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Unsustainable Agriculture and Land Use: Restoring stewardship for Biospheric Sustainability

Calvin B. DeWitt

> One out of every three people on earth is in some way affected by land degradation. Latest estimates indicate that nearly 2 billion hectares of land worldwide – an area twice the size of China – are already seriously degraded, some irreversibly. This … reduces productivity, disrupts vital ecosystem functions, negatively affects biodiversity and water resources, and increases vulnerability to climate change.
>
> ---Food and Agriculture Organization, Fact Sheet AI559/E (2008)

No longer can we take sustainability of the biosphere and its ecosystems for granted. Humankind has become a major biological and geological force, and is now challenging the very sustainability of the biosphere upon which our and every other living creature's lives depends. Our crisis of changing global climate, worldwide loss of biodiversity, and degradation of land and soils requires that we better understand the biosphere as the system that sustains us and all life and the human institutions that guide and shape our thoughts, actions and enterprise.

Understanding the biosphere and the biospheric economy

The biosphere – the earth-enveloping life-support system upon which we and all living things depend – is dynamically created and sustained by vibrant exchanges, transfers and connections of energy, materials and information. The awe and wonder it generates continues to inspire every human being that takes the time to behold and ponder it; it is a great gift – a gift given and yet not owned by all who receive it. This gift is also a giver of gifts; it gives life through a myriad provisions. While many of these provisions have been appreciated for millennia, others remain to be discovered. They have come to be called 'ecosystem services'. Joined with other provisions – like our star's energetic provision of a broad spectrum of light and our moon's provision of gravitational attraction – ecosystem services help to develop a sense of provenance and providence in the world, and an awesome realization of a dynamic sustaining system of systems that supports and fosters the abundant life of earth.

Ecosystem services, such as those summarized in Figure 1 on page 5 below, are most often dealt with individually; however, each operates not as a soloist but as a vital contributor within a kind of 'biospheric symphony', joining in harmony and intonation with the others. Separable for reasons of study, they are inseparable in performance. Each gains from the dynamic integrity and symphonic gifts of the others, even as each makes its particular contribution. Much as the performance of a symphony cannot be

adequately predicted from hearing a single instrument or seeing musical notation, so also the biosphere. Both the biosphere and a symphony display 'emergent properties' not fully predictable by examining its parts or knowing the score.

Emergent properties increase in scope and service at increasingly higher levels in the biosphere. Investigation of the forests, biomes and biosphere finds that ecosystems are nested (like a Russian babushka doll) within ecosystems. Below the level of ecosystems are still more nested systems such as molecules, atoms and subatomic particles. The beauty of the biosphere – including its social, religious, cultural and financial aspects – emerges from its all-embracing integrity and wholeness. As nested systems within the biosphere stand in relationship to the larger system of which they are part, 'reciprocating systems' relate to others within a particular level. Reciprocating photosynthesis and respiration, for example, use carbon dioxide to assemble carbon skeletons, build cells, tissues and whole organisms, and these, after productively passing through food webs and chains, are disassociated and returned for reassembly. In the biosphere's hierarchy of nested systems, each component satisfies its own needs as well as the needs of the larger system of which it is part. If any system satisfies its own needs but fails to meet the needs of its enveloping system, it is in peril and may also imperil the larger system. It is also imperilled if it serves the needs of its enveloping system at the expense of its own integrity. What this means for agricultural systems is that growing crops and raising livestock 'without regard to ecological relationships' is not sustainable.[1] Not surprisingly, the living fabric of the biosphere and its all-pervasive and systemic beauty – with its nested and reciprocating systems – makes sustainability and unsustainability difficult and challenging to assess. Even more so when human beings work in discord with its biospheric services.

Physical chemist and social scientist Michael Polanyi helps us to understand these systems and their integrated complexity and variety.[2] He observed that every component system has its internal control, even as it is controlled by the system of which it is part: photosynthesis has its own internal controls, but is also controlled by the chloroplasts. The chloroplast, with its own controls, is controlled by the cell within which it operates, and so on to leaf, plant and biome. This dual-control relationship continues up through tissue, organ, organism, ecosystem, biosphere and solar system levels, and beyond. Each system is constrained from being anything other than what is by being held in concert within the larger enveloping system.

