

The agrarian question in the web of life: world-ecology and the conjuncture

A. Haroon Akram-Lodhi
Trent University

Introduction

In the past fifteen years world-ecology has developed as a grand meta-theory of historical change. At its most elemental, world-ecology is 'the study of historical change — including the history of the present — as if nature matters'.¹ Stressing a need to transcend a 'Cartesian dualism' (Moore 2015: 20) that fragments the world into the separate spheres of 'nature' and 'society', world-ecology investigates historical change from a perspective that insists that human organizations are producers and products of 'the web of life'.

In this paper I want to focus upon the history of the present. Specifically: in recognition that farming, as the growing of crops and rearing of animals for use or for trade, shapes and is shaped by nature; in light of the fact that the creation of poverty around the world is principally a rural issue; and as an observer of and participant in debates around the character of the so-called 'agrarian question', I want to examine how world-ecology might be used to understand processes of agrarian change in the here and now. In other words, I want to investigate how we might use world-ecology not only analytically, but also empirically, as a theoretically-informed methodology that allows us to understand an actually-existing agrarian structure and how it is or is not changing in ways that do or do not benefit rural people. In so doing, I want to see if world-ecology can move beyond being the dominion of economic and environmental historians and geographers, and become a frame through which the economics, politics, sociology and culture of real rural communities can be better understood, in ways that might even have implications for the policy and practice of the 'development project'.

In order to do this, I will first review the key propositions of the agrarian question. I will then introduce the challenge to agrarian political economy that is offered by world-ecology. I will next assess how agrarian political economy might incorporate world-ecological concerns into its analytical frameworks and tools. Finally, I will reflect upon the methodological implications of this incorporation of world-ecology into agrarian political economy, answering the central question, can there be a world-ecological agrarian political economy, in the affirmative.

The origin of the agrarian question

In the mid-1860s Marx (1976, orig. 1867) published his analysis of the genesis of capitalism, and the processes by which the key characteristics of the capitalist mode of production come to be established: a system that is on the one hand exploitative and inhumane in its construction of the differential and unequal material interests of capital and labour; while being at the same time a system that is, because of its capacity to develop the material forces of production, a necessary precondition of a more economically prosperous and more socially humane society.² Marx's concern with the development of capitalism was shared by the key figures of classical historical materialism in the late 19th century: Engels (1950, orig. 1894), Lenin (1964, orig. 1899) and Kautsky (1988), amongst others, although these later figures offered different perspectives on the processes that Marx had analyzed.

Marx had argued that in order for the development of capitalism to emerge out of feudalism it was necessary for the direct producer of food and non-food crops under feudalism – the peasantry – to be

1 <https://worldecologynetwork.wordpress.com/about/>

2 This essay draws on parts of Akram-Lodhi and Kay (2010a, 2010b, 2016) but goes significantly beyond those earlier papers.

excluded from the land through outright forced dispossession. This was necessary because capitalism required the development of a market in land, which in turn necessitated dispossessing rural labour, which in turn created a waged labour force. In other words, capitalism required the commodification of land and labour and the establishment of the idea of private property as the foundation upon which the production of surplus-value could be constructed. What Engels, Lenin and Kautsky brought to the discussion was a second side of capitalist development: a process of differentiation within a peasantry that was internally stratified into distinct socio-economic groups, commonly labelled 'small'/'poor', 'medium' and 'large'/'rich'. Engels, Lenin and Kautsky can be distinguished by their differing perspectives on the drivers of this process of agrarian class formation. Engels argued that the development of capitalism in farming and agriculture required the elimination of the small peasant, who could be owners of land, tenant operators of land, or both, and who used primarily family labour in on-farm production. The small peasant was eliminated by the middle and large peasants, who required, to differing degrees, waged labour for their farms and for whom the principal source of waged labour lay in an ever-more-steadily floundering, and then disappearing, small peasantry, whose termination provided the labour force necessary for the development of capitalism to be completed. By way of contrast, for Lenin landless waged labour were the remnants of both small and middle peasant farmers, and it was the elimination of the middle peasants that was key to the process of exclusion and social polarization in the villages. For Kautsky, the process of agrarian capitalist development was connected to the concentration of landholdings by the large peasants as the centralization of capital in agriculture drove rural transformation. In this light, the survival of small peasants was, for Kautsky, not a function of their economic efficiency but rather reflected the penury within which they lived, and their willingness to overwork themselves and complement that work with marginal sources of off-farm and non-farm income in order to survive.

Historical materialist political economy thus approaches the development of capitalism in farming and agriculture as a process of the commodification of land and labour through the dispossession of the smallholding peasant from the land, either as a consequence of forced displacement or the dispossession created by peasant class differentiation and the exclusionary implications of the normal, everyday workings of highly imperfect land, labour and product markets. The former has come to be called 'capitalism from above', while the latter has come to be called 'capitalism from below'. Together, these have become the terrain of what Karl Kautsky called 'the agrarian question', which he defined when he asked: 'whether, and how, capital is seizing hold of agriculture, revolutionizing it, making old forms of production and of property untenable and creating the necessity for new ones' (Kautsky 1988: 12). During the current period of neoliberalism David Harvey (2003) encapsulates both collectively, if imperfectly, in the very popular concept of 'accumulation by dispossession'.

Henry Bernstein's (1996/97) review of Terence J. Byres' *Capitalism From Above and Capitalism From Below* (1996) offered both the most clear and the most critical elaboration of how the classical agrarian question has come to be understood in the 21st century. Bernstein did this by persuasively showing that Byres' understanding of the agrarian question could be analytically deconstructed into three 'problematics'.³ The first problematic Bernstein called 'accumulation'. Derived from an understanding of agrarian change rooted in the work of Eugene Preobrazhensky (1965, orig. 1926), this problematic is based upon an argument first identified in classical political economy: that agriculture has the potential capacity to produce food and non-food output and financial resources above its consumption, reproductive, rental and cultural requirements, and that this 'agricultural surplus' could be used to support the substantial resource costs of industrialization, structural transformation, accumulation and the emergence of capital, both within agriculture and beyond. This problematic therefore seeks to understand the extent to which

3 For a review essay of the classic book by T. J. Byres (1996) see Akram-Lodhi (1998).

agriculture can supply a surplus and meet the resource costs of industrialization, the ways by which such a surplus can be mobilized to fund industrialization and accumulation, and the ease or difficulty with which such a mobilization may occur (Byres 1991).

The second problematic Bernstein called ‘production’, and has its origins more centrally in the classic work of Kautsky (1988) and Lenin (1964) and, to a lesser extent, Marx (1976). This problematic explores ‘the extent to which capitalism has developed in the countryside, the forms that it takes and the barriers which may impede it’ (Byres 1991: 10). As has just been stressed, a central moment in the development of rural capitalism is the emergence of generalized rural wage labour and, as a corollary, the emergence of agrarian capital as a consequence of ‘the dispossession of pre-capitalist predatory landed property and the peasantry’ (Bernstein 2006: 451). This dispossession can come about as a result of extra-economic appropriation – capitalism from above – or as a consequence of the normal, everyday working of socially-embedded markets within which asymmetrical relations of power, privilege and status can be expressed – capitalism from below. Thus, this problematic explores the issues affecting the structural transformation of petty commodity producing peasant labour into its commodified form, labour-power, through both the restructuring of rural labour processes, shifts in the technical coefficients of production, and processes of peasant class differentiation, processes that were highlighted by Engels, Kautsky and Lenin, but also by Marx.

