SUSTAINABILITY AS A NORM

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INTRODUCTION

This paper compares two conceptions of sustainability. Resource sufficiency takes an accounting approach to sustainability and has been favored by those who have followed the Bruntland Report. Functional integrity has grown out of the literature in ecological modeling. Each conception can be understood as having normative dimensions. First, each requires normative assumptions or judgments to specify crucial parameters. Second, each conception disciplines or orders the priority of empirical questions, and hence develops an agenda for research that tends to favor (and be favored by) researchers with specific disciplinary and methodological approaches. Finally, each can be tied to general approaches in environmental ethics, with resource sufficiency finding natural affinity with the advocacy of responsibilities to future generations, and functional integrity being favored by advocates of Deep Ecology and intrinsic value.

The principal vehicle for this discussion is an extended case discussion of each conception of sustainability as applied to an ongoing transition in livestock production. The general pheonomenon of industrialization in animal agriculture is described and a place-specific case, Erath County, Texas, is used to make the contrast concrete.

SUSTAINABILITY AND MORAL OBLIGATION

People use the word "sustainability" in so many ways that it is easy to despair of ever reaching any systematic, defensible analysis of its meanings. One problem is that the question of whether a given practice is sustainable or not seems to be a purely factual matter, but when sustainability is sought or questioned, it is almost always with respect to something human beings value, strive for, or hope to attain. In *The Spirit of the Soil: Agriculture and Environmental Ethics*, I argued that it is important to develop a conception of sustainability that frames the factual question, Is it sustainable?, in systems-

oriented operational terms. Asking whether a given practice is sustainable only becomes meaningful when one can assess whether the system of human practices and natural processes in which the practice occurs is not strongly vulnerable to internal or endogenous threats. Systems themselves can be defined at the level of a farmer's field, at a community level, a societal level, or even globally. If a given practice would lead to the collapse of a system, it is, in some sense, not a sustainable practice; but the more important question is to determine whether and how the practice is systemically reinforced. If social norms or economic circumstances would make it very unlikely for many individuals to engage in a questionable practice, it probably represents little threat to the system overall. On the other hand, if profit incentives or lending practices virtually require the performance of the questionable practice (as may well be the case in industrialized countries), the system is vulnerable and hence unsustainable (Thompson, 1995).

The distinction between endogenous and exogenous threats is important at the first order because it seems silly to call a system of agricultural practices unsustainable because it is vulnerable to Martian invasion or nuclear holocaust. However, the matter of whether a threat is internal or external depends on how one defines the system of interest. As will become clear below, choosing one of the two conceptions of sustainability discussed here will affect how one understands the problem of system vulnerability, but neither approach is particularly sensitive to exogenous threats, even when they originate in human practices. Perhaps we should learn to understand agriculture and natural resource management so that matters such as weapons policy or AIDS are relevant, but we must first learn to understand the problems of stewardship, resource availability, and fertility that are clearly endogenous elements of farming practice.

I would not argue that it is possible or desirable to separate facts and values altogether where sustainability is concerned. We need strategies for answering the factual question, Is it sustainable?, in yes/no terms, but we ask the question in the first place because it is closely corellated with ways of conceptualizing human values, responsibilities and goals. In*The Spirit of the Soil*, I argued that we should not collapse traditional moral and social values into our definition of sustainability until we have a compelling demonstration of the claim that no system of human practice that failed to respect such values could long endure. Since we have ample historical examples of reprehensible societies that endure for decades or centuries, I am not hopeful that such a demonstration will

be forthcoming. As such, it is most plausible to argue that we want our societies to be sustainable in addition to being just, fair, free, and ennobling. This formulation allows us to understand the moral importance of sustainability as a value that is of instrumental importance in securing other more fundamental values over time (Thompson, 1992, 1995). Yet even this instrumental formulation wraps value judgments together with factual and methodological presumptions. Two of these fact/value alignments are particularly relevant for evaluating the sustainability of a livestock farming practice or system.

