Beyond productivism versus agroecology: lessons for sustainable food systems from Lovins’ soft path energy policies

Navin Ramankutty and Hadi Dowlatabadi

1 The Institute for Resources, Environment and Sustainability, University of British Columbia, Vancouver, BC, Canada
2 School of Public Policy and Global Affairs, University of British Columbia, Vancouver, BC, Canada

E-mail: navin.ramankutty@ubc.ca

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Half a century ago, the world faced a seemingly insurmountable energy crisis. Demand for energy was rising in lockstep with economic growth. Supply was predominantly from exhaustible resources (oil) bound to rise in price through time. And nuclear power, once thought too cheap to meter, was too costly to build and dreaded by the public.

Today, we face a similar challenge in agriculture. Demand for food and other agricultural products is rising with population and economic growth. This growing demand is met by supply that is encroaching on the last remaining fertile lands (causing tropical deforestation) and using high inputs of water, nutrients and pesticides (depleting freshwater resources and polluting the environment) (Tilman et al 2001). And genetically modified food, a technological breakthrough, is dreaded by a large section of the public.

In 1976, Amory Lovins proposed a ‘soft path’ for meeting the energy crisis (Lovins 1976), as a radical alternative to the business-as-usual ‘hard path’ solution of meeting rising energy demand through reliance on ‘rapid expansion of centralized high technologies to increase supplies of energy’. Lovins’ approach differentiated between energy and energy services. We need energy services, which are the end benefits of energy use such as cooling, lighting, and hot water. Their consumption depends on how effectively we utilize the service and how efficiently we convert energy into the services demanded. Lovins advocated three fundamental pillars for energy policy: (a) promote energy efficiency—which means we would need less energy to provide the services (heat, light, etc.); (b) promote energy conservation—lowering the energy services needed per capita; and (c) invest in renewable energy—which is a sustainable resource, unlike the exhaustible fossil energy resources that have fuelled economic growth since the industrial revolution. Through producing and using energy services more efficiently we could meet our needs using locally sourced and environmentally friendly renewable energy (Lovins 1976). Lovins (1976) warned that ‘it is important to recognize that the two paths are mutually exclusive…because commitments to the first may foreclose the second, we must soon choose one or the other…’

Some ‘soft path’ ideas have since been applied to water systems (Gleick 2003) and could equally provide insights to our current food system challenges (Ramankutty et al 2018). About 800 million people remain undernourished today and nearly 2 billion suffer from micro-nutrient deficiencies. At the same time about a third of food produced is wasted and agriculture is one of the greatest environmental threats. Indeed, there is an ongoing vociferous debate (often termed ‘productivism versus agroecology’) regarding the best solutions, with some scholars arguing for a sustained focus on productivity improvements through new agri-food technologies such as precision agriculture and genetic engineering, while others argue in favour of food sovereignty and a transition to alternative farming systems using agroecological methods (Fraser et al 2016).

Numerous global assessments have already shown that a hard-path strategy focussed on increasing food supply alone will be insufficient to meet our food system challenges (e.g. Foley et al 2011, Erb et al 2016, Springmann et al 2018). While a transition to alternative farming systems can have many benefits (Garibaldi et al 2017), they also entail importanttrade-offs such as lower yields and higher food prices (Ramankutty et al 2019). At the same time, it has been shown that demand-side solutions have great leverage (e.g. West et al 2014). In fact, demand-side solutions have an amplifying effect that is often unappreciated in food system sustainability discussions (figure 1). When per-capita food demand is reduced,
it not only frees up available calories today, but it also reduces the anticipated calorie demand of future populations, leaving a much smaller gap to be filled through increases in supply. The same logic applies to efficiency improvements, as they improve efficiency of present-day food systems (e.g. improved cold storage reducing food losses today), and that innovation continues providing benefits in the future (i.e. reduced food loss in the future will lower future food demand). Thus, a fixation on supply side solutions misses a huge opportunity for addressing food system challenges through improved efficiency, labelled ‘technical fixes’ by Lovins (1976) and demand management, labelled ‘social changes’ by Lovins (1976).

