion)[3].

However, from 1974 to 2005 global food prices decreased by over 75% (UN 2008), but hunger reduction was modest during the same period. The co-existence of hunger with falling prices has led some to believe that hunger is primarily an "access" problem (i.e. of poor to food, which is and will be abundant, owing to technological improvements outstripping population increases). Improving access to food has been another core theme of the solution to hunger, as shown in the relevant policy literature.

Following this period of decline, prices rose fast and dramatically: real prices in 2008 were 65% higher than in 2004 (according to the FAO Annual Real Food price indices data). Following a short interval, real food prices were 91% higher in 2011 than in 2004. With these new phenomena came the re-evaluation of the roots of hunger: It is now starting to be acknowledged that tackling hunger can be no longer be seen as a problem of mainly facilitating access of hungry people to an available (and ever increasing) food supply; it is rather a more complex problem that entails climate, technology and human behavior factors that affect *both* supply and demand:

> "Behind the dramatic surge in food prices lie six major causes: the adverse weather for crops, steep rise in oil prices, speculation in foodstuffs, increasing use of grains to make biofuels, the strong growth of meat consumption and the prevailing inadequate agricultural policies around the world." (UN 2008).

3. In high-income countries, an increase in world crop prices may entail a relative increase in the personal and institutional consumption of less expensive foods (i.e. those yielding cheaper calories (in terms of the monetary price of one calorie), which are usually highly processed and bear large amounts of saturated fat, sugar, and sodium (salt). Those foods have low nutritive content and are associated with obesity which is a risk factor for an array of diseases.

It is fortunate that almost all of the factors (except perhaps occasional adverse climate conditions) that can explain the rise in food prices are mainly anthropogenic. Of the above six factors, four (except speculation and policies) can be seen as directly linked to behaviors of individuals, i.e. to their consumption pattern. Adverse weather for crops can be a manifestation of climate changes, which are largely anthropogenic and have started to be acknowledged as a factor affecting crop yields (WPF 2009) so much as to offset a large part of the increases attributable to technological improvements (Lobell and Field 2007, Lobell *et al.* 2011).

In general, factors affecting demand are by definition anthropogenic because demand is derived mainly from preferences; factors affecting supply are also mainly anthropogenic because, and to the extent that, climate conditions, agricultural infrastructure, and technology are linked to human behavior. Nevertheless it may be obvious that the world community has more, and more direct, control over demand than supply.

However, the demand side of the global food market has not yet attracted proper attention in terms of policies. Policies in place, in their entirety, still *take as given the current demand pattern and trends*. This, despite growing scientific literature implying that supply-side policies on their own may have limited effectiveness in solving the problem of calorie and nutrient intake for the global population. This literature we will present in the next section.

The above discussion can be summarized in two points. First, the part of the equation that is consistently missing from measures against hunger is the side of global demand for food, and, related to this, what is *defined* as (human) food. It is obvious that demand-side policies can act synergistically with supply-side ones; if global demand for food is stabilized or even curbed, this will automatically render existing supply-side measures more effective. Second, the above measures seem to leave uninvolved those who are *less* afflicted by food price crises. It is a shame that the FAO spends money to educate people in poor countries about practical ways to deal with increasing food prices (FAO 2008) while as we will argue below, the anonymous consumer of the more affluent economies, although instrumental in helping reverse the trend, is largely ignored by policy-makers and it is he/her who should be educated to make more prudent decisions.

4. Taking demand more seriously: a new class of goods with negative externalities

It has been estimated that the population capacity of the earth, assuming the European standard of living for all individuals *and* sustainable use of resources, can be no more than two billion people (Pimentel and Pimentel 2003a, Schade and Pimentel 2010, Pimentel *et al.* 2010). Therefore it is evident that even if we manage to slow down the increase in global population, the problem of adequately feeding the current and future populations will be a task that simply cannot be tackled by taking the current

consumption pattern of the rich countries as given. This is at odds with the still widely held perception that "there is enough food", see e.g. the UN Department's of Economic and Social Affairs (2008) News: "The current surge in commodity prices threatens millions with hunger though there is enough food for everyone"[4]. Is there enough food for everyone, or not? And at what price?

