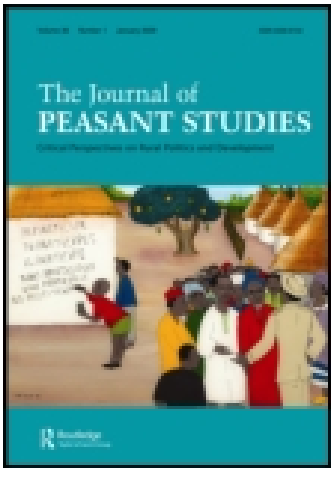

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The EROI of agriculture and its use by the Via Campesina

Joan Martinez-Alier

Via Campesina supports peasant and small farmer agriculture both in the South and in the North. Its basic doctrine is that of 'food sovereignty'. It is a movement that defends an 'ecological neo-Narodnism'. Among the analytical tools used by this international peasant movement is the comparison between the energy efficiency of traditional small farm agriculture and modern industrial agriculture. This article briefly recalls the history of agricultural energetics, and then looks at the use of the concept of EROI (energy return on energy input) by Via Campesina when it claims that 'industrial agriculture is no longer a producer of energy but a consumer of energy', and that 'peasant agriculture cools down the Earth'. The absence in Marxism of a tradition of analysis of energy flows is also reviewed here, since it is of interest in order to bring together the classic economic concept of decreasing returns with the more recent notion of a declining EROI. The article also draws on work analysing how environmental activists use concepts from ecological economics, while at the same time 'activist knowledge' contributes to ecological economics in a two-way communication between activism and science.

Keywords: agricultural energetics; ecological economics; activist knowledge; metabolic rift; ecological Narodnism; S.A. Podolinsky; Marxian economics; EJOLT project

Introduction

This paper has two foundations. The first is work on agricultural energetics (from Podolinsky in 1880 to Pimentel in 1973 and beyond), and in general on social metabolism (Haberl 2001, Fischer-Kowalski and Haberl 2007, Martinez-Alier 1987, 2002, 2009). The second foundation is more recent. In the CEECEC[1] (2008–2010) project on Teaching and Learning Ecological Economics with Civil Society Organizations (www.ceecec.net), and in the EJOLT project (2010–13) on Environmental Justice Organizations, Liabilities and Trade, both sponsored by the European Commission FP7 Science-in-Society program, we look at the use of concepts of ecological economics by activist groups and also at the contributions from activist knowledge (Escobar 2008) to ecological economics and other sustainability sciences. The present article studies one instance of this two-way communication between science and agrarian environmental activism, namely the use of agricultural energetics by Via Campesina. We consider also how the concept

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of 'food sovereignty' first introduced by Via Campesina is later analyzed by academics and used for policy.

Via Campesina is a peasant and small farmer International, with famous activists such as Rafael Alegría in Honduras, José Bové in France, Joao Pedro Stedile in the MST in Brazil, Paul Nicholson in the Basque Country (Desmarais 2007). Via Campesina fulfils what was anticipated 25 years ago as the growth of an ecological neo-Narodnism, in essence a pro-peasant movement that uses arguments from ecological economics and other sustainability sciences (Martinez-Alier 1987). It promotes the socio-metabolic analysis of agriculture, and draws on this perspective for its proposals and policies. Some member organizations of Via Campesina such as the MST in Brazil (the Landless Workers Movement) have a Marxist origin. They are moving slowly towards environmentalism as part of a general trend towards 'the greening of the agrarian question' (Gerber and Veuthey 2010).

Via Campesina is perhaps the most important transnational socio-environmental movement in the world (Borras 2008, Borras *et al*. 2008, McMichael 2008). Local movements or unions of peasants and family farmers have been able to build a democratically structured movement with a common identity that links social struggles on five continents, setting clear agendas for environmental, economic, political and social policies with regard to agriculture and the food system, water use, and international trade (Martinez-Torres and Rosset 2010). For the first time in history there is now a Peasants' Day, the 17th of April – akin to May Day – which was established on the anniversary of the killing of several members of the MST in 1996 in El Dorado, Carajás, Pará. Because of population growth, and their own resilience and active resistance, the world has never had so many peasants as today, although their number is decreasing or will decrease in absolute terms in China and India.

In the early 1970s, taking up H.T. Odum's view of modern agriculture as 'farming with petroleum', several researchers did careful accounts of the energy efficiency of agricultural systems. The best known calculations were undoubtedly by Pimentel, published in *Science* (Pimentel *et al*. 1973). It was striking to realize that the energy efficiency of corn production in Iowa or Illinois was lower than that for the traditional *milpa* corn production system of rural Mexico. From an economic point of view, modern agriculture increased productivity in terms of yield per hour of work and (to some extent) per hectare but from a physical point of view, it lowered the energy efficiency. These ideas are now being taken up, after 20 or 30 years, by pro-peasant think tanks such as GRAIN (Genetic Resources Action International), which defends agricultural biodiversity; the WRM (World Rainforest Movement), which opposes tree plantations; Food First; and the international network Via Campesina.

Agriculture as a system of transformation of energy

This article focuses on the statements by Via Campesina since 2007 that

> ... industrial agriculture is a major contributor to global warming and climate change by: transporting food all around the world, imposing industrial forms of production (mechanization, intensification, use of agrochemicals, monoculture ...), destroying biodiversity and its capacity to capture carbon, converting land and forests into non-agricultural areas, *transforming agriculture from an energy producer into an energy consumer*. (WRM 2008, emphasis added)

So, agriculture has changed from energy producer to energy consumer. What does this mean? Agriculture (and animal husbandry) may be seen as the first energy producing sector that humans developed.[2] By selecting some plants and eliminating other plants, by guiding the flow of nutrients, by increasing or decreasing as required the supply of water, agriculture provides a surplus of photosynthetic energy geared directly to human nutrition. In general, the energy made available by agriculture is less than the amount that would be naturally available from the same territory but it comes in a form suitable for human needs.