The third problematic Bernstein called ‘politics’, and is drawn directly from the classic theorization of Engels (1950). In countries which have or which have had large peasant populations, political formations and forces seeking social justice and human emancipation have had to explicitly seek to create and sustain alliances with strata within the peasant population when such political formations and forces have been successful in facilitating social, political and economic transformation. This problematic I would render in more specific terms: that, following the debate on the transition from feudalism to capitalism (Sweezy *et al.* 1976, Aston and Philpin 1985) and Byres (2006) critique of Brenner (1977, 1986), struggles over class, the emergence of ‘class-for-itself’ action, the balance of class forces and class struggle should be placed at the heart of the rural politics problematic, in order to make clear the dynamic tensions that exist between prevailing structures of domination, subordination and surplus appropriation and the capacity of individuals and social classes to express agency in order to transform and transcend these structures. So the politics problematic examines the impact of the balance of class forces on political forms and processes and their subsequent impact on the evolution of agrarian change and structural transformation. The politics problematic is significant because the factors conditioning or constraining the agrarian change explicit in both the accumulation and production problematics can shape and be shaped by rural struggle.

Agrarian transition and contemporary historical puzzles

Bernstein’s (1996/97) review of Byres (1996) goes beyond a focus on the analytical components of the agrarian question, emphasizing that Byres (1991) had argued that in order for farming as an activity and agriculture as a sector to no longer pose any obstacles to the capitalist transformation of a society the agrarian question must be ‘resolved’ through some form of successful ‘agrarian transition’. In 1996 Byres defined a capitalist agrarian transition as ‘those changes in the countryside of a poor country necessary to the overall development of capitalism and its ultimate dominance in a particular national social formation’ (Byres 1996: 27). Highlighting the concept of agrarian transition allows the agrarian question to be situated historically and spatially, and in so doing it becomes apparent that the character of the agrarian question will be enormously varied: that there will be different agrarian questions depending upon time and place, and thus how the agrarian question is answered through specific agrarian transitions will differ in different times, places and spaces. At the same time, it is apparent that the character of the agrarian question and the specific process of agrarian transition will be shaped by broader social and structural forces in the wider political economy.

Thus, the agrarian question is imbued with manifest complexity, generating the 'substantive diversity' that gives rise to what Byres has termed 'historical puzzles' (1996: 15): contemporary agrarian transitions that do not result in the full development of capitalist social relations of production and where a multiplicity of contrasting social forms might not even resolve the agrarian question (Byres 2003). Understanding these historical puzzles requires focusing upon the specificity of the conjuncture and the character of the prevailing pattern of social property relations, as was made clear by Robert Brenner (1986) and Ellen Meiskins Wood (2009) in their analysis of the transition from feudalism to capitalism. Brenner profoundly disagreed with an implicit assumption, which some would mistakenly trace to Marx, that within the interstices of feudalism lay the basis of capitalism waiting to be unleashed (Akram-Lodhi and Kay 2016). Brenner argued that this was not a historical materialist analysis, and indeed went further when he argued that a historical materialist analysis not only could but had to demonstrate that it was the social property relations of feudalism itself that resulted in its collapse.

In Brenner's argument – and the argument of others – surplus appropriation under feudalism was the basis by which the dominant landlord class reproduced itself. Surplus appropriations from the peasantry were carried out through the mechanism of rent and backed up by coercion. Production was organized through the institution of serfdom to fit the needs of surplus extraction by the lords. Peasant ownership of land was by and large excluded. Social property relations thus resulted in lords and serfs not having to rely on the market. Reproductive strategies, focused not on accumulation but on familial consumption, reproduction, rent and cultural needs, were the logical outcome of such social property relations. So for Brenner feudal social relations of production could not develop the forces of production because lords ultimately used force to appropriate the agricultural surplus of the peasantry, not having to rely upon markets. Lords could increase their incomes by making peasants work harder, work longer, or reducing their incomes, but there was neither incentive nor need to systematically improve efficiency, productivity and competitiveness.

The material benefits of heavy surplus appropriation thus gave no incentive for the dominant classes to innovate, while the peasantry lacked both the incentive and the means to invest. As a result, the productivity of land dropped over time and an exhaustion of peasant production emerged. The class structure of feudalism thus precipitated a crisis of productivity that threatened the basis of subsistence for the rural population. This crisis broke down the inhibiting effect of the lord's coercive capacity among the peasantry. Conflict was the result, which took the shape of class struggles over the control of surpluses and possession of the means of production. These struggles occurred from the 14th century to, in some parts of Europe, the 18th century and beyond (Sweezy *et al.* 1976; Aston and Philpin 1985; Brenner 1986; Hilton 1990). The outcomes of these struggles were regionally- and conjuncture-specific, being based upon the prevailing balance of class forces. In some areas, such as France, the direct producers took control of the land. Freed of the burden of surplus extraction, they could invest to overcome productivity decline. As output increased and surpluses accrued, the gains to be had from the pursuit of efficient, market-oriented competitive strategies became clear. The law of value became binding, market imperatives were imposed, and capital accumulation was fostered. In other areas, such as England, the crisis meant that both landlords and peasants had to become more competitive in the market and more productive on the land: in the lord's case, in order to increase the rents that they were paid, and in the tenant's case in order to keep and indeed enhance their access to land. Those who were not competitive were driven off the land, either by coercive and exclusionary dispossession or through the normal workings of market imperatives, the emerging law of value, and a resulting process of 'market-led enclosure' (Akram-Lodhi 2007). As serfs became separated from the land they had to rely upon the market for subsistence, which became commodified. With a growing demand for commodified subsistence goods and lacking access to secure surpluses, individual landlords started to move directly into agricultural production. Falling under

the sway of market relations and the law of value meant having to compete, which entailed both labour-productivity enhancing specialization and innovation. Those that were competitive and more productive increasingly commodified their output, facilitating the emergence over time of agrarian capital in England, with landlords, capitalist tenants and waged labour. Agrarian production responded and capital accumulation in agriculture began. Again, agriculture was transformed. In yet other areas in Europe the result was the emergence of new, commercially-based tenancy arrangements. In all these instances, then, the law of value was imposed on the countryside.

The key to capitalist agrarian transition in Europe was thus an economic crisis in the pre-capitalist mode of production that the social property relations of that mode could not resolve. So Brenner (1986) argued that capitalism emerged because of the relationships between lords and peasants trying to best reproduce themselves within the conditions that they faced. For Brenner, as for Wood (2009), it was not markets and trade, which had existed for millennia, which fostered change and social transformation. Rather, in the genesis of agrarian capitalism the structure of social property relations fettered the development of the productive forces and brought about stagnation and eventual decline, fostering class struggles that gave rise to social transformation that was spatially and conjuncturely specific; historical puzzles, if you like. Thus, as a consequence of crisis, pre-capitalist property relations and labour-processes were subordinated and integrated into the value relations of the capitalist mode of production.

