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Who needs a greener revolution?

Achieving food security for the future pits production increase against growth control

Valentí Rull

How do we feed the nine billion people who are projected to inhabit the Earth by 2050? The issue is one of serious concern (Ash *et al*, 2010; Butler, 2010), as an increase in food production of up to 40% will be needed to cope with the growing population. In response, many scientists, politicians and economists have proposed a second 'green revolution'. Their call references the first green revolution of the mid-twentieth century, which allowed many developing countries to drastically increase their food production. According to proponents of a new 'global greener revolution' (GGR), it will require an extensive transformation of agriculture to increase production and improve quality in an equitable and sustainable manner without compromising the environment (Godfray *et al*, 2010). Science and technology will be fundamental to achieving the goals of enhancing crop efficiency and food quality, as well as developing new protein sources (Beddington, 2010).

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At a glance, such a philanthropic proposal might seem the right thing to do, but further analysis reveals that a GGR is not as charitable as it first appears; in fact, it could lead to undesired and even disastrous consequences. This essay is therefore intended as a warning to scientists to think critically before signing up to a GRR: consider carefully the political, social and economic forces that would benefit from such a revolution and the potential long-term consequences for the environment and mankind.

In an article for the *Philosophical Transactions of the Royal Society*, Sir John Beddington, the UK Government's chief scientific adviser and professor of applied population biology at Imperial College London, lists the four main challenges for humanity in the twenty-first century as follows: to feed nine billion people in a sustainable way; to cope with increasing demands for clean water; to generate more energy; and to do all of this while mitigating and adapting to climate change (Beddington, 2010). Science will play a crucial role in this endeavour, provided the necessary investments are being made.

The kinds of advances in science that the world requires are far reaching and various. Plant science will need to improve existing crops by breeding or genetic modification to increase photosynthetic efficiency, reduce the need for fertilizers, and develop new methods of pest, disease and weed control. Agricultural science and farmers need to develop sustainable livestock farming that reduces the emission of greenhouse gases, notably methane. Fisheries and aquaculture—high priorities for future food security—will require scientific knowledge and technological innovations to avoid over-fishing, to increase productivity and to deal with climate change and ocean acidification. Engineers will need to develop tools such as global positioning system-based fertilizing or watering systems and remote sensors to optimize the use of resources in agriculture. Nanotechnologies, genomics and electronics can be useful for improving disease diagnostics, the delivery of pesticides, fertilizers and water, or for monitoring and managing soil quality. Finally, science will also play a role in changing our diet to reduce the consumption of meat and dairy products and to develop alternative protein sources (The Royal Society, 2009; Beddington, 2010; Godfray *et al*, 2010).

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Together, these goals aim to achieve so-called sustainable intensification: producing more food from a given area while reducing the environmental impact (Godfray *et al*, 2010). This is a considerable challenge, resting on the hope that 'greener' innovations—mostly based on molecular biology and genetic manipulations of plants and farm animals—will be environmentally safer, although this is not a straightforward path in many cases.

Scale matters in this endeavour, in terms of both space and time. Concerning space, the amount of land and sea surface needed to produce food for nine billion people will obviously be much larger than at present, any scientific progress notwithstanding. As such, given time, the whole planet could turn into one giant farm for producing food and biofuels, with little or no wilderness left. For defenders of the ownership approach (Bruce, 2008), for whom the Earth is ours to be exploited at our convenience, this vision might not be disturbing; nevertheless, the consequences would be catastrophic, not least because this approach gives no consideration to a sustainable future beyond this century. It is important to bear in mind that the GGR is

proposed as a means to cope with human population growth during the next 40 years only. This might seem a long-term view from today's perspective (Godfray *et al*, 2010), but it barely considers even the next two generations. A true long-term view needs to embrace a far more extended timeframe and consider our great-grandchildren and the world they might live in.

If a GGR were a resounding success, most humans living beyond 2050 would be fed and healthy, but they would inherit a planetary farm with little wilderness and biodiversity. This, together with the possibility of notably extending life expectancy (Lucke *et al*, 2010) and the conviction that the next GGR will be always possible—as it has been in the past—will probably exacerbate population growth rates and the demand for another even-greener revolution. In fact, the human population could reach around 14 billion people by 2100 at current growth rates (FAO, 2006) and the number might be even higher if the proposed GGR succeeds.

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As the Earth's carrying capacity is finite (Hueting, 2010; Pelletier, 2010), a GGR would lead to vanishing wilderness, resource exhaustion and, eventually, societal collapse. According to the latest estimates, we are already beyond the Earth's carrying capacity and we would need around 1.2 Earths to support just the current population growth rate (WWF, 2008). In addition to resource exhaustion, another substantial problem of continued growth is the management of the waste generated by humankind, which at present is estimated to be around 30–40% of the food produced (Godfray *et al*, 2010). This mountain of refuse is likely to increase by orders of magnitude in the coming decades (Pelletier, 2010). Therefore, a GGR might be useful, at best, to cope with the near-term requirements of hungry humanity—the next two generations or so—but it is unsustainable in the medium to long term. Still, some solution is needed, as current and prognosticated starvation is ethically unacceptable and might lead to social conflict and war.