The answer depends largely on the relative resource requirements of what we define as food. Our food choices reveal what we define as food, i.e. they reveal our preferences. Global demand for various foods is mainly shaped by people's preferences and the size of the population. Data show that as incomes rise, demand for energy rises, as does demand for resource-intensive foods, such as meat and dairy. This demand is anthropogenic as it depends on individual preferences. Increased demand for foods of animal origin increases demand for feed crops, and sequentially for the resources (inputs) used to produce feed crops; prices of feed crops will increase, *ceteris paribus*; and as more people adopt a diet heavier in resource-intensive foods, an upward spiral is created continuously pushing food prices up. Thus demand for food, as individuals in developed countries define it now, creates negative externalities to the aim of hunger reduction. In this respect food, as we define it through the western "mainstream" diet is not sufficiently abundant for everybody.

If, instead, a larger portion of crops (e.g. corn, soy, sorghum, peas) were consumed directly by humans than indirectly (through animals from humans) the demand for feed crops would diminish considerably - which would create a considerable shift of demand for them and a downward tendency in global food prices. An economics 101 exercise on the production possibilities frontier can reveal that an hour's work could buy more food than before. In other words, the per capita food calories available for human consumption would be considerably increased were we to divert a larger part of feed crops to direct human consumption.

4. See also the FAO hunger website (http://www.fao.org/hunger/en/) FAQs: "How can hunger be reduced?" .
"The world currently produces enough food for everybody, but many people do not have access to it.
There is ample evidence that rapid progress to reduce hunger can be made by applying a twin-track strategy that tackles both the causes and the consequences of extreme poverty and hunger. Track one includes interventions to improve food availability and incomes of the poor by enhancing their productive activities. Track two features targeted programmes that give the most needy families direct and immediate access to food.
Simultaneously, a global food system needs better governance at national and international level. In food-insecure countries, institutions are needed based on the principles of the Right to Adequate Food. These should promote transparency and accountability, the empowerment of the poor and their participation in the decisions that affect them."

How considerable would this "considerable" change be? If we examine the potential economies to be made with changes in consumption habits, they are so vast that they cannot be ignored. It is well documented that the production of animal protein (through land and aquatic animals) is inefficient compared with the production of plant protein, directly in terms of land, energy, fertilizers and water expended for its production and also indirectly through the environmental degradation that it causes (Eshel and Martin, 2006; Pimentel and Pimentel, 2003b; Pimentel *et al.*, 2004; Steinfeld *et al.*, 2006; Leckie, 1999)[5].

The above findings are discussed extensively by UNEP (2010) researchers who acknowledge that "agriculture and food consumption are identified as one of the most important drivers of environmental pressures, especially habitat change, climate change, water use and toxic emissions" (p.13), and suggest that "a substantial reduction of [negative environmental] impacts would only be possible with a substantial worldwide diet change, away from animal products." (p. 82). UNEP's findings can be seen to complement Parry et al. (2009) who document and analyse the negative effects of climate change on world hunger.

It is interesting that diets with even modest levels of animal protein (dairy, meat, and fish) represent a large, unnecessary, and unsustainable waste of global resources; it has been calculated that even lacto-ovo-vegetarian diets (diets that exclude animal flesh but include milk, dairy, and eggs) are not sustainable in the long run (Pimentel and Pimentel 2003b). To understand why, we could look into available estimates of relative resource requirements - see among others, Pimentel et al (2004) and Hoekstra and Chapagain (2007). In this vein, the PROFETAS programme, aiming to develop meat alternatives with low energy, land, and other input requirements, has shown that the resource savings from the adoption of plant-based protein alternatives can be substantial, as summarized in Table 2.

Table 2. Resource requirements for the production of plant and animal protein

	Resource requirements[a]			
Type of output	**Land**	**Water**	**Nitrogen**	**Phospho-rus**
1 kg of digested protein from pig meat[b]	0.0240 ha	11,345 lt	17.9 kg	11.7 kg
1 kg of digested protein from peas[c]	0.0013 ha	185 lt	8.9 kg	6.9 kg

[a] Compiled from data in Aiking et al (2006), p. 28. Nitrogen and Phosphorus are net figures (input minus output).
[b] Crops expended: 22 kg of tapioca and 27 kg of soybeans.
[c] Crops expended: 6.5 kg of peas.

5. Current fishing levels also represent an enormous threat to some species, including those fed by the species we use for food, while fish farming has environmental drawbacks similar to those of intensive land animal farming, see Marine Conservation Society (2007).

The above table highlights the inefficiency associated with food choices. One kilogram of digested protein from peas requires only 5.4% of the land, 1.6% of the water, 50% of nitrogen, and 59% of phosphorus needed for the production of one kilogram of digested protein from pig meat.