In reconciling structure and agency in the explanation of historical puzzles, Brenner rigorously reasserted the centrality of class structure, class relationships and class struggle as the central dynamic variable in understanding processes of agrarian change. In this reassertion, Brenner was able to highlight the importance of the specificity of the conjuncture in producing substantive diversity in processes of change along with the differential uniformity of the outcomes that were generated. In other words, Brenner has offered an analytical approach that seemingly explains Byres' historical puzzles. What is far less well understood is that the complex multiplicity of actual forms of capitalist agrarian transition was in fact well understood by Marx himself.

Marx had noted that 'the entry of capital into agriculture as an independent and leading power does not take place everywhere all at once, but rather gradually and in particular branches of production' (Marx 1981: 937, orig. 1894). While 'supremacy and subordination in the *process of production* supplant an earlier state of *independence*' (Marx 1976: 1028 – 1029, emphasis in original)

capital subsumes the labour process as it finds it. For example[:] ... a mode of agriculture corresponding to a small, independent peasant economy. If changes occur in these traditional established *labour processes* after their takeover by capital ... in themselves these changes do not affect the character of the actual labour process, the actual mode of working (Marx 1976: 1021, emphasis in original).

Marx called this the formal subsumption of labour to capital: formal in the sense that while the labour-process carries on much as it did prior to the entry of capital, the control of the means of production by capital, and hence the means of subsistence, means that labour is compelled to undertake waged labour, which facilitates capital accumulation. Marx contrasted formal subsumption with the real subsumption of labour: the labour-process itself is transformed by capital as it establishes completely capitalist social relations of production, labour regimes and the law of value in order to produce capital accumulation.

Marx did not stop there, however. He also wrote that the modes and mechanisms by which capital subsumes labour in the establishment of the capitalist mode of production can produce 'certain hybrid forms, in which although surplus labour is not extorted by direct compulsion from the producer, the

producer has not yet become formally subordinate to capital' and the law of value (Marx 1976: 645). It is these hybrid forms that are witnessed in the early stages of capitalist agrarian transition as historical puzzles emerge: petty commodity production becomes slowly, differentially, and highly unevenly subordinated to market imperatives and the law of value. Hybrid forms of labour subsumption in peasant production are witnessed because of the 'contradictory unity' (Bernstein 1991: 418) embodied within small-scale peasant farms as capitalism consolidates and petty commodity production becomes established under it:

The independent peasant or handicraftsman is cut up into two persons. As owner of the means of production he is capitalist; as labourer he is his own wage-labourer. As capitalist he therefore pays himself his wages and draws his profit on his capital; that is to say, he exploits himself as wage-labourer, and pays himself, in the surplus-value, the tribute that labour owes to capital (Marx 2009, orig. 1863).

So while peasants may be dispossessed as capitalism develops, capital can also subsume peasant labour through formal or hybrid forms that may, apparently, consolidate the peasantry. The peasantry would outwardly appear unchanged even as capital produced a fundamental transformation in its social characteristics: there would be an ephemeral yet substantive separation of means of production and labour within the peasant farm. Indeed, this is precisely what transforms small-scale pre-capitalist peasant farms into small-scale petty commodity producers under capitalism (Gibbon and Neocosmos 1985; Bernstein 1991).

The transformation of the social characteristics of the peasantry belies their apparent resilience in the face of capitalism. Peasants survive; but their poverty is created because of coping mechanisms that are employed by petty commodity producers under capitalism:

the smallholding peasant's exploitation is not limited by the average profit on capital, in as much as he is a small capitalist; nor by the need for rent, in as much as he is a landowner. The only absolute barrier he faces as a petty capitalist is the wage that he pays himself, after deducting his actual expenses ... and he often does so down to a physical minimum (Marx 1981: 941 – 2).

Kautsky grasped this essential insight into petty commodity production under capitalism, evocatively writing that for peasant farmers 'profit did not mean his barns were full; it meant their stomachs were empty' (Banaji 1980: 70).

So 'smallholding and petty landownership ... production ... proceeds without being governed by the general rate of profit' (Marx 1981: 946), which can foster socioeconomic stratification and peasant class differentiation as

the custom necessarily develops, among the better-off rent paying peasants, of exploiting agricultural wage-labourers on their own account ... In this way it gradually becomes possible for them to build up a certain degree of wealth and transform themselves into future capitalists. Among the old possessors of the land, working for themselves, there arises a seed-bed for the nurturing of capitalist farmers, whose development is conditioned by the development of capitalist production (Marx 1981: 935).

So Marx clearly recognized that the process of capitalist development in agriculture can create both peasant dispossession by displacement, or the enclosures of so-called primitive accumulation of which

he wrote about in *Capital*, and peasant dispossession by differentiation (Araghi 2009: 118; Akram-Lodhi 2007), which is driven by the value relations and market imperatives of capitalism to exploit labour, improve productivity and cut the costs of production (Wood 2009).

Formal, real and hybrid forms of subsumption of labour to capital: clearly, in trying to understand the content of the relations of production there was manifest complexity, substantive diversity and conjunctural specificity, as was witnessed in the context of the developing capitalist countries of Asia, Africa and Latin America throughout the 20th and early 21st century. In this light, it is necessary to disagree, profoundly, with perspectives that suggest that the prevailing multiplicity of 'historical puzzles' displays a deeper process, one in which the agrarian question, as an understanding of the processes by which capital-labour relations coalesce and solidify in the countryside, has been rendered redundant; and that the current phase of capitalist development has resulted in the agrarian question, to paraphrase Marx, melting into air. Indeed, adopting a materialist analysis demands recognizing that notwithstanding the significant transfigurations that can be witnessed within actually-existing global capitalism in the 21st century, the agrarian question continues to have resonance, particularly in countries with large agrarian populations, such as India or Brazil, or countries where the demand for food is outstripping its supply, such as parts of sub-Saharan Africa and, in some places, contemporary East Asia (Akram-Lodhi and Kay 2009).

World-ecology and the agrarian question

The understanding of the agrarian question just outlined has shaped the work that I have done for more than three decades, and in particular the empirical research that I have conducted in Pakistan (1993), Fiji (2016) and Vietnam (2005). However, Jason W. Moore's (2015) magisterial *Capitalism in the Web of Life* has convinced me that my failure to properly account for ecological stocks, flows and surpluses and their role in the development of capitalism in farming and agriculture has led to significant errors of omission that require correcting. Moore's "ambitious project aims to account for ... [a] ... longer history of capitalism in terms of the connections between patterns of accumulation, their increasingly extensive geography of 'commodity frontiers' (in farming, forestry, mining, energy) and ecological change" (Bernstein 2010: 33), and while my work has not been about a longer history of capitalism it has been nonetheless deficient in how it approaches ecological change.

As Moore (2015: 4) might put it, 'the creative, generative and multi-layered relation of species and environment' must be integral to any agrarian question because farming not only uses soil, water, plants and other elements of nature to grow crops and rear animals for direct use or for trade but is itself shaped by the nature, territories and landscapes within which it is situated. For Moore, then, it is necessary to situate any agrarian question within the *oikeios*: 'the relation through which humans act – and are acted upon by the whole of nature – in our environment-making' (Moore 2015: 4). In other words, (farm) production works through nature and nature works through (farm) production.

More specifically and contemporarily, capitalism works through nature and – critically – nature works through capitalism, and, for Moore, nowhere is this more obviously apparent than in farming as a productive activity and agriculture as an economic sector. In this light, the agrarian question must be located within the specifics of the world-ecological context within which it is asked, because these contexts are predicated upon a specific configuration of the forces and relations of production within a historically-constructed nature that is 'both producers *and* products of capitalist development' (Moore 2015: 19).