In this context, the issue of equity or intra-generational social justice—despite the fact that it is mentioned as a premise in almost all proposals on food security—is rarely addressed. Almost everyone agrees that wealth and health should be equitably distributed throughout the world, but there are no firm proposals on how to achieve this goal and little progress has been made. It is a political problem that requires a political solution, but international organizations—notably the United Nations (UN) and its subordinate bodies—have not been able to tackle it, and there is little hope that they will in the current political climate.

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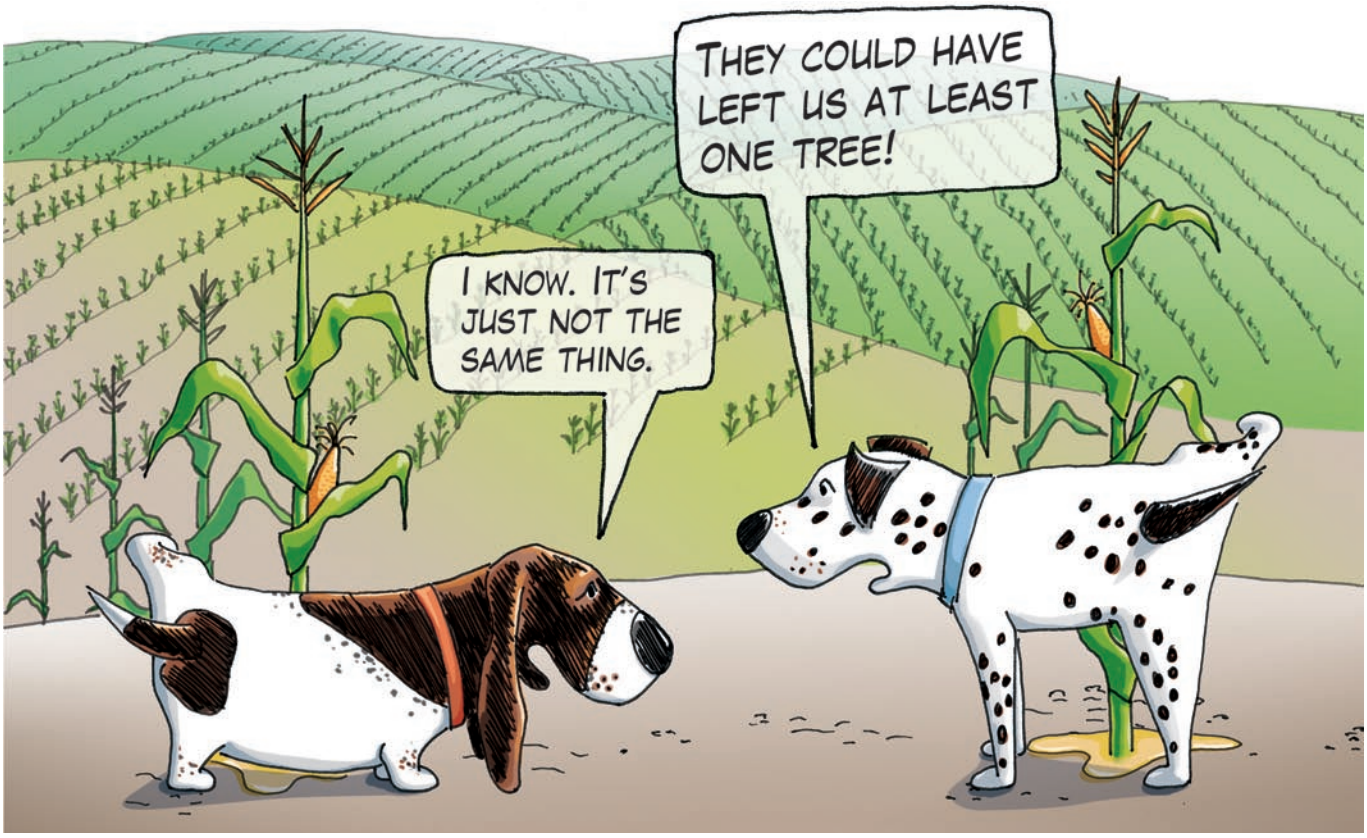
The inequality prevalent in the world serves the economic interest of the richest nations through the near-ubiquitous capitalist model, which equates development with increasing wealth, measured as the gross domestic product (GDP) of a country. Increasing globalization—with the recent demise of the socialist model—has promoted the export of the capitalist model to almost every country. As a result, and through the influence of organizations such as the World Trade Organization, the International Monetary Fund and the World Bank, capitalism has become the dominant economic model. Other issues such as international law, international security, economic development, social progress and human rights are subject to the political and economic interests of the richest economies. Social and environmental policies remain subordinate to capitalist concerns at both the local and regional scale (Pelletier, 2010). The inequality thus created is the cause of starvation and malnutrition in developing countries. Before 2005, more than 850 million people were undernourished. This number then increased by 75 million in only 2 years, owing mainly to the rise of wheat and maize prices for market reasons (Beddington, 2010). Today, hunger is not only a problem of overpopulation, but to a great extent, also of intra-generational injustice. This means that fighting starvation is a matter not only of growing more food, but also of creating social equity, which requires economic and political action.