TWO CONCEPTIONS OF SUSTAINABILITY

Approaches to sustainability in the literature since 1984 seem to come in threes. Gordon K. Douglass (1984) categorized three views of sustainability. Resource sufficiency holds that a practice is sustainable if resources needed to carry on the practice are in hand or foreseen. Ecological sustainability constrains human practice to activities that are consistent with biological processes. Social sustainability is emphasized by those who have an ethically based interest in justice and equal opportunity. Ten years later, the organizers of a World Bank working group on sustainability report that three distinct conceptions emerged from their consultations. The "input-output" view assumes that the internal dynamics of the ecosystem are in a steady state. The "capital," or "stock," view requires the maintenance of natural stock or capital at or above current levels. Finally, the "potential throughput" view emphasizes the use of resources within the capacity of those resources to renew themselves (Munasinghe and Shearer, 1995).

Clearly, the Douglass and World Bank triads are not the same. Douglass's resource sufficiency matches with the World Bank's capital or stock view, but the remaining pairs slice the pie in different ways. The input-output view may in fact simply be a less sophisticated version of the capital or stock view, depending on the degree of sophistication in the modeling of system dynamics. It may also be simply the difference between macro and micro level approaches to ecological modeling. One suspects that Douglass's ecological sustainability is fairly close to the potential throughput view of the World Bank authors, which would suggest either that the World Bank authors have omitted important social dimensions or that Douglass's social sustainability is a red herring. This is not the place for a lengthy discussion, however. In short, there

are important social dimensions to sustainability, but the authors Douglass cites are too anxious to wave the banner of sustainability as a cloak for a very different social and moral agenda. If we are to make sense of social sustainability, we must understand in something akin to ecological terms (Thompson, 1996).

In summary and despite their differences, the pie that Douglass and the World Bank authors are slicing emphasizes the wholeness or integrity of systems. Ecological sustainability addresses biological systems, while social sustainability considers social and political systems. The input-output view takes a macro-level or planetary system approach, where all inputs and outputs must come into balance, while the potential throughput view takes a micro level approach more appropriate to systemic descriptions of fields and fisheries, where humans can extract some of the system output without disrupting its ability to renew the resource base. In each case, it is the functional integrity of the system that must be understood and respected, though the nature and boundaries of the systems being described vary tremendously. Values will clearly influence the way that one understands the nature and boundaries of a system, but the ethical issues that might separate advocates of the steady state view from friends of the throughput view will be set aside here. The first order problem is to choose between resource sufficiency and functional integrity.

SUSTAINABILITY AS RESOURCE SUFFICIENCY

The basic idea of resource sufficiency could not be simpler. One can tell if one's current practice is sustainable by measuring the rate at which resources are being consumed, and then multiplying the rate by the time frame over which the practice is to be sustained. If current or foreseeable supplies meet or exceed the amount calculated, the practice is sustainable. This simple notion needs to be extended in two ways. First, in order to measure sustainability over an indefinite time horizon, it is necessary to define a rolling time frame. Although calculating total resource needs for all future time seems an impossible task, it is more feasible to determine whether consumption over the next fifty years is sustainable in resource sufficiency terms. Next year, the same fifty year time frame will be applied, but of course total resources will have declined by those that have been consumed in the present year. This method can be used to identify three classes of resources: abundant resources, or those with far more than a fifty year supply; renewable resources, or those with a built-in regenerative capacity; and critical

resources, or those with a sufficiency rating less than or near the fifty year time frame.

Second, one needs an account of how sustainability can be maintained in light of declining critical resources. There are two ways. As resources become critical, sustainability requires either a decreasing rate of consumption, or substitution with resources from one of the other two classes. The resource sufficiency notion thus becomes dynamic with respect to critical resources, and meaningful prescriptions for conservation and substitution can be generated from a full accounting of resource sufficiency. Conservation requires either reduced consumption or increased efficiency. Substitution is more nebulous and controversial. Economists such as Julian Simon (1980) and Robert Solow (1993) have presumed a rather high elasticity for resource substitution, while ecologists such as David Pimentel (1989) and Miguel Altieri (1991) make just the opposite assumption. These assumptions have a dramatic effect on the amount of conservation, or reduced consumption, that will be necessary to bring a practice within the parameters of sustainability. Thus, the debate over sustainability as resource sufficiency has tended to be a debate between those who are optimistic about the potential for substitution, and those who are pessimistic.