For Moore, capitalism is 'a set of relations through which the "capacity to do work" -- by human and extra-human natures – is transformed into value' (Moore 2015: 14). I must confess that one key aspect of Moore's point of departure – the 'work' of extra-human natures – took me a long time to

comprehend. However, I came across the work of Nicolas Blomley, a geographer at Simon Fraser University with an interest in property, in the form of land. In writing about the enclosures, which I discussed above, Blomley centers his argument on the social power of hedges. The argument is so interesting that it is worth noting at length:

The work that the hedges did, which was often complicated and even contradictory, was both resolutely material and also representational ... The hedge both helped to concretise a new set of controversial discourses around land and property rights, and aimed to prevent the forms of physical movement associated with the commoning economy ... [T]his spatial discipline was socially directive: in other words, it drew from and helped produce an emergent set of social hierarchies that rested on developing conceptions of private property ... [N]ew forms of discipline ... materialised in the hedge ... Hedges ... signified[,] ... but ... note the complicated material dimensions to the sign ... As both a barrier and a sign, the hedge was a powerful machine of enclosure. However, its very materiality made it vulnerable to those who opposed privatisation (Blomley 2007: 5).

Tania Murray Li makes the same point in the excellent (2014) *Land's End: Capitalist Relations on an Indigenous Frontier*, when she argues that capitalist relations were not imposed upon the indigenous Lauje highlanders of central Sulawesi, Indonesia, but rather emerged within the conjuncture when the introduction of 'new tree crops did the transformative work' (Li 2015: 89) of excluding kin, crossing social boundaries between spatially distinct groups of farmers, and facilitating 'state validation' (Li 2015: 109) of the claims of some highlanders, all of which was necessary to bring about enclosure. This had the eventual effect of terminating the supply of land that could be enclosed: land's end.

This conception of the 'work' of nature is in fact implicit in Marx (1976: 133):

Use-values like coats, linen, etc., in short, the physical bodies of commodities, are combinations of two elements, the material provided by nature, and labour. If we subtract the total amount of useful labour ... which is contained in the coat ... a material substratum is always left. This substratum is furnished by nature without human intervention. When man engages in production, *he can only proceed as nature does herself, i.e. he can only change the form of the materials* (emphasis added).

Perhaps it was, in part, the extent of the correspondence between the work of humans and the work of nature that led Marx to privilege the word 'labour' over the word 'work'.

In conventional historical materialist political economy human work under capitalism takes the form of commodified labour-power that can be exploited by capital. Indeed, an agrarian transition that resolves an agrarian question can have this as its conclusion, as we have seen. However, Moore rightly understands that in capitalism not all work is commodified. Moreover, to this we now have the work of nature. Moore's central analytical argument, then, is that capital accumulation requires the non-commodified work of humans and the work of nature because 'the exploitation of wage-labour works only to the degree that its reproduction costs can be checked' (Moore 2015: 16). Reducing the costs of reproduction requires 'massive contributions of unpaid work, outside the commodity system but necessary to its generalization' (Moore 2015: 16 - 17). A key component of unpaid work that is necessary for the commodity system to operate is reproductive labour carried out within household structures. However, 'the domain where unpaid work is produced for capital' is, as we have seen, not 'a narrowly human affair' (Moore 2015: 17). Unpaid work 'also involves the unpaid work of extra-human natures'. Moore (2015: 17) 'names those extra-economic processes that identify, secure, and channel

(human and extra-human) unpaid work outside the commodity system into the circuit of capital' 'appropriation'.

Thus, in Moore's understanding of capitalism, 'value operates through a dialectic of exploitation and appropriation. The relations of exploitation produce abstract social labour. The relations of appropriation, producing abstract social nature, enable the expanded accumulation of abstract social labour' (Moore 2015: 16) and hence surplus-value. So important is this interrelationship that a 'rising rate of exploitation', which drives capital accumulation, 'depends upon the fruits of appropriation derived from Cheap Natures, understood primarily as the "Four Cheaps" of labour-power, food, energy and raw materials' (Moore 2015: 17). As a result, 'appropriated nature becomes a productive force' (Moore 2015: 16) in capitalism.

In some ways, Moore is offering a radical re-reading of a strand of historical materialist political economy that can be traced back to Rosa Luxemburg, who had argued (1968: 365; orig. 1913) that 'capitalism in its full maturity ... depends in all respects on non-capitalist strata and social organisations existing side by side with it ... [T]he accumulation of capital becomes impossible ... without non-capitalist surroundings'. However, whereas Luxemburg focuses upon the interrelationships between capitalist and pre-capitalist modes of production, Moore's approach is to offer a periodization of capitalist development that reflects shifting access to, use, and depletion of ecological stocks and how such stocks in and of themselves 'work' to shape capitalist development. As he writes (Moore 2015: 18), 'every phase of capitalism has woven together new *and* old strands of the *oikeios*: thus do new historical capitalism and new historical natures flow together'.

In an era in which grand historical narratives rooted in meta theory have been dispensed with, Moore offers a sweeping panorama of historical capitalism and historical natures that situates the origin of capitalism not in the industrial revolution but in the period after 1450 and carries the story through to the present day, arguing that 'capitalism has exhausted the historical relation that enabled it to appropriate the work of nature with such extraordinary and unprecedented power' (Moore 2015: 295). However, for the everyday working agrarian political economist, rooted in the messy complexities of the here and now, and who must focus their attention 'violently' on the 'discipline of the conjuncture' (Hall 1988) in order to understand what is specific and different about the present, the central question that emerges from Moore's meta theory is: how can I use it? What are the methodological implications of the web of life that might facilitate its operationalization so that it could be used to empirically capture the processes of agrarian change confronting living rural communities in the fields of Asia, Africa and Latin America?

Here, I think that the answer is clear: there is a pressing need to 'get real' about the relationship between gender, ecology and the agrarian question. Over the last 40 years these two key 'missing links' within the agrarian question have become central to social theory but have all too often been absent from or marginal to discussions on the agrarian question. Thus, while these two missing links were noted in Akram-Lodhi and Kay (2010), the methodological implications of them for a concrete analysis of a concrete situation were not explored. In what follows, then, I turn to some of the methodological implications of the web of life for investigating agrarian questions.

Gender and the agrarian question

Political economy does provide a reasonably adequate starting point for understanding aspects of gender relations within capitalism in *The Origin of the Family, Private Property and the State* (Engels 2010, orig. 1884). Here, Engels wrote that

according to the materialistic conception, the determining factor in history is ... the production and reproduction of immediate life. This ... is of a twofold character: on the one side, the production of the means of existence, of food, clothing and shelter and the tools necessary for that production; on the other side, the production of human beings themselves, the propagation of the species. The social organization under which the people of a particular historical epoch and a particular country live is determined by both kinds of production (Engels 2010: 35 - 6).

Engels' fundamental point remains valid: the interrelationship of production and reproduction must be central to the understanding of both history and contemporary agrarian questions. Indeed, this was why I got started in agrarian political economy (Akram-Lodhi 1992) and it continues to heavily shape the work that I do.