When our impact upon or investigation of things is done without considering the controlling levels above, it is necessarily 'reduced' in scope. This is often done intentionally to allow discovery and study of internal controls of the system being studied. And while this is a convenient 'fragmentation', it also often leads to a corresponding reduction in the scope of investigation. While this helps us to understand specific systems, it also reduces our view of its context within the larger whole. Such fragmentation might persist and be mirrored in the classes we teach and the structuring of our colleges and universities, as these are divided and subdivided into disciplines, sub-disciplines and specialities. Disciplinary fragmentation is often mirrored in the structure of the practical institutions we create that produce the products bought and sold in business and industry. Ford Motor Company, for example, largely restricts itself to the production of cars and trucks – intentionally reducing its scope to highway motor vehicles; Ford perceives itself as being primarily in the motor vehicle business, not the

transportation business. By contrast, BP – formerly British Petroleum – has expanded its disciplinary scope 'beyond petroleum' to include the wider energy business, and now is also a major producer of solar panels. Whether more fragmented or less, the arrangements we make for shaping car production, energy technology and all other human action in the world brings us to the topic of 'institutions' and it is to understanding them in relationship to society and biosphere that we now turn.

Understanding institutions

Global changes that contribute to unsustainability at all levels – including weather events, degraded ecosystem services and regional public health issues – require understanding not only of the biosphere, but also of institutions, for it is these that produce and can correct the various social drivers of unsustainability. 'If the world fails to meet the challenge of a transition to sustainable growth in agricultural production, the failure will be at least as much in the area of institutional innovation as in the area of resource and environmental constraints' wrote the distinguished international development economist Vernon W. Rattan.[3] And so, what is meant by 'institutions' and 'institutional innovation'? Rattan and other institutional economists define 'institutions' as the sets of rules, conventions, arrangements and framework that form and shape human actions in the biosphere.[4] Institutions shape human relationships within the world, both in support of the way the biosphere works and contrary to it.

Institutions are the social constructs that frame human action in the world, whether that be at the level of Ford, BP, national governments or the Worldwide Fund for Nature. From the perspective of institutional economics – universities, hospitals, courts of justice, non-governmental organizations (NGOs such as Christian Aid), and food and agricultural organizations (like the United Nations' FAO) are themselves not institutions, but are embodiments of institutions. These organizational embodiments incorporate particular rules and arrangements that define and determine what and how things are accomplished. Institutions are determined by beliefs about society and the wider world and are 'external manifestations' of these beliefs. These beliefs, wrote economist and Nobel laureate Douglass C. North, are 'internal representations' of the world.[5] These internal representations taken together form our worldview, which includes ourselves and what we believe makes for good personal character and wholesome relationships within our families and communities, what we believe to be our purpose in life, and what we believe about everything beyond ourselves – the rest of human society and culture, our view of our biosphere from outer space, our biogeophysical world, the biospheric economy, and our planet's ecosystem services. Together, institutions form the 'institutional structure' that reflects 'the accumulated beliefs of the society over time'.

North emphasizes that our internal representations can displace the 'rationality' of market economics, maximization of profit, and attempts that might be made to disconnect the present from culture and history. The 'uncritical acceptance of the rationality assumption', North warns, 'is a major stumbling block in the path of future progress', and its currently wide acceptance 'forecloses a deeper understanding of the decision-making process in confronting the uncertainties of the complex world we have created.'[6] There is of course another warning needed, and that is the falsehood that the human economy 'trumps' the biospheric economy. The uncritical acceptance of this

assumption may prevent ongoing recognition of increasing unsustainability, such as is represented by eight of its signs presented in this chapter, and may foreclose the critically necessary decision-making and urgent action that is required within our institutions and institutional structure.

What this means for addressing the root causes of unsustainability is that institutions and institutional structure must be developed and maintained to match the changing complexity of the biosphere, biospheric change and the broadening 'reach' of human actions that affect the biosphere and its ecosystem services. It also must be matched to human values and aspirations for a world of justice and vibrant human life and culture. Otherwise institutional decay and ineffectiveness results. In the systems language of the management of business, as developed by cybernetician W. Ross Ashby (1903–1972) and business management professor Stafford Beer (1926–2002), the necessary 'match' of the institution to the complexity and variety of the system it mirrors is the institution's 'requisite variety' – the required dynamic variety that needs to be created and sustained within the institution so that it corresponds to the 'variety' or dynamic complexity of the system within which the institution operates.[7]

As institutions change to mirror better the economy of the biosphere and human values – including their complexity and variety – they will also shape and reshape human relationships with the biosphere. As institutions mirror and complement the world within which they operate, they must mirror not a world compartmentalized into specialties and disciplines but a world of dynamic and ordered complexity and variety – a necessarily ethical world – that we have helped to create and have embedded in the symphonic system of systems we call the biosphere.

With this introduction to institutions and institutional structure, and their critical importance for achieving sustainability and avoiding unsustainability, we now can turn to pursue some signs of unsustainability, particularly with regard to agriculture and land use. From these we will identify some of their associated institutional deficiencies. Once identified, these deficiencies can provide a base for appropriate institutional refinement and reform.