Biodiversity requires energy flows (Schrödinger 1944). Life flourishes by using available energy. The larger the human appropriation of net primary production (HANPP) (Vitousek *et al.* 1986, Haberl *et al.* 2009), the lower the amount of energy remaining for other species. Thus, when agriculture implies deforestation as so often it has in history, it destroys biodiversity. This negative aspect of agriculture we leave aside here, as we also leave aside the positive growth in agricultural biodiversity (the many varieties of edible plants) developed in thousands of years by agriculturalists, and today threatened by industrial agriculture and the narrowing of control in the world's seed supply by corporate agri-business.

We focus here on a single issue, the energy provided by agriculture to humans, and the energy requirements to produce that energy. To measure food as energy is not a novelty; it is 150 years old: people have been familiar with measuring food in terms of kilocalories since the 1860s. When newspapers write that 'agriculture will become a source of energy', referring to ethanol from sugar cane or biodiesel from sunflowers, they forget that agriculture has always been a source of energy, and it was invented for this reason. We consume about 2000 or 2500 kcal per day. It is convenient to remember that 2400 kcal equals 10 MJ (megajoules), so that per year we consume endosomatically about 3.6 GJ (gigajoules). The exosomatic use of energy in rich countries per person per year reaches 150 or 200 GJ on average, reflecting the fact that most energy (from fossil fuels, biomass, hydroelectricity, nuclear fission, wind) goes to production and consumption processes different from those directed to basic food needs.

Agriculture can be seen as a system of energy transformation. The energy from the sun is supplemented by the work of humans, animals, and machines, and by the energy spent in manufacturing the fertilizers and pesticides, and pumping the water for irrigation. Most of the energy from the sun is dissipated as heat, but one part is turned into the energy in food, animal feed, or textile fibres. The basic sustainability principle of an agricultural society is that the energy from agriculture must be sufficient, at a minimum, to feed the agriculturalists and their families, and to feed the animals. As society became more diversified (with tributary classes and urban populations), the produced energy surplus had to be larger. This was carefully explained by Podolinsky in 1880 (Martinez-Alier 1987, 2007).

Detailed calculations by ecological anthropologists of energy efficiency ratios in shifting cultivation were published in the late 1960s (Rappaport 1967). Later writing on the use of energy in the economic history of the US (Hall *et al.* 1986) used the acronym EROI (energy return on energy input) for the ratio between the energy

[2]One could argue whether collecting wood and burning it for warmth was not, for a much longer period, the original energy sector. Also, in hunting and gathering societies, humans collect for food a minute part of the energy accumulated by plants and animals derived ultimately from photosynthesis.

obtained and the energy spent in processes geared to supplying energy to the economy. The EROI is the inverse of the energy cost of obtaining energy.

In the course of history, there has been a search for energy sources with a higher and higher EROI. When the main energy source was agriculture, the EROI was low (compared to fossil fuel extraction). Even then, this did not mean that all hours of activity must be devoted to agricultural work (Sahlins 1972). There could be much leisure provided that the surplus was not siphoned off to the upper classes and the cities. But an agricultural economy cannot supply as much energy for many other activities as an economy based on industrial energy sources can. The transitions from energy sources such as plant biomass and draft animals to wind and water power, and then to fossil fuels, hydro-electricity and nuclear energy, enable increases in per capita output and economic diversification because less and less energy is used in the energy securing process itself (Cleveland and Kaufmann 2008). The higher the EROI, the more energy is available to support activities outside the energy sector. At present, in the oil extracting sector, there is a tendency for the EROI to decline as the Hubbert peak in oil extraction is reached, and oil is taken from the bottom of the sea, from tar sands, or from the depths of the Amazonian forests. But fossil fuels (the subterranean forests produced by the photosynthesis of millions of years ago) have been extremely generous to human societies in terms of their EROIs.

The EROI concept is useful in an array of struggles beyond peasant activism, from environmental or indigenous organizations complaining against Alberta tar sands extraction, to opponents of oil extraction in coastal areas in the US, to the environmentalists and policymakers in Ecuador who advocate keeping (heavy) oil in the ground in the Yasuni ITT fields (which, if extracted, would then need to be heated up and pumped up the Andes to reach the coast).

Much before Via Campesina was founded in 1993 (Desmarais 2007) scientists worked on agricultural energetics in a tradition that can be traced back to S.A. Podolinsky in 1880 (Martinez-Alier and Naredo 1982). There were studies on agricultural energetics from time to time in the first half of the twentieth century. Much later, in the 1970s, many analysts began to evaluate the energy efficiency of modern industrial agriculture. As Thompson (1994, 115) wrote, agriculture is a process that converts energy in the form of sunlight, work (human, animal, or mechanical), and carbon, nutrients and other elements in the soil or as fertilizers into energy in the form of biomass. 'Productionists' (as Thompson calls them) who long touted the growth of agricultural productivity were surprised to learn in the 1970s, with the work by Pimentel *et al*. (1973), Steinhart and Steinhart (1974), Leach (1975) and others, that industrial agriculture was less energy efficient than traditional small farm agriculture – and also less energy efficient than traditional agriculture in large landholdings, as shown by Naredo's calculations on energy flow in large olive tree plantations in Southern Spain (Naredo and Campos 1980, Naredo 1983). The reason for the decline in the EROI of agriculture is that the increase in energy inputs was larger than the growth in the yields. Decline in EROI also takes place in regions where small farmers are increasingly using irrigation with pumps and external fertilizers.

In 2007, Via Campesina announced in reports published on their website that 'agriculture has become a consumer of energy instead of being a producer of energy' (WRM 2008). It was deemed unnecessary to quote the authors who had first looked at agriculture as a system of transformation of energy and who had later established

the fact that the modernization of agriculture implied a decreasing EROI. However, in 2009, Via Campesina sought additional academic support for this assertion, and asked sympathetic think tanks and academic researchers to provide further evidence on the decreasing energy efficiency of modern agriculture.