Both groups, however, are likely to agree about the moral basis for making adjustments that bring current practice into accord with resource sufficiency. As Burkhardt has argued, the moral obligation to adjust current practice and to plan for sustainability "derives from a general obligation we have to respect and secure the rights of future generations" (1989, p. 114). Burkhardt discusses some of the well known philosophical problems with formulating rights for future generations (How can people who do not exist have rights?) and concludes that though such rights may be far more limited than those of existing people, they extend to four clear categories: the capability to feed the world's population, scientific knowledge, democratic institutions, and a tradition of moral trust and respect (1989, p. 121). Burkhardt's analysis anticipates that of Avnar de-Shalit, who argues that it is better to think of obligations to future generations as part of our duties to the larger human community than as duties owed to rights-holding individuals (de-Shalit, 1995). Since posterity will have needs that we can anticipate, the bonds of trust that bind the human community preclude practices that make those needs impossible to fill.

SUSTAINABILITY AS FUNCTIONAL INTEGRITY

The notion of functional integrity presupposes an account of a system having crucial elements that are reproduced over time in a manner or at a rate that depends upon previous system states. The elements to be reproduced might be soil fertility, crops, domestic animal herds, wildlife populations, human populations, or even human institutions such as the family or the state. To say that such systems have functional integrity is simply to say that that the system establishes a range for the reproduction of crucial elements allowing them neither to increase without limit nor to disappear from the system altogether. The idea of functional integrity can be applied to extensive livestock farming, where stocking rates, forage, non-forage plants such as brush, and wildlife exhibit complex relationships. These elements of range systems can remain in equilibrium for extended periods of time, but disequilibrium can appear suddenly (or with a substantial time lag) as a consequence of critical changes in the reproductive capacity of any single element.

Human practice bears on such systems in one of two ways. First, human practices can threaten functional integrity if they drive the system into states from which reproductive processes cannot recover. Overfishing is the clearest case of such a threat. As Burkhardt notes, concern for posterity may also be adequate for characterizing the obligation to preserve the functional integrity of systems that provide human wants. Future generations will need fish or pasture as much as we do. But the second way of understanding how human practice bears on a food system points toward a different conceptualization. Human practices can be understood as part of a system, and functional integrity can be disrupted in many ways, including simply failing to
perform an action that is crucial for reproducing some system element. People will perform critical actions only when a complex web of social and psychological prerequisites are in place. They must have the knowledge and capacity needed to perform the activity, and they must have incentives or inducements to do so.

Respecting functional integrity instructs humans to use biological systems within limits that leave intact their capacity to regenerate. In this, the ethics of functional integrity points toward environmental philosophies that value nature and natural systems in themselves, not for their utility to human beings. It also instructs us to make changes in our social systems that regenerate our knowldege

capacities and human incentives advisedly. In this respect, functional integrity may align with a particular form of social conservativism, though what is most important is that the social world be viewed as a system that regenerates human capacities. The biological and social dimensions of functional integrity may thus exhibit a tension of their own. Anthropocentrism, or the view that nature is ethically significant in virtue of its importance to human beings, and ecocentrism, or the view that nature and natural systems have intrinsic value, have been debated within environmental ethics for twenty years. Are the social dimensions of sustainability inherently at odds with the ecocentric tendencies of recent environmental philosophy? In order to answer this question, it is necessary to take a closer look at the sustainability of social institutions for livestock farming.