Signs and Drivers of Biospheric Unsustainability and Institutional Deficiency

Degradation of ecosystem services

The current human challenge to biospheric sustainability now extends to disrupt and diminish the very ecosystem services upon which all life depends. This is the finding of the Millennium Ecosystem Assessment, established in 2001 to assess 'the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being.'[8] This first effort by the scientific community to describe and evaluate the services provided on a global scale identified a wide array of vital ecosystem services, some of which are illustrated in Figure 1. Of 24 ecosystem services for which the Millennium Ecosystem Assessment found sufficient information availle for analysis, about 60% (15 out of 24) were found to be degraded or used unsustainably.[9]

Institutional deficiency: services by the biosphere are not returned sufficiently with services of our own, thereby failing to assure their continuance and fruitfulness. Institutions fail to incorporate dynamically more than one or a few ecosystem services, much less the biosphere and the dynamic biospheric economy, and therefore are not sufficiently robust in their dynamic variety to match the dynamic variety of the systems within which they operate.

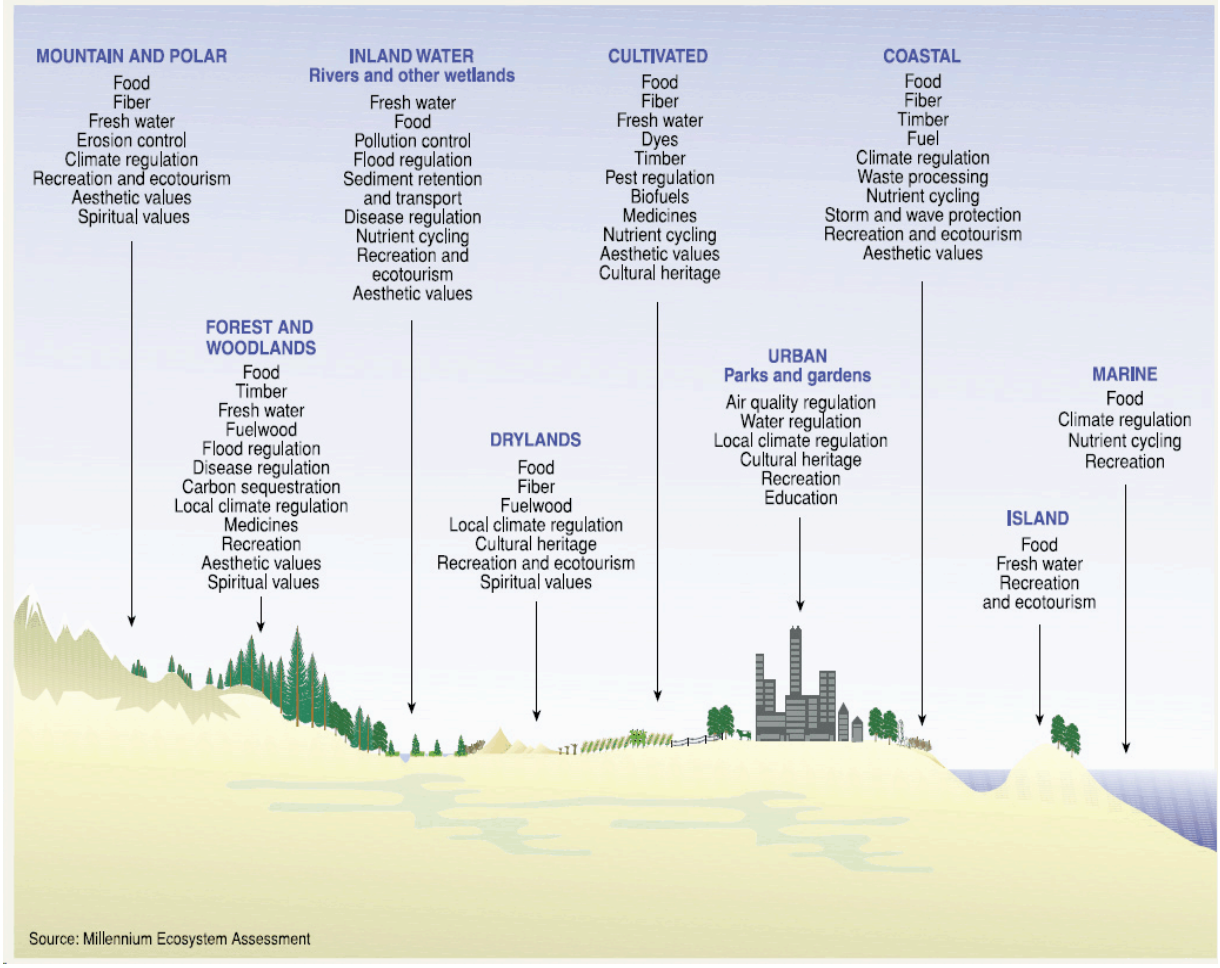

Figure 1. Ecosystem services as identified by the Millennium Ecosystem Assessment and classified into nine major categories. (From www.millenniumassessment.org/en/BoardStatement.aspx.)