Climate change

In 2007, Via Campesina did not quote any academic authorities. Why should they do a 'literature review', as we tell our graduate students to do? Even in June 2010, Via Campesina has not yet used the acronym EROI, which would allow them to make a blunt and powerful statement: the EROI of industrial modern agriculture is lower than that of traditional agriculture. But the fact is that Via Campesina, by consorting with experts and by drawing on the expertise within its ranks, found one additional argument (which augments other ecological cases such as agro-biodiversity conservation and the avoidance of chemical pollution) in order to sensibly defend traditional peasant agriculture in its pursuit of what could be described (Martinez-Alier 1987) as an 'ecological neo-Narodnism'. This additional argument grows stronger yet when it is recognized that peasant agriculture not only has greater energy efficiency but also produces fewer greenhouse gases.

Two years after 2007, shortly before the United Nations conference on climate change of December 2009, John Vandermeer *et al*. published the report *Effects of industrial agriculture on global warming and the potential of small-scale agroecological techniques to reverse those effects*. The Vandermeer report states:

> Agriculture was developed to be an energy producing system (and remains so in more traditional forms of agriculture), but with the introduction of industrial methods it has been turned into an energy consuming system. The new industrial farmer replaces the thought-intensive technology in use for so many years with brute force energy application, made possible because we have an abundant store of fossil fuel energy. Consequently, energy in agriculture was converted from something that originally was the main *product* of agriculture to something that became a main *input* into agriculture – a change from 'using sun and water to grow peanuts' to 'using petroleum to manufacture peanut butter'. It has been estimated that this industrial food system expends 10–15 energy calories to produce 1 calorie of food, an effective reversal of what had been the reason to develop agriculture in the first place.

Industrial agriculture and the whole food system have become net users of energy that (apart from the direct inflow from the sun for photosynthesis) comes mainly from fossil fuels. Because of this, modern industrial agriculture and the modern food system are producers of greenhouse gases. Via Campesina states that, apart from agriculture itself, other causes of GHG production are the transport of inputs and outputs, and the lengthening of the trophic chains producing cattle and pigs, which moreover are a source of other greenhouse gases. Deforestation associated with the spread of large scale monocultures and with cattle ranching is also one of the major emitters of CO_2, although programmes of agroforestry have the potential to reverse this trend. Practices of agroecology could increase both the volume of plant life in a given area and the capacity of the soil to maintain and absorb more carbon.

When all of this is aggregated, Vandermeer *et al*. (2009), writing for Via Campesina, conclude that the industrial agricultural and food system is responsible to a great extent for the warming of the planet because (1) industrial agriculture is fossil fuel intensive; (2) a large proportion of methane emissions come from confined

animal feeding operations; (3) most of the nitrous oxide emissions come from nitrogenous fertilizer applications; and (4) large tracks of land in the tropics are being converted to large scale plantations devoted to animal feed, paper pulp or agrofuels.

Two-way communication between science and activism

Drawing upon Vandermeer *et al*. (2009), Via Campesina insists then on the view that 'agriculture has changed from being a producer of energy to being a consumer of energy'. However, agriculture does not produce energy but rather *transforms* solar energy into food. The efficiency of photosynthesis is around one percent. As is well known, a lot of the solar energy input is not incorporated into the food energy. Despite this, the meaning of Via Campesina's statement is clear: the inputs of energy into agriculture (not counting solar energy) have increased more than the outputs, and in industrial economies much more energy is put into the agricultural and food system than we get out of the system. It is important to notice however that not only energy matters; 'matter matters too', as Georgescu-Roegen (1977) wrote, and the Via Campesina could use (or is already using) other bio-physical arguments for food sovereignty to fortify its social case, such as the immediacy of 'peak phosphorous' and the threats from excessive use of nitrogen fertilizer. With respect to chemical pollution, they could also use not only the notion of the 'pesticide treadmill' but the 'transgenic treadmill', which Binimelis *et al*. (2009) highlight in the context of the resistance to Glyphosate by *Sorghum halepense* (a weed) in Argentina's soybean fields. There is, in short, clearly much to be gained from the two-way communication between science on the one hand, and activism and social movements on the other.

The Via Campesina's main objective is to achieve 'food sovereignty'. This is an activists' concept that is now giving rise to academic literature and policy proposals. In the Declaration of Nyéléni in 2007, food sovereignty was defined

> ... as the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems. It puts those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. It defends the interests of the next generations. It offers a strategy to resist and dismantle the current corporate trade and food regime, and [it offers] directions for food, farming, pastoral and fisheries systems determined by local producers. Food sovereignty prioritises local and national economies and markets and empowers peasant and family farmer-driven agriculture, small scale-fishing, pastoralist-led grazing, and food production, distribution and consumption based on environmental, social and economic sustainability.

Via Campesina has consistently argued that the logic of markets and international trade should not undermine the democratic control of food systems. It has also pointed out that agriculture is a natural process which brings energy into the food chain, and that the first role of plants and agriculture is to transform solar energy into energy in the form of sugars and cellulose that can be directly absorbed in food or transformed by animals into meat, eggs, and milk. As noted above, it is increasingly critical of how industrialization has transformed agriculture into a net consumer of energy (through fertilizers, fuel for tractors, and oil- or gas-based agrochemicals). Moreover, feedstuff and food transport (so-called 'food miles', Pretty *et al*. 2005) and deforestation for monocultures of soybeans or oil palms are

contributing to making agriculture even more of an 'energy consumer' and therefore contributing to climate change, while the capacity of the soils to retain carbon (Lal 2004) is damaged by industrial monocultures.

These points were summarized by Via Campesina in its booklets and posters at the climate change conference in Copenhagen in December 2009 (as in Cancun in Mexico in November 2010), making the bold hypothesis that 'Sustainable peasant agriculture is cooling down the earth'. Via Campesina points out moreover that farms can produce other forms of renewable energy through solar and biogas energy. Via Campesina does not quote H.T. Odum (1971), Pimentel *et al.* (1973), Hall *et al.* (1986) or indeed De Saussure, who in 1804 demonstrated that plants absorb carbon dioxide by photosynthesis, a finding that today is primary (or secondary) school knowledge. But, then, Via Campesina is not writing academic articles.