SOCIAL INSTITUTIONS AND THE SUSTAINABILITY OF LIVESTOCK FARMING

The economic organization of animal agriculture in Europe and North America has changed dramatically since World War II, and similar trends affect livestock farming the world over. There are fewer farms with integrated crop and livestock production, and more that purchase feed to support a specialized, single commodity animal production facility. Old production systems tended to be extensive; new systems are intensive and often utilize confined animal production facilities (CAFOs). The location of animal production is shifting accordingly, and counties, provinces or regions with transportation terminals for feedgrain inputs and a political environment tolerant of CAFO building requirements and waste disposal systems are experiencing a rapid growth both in the number of animal production facilities and in the total number of animals. In the swine sector, these changes are accompanied by vertical integration, where livestock production is either wholly owned or contracted by processing companies that sell directly to retail outlets. The poultry sector in the U.S. became vertically integrated some years ago. These changes are collectively known as the industrialization of livestock farming.

Is industrial agriculture sustainable? Before even thinking about this question it is important to note that there are many important ethical criteria that can be applied to the transition in animal agriculture irrespective of whether livestock farming is sustainable. Does the transformation produce safe food? Do increases in productivity have nutritional or economic benefits to food consumers?

How do animals fare in the CAFO environment? Are effects on rural communities aesthetically pleasing? Do these changes occur in a manner that is consistent with democratic governance? Does the consolidation of economic power create distributive inequalities, or threaten individual participation and consent in the public decision making process? These are all important and legitimate ethical issues, but they are best raised on their own terms, rather than as adjuncts to questions about sustainability. Indeed, using the term sustainability to raise these issues is obscurantism and does nothing to advance ethics or sustainability. Nevertheless, it is important to ask, Is industrial livestock farming more or less sustainable than the conventional systems it replaces?

Burkhardt (1989) argues that social institutions must be sustained as part of our obligations to future generations, but his argument does not capture the sense in which social institutions are crucial to the functional integrity of an agro-ecosystem. If we have any obligations to future generations at all, we surely have the obligation to bequeath governments and other social organizations that respect individual rights and that promote the general welfare. These general obligations have little to do with agriculture as such. What is crucial for sustainable agriculture is the way that human management practices are crucial to the reproduction of herds, of fertility, and to the capital requirements of farming.

When human activity is interpreted as part of the system that is to be sustained, the functional integrity of the system is increased to the extent that the requisite conduct is reinforced by other system elements, and decreased to the extent that disincentives lead to less functional behavior. We generally think that ordinary self-interest will motivate farmers to ensure that human dimensions of the livestock farming system are sustained, but the conflict between long and short term self-interest is one of the enduring themes in human morality. Common folklore teaches the virtues of industriousness, delayed gratification and stewardship. In countless fables and songs the good and prudent person cultivates such virtues, while the wanton and heedless person descends into vice. Moral approbation can itself be a reinforcer for virtuous conduct, and in this sense morality is part of the food system. Folklore (as well as philosophy) may be a medium for reproducing those norms from one generation to the next. When food systems are understood to include the human activity needed to manage them, it is necessary to extend the boundaries

just a bit farther to include the incentives and reinforcers that regulate human conduct. We need to ask, Is the human conduct needed to manage with an eye toward sustainability itself sustainable?

Self-interest, narrowly conceived in the sense of profit seeking, is not sufficient. Humanity would not need stories about the grasshopper and the ant if acting in one's long term self-interest was so simple. Clearly, any farming system must be profitable for producers, processors and distributors, but an individual firm trying to maximize profit from farming may well deplete resources over the long term. When the soil is gone, they can invest their profits in something else, or simply relocate. The view that profit is a sufficient incentive for sustainability contradicts everything that we know about human motivation. The traditional agrarian ethic placed profitability within a subtle and complex web of constraints. The comprehensive goal of farming was to dwell within a given place on earth, to make that place into a home, and in so doing to make oneself native to the place. To dwell within a place is to engage in productive activity that creates one's character and biography at the same time that it brings forth the sustenance for life. This process of dual creation, of simultaneously producing material and spiritual goods, was implicitly communal, and the heritability of the dwelling place was assumed. This need not imply holding or transferring a specific plot of land as property, though that was the form of dwelling that took shape for most of European agriculture. Outside Europe and the countries of European influence, livestock farming produces an itinerant rather than a settled character, but it is no less committed to the ideal of dwelling within a given (if larger) place. Whether sedentary or nomadic, a farming people quits the dwelling place only when it has become thoroughly inhospitable.