Agricultural land and soil loss

Among the signs of unsustainability in agriculture and land use are that, during the latter half of the twentieth, nearly one-third of the arable lands worldwide were lost to erosion and taken out of production. In Asia, Africa and South America, annual soil loss was about 31 tonnes per hectare (ha), and in the USA and Europe about 15 tonnes/ha – losses that contrast sharply with annual soil formation rates, which average about 1 tonne/ha.[10] Soil erosion and degradation is rampant (Table 1). These losses are compounded by associated reductions of water infiltration, soil water-holding capacity, topsoil thickness, soil carbon sequestration (capture), organic matter and nutrients, soil biota and productivity and also by associated increases of water run-off,

surface water overfertilization, silting up of rivers and streams; and by reduction of hydroelectric capacity by silting up of reservoirs.[11]

Institutional deficiency: services by soils to soil formation and sustaining food production are not sufficiently returned with services of our own to assure replacement of soil losses and sustained productivity. As a result land is made unproductive and in time abandoned for food production.

Table 1. Estimates of the global extent in millions of acres (hectares in parentheses) of land degradation

Type	Light	Moderate	Strong plus extreme	Total
Water erosion	847 (343)	1302 (527)	553 (224)	2702 (1094)
Water erosion Wind erosion	664 (269)	627 (254)	64 (26)	1355 (549)
Chemical degradation	230 (93)	254 (103)	106 (43)	590 (239)
Physical degradation	109 (44)	67 (27)	30 (12)	206 (83)
Total	1850 (749)	2250 (911)	753 (305)	4853 (1965)

----From L. Roel Oldeman, 'The global extent of land degradation', in *Land Resilience and Sustainable Land Use*, ed. D. J. Greenland and I. Szabolcs (Wallingford, UK: CABI, 1994), 99–118.

Masking of soil degradation by unsustainable amendments

A particularly serious problem is the temporary compensation for loss of soil and soil fertility by the addition of chemical amendments or 'improvers'. While such amendments may be acceptable, they become deceptive when they mask the degradation and loss of soil by erosion and oxidation of soil carbon. Figure 2 shows how corn production can increase even as the topsoil is decreased.

Institutional deficiency: degradation of soils and soil structure are compensated for, not by processes of soil formation but by soil additives. As soil structure and intrinsic soil fertility is thereby diminished, the resulting soil serves primarily as an infertile root-holding medium that requires continued application of more soil additives and masks the degradation and loss of soils and soil structure. Current institutions diminish incentives to maintain inherent soil fertility and soil structure, failing to recognize that land produces not one but two crops: soil and plant material.