Via Campesina insists also on the fact that peasant agriculture conserves seeds and biodiversity, and that it often makes little use of polluting agrochemicals. It could further use concepts of 'virtual water' and 'embodied HANPP' (Haberl *et al.* 2009) to criticize the currents of international trade and champion local and democratic food supply systems against the threats of agrofuels and tree plantations.

Agrofuels

Criticism of biofuels or agrofuels by ecological economists and activists (GRAIN 2007, Russi 2008, Cotula *et al.* 2008, Giampietro and Mayumi 2009) has been based so far on three main points. First, agrofuels mean an increase in the HANPP, the human appropriation of net primary production, to the detriment of other species. Second, agrofuels consume a lot of 'virtual water' (the water used to grow them) that could be used for other crops or for other purposes. Third, agrofuels have a low EROI (energy return on energy input), perhaps lower than one, or perhaps only 1.5 to 1, or 2 to 1 – when we deduct from the output, as we should, the net energy produced on the land before it was turned into agrofuel monocultures. The debates on agrofuels have popularized the analysis of agriculture as a system of transformation of energy (cf. Martinez-Alier 1987, 21–7, for an analysis of the EROI of ethanol from sugarcane).

The concept of agrofuels is older than many realize: 100 years ago, agriculture was seen not only as a producer of food energy but also as a potential source of fuel for cars when Rudolf Diesel himself said that his engine could work with vegetable oils. However, these three criticisms against agrofuels (low EROI, heavy 'virtual water', and increasing HANPP) have been developed only in the last decades. They were indeed unknown to most Via Campesina activists 15 years ago, but Via Campesina is now very much aware that agrofuels have low energy efficiency, and argues that feeding cars instead of people is insanity, both socially *and ecologically*, not only because of competition for land but also because of the low EROI (though without this precise terminology). This conceptualization is remarkable in a network of peasant and small farmer movements that, some might assume, ought to be pleased with the increased demand for agricultural products for the new agrofuel market.

The origins of agricultural energetics

The Via Campesina's arguments in favour of peasant agriculture on the grounds of energy efficiency and 'cooling down the earth' are not a surprise for ecological

economists but they are still an intriguing novelty for agricultural and development economists, as also for most Marxian scholars although Marx himself blamed capitalist agriculture for soil exhaustion and nutrient depletion. Here we need to go back to the work by S.A. Podolinsky (1850–1891) and its reception by Marx and Engels.

Podolinsky was a medical doctor and a Ukrainian narodnik activist. In 1880 (while living in Montpellier) he published accounts for French agriculture on the energy input/output ratio in different systems (forests, natural pastures, sown pastures, wheat). In the input he included human and animal work, counted in kcal, comparing this to the output, also in kcal. His main argument was that the total kcal per hectare harvested increased when more energy was put into agriculture in the form of human work and work of animals directed by humans. Agriculture was therefore a producer of energy. He did not foresee that agriculture would become a net consumer of energy. He mentioned guano from Peru as an input but did not give its energy equivalent.

Podolinsky believed that the role of human labour should be to increase the accumulation of solar energy on earth rather than the simple transformation into work of energy already accumulated on earth. Thus, he noticed that the work done with coal was accompanied by a great dissipation of heat-energy into space. The energy productivity of a coalminer was much larger than what a farmer could obtain, but this surplus from coal was transitory, he wrote.

Podolinsky sent his novel accounts on (what we now call) the EROI of agriculture to Marx in 1880. He published these accounts in several versions of the same article in several languages between 1880 and 1883. Engels' reaction to Podolinsky's accounts, when asked to comment on them by Marx, was negative. Engels (1882) wrote:

> ... if one chooses, one can translate into a physical language (*ins Physikalische übersetzen*) the old economic fact that all industrial producers have to live from the products of agriculture, cattle raising, hunting, and fishing – but there is hardly much to be gained from doing so.

Engels also wrongly wrote that 'the energy value of a hammer, a screw or a needle calculated according to the costs of production is an impossible quantity', concluding, 'In my opinion it is absolutely impossible to try and express economic relations in physical magnitudes'. Engels' reaction to Podolinsky's work, and Marx's silence from mid-1880 to the end of his life in early 1883, were a missed chance for a Marxian approach to agricultural and economic history based on the study of energy metabolism, and this omission affected the Marxian tradition long after. Later work on energy use by historians of a Marxian bent (Debeir *et al.* 1991, Sieferle 2001) could not draw on an established body of Marxist scholarship on this topic, apart from the writings on energy and society by Bogdanov, Kautsky, and Bukharin, and others such as the anthropologist Leslie White, which lacked empirical accounts (Martinez-Alier 1987). This is reflected in the fact that Haberl's historical survey (2001) of energy accounting methods and empirical examples lists few if any Marxian authors.

Engels was right when he wrote to Marx on 19 December 1882 that:

> ... man as a worker is not merely a fixer of *present* solar heat but a still greater squanderer of *past* solar heat. The stores of energy, coal, ores, forests, etc., we succeed in squandering you know better than I. From this point of view even fishing and hunting

> appear not as the fixation of new sun heat but as the using up and incipient waste of solar energy already accumulated.

However, he was totally wrong when he wrote that Podolinsky had forgotten such facts, as Podolinsky was very clear about the difference between incoming solar energy and the energy stored in fossil fuels.

In a recent 'obituary', Burkett's and Foster (2008) dismiss the relevance of Podolinsky's pioneering work in agricultural energetics, and in doing so, they faithfully try to defend Marx and Engels' failure to grasp the relevance of energy accounting for economic history, deny that Podolinsky explicitly compared a coal-based economy to a solar energy-based economy, and try to defend Engels' views on the Second Law of Thermodynamics (in notes of 1875 that were published 30 years after his death in 1895 in the *Dialectics of Nature*). They are right on one point: the difficulty of bringing together energetics with the Marxist theory of surplus labour (*Mehrarbeit*) and surplus value, as Podolinsky thought he had done. However, their claim to have debunked 'the Podolinsky myth' is vastly premature.