It is appropriate to reconsider the trends toward industrialization of livestock farming at this juncture. There is little doubt that industrialization comes about through ordinary profit seeking behavior on the part of both producers and their suppliers. Farmers were historically mistrustful of merchants because they lack the commitment to place that generates the agrarian world of values. Yet when profit becomes the sole guide to conduct, commitment to place comes to be seen as quizzical, quaint and nostalgic, even for livestock farming. It will be useful to apply both conceptions of sustainability to the industrialization of animal agriculture.

THE INDUSTRIALIZATION OF LIVESTOCK FARMING

As a resource sufficiency question, industrialized livestock farming is evaluated by taking an inventory of the key inputs into the system, the rate of transformation into outputs such as meat, money, and manure, and then calculating whether the amount of input is sufficient to sustain production over an arbitrary rolling time horizon. The calculation is complicated by outputs like manure. A livestock producer is not so much interested in sustaining high levels of manure production as in sustaining the ability to do something with it. The resource sufficiency problem must be framed so that resources needed for manure disposal are included as inputs. As already noted, increasing efficiency of production is a key to resource sufficiency, so it is likely that industrial livestock farming will compare favorably to conventional livestock systems in virtue of its ability to minimize the inputs needed to produce livestock at a given rate (Hurt, 1996). This evaluation is likely to be controversial. For example, a Worldwatch paper predicts a decline in cropland, suggesting that the resource base for feed production may eventually become a constraint on the sustainability of intensive livestock farming (Gardner, 1996). A survey article by Harris (1996) contradicts that assessment. However the facts turn out, the greater productivity of industrial agriculture will weigh heavily in its favor from a resource sufficiency standpoint.

Industrial agriculture looks somewhat different from a functional integrity standpoint. The key to functional integrity resides in finding the correct dimensions for the relevant system. For conventional livestock farming, the relevant system is probably the individual farm. Extensive grazing or integrated crop and animal production are reproduced because nutrients cycle from soil to crop to feed to animal to waste to soil. Clearly, traditional farmers need some external inputs as well as markets to sell animal products, just as they need sunshine and water. Farmers also need the knowledge and norms required to perform the management activities that allow nutrients to cycle. If knowledge and norms are reproduced, and if the external environment is stable, traditional farms are functional systems that are indefinitely sustainable.

Industrialization changes the relevant system. If feed is produced off the farm, the system must, at a minimum, include both the crop farm and the livestock production facility, as well as the transport and financial institutions that link them. If fuels and technology are needed to move grain to animal, they too

must be included in the system of relevance. Then we must ask, What is happening to animal waste? If nutrients in waste are not being recycled eventually, then the entire nature of the system changes from a renewable resource or ecological system to a non-renewable resource system that can only be made sustainable by continuous improvement in waste reduction and storage. If so, then the scientific research needed to make these improvements must also be included in the system design, and it becomes necessary to ask whether the capacity to produce such improvements is itself sustainable. Science may well be the weak link in the industrialized agriculture system, as some studies indicate a declining willingness to invest in agricultural research (Pray, 1993; Schweikhardt and Whims, 1993). Concern arises over the sheer complexity and apparent increase in the vulnerability of this system. Of course it may turn out that this dramatically expanded and intricately more complex system of industrialized agriculture is more stable than a conventional livestock production facility. Like the debate over the future of available cropland, it is an empirical question.

One might object to this way of framing the sustainability of livestock farming by saying that this comparison of traditional and industrial systems simply assumes stability in the external environment for traditional livestock farming, while it incorporates many elements of the external environment into the model for industrial animal agriculture. This lack of parallelism, one might argue, favors the conventional livestock system. However, the elements that have been included within the system boundaries are all really needed as components of livestock farming itself under the industrialized model. Both systems would be vulnerable to truly external threats: global climate change, economic depression or nuclear war. They would also be vulnerable to less total threats, such as a gradual but pervasive growth of vegetarianism, or a rise in interest rates. It is always an open question as to whether the livestock system should be modeled so that these threats are internal (i.e., generated by system performance) or external (i.e., unrelated to system performance). The ecologist's motto, "Everything is related to everything else," implies that there is a global model that internalizes all threats, but to the extent that a threat comes from sources truly exogenous to livestock farming, it is pointless to include it within the livestock system.