Within capitalism production is for the purpose of capital accumulation, while reproduction is for the maintenance of life. Production for the purpose of capital accumulation takes place under capitalist social property relations and the market imperatives and labour-processes that these generate. Reproduction for the maintenance of life takes place within the social institution of the household, which historically and contemporarily witnesses non-commodity production, consumption, and labour-processes that are held together by the extra-economic compulsions of patriarchal ideology.

This begs a question that has bedeviled feminist political economy for decades: what is the relationship between production and reproduction? Here, historical materialist political economy has been especially weak. For Marx, 'the value of labour-power is the value of the means of subsistence necessary for the maintenance of its owner' (Marx 1976: 274). Marx further argued that the value of the means of subsistence is the value of the labour-power which goes into the creation of these subsistence commodities. However, as has been recognized for decades, this is a circular argument. The labour time necessary to replenish labour for commodity production is not equivalent to the labour-power embodied in the means of subsistence because reproductive labour is also required to convert commodities into use-values which are capable of regenerating labour. This gave rise, in the 1970s, to the so-called 'domestic labour debate', which tried to specify the relationship between productive and reproductive labour (Molyneux 1979). However, there is more. Within the concept of 'reproduction' can in fact be found three distinct social processes: biological reproduction, labour force reproduction and social reproduction (Edholm, Harris and Young 1978). In all three instances, reproductive labour must temporally precede productive labour.⁴ This means that reproductive labour is a socially-necessary component of a mode of production, including the capitalist mode of production.

It is at this point that gender intersects with the mode of production. Gender ideologies use biological differences between females and males to construct socially-defined differences that result in the asymmetrical assignation of tasks to specific genders. Biological sex is a powerful, available metaphor for organizing society, generating a system of symbols which can interact with institutions, the political economy and nature to structure social relations between genders. The result is a gender-typing of tasks that is most regimented in those activities which focus upon reproduction and which require reproductive labour: caring for children and the aged, cooking, cleaning, household maintenance activities and any non-commodity production that is required for reproduction such as collecting water and fuel. Today, these tasks are called unpaid care and domestic work, and in many societies these tasks are strongly tied to the dominant gender identity of women.

The gender-typing of tasks thus results in the reproductive labour process becoming stereotypically

⁴ Interestingly, this historical materialist point can also be rendered in the language of capability theory; see Akram-Lodhi (2015)

assigned to females. The result is a hierarchical social relation of reproduction which, as a consequence of patriarchal gender ideologies, produce the structural control of female labour and labour-processes by males. Moreover, structural control makes female claims upon shares in net household product conditional on the fulfilment of ideologically-based ideals concerning behavioural patterns and relational roles which merely serve to deepen female subordination (see Pearson et al 1984).

Recalling the above point that reproductive labour must temporally precede productive labour, the gender division of labour that results from the social relations of reproduction has three critical implications for historical materialist political economy. The first is that in capitalism reproductive labour can be thought of as 'producing' the labour required by capital. As Marx wrote, 'the maintenance and reproduction of the working class remains a necessary condition for the reproduction of capital' (Marx 1976: 718). This is however a two-sided process, as Moore might suggest; reproductive labour shapes capital by producing the labour it requires, while at the same time capital shapes how reproductive labour produces labour. In any event, reproductive labour is integral to the complete process of capitalist production, reproduction and accumulation even if it is not explicitly subsumed within such a process.

The second implication for historical materialist political economy is that if it is accepted that the value of the share of net household product accruing to those performing reproductive labour may be less than the cost of purchasing such services on a market, it then follows that if measured in terms of the market-determined opportunity cost of labour the remuneration for the performance of reproductive labour is below that which would be obtained in the labour market. Assessed in terms of the returns to labour, the gender division of labour does not result in the exchange of quantitative equals. At the same time, if assessed in terms of the results of work performed the gender division of labour does not result in the exchange of qualitative equals – in historical materialist language reproductive labour produces use-values while productive labour produces exchange-values. These inequalities are obscured by the private and non-market-oriented character of reproductive labour. The fact remains however that the gender division of labour is fundamentally a mechanism of unequal exchange, which is only logical considering the fact that it is a result of a hierarchical social relation of reproduction.

The third implication for historical materialist political economy is that it is possible to conceive of reproductive labour affecting the rate at which surplus labour is extracted from exploited productive labour. As Beechey (1987: 62) wrote, 'capital can pay wages below the value of labour-power where his wife is engaged in ... [reproductive labour,] ... through which she can contribute to the reproduction of herself, her children and her husband'. Reproductive labour thus lowers the overall value of labour-power by producing use-values that contribute to the reproduction of labour-power without being accounted for in wages equivalent to the value of the means of subsistence (Harrison 1973; Beechey 1987). Indeed, Marx wrote (1976: 747 – 8) that

reduction of the wage of labour beneath ... [the] value [of the labour-power] ... plays too important a role ... In fact, it transforms the worker's necessary fund for consumption ... into a fund for the accumulation of capital.

In this way, reproductive labour raises the rate of exploitation. As a consequence, it is to be expected that gender subordination dynamically interacts with the agrarian question and processes shaping the development of capitalism in agriculture. The production and extraction of surpluses, peasant class differentiation, mechanization, proletarianization and dispossession will affect females and males in both uniform and different ways, the latter occurring because of the differential productive and reproductive labour-processes within which they are engaged.

Thus, as Bridget O’Laughlin (2009) has cogently argued, the production, accumulation and politics 'problematics' of the agrarian question have profound gender dynamics. Gender is a relation of production and reproduction that encompasses cooperation, conflict and contradiction and which as such directly impacts upon the process of production; unpaid care and domestic work can play a central role in both the process of production and the process of accumulation; and gender relations shape and are shaped by the balance of class forces and the operation of the formal and informal political institutions that result from the balance of class forces. As a result, a failure to address the gender dimensions of production, accumulation and politics renders any understanding of the agrarian question, at best, as highly partial and, at worst, as wrong. The agrarian question must interrogate the character of gender relations and the ways in which they impinge upon and refract through the resolution or otherwise of the agrarian question, and in so doing address contradictions of class and gender if it is going to offer an account of social change in contemporary rural settings.

Ecology and the agrarian question

Any account of Marx's ecology must engage with the extraordinary work of John Bellamy Foster (2000, 2009), who has excavated it. In *The Economic and Philosophical Manuscripts* (1974: 328; orig. 1844) Marx wrote that 'man is a part of nature...Man lives from nature; ie, nature is his body and he must maintain continuing dialogue with it if he is not to die'. Humans maintain their dialogue with nature through labour, which

is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates and controls the metabolism between himself and nature. He confronts the materials of nature as a force of nature. He sets in motion the natural forces which belong to his own body, his arms, his legs, head and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature...[The labour-process] is the universal condition for the metabolic interaction [*Stoffwechsel*] between man and nature, the everlasting nature-imposed condition of human existence ... (Marx 1976: 283, 290)

With nature providing the material means of life and (some of the) tools needed to access those material needs, the production of goods and the reproduction of the species results in energy and materials being appropriated by humans as use-values to satisfy human needs and generating a material by-product, waste. Thus, as Marx (1976: 42; orig. 1845) wrote, 'the first historical act' is 'the production of the means to satisfy these needs, the production of material life itself'. However, as noted above and on which Marx is exceedingly clear, 'labour is *not the source* of all wealth. *Nature* is just as much the source of use values (and it is surely of such that material wealth consists!) as labour, which itself is only the manifestation of a force of nature, human labour power' (Marx 1970: 13). As a consequence, over the course of his life Marx was reasonably consistent that nature and social relations are not independent of each other; rather, they co-evolve: 'the production of life ... appears as a twofold relation: on the one hand as a natural, on the other hand as a social relation' (Marx 1975: 48 – 9). Thus, the “unity of man with nature” has always existed in industry ...just like the “struggle” of man with nature' (Marx 1977: 174). In this way, Marx's conception was that the way in which human society relates to the natural world makes life and society possible, and that this in turn, *pace* Moore, is shaped by the natural world itself.