The Via Campesina's arguments in favour of peasant agriculture (because of its higher energy efficiency and other reasons) are congruent with Marx's explicit remarks against soil exhaustion and nutrient depletion. Marx used Liebig's agricultural chemistry to discuss the 'metabolism' (*Stoffwechsel*) of capitalist agriculture (Martinez-Alier 1987, 220–1, Foster 2000, 156–7). I sympathize with the attempts to show that Marx was already a proto-ecological author, in particular with respect to how he described the 'metabolic rift' caused by capitalist agriculture (Foster 2000). In volume 3 of *Capital* (chapter 47) Marx showed himself to be in favour of Liebig's argument for small-scale agriculture in terms of its greater capacity to return nutrients to the soil as compared to large-scale agriculture producing for distant markets. Schmidt (1978, 86–9) was right in pointing out that Marx's metabolism between humanity and nature referred specifically to the cycles of plant nutrients. However, it is obvious that Marx never analyzed agricultural energetics and, as was explained already (Martinez-Alier and Naredo 1982, Martinez-Alier 1987), Engels' reaction to Podolinsky was not a stimulus for a Marxian economic history that would look at the economy in terms of energy metabolism.

Marxian economists and economic historians of the mid-twentieth century still did not focus on the metabolic flows on the economy – for instance, Paul Baran or Paul Sweezy. They did not analyse either what the economist James O'Connor (1998) would later call 'the second contradiction of capitalism', today so visible around the world in the myriad resource extraction and waste disposal conflicts (including excessive carbon dioxide emissions). In short, as Huber (2008) acknowledges, energy has been one of the blind spots in Marxian thought. Huber then cites the ecological economists who have worked on energy and society but finds that they do not focus enough on the political struggles on energy flows. Therefore, he says, the most important question is not, what is the absolute, biophysical 'limit' to the future of fossil-based economies but rather what are the social and political implications of a declining EROI. The present article seeks to provide an answer to this question, as regards agriculture.

Podolinsky was in 1880 a young Narodnik (closely associated to Piotr Lavrov, and later to the most radical branch of the Russian Narodniki); he was also a Ukrainian nationalist. I do not think that Marx and Engels were prejudiced in

advance against him although politically he was not one of their followers. Podolinsky thought very highly of Marx's economics and believed he was making a contribution to it. One version of his article on agricultural energetics was published in 1883 in *Die Neue Zeit*, the journal of the German socialist, Marxist party.

Podolinsky was certainly not anticipating that capitalist agriculture was going to become so energy-intensive that instead of being a 'producer of energy' it would be a 'consumer of energy'. He was pro-peasant because he was politically a Narodnik, not because he anticipated an ecological–energetic argument in favour of peasant agriculture. Nevertheless, because of his competent analysis of the basic principles of agricultural energetics, and because of his Narodnik political position, his work of 1880 should be of interest to today's 'ecological Narodniki', the Via Campesina.

Marx at the end of his life was trying to understand the socialist and pro-peasant positions of the Russian Narodniki, who dreamt of moving towards a kind of socialism based on peasant communes without relying on the growth of an industrial proletariat. Marx's position is analyzed in Shanin's (1983) book, *Late Marx and the Russian Road*. Marx's tentative answers in drafts of letters to Vera Zasulich that he did not send to her, and which were published long after Marx's death, show that he was sympathetic to, or at least open to discuss, the Narodnik position, which was later liquidated by the October Revolution of 1917 and the subsequent policies of the Communist Party. For 20 years before 1917, Lenin strongly opposed 'the peasant way' in Russia; this was one of the constant traits in his politics. No protagonist role was to be given to the peasantry (which was increasingly socially divided, as shown in his well argued and well written book *The development of capitalism in Russia*) (Lenin 1899). The protagonist role fell, instead, to the industrial proletariat and its (alleged) political party.

The word 'Narodnik' became thereafter an insult in the practice of the newly founded Communist Parties after the October Revolution. Nearly 100 years later, the word still resonates in the political culture of countries with long traditions of Marxist debate, as in Bengal (India) where the secretary of the Communist Party of India, Prakash Karat, described those who opposed the state-ordered displacement of peasants to make way for large scale industry in Nandigram and Singur in 2007 (including the environmental activist Medha Patkar) as 'the modern-day Narodniks who claim to champion the cause of the peasantry' (Karat 2007).

Another example of the persistent denigration of this tradition is in how Georgescu-Roegen's (1960) classic article on the economics of peasant farming (where Chayanov was quoted) was once briskly dismissed as 'Narodnik' (Patnaik 1979, 1981). This was a strange move to make at the time when Patnaik was writing, as the ecological economics arguments (that Chayanov did not make but Georgescu-Roegen himself developed from 1965 onwards) were giving a renewed support to the Narodnik position (Martinez-Alier 1997).

Podolinsky's analysis of agricultural energetics is relevant not only in the Marxian context. As Cleveland (2008a) has argued, Podolinsky's work foreshadowed by nearly a century three research approaches now widely used: first, the use of energy flow analysis to characterize the efficiency of food production systems (Steinhart and Steinhart 1974, Pimentel and Pimentel 1979); second, modeling labour productivity as a function of the quantity of energy used to subsidize the efforts of labour (Cleveland *et al.* 1984); and third, the importance of the energy surplus or net energy yielded by an energy supply process (Cottrell 1955, Odum 1971, Hall *et al.* 1986, Cleveland 2008b).

As discussed, Podolinsky wrote that agriculture achieved a viable energy surplus (thanks to photosynthesis and human work and ingenuity), while the industrial economy relied on an exhaustible stock of coal. The Second Law meant that energy used once (whether from today's sunlight or from coal) could not be used again. For sunlight this did not matter, as there was an inexhaustible supply for a long time, while the stock of coal was limited. Though this last point was certainly not new (Jevons 1865), the view of the agricultural economy as a system of transformation of energy was an important conceptual innovation, highlighting how agriculture managed to produce an energy surplus over the food energy requirements of the agricultural workers and draft animals.