Another index of the inefficiency in food production is the environmental footprint of a product or a lifestyle and the associated concept of biocapacity deficit. The most encompassing term is the "ecological footprint", coined by Rees (1992). It provides a measurement of human activities relative to the earth's capacity to regenerate its resources and absorb pollution (biocapacity). The scientific methodology has been developed by the nonprofit Global Footprint Network. It takes into account acreage needs for various activities (including housing, energy production, food production, and transport), water use and pollution, and atmospheric pollution of production and consumption. Lately it has been redefined to include biodiversity issues. A drawback is that it only takes into account CO_2 emissions leaving outside other greenhouse gases such as CFCs, and crucially methane (CO_4) and nitrous oxide (N_2O) which are produced in great quantities by animal farming. Even with these limitations, "environmental footprinting" reveals that the majority of developed countries need more than the available earth's resources to sustain their consumption pattern (Global Footprint Network 2011).

Another interesting facet of resource inefficiency is the water footprint. The methodology for calculating the water footprint of consumers, products, production processes, or entities (businesses, cities, regions) has been developed by the nonprofit *Water Footprint Network* at the University of Twente in the Netherlands. The water footprint of a product includes three forms of water use (freshwater, rainwater, and water used to dissolve pollutants into acceptable levels). It is more inclusive than the carbon footprint, as it takes into account the water footprint not only of the final product but also of water requirements of all inputs in the production chain. The water footprint differential of animal vs plant foods is substantial. Indicatively, the calculated water footprint for the production of a litre of soy milk (including packaging) is 72% lower than that of a litre of cow's milk. The water footprint of a 150 gram soyburger is 93% lower than that of a 150 gram beef burger (Ercin et al 2011). This is good news not only for local and global water authorities and water management organizations, but for consumers as well. If water embedded in our diet can be so dramatically reduced, then pressures on the water basins would be considerably eased, prices of foods would reflect the lower water prices, and the threat of future water scarcity would be reduced.

The above examples suggest considerable resource inefficiency of the production process associated with the mainstream food paradigm, in which resource-intensive foods have a prime position. But the inefficiency associated with our dietary paradigm is not exhausted in the production process. To this inefficiency we should add

the costs, in terms of resources expended, of health care (e.g. to fight obesity and diet-related diseases, which now prevail as early as in childhood, see e.g. Baker *et al.*, 2007; Ludwig, 2007). The resources used to treat, (or find new drugs and procedures for) obesity, diabetes, and cardiovascular disease could be dramatically reduced. For example, Esselstyn (2011) argues that the need for procedures and medication to treat cardiovascular disease can be *eliminated* by a low-fat, plant-based diet. Many other medical researchers and/or doctors suggest a plant-based diet for optimum health (Neil Barnard, Dean Ornish, John McDougall to name a few).

To the above cost we should add the costs of environmental protection and restoration, and the costs of development of technologies to prevent the harmful environmental effects of food production. If for example the diet paradigm shifted to a plant-based diet, the need to use resources (researchers, funds, etc.) to find new technologies for dealing with the waste created from animal feeding, cheese production, fish farming, and slaughterhouses could be almost totally eliminated[6].

Finally, apart from the inefficiencies associated with production and post-consumption treatment, there is a secondary adverse effect of rich countries' diets: i.e., apart from representing an unnecessary waste of resources, they seem to also serve as a *consumption paradigm* for both developing and developed countries. It is documented that as per capita incomes rise in developing countries, so does consumption of resource-intensive foods increase towards the levels of rich countries. The implications of this paradigm are more severe than the implications of the food choices of a certain group of people *today*. This is so because it creates a vicious never ending circle: as more people adopt the "mainstream-western" dietary paradigm, more resources are lost to inefficiency, and greater increases in supply are needed to counteract an increasing global population, the more difficult it is to produce food for the world population without endangering the environment and the resources that can be used by future generations.

We call the western dietary pattern a paradigm in the Kuhnian (1962) sense because, as current policies reveal, we are locked inside it and cannot see outside. There is the knowledge and the evidence to suggest the necessity for a dramatic shift of dietary habits but societies, individuals, research, and policies persistently cling to it. Here are two notable examples:

First, the French government adopted in 29 July 2010 a law requiring that schools should include specific number of portions of meat, dairy and other foods of animal origin in the menus provided to children (Le Figaro, 2010)[7]. Upon closer examination,

6. Indicatively, estimates for fecal production from farmed animals in the US range from 86,000 pounds per second (WorldWatch Institute 2003) up to 250,000 pounds per second (Robbins 1987; 2001). This is at least 130 times the US human population excrement.