The development of capitalism ruptures the relationship of human society to the natural world because capitalism commodifies. Commodification requires undermining a 'whole gamut of permanent conditions of life required by the ... generations' (Marx 1981: 754 fn 27). It not only requires commodifying labour by creating labour-power, as is emphasized in the analysis of agrarian transitions.

It also requires commodifying nature: land, materials and tools, and the energy used in the labour process. The process of commodification appropriates and then encloses nature as private property emerges, but, *pace* Moore, the character of nature itself also shapes what is appropriated, what is enclosed, and what is rendered as private property. In so doing, enclosure and commodification turns use-values into exchange-values not only as capitalism develops but as a continual and ongoing process under capitalism (Akram-Lodhi 2007).

Commodification has two crucial implications in Marx's ecology. First, when commodified and then exploited by capital labour is subjected to a process which severs it from its direct relation with nature. As Marx wrote in the *Economic and Philosophical Manuscripts*, 'alienated labour alienates (1) nature from man, and (2) man from himself, his own active function' (Marx 1977: 81-2). Thus, it is under capitalist production that nature becomes alienated from people. Second, capitalism undermines biological balances within nature because of its relentless alienation and commodification. As he states in *Capital*, the development of private property and hence capital in farm production and the agricultural sector gives rise to an 'irreparable rift in the interdependent process of social metabolism, a metabolism prescribed by the natural laws of life itself' (Marx 1981: 949). This is because it

disturbs the metabolic interaction between man and the earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil ... Thus ... capitalist production ... only develops the techniques and ... the social process of production by simultaneously undermining the original sources of all wealth – the soil and the worker (Marx 1976: 637-8).

This, then, is Bellamy Foster's 'metabolic rift' (2000) between humans and nature, which he attributes to Marx and which is expressed in *Capital* as a rift between town and country. What Moore brings to the discussion of the metabolic rift is that not only does the development of capital lead to a rift between people and nature but that nature also shapes the development of capital and thus the character of the rift that emerges.

At the same time, Marx has an exceedingly clear understanding of how the metabolic rift is to be repaired. In *Capital* he writes that the 'systematic restitution' of conditions that re-establish the metabolism between humans and nature is 'a regulative law of social production, and in a form adequate to the full development of the human race' (Marx 1976: 638). This has within it two key implications. The first is that Marx invents the paradigm of human development 120 years before Amartya Sen (Harriss-White 2012a). Second, through the idea of systematic restitution Marx develops a preliminary definition of what we now call sustainable development. Restitution is drawn from his reading of Justus von Liebig's understanding of soil fertility, and leads him to conclude in volume 3 of *Capital* that 'societies ... are not the owners of the earth. They are simply its possessors, its beneficiaries, and have to bequeath it in an *improved state* to succeeding generations' (Marx 1981: 911, emphasis added). This is a much more demanding definition of sustainable development than that which is currently used, as it stresses the central need not to maintain ecological conditions but to improve ecological conditions.

Facilitating restitution, transcending the metabolic rift, and establishing the foundations of sustainable human development was discussed by Marx in volume 3 of *Capital*. He wrote that 'freedom ... can only consist in this, that socialized man, the associated producers, govern the human metabolism with nature in a rational way ... with the least expenditure of energy and in conditions most worthy and appropriate for their human nature' (Marx 1981: 959). For Marx, this is not compatible with capitalism, because

nature had been alienated. The application of industrial methods to farming created pressures to maximize returns and thus became 'the means of exhausting the soil' 'at heavy expense' (Marx 1981: 949 – 950); the deepening of the metabolic rift is intrinsic to capitalism. So there can be little doubt that for Marx truly sustainable human development *is* socialism, and it is only by examining Marx's ecological materialism that this can be unpacked. As I have stressed, Marx writes at the beginning of *Capital* that 'labour is ... not the only source of material wealth ... labour is the father of material wealth, the earth is its mother' (Marx 1976: 134). As Frederick Soddy later commented, 'Marx's disciples ... forgot all about the mother' (quoted in Harriss-White 2012b: 102).

Thus, as Piers Blaike (1985; see also Wisner, Blaikie, Cannon and Davis 2014), Michael Watts (2009), and John Bellamy Foster (2000) have in effect argued, the production, accumulation and politics 'problematics' of the agrarian question shape and are shaped by the ecology of farm production: the agroecological setting by definition must directly impact upon the process of production, whether it be in the assets that are available to rural producers, the adoption of techniques and technologies that are or are not suitable to the agroecology, and in the food and non-food products that are eventually produced using agroecological resources. In this way, the landscape shapes production, just as production shapes the landscape. In so doing, agroecological resources, whether or not expressed in monetary values, can contribute to or constrain the process of accumulation even as the process of accumulation shapes ecological stocks, flows and surpluses. Furthermore, the balance of class forces and the operation of the formal and informal rural political institutions that result from this balance shape and are shaped by a set of ecological social relations between people and nature through which individual and collective agency are refracted. In this way, a failure to address the ecological dimensions of production, accumulation and politics renders any understanding of the agrarian question, at best, quite limited. The agrarian question must critically investigate the character of ecological relationships and the ways in which they impinge upon and alter the resolution or otherwise of the agrarian question, and in so doing address contradictions of class and ecology if it is going to offer a well-rounded account of social change in contemporary rural settings.

A question of method

The implication of the analysis so far is that a fuller account of the agrarian question in a specific setting requires, in addition to a focus on production, accumulation and politics, an assessment of how gender and ecology shapes and is shaped by production, accumulation and politics. The question which then flows from this is: how? What are the methodological guidelines that can shape and ground such an analysis? In this regard, for the conventional parameters of the agrarian question, there are well-established methodologies and methods. However, for the issues of gender and ecology, there is much less clarity. In part, this lack of methodological clarity is the purpose of this paper. With this in mind, this section will review the methodological guidelines that can drive an empirical investigation of the agrarian question, in both its conventional 'problematics' and in its gender and ecological dimensions.

Prior to such a review, however, there is a critical caveat to elaborate. Market-derived prices and quantities of are the common yardstick of empirical investigation; yet such an approach, while capable of generating important insights, is at the same time woefully inadequate on its own, within the context of historical materialist political economy. The reason for this is twofold. The first is that in rural economies undergoing some form of agrarian transition petty commodity peasant producers are only partially integrated into market processes (Ellis 1992: 9). Moreover, those markets within which they do operate are both highly imperfect and highly incomplete, being 'socially embedded' (Polanyi 2001) and thus politically constructed so as to be mechanisms through which power can be expressed (Akram-Lodhi 2001). This means that market prices may be poor guides to social relations in many settings, and moreover that shadow pricing is an exercise of little practical use in the context of politically-constructed markets. Thus,

the pricing of unpaid care and domestic work and 'natural capital' are both misguided. The second reason is that if, temporally, ecological stocks and unpaid care and domestic work precede any market-oriented activities, then it is necessary to construct methodological frameworks that are independent of markets but which can incorporate market-based activity. An alternative mechanism of empirical investigation is therefore required.