In contrast to its reception by Engels, Podolinsky's analysis of agricultural energetics was noticed and praised by the ecologist Vernadsky in a section of *La Géochimie* (1924) summarizing work by several authors who, before Schrödinger (1944), had the intuition that life slowed down the dissipation of energy. Vernadsky then added a memorable phrase – Podolinsky studied the energetics of life and tried to apply his findings to the study of the economy (Vernadsky 1924, 334–5) – a phrase that recalls the title of Georgescu-Roegen's *The Entropy Law and the Economic Process* (1971). Thus, in the field of science, Vernadsky's praise certainly compensates for Engels' (and Burkett's and Foster's) rebuke.

Since the 1940s, ecologists have published detailed studies on the flow of energy in ecosystems. There was a Russian tradition before Raymond Lindeman's classic paper on energy flow in ecosystems (Lindeman 1942). The work by H.T. Odum (1971) on energy flows in human ecosystems (and his idea that modern agriculture meant 'farming with petroleum') was one of the sources of the abundant work on agricultural energetics in the 1970s. It is intellectually and politically exciting to see a distillation of this work being used by the activists of Via Campesina.

Decreasing returns and neo-Malthusianism

Marx and Engels were one generation younger than the agricultural chemists (Liebig, 1803–1873, Boussingault, 1802–1887) who published their research on the cycles of plant nutrients (phosphorous, nitrogen, potassium), influenced by the threat of decreasing agricultural yields and the wholesale imports of guano after 1840 from Peru. The analysis of the composition of guano, and also of other manures and fertilizers well known to farmers (bones, for instance), laid the foundations for agricultural chemistry. Marx found Liebig's writings interesting because he described the natural conditions of agricultural fertility and their undermining by capitalist agriculture, and also because Liebig foresaw the development of the productive forces by the fertilizer industry. This was useful for the polemics against Malthus.

Marx wrote to Engels on 13 February 1866 (Marx and Engels 1942) that Liebig's agricultural chemistry was more important for the discussion on decreasing returns than all the economists put together. This must be interpreted in this sense: the economists talked about decreasing returns in the intensive margins, but these could be overcome by fertilizers. The 'metabolic rift' caused by capitalist agriculture (export of nutrients that were not put back into the fields) would be solved in the way that Liebig himself proposed, through factory fertilizers.

Was Marx right in dismissing decreasing returns? It would seem so, but long after his death agricultural energetics shows that there is a decreasing efficiency in the use

of energy. From this point of view, modern agriculture is less productive. Was Marx right in attacking Malthus? Yes, in a way, because Malthus thought that improving the situation of the poor was counterproductive because they would immediately have more children. On the other hand, Marx proved to be too optimistic when attacking the notion of decreasing returns that now reappear, not as lower labour productivity or lower yields in the intensive or extensive margins, but as lower energy efficiency. Further, because of Marx's technological optimism and anti-Malthus position, Marxists did not strongly support the bottom-up, feminist Neo-Malthusian movement of 1880–1920 that was concerned about the balance between population growth and availability of resources and wanted women to have the right to choose the number of children they wanted to have (Ronsin 1980, Martinez-Alier and Masjuan 2005).

Malthus (and Ricardo) believed in decreasing returns; this went later out of fashion because of 'technical progress' (industrial fertilizers) and also accessible fertile land in the Americas. Therefore both Marxists and other economists coincided in the view that there was no menace to the food supply. Indeed, human population has increased fivefold since Marx's death. Moreover, in 1965 Boserup published her influential work on how population growth caused increased agricultural production by inducing change in the agricultural systems towards methods with reduced fallow periods or even annual multiple cropping (Boserup 1965). However, energy (and material) accounting is again raising the spectre of decreasing returns. 'Peak phosphorous' is a threat, as well as the decreasing EROI of agriculture. Does this mean that we should become Malthusians? There have been different varieties of Malthusianism. The radical, feminist neo-Malthusian tradition of thought was forgotten even among feminists with some exceptions. Thus, Françoise d'Eaubonne's book of 1974 (credited with introducing the word 'ecofeminism') recalled the debates of 1900 on women's reproductive rights and the balance between population and resources.

Conclusion

In 1987 I explicitly asked which social groups, if any, would use the findings of ecological economics and its insights on agricultural energetics whose history I had retraced with Klaus Schlüpmann in our book *Ecological economics: energy, environment and society*. Now we have something of an answer.

Via Campesina has been at the forefront of intellectual and political struggles to keep agriculture out of the WTO and the Doha round, and it supports peasant and small farmer agriculture both in the South and in the North. Its crucial doctrine is that of 'food sovereignty', and it challenges the legitimacy of the subsidy regimes of the US and EU. As a Peasant International, they defend –whether they know it or not – an 'ecological neo-Narodnism', where the word 'Narodnism' refers to the ideology of the pro-peasant movements in Russia and Eastern Europe in the second half of the nineteenth century and the early twentieth century.

Among the analytical instruments used by Via Campesina in defence of peasant agriculture is the comparison between the energy efficiency of traditional agriculture and modern industrial agriculture. In this article, I have briefly reviewed the history of agricultural energetics (looking at agriculture as a system of transformation of energy), and then looked at the implicit use of the concept of EROI (energy return on energy input) by Via Campesina when it rightly claims that 'peasant agriculture

cools down the Earth'. Although Via Campesina is not yet using explicitly the acronym EROI (and is therefore missing the connection to a large body of research on energy use and economic history), this could easily be remedied.

This article draws also on work in the CEECEC and EJOLT projects sponsored by the European Commission FP7 Science-in-Society programme. Civil society organizations, and particularly the EJOs (environmental justice organizations), have accumulated large stocks of activist knowledge (Escobar 2008) which sometimes becomes available to academics in the form of new concepts. 'Food sovereignty', introduced by Via Campesina, is one example; another is the concept of 'ecological debt' or 'climate debt' introduced by activists in other fields. Vice-versa, some concepts and methodologies developed by academics working in ecological economics (such as the EROI, 'virtual water', the HANPP) are useful in practice to the EJOs.