7. Décret n° 2011-1227 du 30 septembre 2011 relatif à la qualité nutritionnelle des repas servis dans le cadre de la restauration scolaire. http://droit-medecine.over-blog.com/article-decret-2011-1227-qualite-nutritionnelle-des-repas-en-restauration-scolaire-85718796.html.

it is evident that the detailed specifications laid out by the law essentially ban the provision of plant-based foods on a frequency consistent with optimum health.

Second, in popular literature and the press the onus of the increase in animal protein demand is mainly attributed to developing countries, while individuals from developed countries have higher per capita consumption[8]. Consider, for example, that during the period 1961-2007 China and South Korea have increased their daily per capita consumption of protein from both animal and plant sources by 121% and 56%, respectively – nevertheless the actual per capita consumption of these countries in 2007 was 89 and 88 grams daily, i.e. well below that of the daily consumption in the US (114g), Canada (106g), the UK (105g), and Greece (119g)[9]. Seen in another way, during 1961-2007, the ratio of animal protein to total protein consumed has increased from 9% to 38% in China and from 12% to 18% in India, while in the US and Canada this ratio has been well over 60% since 1961.

It should be noted that the 2007 quantities of per capita protein consumption of the above mentioned countries are in excess of the safe level of protein intake from both animal *and* plant sources, which is 0.83g/kg of body weight (WHO 2007, USDA 2005). For example, a person with an optimal weight of 75 kilograms would need no more than 63g of protein daily to sustain optimum health.

Table 3 also reveals that this increase in protein consumption (unnecessary in many countries, in terms of health benefits) has not resulted from a balanced increase in both animal and plant-based protein. In most countries, the percentage increase in animal protein is larger than the percentage increase in plant protein. At the global level, protein consumption has increased by 26% within 1961-2007, while animal protein consumption has increased by 52% and plant protein consumption by only 13%. This bias towards animal protein is evidence of a large waste of resources used up through the current dietary paradigm which is followed by the majority of developed and developing countries.

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8. It is notable that in the US, a country among those with the highest per capita consumption of resource-intensive foods, the public is very slow to realise the negative consequences of their dietary habits, see e.g. Neff, 2008, who researched the lack of cognizance of the connection between food production and environmental degradation. This lack of cognizance is expanded upon by Oppenlander (2011).
9. Greece, a country which in the 1960s still ate the healthy Mediterranean diet (Trichopoulos and Lagiou, 2004), had the fourth largest per capita consumption of protein in 2007. The first three countries are Iceland, Israel, and Malta, with daily per capital consumption of 137, 126, and 121 grams, respectively. The ratio of animal to total protein consumption in Greece has increased from 33% to 59% during 1961-2007.

Table 3. Per capita consumption of protein in selected countries, 1961-2007 (in g/day)