Future population growth and the corresponding demand for more food therefore support the current capitalistic model, which is based on economic growth and unequal wealth distribution. A GGR would be subject to this growth model; in other words, capitalism, not humanity, needs a GGR. Scientists should be aware of this and consider whether a GGR is really the best option from both a professional and personal point of view, as science should serve humanity and Earth, not any particular social, religious, ideological, political or economic system (Rull, 2010).

Those who prefer a more sustainable path for future development might consider demand reduction—an option to avoid future food scarcity that is rarely considered (Westing, 2010). For their part, economists and politicians should also develop and implement alternative economic models that aim for a sustainable future for both humans and nature. The alternative—trying to reconcile economic growth, social justice and environmental safety—is akin to putting a square peg into a round hole (Lawn, 2010). In his 2008 book, *The Bridge at the Edge of the World*, the environmental advocate James Speth laments that modern capitalism is already out of control and that "growth is the enemy of environment. Economy and environment remain in collision" (Speth, 2009).

Humanity has […] organized itself in such a way that different nations, ideologies, races, social classes and so on, compete with each as though they were 'cultural species'

There are alternative economic models that recognize ecological limits to human development and emphasize social equity. The first of these proposes a steady-state economy: one that has stopped growing in terms of GDP, but continues to improve quality of life and is maintained by an ecologically sustainable rate of resource throughput and a constant human population (Kerschner, 2010; Lawn, 2010). The second is a sustainable de-growth model that



has been defined as "an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global level, in the short and long term" (Schneider *et al*, 2010). The paradigm is that human progress without economic growth is possible; it has been shown repeatedly that GDP per capita does not correlate with overall happiness above a certain level of satisfying people's basic needs (Layard, 2010). According to these proposals, rich nations would need to start the transition to a steady-state economy through the reduction of GDP or de-growth within the next 5 years, and poor nations could take 20–40 years to make the transition in order to ensure a sustainable future. As many poor nations have the highest population growth rates, a first step should be to implement suitable controls to stabilize their populations with support from rich countries.

The defenders of de-growth emphasize that this process is not the same as recession or depression—there should be no social or quality of life deterioration—nor does it promote a return to a fictitious pre-industrial pastoral past. GDP reduction

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involves mainly components that require large-scale, resource-intensive production and socio-political and lifestyle changes (Schneider *et al*, 2010). Steady-state and de-growth models are based on the principle of ecological economics, which emphasizes the importance of the interactions between the environment and the economy, and of biophysical laws and constrains to human development (Costanza *et al*, 1997; Victor, 2010). Ecological economics is based on simple premises: the laws of thermodynamics, which state that the amount of energy in a closed system is constant and that any transformation degrades usable energy into entropy. All economic activities therefore deplete the available stock of usable energy and produce entropic waste; a closed system such as the Earth has a limited capacity to supply energy and material resources and to absorb the associated entropic waste (Pelletier, 2010).

Among the different meanings of sustainability, ecological economics defends a so-called strong sustainability (Munda, 1997). This is in contrast to weak sustainability, which assumes an abundance of natural resources and that technological progress can increase the productivity of natural capital faster than it is being depleted. Weak sustainability could be considered a moderate version of the planetary ownership view (Bruce, 2008). By contrast, strong sustainability argues that natural capital—which provides raw materials for production and consumption, assimilates the resulting waste products, and provides amenity services and basic life-support functions on which human life depends—is largely non-substitutable (Neumayer, 2003; Dietz & Neumayer, 2007). The idea behind strong sustainability is to strike a balance between nature intervention and conservation—that is, the stewardship approach described by Bruce (2008). Despite its concern for nature, the idea of strong sustainability is still anthropocentric, as the primary objective is human survival and welfare. Therefore, strong sustainability could be viewed simply as a wiser form of planetary ownership than weak sustainability.

Although steady-state and de-growth are interesting and promising proposals to meet the problem of food security, there are some concerns; namely, the considerable changes required of socio-political organizations and lifestyles, the adherence to an intrinsically anthropocentric concept of sustainability, and the lack of a consolidated programme to realize these ideas.