In truth, the relationships are complex. In the real world, livestock

farming has been a mixed system with industrialized and traditional producers. Industrializing producers are increasing productivity for the entire livestock sector, which depresses unit prices. The only way to maintain income in such circumstances is to increase volume, a response more readily adopted by industrializers, and that can turn a traditional producer into an industrializer without knowing it. Since all producers require income, traditional farming may not be sustainable in a mixed system due to competitive pressure from industrializers. Is this threat to traditional farmers within a mixed-system internal or external? It is a question only a philosopher could take seriously. The mixed-system is tending toward full industrialization, and industrialized livestock farming may not be sustainable with respect to functional integrity. That is what matters from an ethical perspective. The comparison between conventional and industrialized livestock farming illustrates how resource sufficiency and functional integrity organize priorities with respect to which empirical questions are most important. The resource sufficiency approach directs attention to potential sources of total resource scarcity. The implicit values of the functional integrity approach lead us to look toward weak links in a system's ability to reproduce its essential elements.

THE CASE OF ERATH COUNTY, TEXAS

Considering a single case in the general trends of industrialization brings forth a different contrast between resource sufficiency and functional integrity. Erath County in central Texas experienced rapid growth of livestock farming during the 1980s characteristic of industrialization within the dairy sector. It would be difficult to argue that dairy farming in Erath County is unsustainable from a resource sufficiency standpoint. Certainly all the key inputs are in adequate supply. The environmental problem faced by confined animal feeding operations (CAFOs) is pollution. The constraint on the operations, from a resource sufficiency standpoint, is clean water, but engineering studies developed for dairies in Erath County provide a clean bill of health for large dairies, once adequate waste control technology is in place.

Nevertheless, Erath County has been the site of extremely contentious political conflict over the environmental impact of animal agriculture. That conflict, I will argue, was a symptom of disturbances in the functional integrity of the region as a place for livestock farming.

Dairying grew in Erath County over a period of several decades, but industrialized dairying began when some (how many?) dairy producers relocated dairy operations to Erath County between 1985 and 1992. These producers were from families long involved in dairying in California, and the Netherlands. They were experienced and expert producers recruited to Erath County by the prospects of good access to inputs and a favorable local political environment. The local political environment was favorable at the outset because leaders in Erath County and in Stephenville, the county seat, were searching for ways to revitalize the local economy. Yet their search for economic revitalization was not simply a search for investors. County leaders wanted to sustain Stephenville as a place to dwell. They were favorably disposed toward agriculture precisely because they believed that farmers who came to Erath County would, like the European migrants of an earlier time, come with the intention of settling.

The word "settler" connotes someone who intends to stay put. Settling in a place means transforming, even "taming" the place to suit one's purposes, but it also implies taking on a process of adapting oneself to the existing conditions of the place. Settlers become integrated into a place, and eventually become of the place. The place, meaning both physical and social environment, determines their identity and personality. The place conditions their character and shapes the moral personality of the settlers' children. The character and temperament of community leaders who sought economic growth had been shaped long ago by the physical and cultural geography of Erath County. Physically, it is a land of rapid and extreme climatic change and fragile soils,
a place that rewarded careful monitoring and conservative management strategies. Culturally, it is like much of the American South, a community where race, family and social class fix behavioral expectations. Long time residents of Erath County know their place, and stay there. To settle in Erath County would be to find a plot of land and to develop intimate, detailed personal knowledge of it as one conservatively establishes a livestock or other
farming operation. It would have been to find a place in the existing social hierarchy, and to act in accordance with that place.