Country	Per capita consumption of total (TP), animal (AP), plant protein (PP)									% change in total (TP), animal (AP), plant protein (PP)								
	1961			1992[a]			2007			1961-2007			1961-1991			1992-2007		
	TP	AP	PP[c]	TP	AP	PP	TP	AP	PP	ΔTP	ΔAP	ΔPP[c]	ΔTP	ΔAP	ΔPP	ΔTP	ΔAP	ΔPP
Croatia	–	–	–	61.64	31.03	30.61	80.11	42.47	37.64	–	–		–			30%	37%	23%
Bulgaria	91.45	23.39	68.06	91.12	39.06	52.06	75.62	35.89	39.73	-17%	**53%**	-42%	-0.4%	**67%**	-24%	-17%	-8%	-24%
Slovenia	–	–	–	77.45	39.53	37.92	101.33	57.26	44.07	–	–	–	–	–	–	31%	45%	16%
Serbia & Montenegro[b]	–	–	–	87.94	46.51	41.43	76.86	44.55	32.31	–	–	–	–	–	–	-13%	-4%	-22%
Bosnia-H	–	–	–	70.07	16.00	54.07	88.21	30.27	57.94	–	–	–	–	–	–	26%	89%	7%
FYROM	–	–	–	70.70	22.15	48.55	79.04	35.04	44.00	–	–	–	–	–	–	12%	58%	-9%
Albania	66.43	18.96	47.47	75.38	28.02	47.36	97.42	49.94	47.48	47%	**163%**	0.0%	13%	**48%**	-0.2%	29%	78%	0.3%
Romania	87.78	23.89	63.89	89.61	44.85	44.76	109.94	55.45	54.49	25%	**132%**	-15%	2.1%	**88%**	-30%	23%	24%	22%
Greece	83.72	27.45	56.27	112.32	57.21	55.11	119.10	64.19	54.91	42%	**134%**	-2.4%	34%	**108%**	-2.1%	6%	12%	-0.4%
Cyprus	66.73	20.96	45.77	92.25	52.93	39.32	97.14	59.78	37.36	46%	**185%**	-18%	38%	**153%**	-14%	5%	13%	-5%
Portugal	69.78	27.35	42.43	102.66	54.78	47.88	115.07	71.13	43.94	65%	**160%**	4%	47%	**100%**	13%	12%	30%	-8%
Italy	82.49	29.04	53.45	112.01	60.76	51.25	111.44	60.96	50.48	35%	**110%**	-6%	36%	**109%**	-4%	-0.5%	0%	-1.5%
US	95.26	63.02	32.24	108.98	69.17	39.81	113.61	73.09	40.52	19%	**16%**	26%	14%	**10%**	23%	4%	6%	1.8%
Canada	91.24	58.40	32.84	96.32	57.52	38.8	105.58	58.77	46.81	16%	**0.6%**	43%	6%	**-1.5%**	18%	10%	2.2%	21%
UK	91.51	53.90	37.61	92.68	53.15	39.53	104.50	59.58	44.92	14%	**11%**	19%	1%	**-1.4%**	5%	13%	12%	14%
Malaysia	47.17	14.12	33.05	66.74	36.66	30.08	77.95	39.03	38.92	65%	**176%**	18%	41%	**160%**	-9%	17%	6%	29%
South Korea (ROK)	56.85	5.79	51.06	76.17	27.02	49.15	88.41	40.34	48.07	56%	**597%**	-6%	34%	**367%**	-4%	16%	49%	-2%
China	40.29	3.61	36.68	66.14	15.63	50.51	88.89	33.91	54.98	121%	**839%**	50%	64%	**333%**	38%	34%	117%	9%
Japan	73.48	24.18	49.3	95.62	54.16	41.46	91.78	52.05	39.73	25%	**115%**	-19%	30%	**124%**	-16%	-4%	-4%	-4%
Saudi Arabia	45.91	8.11	37.8	80.79	30.21	50.58	88.06	34.35	53.71	92%	**324%**	42%	76%	**273%**	34%	9%	14%	6%
India	52.17	6.11	46.06	56.35	8.54	47.81	57.43	10.20	47.23	10%	**67%**	3%	8%	**40%**	4%	1.9%	19%	-1.2%
Global average (animal and plant protein)	61.39	19.62	41.77	70.48	25.09	45.39	77.12	29.81	47.31	26%	**52%**	13%	15%	**28%**	9%	9%	19%	4%

Notes:

[a] For countries with available data since 1961, the figure refers to 1991.

[b] The rate of increase is calculated within the 1992-2005 period.

[c] Plant Protein (PP) calculated as Total Protein (TP) minus Plant Protein (PP)

Source: compiled by authors. Data source: FaoStat data, http://faostat.fao.org/site/610/DesktopDefault.aspx?PageID=610, http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368, last accessed 19 March 2012.

To summarize the above analysis, depletion of the earth's natural resources and pollution of the soil, water, and atmosphere undermine future productive opportunities and are mainly an outcome of choices of individuals, businesses, and governments for which the full cost of economic activity on present and future generations and the environment is not taken into account. The full costs of economic activity leading to the production of what is considered by individual and institutional consumers as food are not reflected in the prices of goods. Eminent academics have long highlighted that we can no longer ignore the environmental costs of economic activity (Arrow *et al.* 1995, National Academy of Sciences and Royal Society of London, 1997). As we have explained above, a large body of knowledge informs us that choosing what to eat daily is an economic activity with the potential to harm both the environment and low-income communities. This means that consumer, producer, and government choices in at least the developed and developing countries have to be re-defined so that they accord to poorer communities the same rights. Ceteris paribus, if higher-income countries keep up their current consumption pattern, people in the poorer communities may wait indefinitely for their right to adequate nutrition to be actually fulfilled.

5. A new class of goods with negative externalities and a win-win scenario

What we know is that rising incomes raise consumption of animal protein, processed foods, transport, energy, and waste production. What we do in developed countries is to deal with CO_2 emissions, promote recycling, develop more sophisticated waste disposal systems, increase the use of renewable energy sources and make more prudent use of energy. It is time to deal with animal-derived food as well, because its impact on the environment, global food prices, growth rates, and even health, is substantial. The global academic community and developed countries' policy-makers should dedicate more resources to switching consumer demand away from resource-intensive foods, thus reversing the ongoing trend.