Production and accumulation

Classes and the class formation that is underscored in the agrarian question can be defined, in classical historical materialist fashion, by their relationship to the principal means of production. This in turn defines the relationships under which surplus labour is appropriated from the direct producers, and thus relations of exploitation. This provides a key empirical insight into understanding peasant class differentiation: whether an individual or a farming household is exploiting or being exploited. As stressed by Utsa Patnaik (1987), wage labour and land rent are the main avenues by which surplus is appropriated in rural economies; to this one might also add the terms of trade for marketed products (Harriss 1982) and debt (Deere and de Janvry 1979). However, in an important insight Patnaik noted how these forms of surplus appropriation are predicated upon the expenditure of labour, whether it be of household members or people from outside the household. Therefore, these forms of surplus appropriation can be expressed in terms of the labour expenditure that is facilitated. Moreover, the labour expenditure that is facilitated must by definition have an affect upon the overall composition of household labour expenditure between employment for others and self-employment. Patnaik therefore argued that labour employment, of others and of the members of a household, relative to self-employment, be used as a preliminary method of classifying a given sample of peasant households into class categories which reflect economic strength. This she called the 'labour-exploitation criterion'. Further, in that it reflects the basis of production labour employment relative to self-employment should correlate with possession of the means of production and surplus generation, allowing insights into transformations into production processes and the character of accumulation to be uncovered.

The labour-exploitation criterion is predicated upon an assumption that labour is relatively homogenous and substitutable, which is not a stringent assumption in agrarian settings. As a result, the labour-exploitation criterion has been used in several settings to examine the character of the agrarian question (Patnaik 1987, Akram-Lodhi 1992, Bhattacharyya 2005, Rakshit 2016). It requires that empirical research undertake time use studies that explore the allocation of labour amongst various activities during the course of a 'normal' working day, working week, or other time period. There are well-established methods for collecting time use data, and several countries do this as a matter of routine.⁵

Gender

Time use data also allows the collection of information on unpaid care and domestic work. The key empirical issue, then, is that labour employment, of others and of the members of a household, relative to self-employment must be related to patterns of reproductive unpaid care and domestic work, which is a precondition of any productive activity. Paddy Quick (1992) has sought to offer an empirical strategy for establishing this relationship by arguing that Marx's socially-necessary labour time should be thought of as having two components. One she terms 'necessary labour', and is performed for the dominant class by household members using the means of production of the dominant class. Such labour produces value which becomes inputs into reproduction labour, either directly or through wage flows obtained by employed household members. The other component she terms 'domestic labour': unpaid care and domestic work performed by household members using such inputs and the insufficient means of production owned by them for the purpose of creating use-values capable of renewing the capacity to work

⁵ A wealth of material can be found at <http://www.timeuse.org/>.

and thus facilitating social reproduction by 'producing' labour. This distinction allows Quick to offer a means of understanding the relationship between unpaid care and domestic work and socially-necessary labour time, and by implication surplus labour, by examining the quantity of time dedicated to unpaid care and domestic work in relation to the quantity of time spent in socially-necessary labour time. Quick's key analytical point is that if the quantity of time dedicated to unpaid care and domestic work is greater than the quantity of time spent in socially-necessary labour time, it might be argued that the appropriation of surplus labour in production was predicated upon unpaid care and domestic work, in that exploitation in the labour market was redistributed within the household through the appropriation of unpaid care and domestic work. Thus, the provision of labour services in labour markets involves an expenditure of labour which is not valorized on the labour market and which, as noted above, is subject to a rate of return below opportunity costs and is therefore the subject of unequal exchange. Such services lower the value of the labour-power that is serviced and hence raise the rate of exploitation, and in so doing contribute to capital accumulation.

Ecology

Gender, production and accumulation can therefore be captured empirically through the use of time use surveys buttressed with other quantitative information around stocks of assets and flows of income. However, when coming to think about empirically capturing ecological stocks and flows without resorting to misguided efforts to shadow price, I must confess that I was stumped. However, I then recalled that Jason Moore (2015: 13) continually directly links work with energy, through the formulation 'work/energy', which is found throughout *Capitalism in the Web of Life*. In order to better understand what Moore means by work/energy, I reread his section on the ecological surplus and the tendency of the ecological surplus to fall during the course of capitalist development. In this section, Moore argues that the 'ecological surplus is the ratio of the system-wide mass of capital to the system-wide appropriation of unpaid work/energy ... The ecological surplus is suggested, albeit too narrowly, by the EROI ratio – energy returned on energy invested' (Moore 2015: 95 – 96). Looking into how ecological economists calculate the EROI, I discovered that investments are translated into kilocalories of energy and returns are translated into kilocalories of energy. This was when I finally 'got' the formulation of work/energy, because labour expenditure can be expressed in terms of kilocalories of energy. But there is more. Production inputs can also be expressed in terms of kilocalories of energy. Production output can also be expressed in terms of kilocalories of energy. In this way, I had stumbled across a new numeraire that could be used to empirically evaluate production, accumulation, gender and ecology: kilocalories of energy.

I am not suggesting that well-rounded empirical research into the agrarian question and agrarian transitions must therefore develop research methods that allow the researcher to comprehensively evaluate patterns of energy flows. What I am suggesting, however, is that time use surveys that can be used to evaluate patterns and relationships between productive and reproductive labour can be fairly easily translated into kilocalories of energy; that some non-land inputs and assets can also be translated into kilocalories of energy, and that there may be a reasonable expectation that these will be correlated with other assets and inputs, including land; and that farm output can also be fairly easily translated into kilocalories of energy. In this way, labour employment, of others and of the members of a household, relative to self-employment can be related to patterns of reproductive unpaid care and domestic work and to the ecological surplus when expressed in terms of kilocalories of energy. Further, in that it reflects the basis of production labour employment relative to self-employment should correlate with kilocalories of energy, allowing insights into ecological surpluses, transformations in production processes and the character of accumulation to be uncovered. We therefore have the research methods needed to better capture actually existing processes of agrarian transition that answer actually existing agrarian questions.