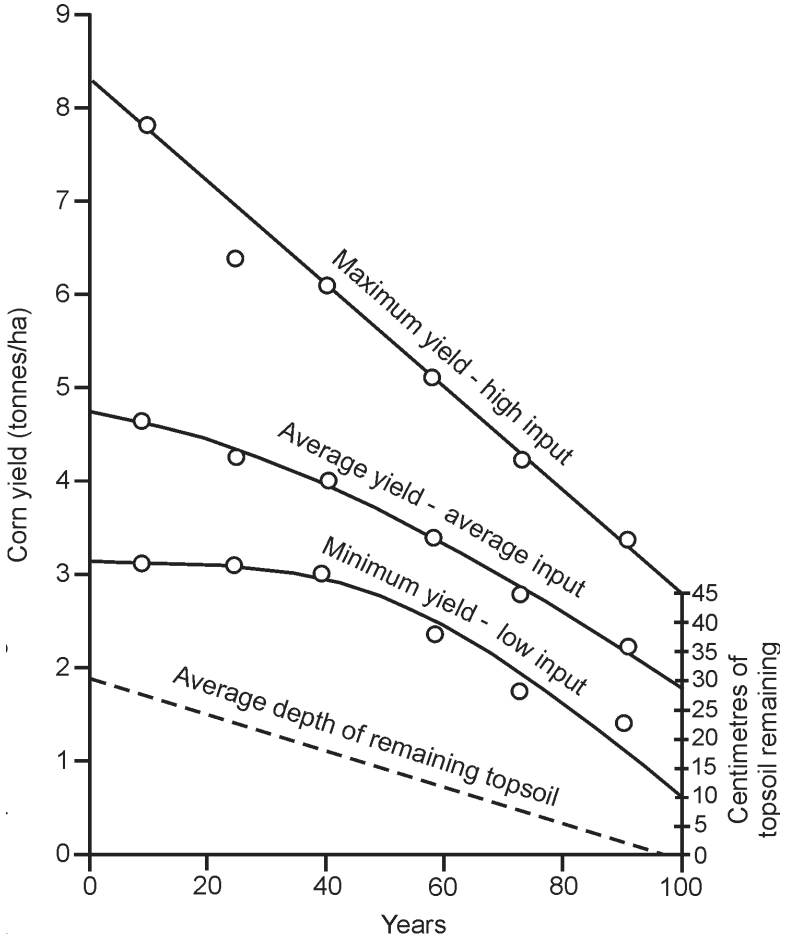

Figure 2. Decline of corn yield and topsoil under three different levels of management: high fertilizer and other technology, low fertilizer and other technology, and an intermediate case. (Graph based upon data for corn yield versus topsoil depth and technology input and data on loss of U.S. topsoil given in D. Pimentel, E. C. Terhune, R. Dyson-Hudson, *et al.*, 'Land degradation: effects on food and energy resources', *Science* (1976) **194**:149–55, and adapted from, with permission, C. B. DeWitt, 'The land entrusted to us', in *Earthkeeping in the Nineties: Stewardship of Creation*, ed. Loren Wilkinson (Grand Rapids, MI: Eerdmans, 1991), 19–67.)

Conversion of farm land to urban uses

In the USA about 900,000 ha of crop land are converted annually for development of residential areas and associated infrastructure, including commercial districts, roads, parking areas and highways.[12] On the global scale, losses of agricultural land to urbanization and other non-agricultural purposes are also underway as food and land are converted from subsistence uses into commodities that become accessible only to those with money. Labour-saving technology, increasing land values and undercutting of local food prices result in people migrating to cities, which in turn expand outwards to cover adjoining farmland. As urban expansion utilizes agricultural land, agricultural land area is reduced and this joins with population increases to drive intensification of agricultural production through fertilizers, herbicides, pesticides, higher-producing

strains of crops and new genetically modified varieties (see also Chapter 6). Agrarian culture in time is displaced by agribusiness, and local stewards of the land are replaced with managers who administer industrialized crop production. Land as gift becomes land as commodity.

Institutional deficiency: prices and rent of land for agrarian uses are lower than for industrial agriculture and still lower than for residential, business and industrial development use. Institutions fail to create, develop and sustain means for keeping land affordable for agrarian purposes. Institutions fail to create, develop and sustain means of land ownership and tenure that allow and sustain earth-keeping by resident stewards of the land.

Deforestation

Deforestation reduces sustainable production of native forest products and support for indigenous human inhabitants, increases run-off, reduces recharge of the watersheds, increases flood peaks (storm flows) and diminishes drought flows (low flows). Deforestation reduces evapotranspiration of water from vegetation to the atmosphere, with consequent potential reduction in rainfall; increases exposure of soil surfaces to direct sunlight, with resulting higher ground temperatures and soil oxidation; and increases atmospheric carbon dioxide levels, with consequences for climate change (see Chapters 2 and 5). Deforestation also destroys the habitats of a wide diversity of forest-dependent creatures, fragments habitats that previously were connected, and increases the forest-edge and edge effects.[13] And increases in forest edge exposure lead to windfall of trees and in many areas of the world open access to roaming cattle, other non-forest animals and, particularly important for tropical forests, to hunters and poachers. One net result is a large loss of native plant and animals species, including extinction of some.[14] Losses to deforestation are greatest in the tropical rainforests, where around 8 million ha are destroyed each year.

Institutional deficiency: the costs and benefits of deforestation are determined primarily if not exclusively in terms of the immediate taking, in disregard and neglect of biospheric costs and benefits. Institutions fail to incorporate dynamically the wide range of benefits and services of forest ecosystems in the present and over the lifetime of forests, and therefore are not sufficiently robust in their dynamic variety to match the dynamic spatial and long-ranging temporal variety of the systems within which they operate.

Biogeographical and trophic restructuring of the biosphere

Climate change is now pushing plant and animal ranges 6 kilometres towards the poles every decade; almost a third of earth's arable land has been lost to erosion, biodiversity is being threatened by habitat destruction and toxification, and overexploitation of the world's major fisheries have caused most of them to collapse and this has led to an adverse restructuring of ocean food webs. Earth has come to be under human domination, and this means that human responsibility has thereby been extended to the whole biosphere. This requires a more robust stewardship that preserves intact biospheric systems, establishes the conditions for restoration and healing of degraded systems, and makes peace with creation through deliberate and determined reconciliation.[15] Restructuring of the biosphere creates ecological unsustainability.