Indeed, it is not in anyone's genes to drink carbonated drinks as his/her income rises; nor to drive an inefficient gasoline-fed automobile; nor to dye grey hair; nor to eat white bread instead of whole-grain; nor to replace nuts and fruit with candy bars. Nor are we predestined to become less happy (Layard, 2005) as our incomes rise (but we do). Societies shape the way needs can be actually expressed and fulfilled. Our economies should co-operate to face the challenge of re-shaping consumption ideals so that we do the least possible harm to current and future populations and to the environment.

This is a cause that can be successfully pursued; countries are already co-operating or have a common strategy for other causes. There seems to be agreement that the increasing global demand for energy raises prices of oil and biofuels. Increasing demand for biofuels diverts land from food cultivation, thus raising the price of food.

It is clear that contraction or stabilization of demand for energy will help decrease fuel and crop prices: thus governments have set agendas with clear timelines towards this end. In the same manner, contraction or stabilization of demand for resource-intensive foods can have similar effects. It is time to set policy agendas with clear timelines to curb demand for resource-intensive foods, and channel funds away from measures aiming only at increasing supply and improving market functioning.

To re-shape consumption ideals we should re-shape individual preferences. Effective policies can be drawn based on contemporary theory of human choice (Gowdy 2008). Preferences can be targeted to substantially reduce demand for resource-intensive foods in general, i.e. meat, dairy, and fish, in both developed and developing countries. In practical terms, individuals in high-income countries can be educated on healthy ways to reduce animal protein consumption by substituting it with plant protein, which is less resource-intensive, such as beans, grains, pulses, nuts, and seeds. Given that vegetarian diets are acknowledged as acceptable diet choices (American Dietetic Association 2003, 2009; USDA 2005, USDA 2010), a minimal amount of animal protein can be set as a target with the rest coming from plant sources. This reduction in animal protein consumption in high-income countries will substantially ease the pressure on resources and grain prices and will allow individuals in poorer countries to increase the energy and nutrient intake that can be afforded on low incomes. This is a policy that clearly saves resources and makes individuals in rich and poor countries better off[10].

6. Shaping preferences by policies

At first sight, re-shaping preferences might sound intrusive to personal freedom of choice. However, governments have long been engaged in efforts to switch demand away from products or behaviors creating negative externalities. They have been doing this with smoking since the 80s. Smoking in the developed countries used to be a symbol of desirable traits (emancipation, virility, status, etc.); now it has been converted into a symbol of ignorance and disrespect for others in the eyes of most. Governments are also undertaking campaigns for energy conservation, for the consumption of more fruit and vegetables, for recycling, against alcoholism, for breast-feeding, against child abuse, for the use of condoms as protection from STDs, for population control, and in many other instances where a switch to different behaviors is socially desirable, i.e. serving the general good.

10. This is especially relevant to poor countries but also richer countries that undergo massive disposable income reductions, as is Greece at the moment. A well-planned switch to plant-based protein may reduce food budgets without compromising the nutritional value of the diet.

In the same vein, shifting dietary consumer preferences away from resource-intensive foods is of great service to the general good and it is time it was actively pursued by developed countries. There are numerous appeals to promote plant-based diets to individuals. Most of them rely on knowledge of simple facts related to the consequences of resource-intensive food production. Individuals will be motivated by a desire to help people in low-income countries; to protect the environment in general; to protect species (aquatic and land animals) living in habitats harmed by eutrofication, pollution, deforestation, and desertification; to save water; to enjoy health benefits; to reduce food budget costs; others will be motivated by the fact that a reduction in animal protein consumption will mean fewer aquatic and land animals will have to be slaughtered; other individuals could be motivated by the need to accord to all sentient beings their due moral value and include them in the moral community (see Francione 2009). Overall, motivation can be based on both moral and practical factors.

7. Facilitating the transition

Obviously some sectors may be hurt in the short term. These changes may reduce employment in some sectors. But this is always the case with changing preferences. Changing preferences away from energy-guzzling automobiles towards more efficient ones poses a threat to the producers of the former cars. Giving up smoking reduces demand for tobacco products. Increasing the number of days that people use public transport or cycle to work reduces demand for gasoline. Eating more fruit and vegetables reduces demand for snacks and candy. Breast-feeding reduces demand for infant formula and feeding devices. Recycling aluminum cans reduces demand for bauxite. But at the same time other sectors will benefit, with demand and employment in other sectors increasing, and society as a whole will benefit from theses changes in preferences. Given sufficient time and resources to adapt, the consequences to producers and employees can be minimal. Employees can earn similar incomes in different sectors. Businesses can also make similar profits in different sectors or different products.