The dairymen who came to Erath County were not settlers. They violated cultural expectations by wearing gold chains, drinking in public and building lavish modern homes in town. They managed their farms by calculating whether they could recoup capital investments within the seven year period

needed to depreciate them, and that time period represented the extent of their commitment to Erath County. Some have already moved on, repeating their strategy of obtaining favorable terms for relocation in New Mexico and Utah, more than 100 km from Stephenville. While they were there, their conduct threatened the old Southern hierarchies. They exploited their agricultural tax exemptions with industrial practices that imposed costs on longtime residents. They were considered poor role models for children. Their Spanish speaking employees demanded social services that Stephenville was not used to providing. Eventually, their very being came to be an affront to the people of Stephenville. Clearly, something had to give. Twenty-five or thirty years ago, the people of a town like Stephenville in the Southern U.S. would have maintained their community by making life very difficult, even dangerous, for the outsiders. It is a mark of progress that citizens of Erath County confined their umbrage to meticulous enforcement of environmental laws. Doing so made Erath County less inviting for other peripatetic dairymen, and it ensured that those who did stay would be forced to make some
accommodation with local geography and culture. In the meantime, many in Stephenville derive some compensation for the way that their community has changed from the fact that these dairies have indeed contributed to an increase in economic activity. But the conflict itself showed that industrialized dairying was not consistent with the functional relationships that existed in Stephenville prior to 1985. Livestock farming will be made sustainable there only by tearing down the old system and by replacing it with a new one.

SCIENCE, SUSTAINABILITY AND ENVIRONMENTAL ETHICS

Does the distinction between resource sufficiency and functional integrity have any practical importance for research on livestock systems? Clearly, the mere fact that there are two ways to describe sustainable agriculture creates an opportunity for confusion and miscommunication, and it goes without saying that researchers must be careful in defining their terms. Guarding against equivocation of vagueness with respect to sustainability involves a special set of ethical responsibilities because each way of conceptualizing sustainability has an implicit hierarchy of knowledge. Some things are more important to know than others, and this translates into a set of priorities for research. The section that follows immediately examines this problem. In the final analysis, the anthropocentrism of respect for future generations, and the ecocentrism of functional integrity can

indeed clash in
the practice of livestock farming, though I will argue in the closing section that the tension between these two philosophies is less than it might seem.

THE HIERARCHY OF KNOWLEDGE

The resource sufficiency conception of sustainability provides a powerful approach for understanding the role of nonrenewable resources in economic development. It also links easily to ethical systems that emphasize the rights of future generations. There may, as well, be good pragmatic reasons for choosing to frame certain questions in terms of resource sufficiency. If one is trying to understand the longterm effects of fossil fuel use in agriculture, for example, the resource sufficiency approach will be very useful. One must know the amount of a resource available, and the prospects for expanding or substituting for the resource in the future. For animal agriculture, this means a good understanding of the basic production practices for livestock, some production economics, and some factual knowledge about current resources and future trends. This is knowledge that can be found in the traditional production-oriented disciplines of agriculture, and in conventional economics.

If one is attempting to understand whether either biological or social processes of reproduction and resource renewal are likely to remain intact over time, the functional integrity approach is more promising. It will also be more appealing to ecocentric environmentalists who wish to understand duties to nature, not simply to other humans. Functional integrity requires a systems
view of agricultural production, and questions about the sustainability of a practice only become meaningful when one has modeled all the elements necessary to reproduce the practice over time. Ecology, ecosystem modeling, and systems analysis are crucial to this approach. Though much of the empirical knowledge about specific elements of agro-ecosystems can be found in traditional agricultural disciplines, the general framework for integrating these elements into a system is better represented in ecology, engineering, and even business schools.