Institutional deficiency: human responsibility fails to extend to the biogeophysical reach of human domination. Institutions fail to incorporate dynamically the full biogeophysical system to include the full reach of the consequences of human action in the world. Institutions are not sufficiently robust in their dynamic variety and biogeophysical reach to match the dynamic variety of the systems within which they operate. Institutions are not sufficiently robust to assure and support human responsibility and stewardship that reciprocates the ecosystem services of the biosphere.

Institutional decay

Institutional economist Daniel Bromley described instances of institutional decay in African agriculture from which he concluded that 'When law enforcement is indifferent or non-existent, and when the judicial system has fallen into disrepair (and disrepute), institutional coherence is lacking, and economic transactions are stifled. Farmers receive prices below those required to cover production costs, and those production factors of production.' If the livelihoods of rural citizens 'are to recover from years of institutional decay,' wrote Bromley, 'it will be necessary for national governments to create an institutional structure (the legal architecture) that will encourage productive initiatives on the part of individuals'. It will also be necessary for those governments 'to establish the means and the procedures for that institutional structure to be modified through time as social and economic conditions warrant'.[16]

Institutional deficiency: institutions fail to match the dynamic values and requirements of local, regional and global economies and their corresponding biospheric integrity, including education, the judicial system, law enforcement, ecosystem restoration, nurture of land stewardship norms and prevention of predatory undercutting of local economies.

Neglect of the agrarian majority

Where farmers and agrarian culture remain in the world – and this consists of 2.5 billion people whose livelihood is in farming – stewardship of land held in trust over the generations largely remains the cultural and ethical norm. However, external factors increasingly push these people to the margins, even going so far as eliminating these farmers and agrarian land altogether. Put on a shorter-term programme of agribusiness, agrarian culture is degraded and destroyed, and soil stewardship is maintained only insofar as it is required for present and immediate gains (see Chapter 11). Both local knowledge and local investment in land and soil are discarded, and the pleasure of living on the land, the wholesomeness of agrarian culture and the beauty of the earth are thereby diminished (see Chapters 8, 12 and 13). An article entitled 'Food is gold' in the *New York Times* in 2008 announced such transformation of land from trust to commodity.[17]

> Huge investment funds have already poured hundreds of billions of dollars into booming financial markets for commodities like wheat, corn and soybeans. But a few big private investors are starting to make bolder and longer-term bets that the world's need for food will greatly increase – by buying farmland, fertilizer, grain elevators and shipping equipment ... And three institutional investors, including the giant BlackRock fund group in New York, are separately planning to invest hundreds of millions of dollars in agriculture, chiefly farmland, from sub-Saharan Africa to the English countryside.

The article announced the 'ambitious plans' of Emergent Asset Management, UK, 'to invest in farmland in sub-Saharan Africa, where it plans to consolidate small plots into more productive holdings', explaining that Africa was chosen because 'land values are very, very inexpensive, compared to other agriculture-based economies'.

Institutional deficiency: many current forces create and shape institutions to create and sustain means for protecting the powerful and their actions in the world to the detriment of people who live and sustain themselves on land that supports them and their cultures over the generations. They may degrade and destroy human cultures and indigenous food production, allow for legal and illegal takings of land, genetic material, intergenerational soil investments, may redefine land and its life from trust to commodity, and may degrade and destroy the dignity of local people

Matching institutions to the systems they serve

Unpalatable or distasteful as it might be, we must conclude that our institutions, as currently constituted, are driving biospheric unsustainability. Institutions need to be transformed so that they, individually and collectively as institutional structures, will shape society towards sustainability – of both human society and the biosphere. In summary, institutions must be sufficiently robust in their dynamic variety to match the dynamic variety of the systems they serve and shape. The requisite variety of institutions must be refined and transformed to match the dynamic variety of the systems they serve and shape, thereby to do a number of things. Theses should include: defining human duty, individually and collectively; indicating what must be done and what must not be done; defining human privilege, individually and collectively, indicating what may be done without interference from other individuals or groups; and defining rights and things for which there are no rights, including what individuals and groups can expect to do on behalf of others. They need to be enhanced to match the full and expanding reach of human impact and interaction with the biosphere. This will occur in part by necessity, for example as we see happening when some disabled economic entities are 'bailed out' by governments during times of serious economic recession. Beyond immediate necessity, it must also occur by design, particularly design that better matches new variety – both anticipated and unanticipated – as it emerges. What might and should this transition include, both by design and of necessity? For agriculture and land use it is institutional development and creation that critically addresses and corrects the eight drivers of unsustainability presented above. Beyond these are institutional changes and transformation of institutional structure that address more deeply the root causes of unsustainability. Of these causes, three are identified next.