In practical terms, it is time to take immediate action and set specific targets with a clear timeline. Thus the challenges for policy makers are to find ways to simultaneously implement three groups of measures in order to shift preferences away from resource-guzzling foods and increase consumption of "resource-wise" foods.

1. **Shift preferences towards a purely or mainly plant-based diet.** This can be done with an aggressive educational and marketing campaign, clarifying the pros and cons of this choice, e.g. health, environment, ethical considerations for people with low incomes, ethical considerations for non-human animals. This campaign should also emphasize practical ways to replace meat, dairy, eggs, and fish with healthy plant-based equivalents. With time, high personal consumption of animal products may turn out to symbolize ignorance and disrespect for other human beings, and low economic and social status.

2. **Allow prices of final food products to reflect more accurately the differentials in intensity of resource use and environmental damage.** This can be done by (a) taxing end food products according to their relative inefficiency in the use of resources (e.g. those with high water, land, CO_2 and overall environmental footprint) and/or (b) subsidizing consumption of plant-based final food products.
3. **Ease the transition of businesses and employees.** Existing producers and employees in supply chains of animal-based final food products should be facilitated to enter into the supply chains of plant-based final food products, e.g. dairy cheese/yoghurt makers to switch into manufacturing of non-dairy alternatives. Also, new or existing businesses involved in the production of plant-based final food products should be supported.

The first two groups of measures will help increase consumption of resource-wise foods. The third group of measures will facilitate increases in the supply of resource-wise foods, by making the transition as smooth as possible for both businesses and employees with the least impact on incomes and profits. The latter group of measures will also provide opportunities for businesses to actively embrace societal and environmental aims in their corporate responsibility agenda.

There are also challenges for the academic community. Here are some areas that would benefit from future research:

- the relative resource efficiency and the relative nutritional efficiency of "similar" products (e.g. animal-based vs plant based burgers)
- environmental footprinting of animal-based vs plant-based diets
- footprint-based food labeling standards and footprint-based taxing schemes
- food product re-engineering (e.g. of burgers) to substitute animal inputs with plant-based inputs to achieve a targeted (enhanced) nutritional profile

Box: simple ideas for policy makers, businesses, and marketers

- Introduce compulsory requirement for (approximate) water, land, and CO_2 footprint per 1000gr of product on food package labeling.
- Subsidize production and consumption of nut milks, nut and grain-based cheese alternatives, and plant-based burgers (i.e. made of legumes, beans, nuts, seeds, and herbs).
- Substitute dairy milk and cheese with nut milks and plant-based cheese alternatives in mass-catering establishments, such as schools, prisons, army camps, hospitals, company cafeterias, and in all publicly-funded institutions.
- Substitute animal-derived burgers and steaks with plant-based burgers in mass-catering establishments, such as schools, prisons, army camps, hospitals, company cafeterias, and in all publicly-funded institutions.

8. Summary and Conclusion

Currently, the focus of policies aimed at combating hunger and poverty are: (a) the person or community living in hunger, (b) ways to achieve an increase in the supply of food locally and globally, and (c) proper functioning of markets. The demand side is largely ignored. This paper combines multi-disciplinary evidence that the current dietary pattern of wealthy countries is unsustainable, both in terms of economic efficiency and in terms of environmental impact. We go on to suggest that (a) demand-side policies can be more efficient in the long-term than current anti-hunger policies and (b) individuals in wealthy countries can be instrumental in helping combat hunger through their food choices. We thus suggest that policies to divert consumption away from resource-intensive foods will have positive effects on hunger reduction, and will at the same time have beneficial effects on public health and the environment.

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Appendix

The "1 billion hungry" protest gained support from international organizations and persons such as the US Olympic athlete Carl Lewis and British actor Jeremy Irons. Almost 3.4 million people had signed the petition by July 2nd, 2011 (a global ratio of about 1 in 2,000 people). As of Jan 4th, 2012, the signatures were still not more than 3.4 million, which gives a ratio of 235 hungry people to each signature[11]. As shown in Table 2 (see Appendix), with the exception of Italy, the G8 countries had a participation rate of less than 1 signature per 2,000 people.