Indeed, affluent democratic societies might be highly resistant to the necessary changes in lifestyle and consumption. A reduction of material living standards and consumption in industrialized countries would probably cause feelings of loss (Matthey, 2010). Few politicians or political parties with aspirations to government would be willing to defend such an unpopular proposal. Another obstacle in Western democratic systems is the short duration of each government, which is usually 4–5 years. Most governments are therefore reluctant to address problems that require large-scale, long-term changes. The problem is even more serious given that international organizations such as the UN, which were created specifically to meet such global challenges, remain subject to political and economic interests of the richer countries and therefore powerless to implement changes in such nations. Some have therefore proposed the creation of a new World Environmental Organization with the teeth and authority to legislate and enforce compliance (Pelletier, 2010).

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The problem of acceptance might be even worse in developing nations. The promise of capitalism has created expectations of wealth and consumption in these countries that people would be asked to renounce even before they had had a chance to enjoy them. Thus, population control is not sufficient, as most humans also need more food, better health and better living conditions. To mitigate this problem it has been proposed that developed countries should switch to a steady-state economy now, thereby leaving space for growth in the developing nations as a sign of intra-generational social justice (Kerschner, 2010). Of course, such economic growth should include effective population control in order to increment per capita income and to increase social and individual well-being. To make such growth sustainable, it would still require a GGR to increase food production and reduce the degradation of nature.

Worldwide social justice is a complex issue that is beyond the scope of this article, but some ideas are pertinent in this context. Perhaps our lack of a species consciousness is a main obstacle to attaining goals such as intra-generational justice, the eradication of hunger, sustainable development and nature conservation—all of which are apparently desired by most people. Humanity has won its battles against its competitors—other violent, omnivorous species—but has organized itself in such a way that different nations, ideologies, races, social classes and so on, compete with each as though they were 'cultural species'. In this context, capitalism is a successful strategy with strong selective value to increase evolutionary fitness. Some anthropologists believe that we are not yet humans, as we are still too attached to ancestral primate values such as selfishness, territoriality and violence (Carbonell & Sala, 2001). According to the same authors, the necessary species consciousness will emerge from altruism and the socialization of knowledge (Carbonell, 2007). Apart from the manifest ownership attitude of these anthropologists—whose ultimate aim is to replace the natural order with human organization of Earth—their concept of a global human species consciousness and how to attain it could be interesting for its use as a tool to address sustainable development under ecological economics principles.

The formulation of ideas to achieve steady-state and de-growth economies is still in progress, but some clues to a solution can already be seen. For example, Lawn (2010) offers some macroeconomic considerations on how governments can regulate the private sector to facilitate the transition to a steady-state economy. Another interesting proposal is to reduce the dependence on markets and to develop alternative political and economic infrastructures with different values (Latouche, 2010). Steady-state and de-growth proposals are encouraging manifestations of the interest of certain economic sectors to develop credible and viable alternatives to uncontrolled growth, but more options are needed with special emphasis on reducing or avoiding anthropocentrism, and limiting or eliminating the prevalence of the market economy (Rull, 2010). Economic crises such as the present one are excellent opportunities for questioning the dominant capitalist model (Schneider *et al*, 2010; Johns, 2010). Now is the time for economic creativity and political will.

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In the context of GGR, scientific research and technological development are parts of the so-called sustainable intensification to produce more food. In the steady-state or de-growth models, science and technology are tools to reduce the land needed to produce a given amount of food. The key is the big picture; molecular research focused on food improvement is justified, but its contribution to either development model depends—as do most, if not all, scientific contributions—on social and political interests. In this regard, the scientific and technological developments proposed in the context of a GGR, such as crop improvement and protection, sustainable livestock farming, fishing and aquaculture improvement, mechanization, engineering, nanotechnology and diet changes, should be encouraged anyway, as these can contribute greatly to more efficient and hopefully safer food production practices in the future.

In summary, while global capitalism needs a GGR to continue along its unsustainable path, there are alternative models of human development that accept and address the biophysical constraints on economic and population growth on Earth. Some steady-state and de-growth alternatives have been proposed, based on the emerging discipline of ecological economics, but these would require a political and societal revolution, and a reassessment of the role of the market economy and true nature conservation. However, the basic principles of ecological economics seem potentially useful if we are to avoid a succession of GGRs that exhaust the Earth's resources. The acceptance of those principles could represent a first step towards a better world.

It is beyond all doubt that scientists defending a GGR have good intentions. But this should be done in a different scenario than the utopia of unlimited growth. Otherwise, politicians, stakeholders and the public in general might get a wrong idea of what is considered right from a scientific point of view and, what is worse, they might lose confidence in science and its practitioners.

CONFLICT OF INTEREST
The author declares that he has no conflict of interest.

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