In this paper, we propose a soft path for environmentally sustainable food systems that follows the logic of Lovins’ philosophy to leverage efficiency improvements in farming and along the food supply chain, along with measures to curb demand through social change, and incentivizes shifts to more environmentally friendly alternative farming practices. This multi-pronged approach avoids getting trapped in the productivism versus agroecology debate. For each soft path strategy, we present a few examples of potential solutions along with an equivalent example from energy systems. Finally, based on a review of the evolution of energy systems over the 45 years since Lovins’ first wrote his paper, we draw lessons for food systems from following soft path policies.

1. Soft paths to a sustainable food system

Our proposed soft path for environmentally sustainable food systems consists of three overall strategies: (a) Social changes to reduce food consumption; (b) Technical fixes and innovations to improve on-farm and supply-chain efficiencies; (c) Incentives to transition to alternate agriculture practices.

1.1. Reduce food consumption through social changes

Outside wartime, we have not employed a policy supporting dietary adequacy. Overall food demand can be reduced by cutting out dietary excess (consuming calories in excess of energy needs), eating more plant-based diets (as this can shift calories from animal feed back to human food; Cassidy et al 2013), and eating more seasonally (as it can reduce the amount of out-of-season energy-intensive production in greenhouses or imports from elsewhere) (table 1). Eating fewer ‘empty calories’ (refined fats, refined sugars, alcohols and oils) and eating more plant-based diets have been shown to have co-benefits for human health (Afshin et al 2019). Finally, the use of agricultural products for biofuel production should be restricted to situations with low or negative life-cycle greenhouse gas emissions, that do not compete with food crops, and do not cause direct or indirect land use change (Tilman et al 2009).

1.2. Improving on-farm and supply-chain efficiencies (through technical fixes and innovations)

Substantial benefits can be had from supply-side innovations (e.g. table 2) to improve resource-use efficiencies in all farming systems (Foley et al 2011). Important strategies in this regard include:
Table 1. Reducing (food) consumption through social change. Three pathways (and their energy equivalents) are briefly outlined below.

| Food system solution | Energy system equivalent | Motivation | Spillovers | Policy recommendations |
|----------------------|--------------------------|------------|------------|------------------------|
| Decreased intake of empty calories | Reduced heating/cooling of outdoor spaces | Reduces resource pressures | Reduced expenditure; improved health and longevity | Education; food guides; taxes on empty calories |
| Shifting to more plant-based diets | Switching from electric baseboard heaters to heat pumps | Calories produced are used more effectively | Plant-based diets have human health benefits; more expensive in terms of dollars and time to create | Education on health benefits of plant-based diets; evidence-based food guides (e.g. Canadian food guide recommends half the plate should consist of fruits and vegetables); tax on meat and dairy. |
| Seasonally adjusted diets | Seasonally adjusted thermostat | Adjusts demand to when supply is available | Lower food expenditure, better food quality and less spoilage | Farmers markets; seasonal produce guides; more home-economics education on preparing seasonal foods |

Table 2. Improving on-farm and supply-chain resource-use efficiencies through key technologies and innovations. Five pathways (and their energy equivalents) are briefly outlined below.

| Food system solution | Energy system equivalent | Motivation | Spillovers | Policy recommendations |
|----------------------|--------------------------|------------|------------|------------------------|
| Integrated crop-livestock systems | Combined heat and power\(^a\) | More efficient use of resources and waste recycling | Lower environmental impacts | Subsidies or tax breaks; taxing environmental externalities; payments for environmental services; extension services |
| Indoor farming | Superinsulated home | Higher yields of high value products | Higher water and nutrients use efficiency; protected from weather; better control of pests and diseases | Lower cost of borrowing |
| Plant-based meats (e.g. impossible burger) | High efficiency motors; LEDs | Provide the same experience of eating meat at lower resource costs | Slightly more expensive; highly processed and long-term health effects unknown | Food safety approvals; social movements |
| Reduce food loss and waste along the supply chain | Reduce losses in transmission and distribution networks | Calories produced are used more effectively | Reduced resource use; lower food price | Improve handling and storage technologies; develop closed-loop supply chains; change food date labelling; education |
| Food preservation (drying, canning, freezing) | Time shifting (buy cheap energy and store it for later use) | Reduces spoilage by matching supply and demand over time | Improved quality and taste; more flexible diets; less water transported | More home-economics education |