These figures show that we do not seem to be "mad as hell". There are numerous examples of different causes gaining relatively larger participation for causes of lesser importance. In the UK, the Anti Road Charge petition in 2007 was signed by 1,811,424 people (i.e. 3% of the UK population). Currently in the US 102,930 people (52,827 by July 5th, 2011) have signed a petition demanding international attention and intervention for imprisoned women and children in Afghanistan[12], which gives a better (lower) ratio of sufferers to each signature. We might actually care about hunger, we might not. What is argued in this paper is that there are far more effective ways to act than collecting signatures.

11. http://www.1billionhungry.org/
12. http://www.thepetitionsite.com/9/tell-president-obama-imprisoned-afghan-women-deserve-due-process-according-to-international-rule-of/ accessed 5 July 2011 and 4 January 2012.

Table A1. Signatures collected at the www.1billionhungry.org website until January 2, 2012

				Prevalence of undernourishment in total population (%)[i]			
Country	Signatures[ii]	Population[iii]	Response rate, per 1,000 of population	1990-1992	1995-1997	2000-2002	2005-2007
Algeria	172 751	34 586 184	4.99	—	5	5	—
Thailand	248 946	67 089 500	3.71	26	18	18	16
Congo	13 590	4 125 916	3.29	26	55	70	69
Italy	78 333	58 090 681	1.35	—	—	—	—
Brasil	246 824	201 103 330	1.23	11	10	9	6
Turkey	20 966	77 804 122	0.27	—	—	—	—
Sweden	2 360	9 074 055	0.26	—	—	—	—
France	13 890	64 768 389	0.21	—	—	—	—
Canada	5 758	33 759 742	0.17	—	—	—	—
India	156 436	1 173 108 018	0.13	20	17	19	21
Netherlands	2 373	16 783 092	0.14	—	—	—	—
UK	6 778	62 348 447	0.11	—	—	—	—
US	21 644	310 232 863	0.07	—	—	—	—
Germany	5 389	82 282 988	0.07	—	—	—	—
Japan	6 435	126 804 433	0.05	—	—	—	—
China	16 417	1 330 141 295	0.01	18	12	10	10
Russia	1 849	139 390 205	0.01	—	—	—	—
Croatia	1 797	4 486 881	0.40	—	—	—	—
Montenegro	209	666 730	0.31	—	—	—	—
Bulgaria	1 105	7 148 785	0.15	—	—	—	—
Slovenia	295	2 003 136	0.15	—	—	—	—
Greece	1 521	10 749 943	0.14	—	—	—	—
Serbia	958	7 344 847	0.13	—	—	—	—
Bosnia-H	470	4 621 598	0.10	—	—	—	—
FYROM	162	2 072 086	0.08	—	—	—	—
Albania	176	2 986 952	0.06	—	—	—	—
Romania	1 357	21 959 278	0.06	—	—	—	—

[i] Undernourishment prevalence data from FAO Statistics Division.

[ii] Numbers manually collected by author from Global Activity Map provided at www.1billionhungry.org/impact.

[iii] Estimates for 2010, CIA World Factbook.

Table A2. Prevalence of undernourishment (% of population) by country group 1969-71 – 2006-8.

Country groups	1969-71	1979-81	1990-1992	1995-1997	2000-2	2006-8
WORLD	26	21	16	14	14	13
Developed countries			—	—	—	—
Developing regions			20	17	17	15
Least developed countries			39	41	35	33
Asia			20	16	16	15
Latin America and the Caribbean			12	11	10	8
Africa			26	26	24	23
Oceania			12	11	13	12

Source of undernourishment data: FAO Statistics Division, last accessed 4 Jan 2012. http://www.fao.org/economic/ess/ess-fs/en/

Table A3. Number of undernourished persons (millions) by country group 1969-71 – 2006-8.

	1969-71	1979-81	1990-2	1995-7	2000-2	2006-8
WORLD *	878 (3,706.6)	853 (4,453.8)	848.4 (5,363.4)	791.5 (5,779.6)	836.2 (6,178.5)	850.0 (6,652.5)
Developed countries			15.3	17.5	15.4	10.6
Developing regions			833.2	774.0	820.8	839.4
Least developed countries			211.2	249.4	244.7	263.8
Asia			607.1	526.2	565.7	567.8
Latin America and the Caribbean			54.4	53.4	50.8	47.0
Africa			170.9	193.6	203.3	223.6
Oceania			0.7	0.8	1.0	1.0

* Population (in millions) in parentheses.

Source of population data: US Bureau of the Census http://www.npg.org/facts/world_pop_year.htm. Last accessed 04 Jan 2012.

Source of undernourishment data: FAO Statistics Division, last accessed 4 Jan 2012. http://www.fao.org/economic/ess/ess-fs/en/