Via Campesina asserts that false solutions are being promoted in the face of climate change, such as agrofuels from monocultures (including tree plantations), which are undermining food sovereignty. In fact, industrial agriculture is one of the main drivers of climate change, carrying food around the world and imposing monocultures and mechanization and the use of agrochemicals while destroying biodiversity and its ability to capture carbon and 'transforming agriculture from a producer of energy into an energy consumer'. The solutions that Via Campesina puts forward are small scale agriculture, which is labour intensive, uses little fossil fuel energy and can actually help stop the effects of climate change; a genuine agrarian reform to strengthen peasant agriculture; promoting food production as the primary land use; and considering food as a basic human right that should not be treated mainly as a commodity. Local food production should be supported because it avoids unnecessary transport, while patterns of production and consumption that promote waste and unnecessary consumption by a minority of humanity should be stopped because hundreds of millions of people still suffer hunger. While these proposals have not been analysed in detail here, they have strong empirical and theoretical footing in the study of energy flows in agriculture by academics over many decades.

At least until the Vandermeer report of 2009, Via Campesina did not quote Pimentel (1973, 1979, 2005), nor Podolinsky (1880), Martinez-Alier (1987) or anybody else who had worked on agricultural energetics and their socio-economic implications. Why should they? However, they have now clearly found the academic literature on agricultural energetics to be useful, in particular with respect to their case against agrofuels as well as in building one more argument in favour of the traditional peasantry and 'food sovereignty'. It remains to be seen how the socio-metabolic perspective will influence the Via Campesina's view of a future 'Malthusian' food crisis, in other words, whether the vexing issues of a decreasing EROI and population growth (and women's reproductive rights) will be incorporated into the Via Campesina's vision, taking into account that although we are approaching 'peak oil' and 'peak phosphorous' we are also, more slowly, approaching 'peak population', and this is a good thing.

References

Binimelis, R., W. Pengue and I. Monterroso. 2009. 'Transgenic treadmill': responses to the emergence and spread of glyphosate-resistant johnsongrass in Argentina. *Geoforum*, 40(4), 623–33.

Borras Jr., S. 2008. La Vía Campesina and its global campaign for agrarian reform. *Journal of Agrarian Change*, 8(2/3), 258–89.
Borras Jr., S., M. Edelman and C. Kay. 2008. Transnational agrarian movements confronting globalization. *Journal of Agrarian Change*, 8(2/3), 169–204.
Boserup, E. 1965. *The conditions of agricultural growth*. Chicago: Chicago University Press.
Burkett, P. and J. Bellamy Foster. 2008. The Podolinsky myth: an obituary introduction to 'Human labour and unity of force' by Sergei Podolinsky. *Historical Materialism*, 16(1), 115–61.
Cleveland, C.J. 2008a. Biophysical economics. *Encyclopedia of Earth* (online), November.
Cleveland, C.J. 2008b. Energy return on investment (EROI). *Encyclopedia of Earth* (online), April.
Cleveland, C.J., *et al*. 1984. Energy and the US economy: a biophysical perspective. *Science*, 225, 890–7.
Cleveland, C.J. and R. Kaufmann. 2008. Fundamental principles of energy. *Encyclopedia of Earth* (online), August.
Cottrell, F. 1955. *Energy and society: the relations between energy, social change and economic development*. New York: McGraw Hill.
Cotula, L., N. Dyer and S. Vermeulen. 2008. Fuelling exclusion? The biofuels boom and poor people's access to land. London: IIED; Rome: FAO.
Debeir, J.C., D. Hemery and J.P. Déleage. 1991. *In the servitude of power: energy and civilisation through the ages*. London: Zed Books.
Desmarais, A.A. 2007. *La Via Campesina. Globalization and the power of the peasant*. Halifax: Fernwood.
D'Eaubonne, F. 1974. *Le féminisme ou la mort*. Paris: Pierre Horay Editeur.
Engels, F. 1882. Letters to K. Marx, 19 and 22 December. MEW, vol. 35. Berlin: Dietz Verlag.
Escobar, A. 2008. Territories of difference: place, movements, life. *Redes*. Durham, NC: Duke University Press.
Fischer-Kowalski, M. and H. Haberl. 2007. *Socioecological transitions and global change. Trajectories of social metabolism and land use*. Cheltenham: Edward Elgar.
Foster, J.B. 2000. *Marx's ecology: materialism and nature*. New York: Monthly Review Press.
Georgescu-Roegen, N. 1960. Economic theory and agrarian economics. *Oxford Economic Papers*, 12(1), 1–40.
Georgescu-Roegen, N. 1977. Matter matters, too. In: K.D. Wilson, ed. *Prospects for growth: changing expectations for the future*. New York: Praeger Press, pp. 293–313.
Gerber, J.F. and S. Veuthey. 2010. Plantations, resistance and the greening of the agrarian question in coastal Ecuador. *Journal of Agrarian Change*, 10(4), 455–81.
Giampietro, M. and K. Mayumi. 2009. *The biofuel delusion*. London: Earthscan.
GRAIN. 2007. Stop the agrofuel craze. *Seedling: Biodiversity, Rights and Livelihood*, July, 2–9.
Haberl, H. 2001. The energetic metabolism of societies, Part I: accounting concepts. *Journal of Industrial Ecology*, 5(1), 11–33.
Haberl, H. 2001. The energetic metabolism of societies, Part II: empirical examples. *Journal of Industrial Ecology*, 5(2), 71–88.
Haberl, H., *et al*. 2009. Using embodied HANPP to analyze teleconnections in the global land system: conceptual considerations. *Danish Journal of Geography*, 109(2), 119–30.
Hall, C.A.S., C.J. Cleveland and R. Kaufmann. 1986. *Energy and resource quality: the ecology of the economic process*. New York: Wiley-Interscience.
Huber, M.T. 2008. Energizing historical materialism: fossil fuels, space, and the capitalist mode of production. *Geoforum*, 40(1), 105–15.
Jevons, W.S. 1865. *The coal question*. London: Macmillan.
Karat, P. 2007. 'Double-speak' charge: maligning the CPI(M). *People's Democracy*, 31(4). Available from: http://pd.cpim.org/2007/0128/01282007_prakash.htm
Lal, R. 2004. Soil carbon sequestration impacts on global climate change and food security. *Science*, 304, 1623–7.
Leach, G. 1975. *Energy and food production*. Guildford: IPC Science and Technology Press.
Lenin, V.I. 1899. The development of capitalism in Russia. In: *Collected works,* 4th edition, Moscow, 1964. vol. 3, pp. 21–608.
Lindeman, R.L. 1942. The trophic-dynamic aspect of ecology. *Ecology*, 23, 399–418.