\(^a\) In electricity production roughly 2/3 of energy content is lost as heat and 10% of power is lost in transmission and distribution to point of consumption. Combined heat and power generates electricity locally and utilizes the heat. A well-designed system with balanced heat and power loads can utilize \(~80\%) of the energy content of the fuel used.
Table 3. Reducing environmental externalities through transitioning to alternate farming systems. A pathway (and its energy equivalents) are briefly outlined below.

| Food system solution                             | Energy system equivalent | Motivation                              | Spillovers                          | Policy recommendations                      |
|--------------------------------------------------|--------------------------|-----------------------------------------|-------------------------------------|--------------------------------------------|
| Organic, agroecological, or regenerative farming | Solar or wind energy     | Lower environmental costs, improved soil health | More unaffordable for consumers; More land use if demand is inelastic | Tax or regulate agricultural inputs; payments for environmental services; sustainability certifications |

(a) practices such as mulching, incorporating crop residues into the soil, split fertilizer application, and use of biofertilizers, (b) integrated crop-livestock systems that use circular-economy principles such that animal manure that might otherwise contribute to waste is recycled to improve soil fertility; (c) shifting to more nutrient-dense, less water-intensive and more climate resilient crops such as millets (coupled with concomitant demand-side policies to stimulate social acceptance of such traditional crops), and (d) reducing fertilizer applications in regions where applications exceed uptake and eliminating unsustainable groundwater extraction. Modern innovations such as indoor farming, precision agriculture, genetic engineering, and plant-based meats can also help. Such efficiency improvements can be achieved through the use of markets and regulations, and can reduce the environmental footprint of agriculture and also increase farmer profits and welfare by reducing input costs.

Technologies and innovations can also help improve food supply-chain efficiencies. It is often reported that one-quarter to one-third of global food is lost or wasted (Kummu et al. 2012). A wide range of strategies exist to reduce, recover, and recycle food loss and waste, although a review found that a majority of global policies are focused on recycling, for example, through bans on organic waste (Spang et al. 2019). An increased focus on reduction and recovery through technological improvements (improved cold and dry chain), discount pricing for about-to-expire foods, development of secondary markets for imperfect produce, or consumer campaigns can have large benefits (Spang et al. 2019). Food preservation technologies can also help store excess food produced during the growing season and make them available during times of need.

1.3. Incentivize alternate agriculture practices (‘renewable agriculture’)

Conventional agriculture is a major driver of global environmental change (Foley et al. 2011) and a transition to alternative farming systems (table 3) can have major environmental (and social) benefits (Garibaldi et al. 2017). Organic agriculture is growing fast and can become an important part of the transition to sustainable food systems (Eyhorn et al. 2019). However, productivity levels can be lower necessitating more land dedicated to meeting a given demand. Bhutan and several Indian states have targeted complete conversion to organic agriculture, and many other countries are targeting increased shares. Interest in regenerative agriculture—a set of practices such as no-till and use of cover crops to increase soil organic carbon—has risen over the last few years as a solution to climate change (Giller et al. 2021). And finally, agroecological practices can introduce more ecological insights into farming, and provide benefits for food security and nutrition (Bezner Kerr et al. 2021).

2. Lessons from energy systems for following soft-path food system solutions

There are many useful lessons for food systems from examining the evolution of energy systems. Many policies and technological innovations have successfully improved efficiency in energy use in the 45 years since Lovins proposed his ideas. However, the centralized nature of capital and technology development has favoured supply-side initiatives over measures to reduce demand. Today, energy prices are lower than in the 1970s and 1980s; this, combined with growing prosperity, has led to ballooning of demand for energy services. For example, while LED lightbulbs are ten times more efficient per lumen of lighting than incandescents, excessive lighting now obscures the night sky in most urban areas. At the same time, over 15% of the world’s population remains without electric lighting. This pattern of improved efficiency combined with increased and highly inequitable consumption is repeated across most end-uses. Yet, energy supply is still largely based on fossil fuels and we face the climate crisis because of negligent energy policies dating back to the 1970s.