Defragmentation the disciplines

Our institutions have to address the pervasive problem of the fragmentation of the disciplines, and its transfer from academia into our communities, businesses, public policies and government. This reintegration and defragmentation needs to occur at all levels of human endeavour, with the economy of the biosphere and understanding this economy both as the trophic and biogeographical fabric that sustains us and all life as an essential starting point and also as the vital system in which every endeavour operates and derives its capacity to flourish. At the core of this transition is the vital need for developing integrative 'cross-disciplinary' institutions and education within the university and college. In agriculture and land use, for example, this might begin with

retitling ‘agronomy’ as ‘agricultural ecology’ or ‘agroecology’ and extending this field to integrate within it agrarian cultures, agrarian economies and the ethics of agrarian sustainability and biospheric prosperity.

Re-connection of economics and the political economy

A century ago, economics and political theory were combined into an integrated approach to government. But, wrote Daniel W. Bromley, ‘in the earlier years of the 20th century, when economics came to be defined more by its method (rational choice under cover of methodological individualism) than by it subject of inquiry (the economy), there emerged a felt need to differentiate the alleged “science” of economics from the mere “art” of governance and politics.’[18] He wrote further that ‘Economics came to be about axiomatic models of rational choice, while government and politics remained concerned with interest groups, logrolling, power, and contested visions about the purposes of government in society.’ This demarcation is divisive of government, and needs to be removed, thereby creating a governance whose variety matches the variety of the system that government needs to govern. This would broaden the view of the economy to integrate political theory, politics, government – and the biosphere. Our institutions need to reintegrate economics and political theory again to be defined by the economy – the ‘subject of inquiry’ – including the economy of the biosphere (see Chapter 4). In the area of agriculture and land use this would include integration of agroecology and agrarian stewardship into the domain of core institutions. Its status would be transformed from a ‘special interest’ to a vital interest.

Desecularization of ethics and values

International law, and through it also the law of nations, has suffered from secularization – principally by being distanced from ethical concern. Theologian William P. George from the Dominican University (Illinois, USA) provided the analysis of this separation when he wrote, ‘Over the past four hundred years, international law has increasingly distanced itself from the theological discourse that was once at its core.’[19] Particularly problematic is that natural law at the time of the foundation of international law by Hugo Grotius (1609) and others had not yet incorporated the later work of Charles Darwin (1859) that could be interpreted as allowing unbridled competitiveness and natural selection to operate within the human economy – in disregard of the incapacitated, the downtrodden and the meek.[20] It has now become necessary to address this separation in order to reinstitute ‘a renewed and robust conversation between international law and theology’ with this fully recognizing that international law has been arrogated to claim its exclusive basis in natural law.[21] In the area of agriculture and land use this can include a ‘re-enchantment’ of the land, an introduction of the spiritual into land stewardship, a restoration of neighbourliness, and the belief that sustaining land and soil as a gift from previous generations and gift to future generations is right for society and the biosphere. Institutions need to reinstate the moral compass that is at the core of religious institutions and thereby restore respect for theological discourse and public theology.

Paradigm and task

From the earliest written records, living and working in the garden is all about life. Gardening is ‘guardening’ – a service and safe-guarding that is returned to the land and its creatures in return to their service to their guards and guardeners. For centuries following Eden farming was viewed as life, as full-orbed living. Farming was

necessarily ecological because it is done 'at home' and in 'one's place.' In reflecting on this earliest-reported garden, the French lawyer and legal scholar, Jean Cauvin – who studied law under pre-eminent legal scholars Peter De l'Etoile at the University of Orleans and Andreas Alciati at the University of Bourges – wrote in the year 1554,

> The earth was given to man, with this condition, that he should occupy himself in its cultivation. . . . The custody of the garden was given in charge to Adam, to show that we possess the things which God has committed to our hands, on the condition that, being content with the frugal and moderate use of them, we should take care of what shall remain. Let him who possesses a field, so partake of its yearly fruits, that he may not suffer the ground to be injured by his negligence, but let him endeavor to hand it down to posterity as he received it, or even better cultivated. Let him so feed on its fruits, that he neither dissipates it by luxury, nor permits it to be marred or ruined by neglect. Moreover, that this economy, and this diligence, with respect to those good things which God has given us to enjoy, may flourish among us; let everyone regard himself as the steward of God in all things which he possesses. Then he will neither conduct himself dissolutely, nor corrupt by abuse those things which God requires to be preserved.[22]