Martinez-Alier, J. 1997. Some issues in agrarian and ecological economics, in memory of Georgescu-Roegen. *Ecological Economics*, 2(3), 225–38.
Martinez-Alier, J. 2002. *The environmentalism of the poor. A study of ecological conflicts and valuation*. Cheltenham: Edward Elgar.
Martinez-Alier, J. 2007. Marxism, social metabolism and international trade. In: A. Hornborg, J. McNeill and J. Martinez-Alier, eds. *Rethinking environmental history. World-system history and global environmental change*. Lanham: Altamira, 221–237.
Martinez-Alier, J. 2009. Social metabolism, ecological distribution conflicts, and languages of valuation. *Capitalism Nature Socialism*, 20(1), 58–87.
Martinez-Alier, J. and J.M. Naredo. 1982. A Marxist precursor of energy economics: Podolinsky. *Journal of Peasant Studies*, 9(2), 207–24.
Martinez-Alier, J. with K. Schlüpmann. 1987. *Ecological economics: energy, environment and society*. Oxford: Blackwell.
Martinez-Alier, J. and E. Masjuan. 2005. Neo-Malthusianism in the early 20th century. *Encyclopedia of Ecological Economics*. Available from: http://www.ecoeco.org/pdf/Neo-malthusianism.pdf
Martinez-Torres, M.E. and P. Rosset. 2010. La Vía Campesina: the birth and evolution of a transnational social movement. *Journal of Peasant Studies*, 37(1), 149–75.
Marx, K. and F. Engels. 1942. *Selected correspondence*. New York: International Publishers.
McMichael, P. 2008. Peasants make their own history, but not just as they please... *Journal of Agrarian Change*, 8(2/3), 205–28.
Naredo, J.M. 1983. La crisis del olivar como cultivo biológico tradicional, *Agricultura y Sociedad*, 26, 167–288.
Naredo, J.M. and P. Campos. 1980. Los balances energéticos de la agricultura española, *Agricultura y Sociedad*, 15, 163–255.
O'Connor, J. 1988. Capitalism, nature, socialism: a theoretical introduction. *Capitalism, Nature, Socialism*, 1, 11–38.
Odum, H.T. 1971. *Environment, power and society*. New York: Wiley.
Patnaik, U. 1979. Neo-populism and Marxism: the Chayanovian view of the agrarian question and its fundamental fallacy. *Journal of Peasant Studies*, 6(4), 375–420.
Patnaik, U. 1981. Reply to Nicholas Georgescu-Roegen. *Journal of Peasant Studies*, 8(2), 244–6.
Pimentel, D., *et al*. 1973. Food production and the energy crisis. *Science*, 182, 443–9.
Pimentel, D. and M. Pimentel. 1979. *Food, energy and society*. London: Arnold.
Pimentel, D., *et al*. 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. *Bioscience*, 55, 573–82.
Podolinsky, S.A. 1880. Le socialisme et l'unité des forces physiques. *Revue Socialiste*. June, pp. 353–365.
Pretty, J., *et al*. 2005. Farm costs and food miles: an assessment of the full cost of the UK weekly food basket. *Food Policy*, 30(1), 1–19.
Rappaport, R. 1967. *Pigs for the ancestors: ritual in the ecology of a New Guinea people*. New Haven: Yale University Press.
Ronsin, F. 1980. *La grève des ventres: propaganda néo-malthusienne et baisse de la natalité en France, XIXe–XXe siècles*. Paris: Aubier.
Russi, D. 2008. An integrated assessment of a large-scale biodiesel production in Italy. *Energy Policy*, 36(3), 1169–80.
Sahlins, M.D. 1972. *Stone age economics*. New York: Rinehart.
Schmidt, A. 1978. *Der Begriff der Natur in der Lehre von Marx*. Frankfurt-Cologne: EVA.
Schrödinger, E. 1944. *What is life?* Cambridge: Cambridge University Press.
Shanin, T. 1983. *Late Marx and the Russian road: Marx and the 'peripheries of capitalism'*. London: Routledge.
Sieferle, R. 2001. *The subterranean forest: energy systems and the industrial revolution*. Cambridge: White Horse Press.
Steinhart, J.S. and C.E. Steinhart. 1974. Energy use in the US food system. *Science*, 184, 307–16.
Thompson, P.B. 1994. *The spirit of the soil: agriculture and environmental ethics*. London: Routledge.
Vandermeer, J., *et al*. 2009. *Effects of industrial agriculture on global warming and the potential of small-scale agroecological techniques to reverse those effects*. Available from: viacampesina.net/downloads/DOC/ViaNWAEG-10-20-09.doc [Accessed 19 October 2010].

Vernadsky, W., 1924. *La Géochimie*. París: Felix Alcan.
Vitousek, P., *et al*. 1986. Human appropriation of the products of photosynthesis. *Bioscience*, 34, 368–73.
WRM (World Rainforest Movement). 2008. Via Campesina: food sovereignty as the peoples' alternative to destructive agribusiness. Bulletin, 135.

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