In the period since Lovins’ proposal, there has also been an unanticipated shift in the nature of energy demand in post-industrial countries. While manufacturing remains a strong driver of energy demand, economic returns are far higher in the less energy-intensive service economy. The high growth in energy demand that Lovins anticipated for the US did not materialize largely because manufacturing has been outsourced, along with its associated energy demand and environmental impacts. In other words, while the
Global North has celebrated a decrease in domestic energy demand and emissions, much of the Global South prosperity and increased emissions arise from serving consumers in the North. Thus, failing to account for global trade has obscured the lack of progress in curbing demand.

In summary, the energy system has seen vast improvements in supply efficiency with concomitant decreases in energy prices, but little progress has been made in managing global demand growth or in switching to renewables. From this historical review, we can distil the following lessons for food systems:

(a) **Beware of the Jevons effect.** Efficiency improvements can lower prices and precipitate higher demand. In situations where basic human needs have been previously unaffordable, this decrease in price improves welfare. However, where need was already well met, further increases in consumption are counter-produtive. Lower food prices and increasing prosperity are leading to increased consumption of meat, sugars, oils and fats with high embodied calories that can be detrimental to human health. As Tilman et al. (2011) showed, embodied per-capita calories consumed continue to increase with wealth, reaching nearly 9000 kcal per-capita per-day, more than four times the average human’s need. Thus, improved efficiency will enable meeting food demand with less land, but rising demand for fuel and fibre may recapture that land and hamper efforts to reduce the overall footprint from agriculture.

(b) **Beware of unbridled demand.** The energy system witnessed much greater technological innovation in supply compared to demand management. The same pattern appears to be true of food systems, with far more ongoing investments in high-tech food system solutions such as indoor farms, genetic engineering, precision agriculture, and plant-based or lab-grown meats. Such innovations can help reduce resource use, increase farmer profits and reduce environmental pollution. But one needs to again heed the wisdom of Jevons. A predominant focus on supply without equivalent attention to demand management can result in rising consumption of agricultural products as mentioned previously. In other words, technical fixes without social change will not solve the problem.

(c) **Beware of distributional inequities.** Innovations have more often benefited the Global North, leading to exacerbation of distributional inequity in access to energy services. Food consumption is similarly inequitable with gross waste, over-consumption and obesity being an epidemic in the Global North and among the wealthy in the Global South while at the same time many in the Global South, especially Sub-Saharan Africa, continue to face high degrees of under- and mal-nourishment. This, while the world as a whole is producing more calories per person than ever before. Technological innovations in food systems are often aimed at improving the welfare of the wealthiest farmers or food businesses in rich nations, and not the 84% of farms worldwide that are less than 2 ha in size. Unless food system innovations are designed with the right problem and target populations in mind, they may further exacerbate existing inequities.

(d) **Beware of inappropriate boundaries.** Environmental progress is often measured through national production accounts. Yet, wealthy nations have achieved much of their progress through outsourcing their environmentally damaging activities—e.g. manufacturing, e-waste and deforestation. So, although technological innovations in more efficient food supply may be seen as the cause of improving domestic environmental performance, there is also a great deal of exports from countries guilty of unbridled deforestation. Progress in limiting adverse impacts of agriculture at the national level is only meaningful when measured using the environmental footprint of their consumption.

Markets and technical change helped achieve Lovin’s vision for improved efficiencies in energy supply, and also energy demand to a more limited extent. Yet a wholesale transition to renewables remains elusive. Future generations will be facing the consequences of our failure to curb climate change. There are lessons here for food systems. A soft path to global food systems will embrace multi-pronged solutions, tackling both demand and supply equally, and embracing both the efficiency improvements of productivists and a graduate expansion of agroecological agriculture. But to succeed it needs more than market forces and technological change—social change is critically important. Deliberate multi-pronged policies are needed right away if we wish to achieve zero hunger, curb climate change, bend the biodiversity loss curve, and preserve freshwater resources.

**Data availability statement**

No new data were created or analysed in this study.

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ORCID iDs

Navin Ramankutty  
[https://orcid.org/0000-0002-3737-5717](https://orcid.org/0000-0002-3737-5717)

Hadi Dowlatabadi  
[https://orcid.org/0000-0001-8522-748X](https://orcid.org/0000-0001-8522-748X)

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