Clearly, as *The New York Times* story mentioned above shows, land, farming and food production are now becoming competitive investments that line up absentee corporate owners from across sub-Saharan Africa to the English countryside. They need not know their land or its place; all that matters is profit – 'the bottom line'. Secularization, fragmentation of the disciplines and reductionism in academia here as elsewhere have helped to set the pattern for agriculture, land use, government, law and institutions. As in academia, this fragmentation poses difficulty for, and even prevents, engaging responsibility with the land and the wider biosphere with appropriate stewardship. The separations that alienate food from agrarian culture, nutrition from agricultural production and financial investments from farm and land stewardship are among many that establish and perpetuate the problem of unsustainability. The higher purpose for agriculture and land stewardship can be reinstated institutionally where it has been lost. There can even be a 'buying back' of what has been taken – a redemption of life and work to assure that it is driven by vocation rather than greed. This does not mean of course that what has been gained by professional study of agriculture is lost; instead, it is a repurchase of a real and full-orbed life, made worthy by doing grateful work and pursuing effective service to family, land and community, with the support of knowledge gained by research and stewardship experience.

Are there examples – paradigms – of what can be done within and through our institutions? Yes, and one of these is the subject of a comprehensive study by Jules Pretty, professor of environment and society at the University of Essex. With his colleagues, he studied 4104 certified organic farms in the UK covering some 741,000 hectares.[23] And while these farms are not fully 'agroecological' they had to meet UK standards for sustainable agroecological systems. They make up 'a defined and certified system of agricultural production that seeks to promote and understand ecosystem health whilst minimizing adverse effects on natural resources' and as such is 'a restructuring of whole farm systems.' The results of their study are presented in Table 2 below.

Table 2. The negative externalities of UK agriculture (year 2000)

Source of adverse effects	Actual costs from current agriculture (millions of £/year)	Scenario: costs as if whole of UK was organic (millions of £/year)
Pesticides in water	143.2	0
Nitrate, phosphate, soil and *Cryptosporidium* in water[a]	112.1	53.7
Eutrophication of surface water[b]	79.1	19.8
Methane, nitrous oxide ammonia emissions to atmosphere	421.1	172.7
Direct and indirect carbon dioxide emissions to atmosphere	102.7	32.0
Off-site soils erosion and organic matter losses from soils	59.0	24.0
Losses of biodiversity and landscape values	150.3	19.3
Adverse effects to human health from pesticides	1.2	0
Adverse effects to human health from micro-organisms and BSE[c]	432.6	50.4
Totals	1501.3	371.8

---Adapted from J. N. Pretty, A. S. Ball, T. Lang and J. I. L. Morison, 'Farm costs and food miles: an assessment of the full cost of the UK weekly food basket', *Food Policy* (2005) **30**: 1–20.

[a] *Cryptosporidium* is a bacterium found as a contaminant in untreated domestic water supplies: it can cause gastric problems.

[b] Eutrophication here is the overfertilization of water caused by run-off of agricultural chemicals. It can cause growth of unwanted plant matter and poison fish.

[c] BSE is bovine spongioform encephalitis, often referred to as 'mad cow' disease.

Their research, summarized in this table, found that the ecological and health costs of current agriculture were far greater than they would if organic agriculture were adopted in its place. Pesticides and their adverse health effects would be reduced to zero, loss of biodiversity would be dramatically reduced, releases of so-called greenhouse gases

(methane and carbon dioxide) to the atmosphere would be diminished greatly along with water pollution, soil erosion and human disease. Clearly, agricultural practice can respect ecosystem services beyond mere food production in a program of responsible stewardship. This study is but a beginning of the kind of assessment that illustrates the consequences of new institutions that identify the domain of agriculture to include ecosystem services beyond food production, moving agricultural practice developed in reciprocal service with the biospheric economy.

But will it 'feed the world?'

Prof. Petty and his colleagues concluded that there are grounds 'for cautious optimism that future food needs can be met' following similar interventions. They emphasize, however, that improved access by farmers to productive resource-conserving practices and technology is also needed. And the availability of such access depends upon institutional reforms from local to global levels. Important to instituting reforms is to give due recognition to the problem that the phrase 'feedingthe world' may divert our attention immediately from the local to global scale, and unwisely may indicate the need for a global solution. Yet their study shows that the 2.5 billion agrarian majority that need to benefit from institutional reform are in fact local. Institutions that might push these billions to the margins – or even eliminate them – does not help to 'feed the world.'

Unsustainable agriculture and land use and other unsustainability bring humanity up against the challenge to transform any and all degrading and destructive institutions that support human domination into restorative and supportive institutions that in turn shape and sustain responsible stewardship from local places to the entirety of the biosphere. This is the task before us; this is the task of the institutions we develop, transform and create.

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