In an otherwise unimpressive work, Thomas Homer-Dixon (2006: 51 - 2) notes that 'in agrarian societies ... where people did most of the farm work, food production ... had to have an EROI of well over 1 to 1 for the society to support any kind of social and technological complexity ... [because] those of us who aren't farmers are essentially parasites on those of us who grow the sources of energy – the grain, vegetables, fruit and meat'. He then quantifies the example of Rome. Homer-Dixon notes that Roman 'farming technologies were remarkably similar to those used today in many rural zones of Asia and Africa' (Homer-Dixon 2006: 52). Historians estimate that in Rome 58 days of labour were needed per year to farm a hectare of wheat, Rome's principle staple food. Each day of labour burns about 3000 kilocalories, and therefore growing and harvesting a hectare of wheat requires 174000 kilocalories. Taking into account the fact that slaves working on wheat estates had to be fed year-round, that there would be spoilage and vermin, and that a amount would also have to be set aside for subsequent seeding, Homer-Dixon arrives at an estimate of energy returned on energy invested for rural Rome of 12:1. This would suggest that the mode of production, shaped by the historical nature of the Roman Empire, rested upon an ecological surplus necessary for the Empire to survive. However, 'as the empire expanded and matured; as it exploited, and in some cases exhausted, the Mediterranean region's best cropland and then moved on to cultivate poorer lands; and as its grain supply lines snaked farther and farther from its major cities, it had to work harder ... to produce each additional ton of grain' (Homer-Dixon 2006: 55) as the ecological surplus dwindled. Thus, declining access to ecological surpluses underpinned the decline of the Roman Empire. This approach also underpins the economic history deployed by Clark in his (2007) brief history of the world.

In exploring the potential role played by kilocalories in understanding processes of agrarian transition, I came across the work of David Pimentel and Marcia Pimentel (2008), professors emeriti at Cornell University, who appear to be the world's leading authorities on energy flows in farming and agriculture. In a lifetime of work, they have painstakingly put together comprehensive assessments of inflows and outflows of energy across a variety of farming systems; their results take into consideration farm labour that does not confront labour markets and common property resources. In other words, they try and incorporate all forms of energy flows in farming, including solar energy. Some of their results are worth reviewing.

Table 1: Energy ratios by crop, farming system and location

Type of farming system	Location	Energy ratio (output/input)
Maize (human power)	Mexico	10.7
Maize (mechanized)	United States	2.5
Rice (human power)	Borneo	7
Rice	California	2
Sorghum (human power)	Sudan	14
Sorghum	United States	2

Source: <http://geo-mexico.com/?p=2548>, accessed on 25 March 2016

In Table 1, farming systems that are defined as 'human power' systems rely on self-employed farm labour, self-provided inputs, and simple tools and equipment such as axes and hoes. No livestock or machinery is used to supplement human labour. Farming systems that are defined as 'mechanized' rely on self-employed and waged farm labour, purchased seeds, herbicides and pesticides, irrigation, farm machinery and gasoline. The characteristics of farming systems that are not defined can be assumed on the basis of their

location, the United States, as being mechanized.

It is easy to demonstrate that in terms of output of maize per hour of labour US farms are always more efficient than Mexican farms. It is also easy to demonstrate that in terms of yields per unit of land American farms are always far more efficient than Mexican farms. More generally, US agricultural value added per worker in 2013 was \$69457; for Mexico, the figure is \$4221. Cereal yields per hectare in the United States in 2013 was 7340 kilograms; for Mexico, the figure was 3387 kilograms.⁶ Thus, by conventional measures American farms are far more productive than Mexican farms. However, in terms of energy ratios, the Mexican farm that relies on human labour is four times more efficient than the American farm that relies on mechanization. As Jason Moore might put it, the productivity of mechanized farms in terms of land and labour is predicated upon significant inputs of unpaid work/energy from within the household and within the web of life, and when such inputs are fully accounted for the productive superiority of the mechanized farm becomes a chimera. Such a finding is consistent with a conclusion reached by Tim Bayliss-Smith (1982) almost 35 years ago: 'only in fully industrialized societies does the use of energy become so profligate that very little more energy is gained from agriculture than is expended in its production.'

This gets to heart of the question of the sustainability of industrialized capital-intensive farming methods; clearly, labour-intensive farming is sustainable virtually indefinitely, given the energy surpluses that they generate, while mechanized farming is quite possibly unsustainable unless it can come to rely on renewable sources of energy such as solar and wind power. It is this that perhaps helps to explain the spectacular productivity performances that have been witnessed in some places using system of rice intensification (SRI) farming methods. SRI is an agroecological approach to farming that originated in Madagascar in the 1980s. More generally, agroecological farming practices adapt crop and input choices to reflect landscapes within which farms are embedded, and use on-farm practices that seek to sustain soil micronutrients over time. SRI, which is one form of agroecological farming, changes the management of plants, soil, water and nutrients in order to increase the productivity of irrigated rice while sustaining soil micronutrients.⁷ The benefits of SRI have been demonstrated in over 50 countries and include yield increases of between 20 and 100 per cent (and in some instances even more), a reduction of up to 90 per cent in seed requirements, savings of up to 50 per cent in water utilization, and a significant increase in employment. Moreover, SRI methods have extended out of rice and into wheat, sugarcane and teff, all of which have witnessed similar benefits. Simply put, focusing analytical attention on inputs and outputs of energy leads to the conclusion that the superiority of industrial agriculture is far from a given, and indeed might be simply wrong.

Conclusion

In this paper I have first reviewed the key propositions of the agrarian question. I have then introduced the challenge to agrarian political economy that has been offered by world-ecology. The focus of my concern has been to evaluate how agrarian political economy might incorporate world-ecological concerns into its analytical frameworks and tools. Flows of labour have been identified as a way of both better understanding the conventional dynamics of an actual agrarian question, but also the role of unpaid care and domestic work in providing the reproductive labour necessary for productive labour to take place. Kilocalories of energy into and out of farms and farm systems have been identified as a means by which the role of ecological surpluses in sustaining or restricting the development of capitalist social-property relations in agriculture might be understood. Moreover, flows of productive and reproductive labour can be expressed in terms of kilocalories of energy. Thus, world-ecology has opened up an entirely new way of investigating actual agrarian questions and processes of agrarian transition.

⁶ <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>, accessed on 26 March 2016.

⁷ <http://sri.cals.cornell.edu/>, accessed on 26 March 2016.

Finally, it is worth reflecting upon the implications of this incorporation of world-ecology into agrarian political economy. Factoring into an analysis the role of unpaid care and domestic work and ecological surpluses renders the supposed productivity benefits of industrial agriculture much more problematic. Indeed, in terms of energy flows, the industrial agriculture that has developed under capitalism has only been able to sustain its productivity by drawing on unpaid work/energy and has faced a binding constraint as ecological surpluses fall. As a consequence, industrial agriculture is, over time, failing to develop the forces of production. In a sense, however, this is not surprising. Recall that for Marx human freedom could only be achieved under socialism. Then recall that in volume 3 of *Capital* Marx wrote that 'freedom ... can only consist in this, that socialized man, the associated producers, govern the human metabolism with nature in a rational way ... with the least expenditure of energy and in conditions most worthy and appropriate for their human nature' (Marx 1981: 959). Thus, it might be suggested that Marx implicitly equated the development of the forces of production with a minimization of energy expenditure. In this light, and given the deep-seated and well-established economic and ecological contradictions of industrial agriculture, it might be suggested that the structure of social property relations under capitalism have fettered the development of the productive forces in farming and agriculture, creating the preconditions for the social and political struggles that could give rise to social transformation. Moreover, from the standpoint of energy flows, productivity per unit of land, productivity per unit of labour, and employment, agroecological farming practices have, apparently, by working with the web of life, continued to develop the forces of production in farming and agriculture. Clearly, there can there be a world-ecological agrarian political economy that investigates world-ecological dimensions of agrarian questions 'in the flesh'. Moreover, it is only world-ecology that allows us to recognize that the continued further development of the forces of production in agriculture may require a broadly-defined agroecological transition.

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