The fact that each approach to sustainability has an implicit hierarchy of knowledge has extremely important implications for the politics of scientific research. When major government or grant programs are configured in terms of one conception of sustainability, rather than the other, that is a decision

that materially affects the career and livelihood of researchers in the respective fields. Researchers thus have powerful incentives to lobby for one conception of sustainability, and to deprecate the other as misconceived or unscientific. This competition need not arise from nefarious motives. Given the human tendency to denigrate what one does not understand, it is to be expected that researchers will tend to find their own methods and approaches more scientific than those of other disciplines. It should be obvious that the proper way to set priorities should involve a clear antecedent judgment as to whether resource sufficiency or functional integrity is more central to the problem at hand. One may then recruit the scientific expertise needed to research the problem. Unfortunately, few experts acknowledge either the normative dimensions of sustainability, or the affinity between a given approach to sustainability and specific types of knowledge. As such, the ambiguity between resource sufficiency and functional integrity militates against the formation of successful teams. When the hierarchy of knowledge is combined with the potential for honest miscommunication, it is not surprising that interdisciplinary research on sustainable agriculture often devolves into squabbling.

ANTHROPOCENTRIC AND ECOCENTRIC ENVIRONMENTAL ETHICS

The scientific community's capacity to offer clear and understandable advice on sustainability is reduced by the confusing and contentious character of interdisciplinary squabbling, but the root philosophical commitments of the two approaches to sustainability also complicate the practice of sustainable agriculture, and the analysis of public policies needed to bring it about. At first blush, this might appear to be a conflict between ecocentric policies that stress preservation of agro-ecological systems, and anthropocentric policies that stress conservation of resources for future generations. Philosophers such as Holmes Rolston (1975, 1991) have argued that obligations to future generations do not explain why human beings should be obligated to preserve wild ecosystems, and that they provide insufficient motivation to do so. John Passmore (1974) has defended anthropocentric approaches arguing that the notion of intrinsic value as distinct from value to humans is conceptually incoherent, and that preservation is itself a kind of human use whose value should be weighed against other uses.

The values that separate these two philosophies have enlivened policy

debates over wilderness protection and endangered species preservation (Gunn, 1984). There are two reasons for thinking that this way of framing the philosophical issues is not helpful in evaluating animal agriculture. First, as Bryan Norton has argued, when sufficient attention is truly given to the rights and needs of future generations over and against shortterm needs of the present, both of these philosophies tend to converge on the same set of policy prescriptions (Norton, 1991). Once anthropocentrism has become sufficiently enlightened and extended into the future, it can support a conception of functional integrety as readily as the ecocentric alternative. Second, ecocentric views that are defended by environmental ethicists have not even been applied to agro-ecosystems. Instead, they emphasize wild ecosystems, ecosystems unaffected by human use. If the ecocentric view is applied with logical rigor, it entails no obligation whatsoever to care for agro-ecosystem integrity (Thompson, 1995, pp. 11-13).

When preservationist language does appear in debates over sustainable agriculture, it is aimed at the protection of small farms and rural communities, the theme that Douglass (1984) analyzed in terms of "social sustainability" (see also Feenstra, 1993). I have argued elsewhere that the best reasons for preserving rural communities with the aesthetic characteristics of small, diversified farming have little to do with sustainability (Thompson, 1992; Thompson, Matthews and van Ravenswaay, 1994, pp. 211- 215). Nevertheless, to the extent that the structure and social organization of livestock farming can be shown to have functional roles in reproducing the moral motivation for stewardship from one generation to the next, it will be possible to derive a moral imperative for preserving the social institutions that contribute to those functions. An emphasis on functional integrity is far more likely to produce an obligation to preserve both social institutions and ecological systems than is resource sufficiency. To the extent that social institutions contribute to the functional integrity of livestock farming, we can identify an important philosophical divergence between the two approaches to sustainability as applied to animal agriculture.

CONCLUSION

It is an open question whether industrialization of livestock farming or the transformation that took place in Erath County, Texas, is good or bad. Some

liberal ethical criteria, such as economic wealth and ethnic diversity, could clearly be called upon in defending both. The concluding point, however, is not whether these transformations are good or bad, but the way that resource sufficiency and functional integrity each order our priorities, or values, when we look for signs of sustainability or its opposite. This means that certain kinds of values will inevitably be served in adopting one approach or the other, and in defining the system boundaries for articulating a conception of functional integrity. Open discussion and airing of these values is crucial to wise and informed research on sustainable livestock farming. It may be impossible to arrive at consensus on these value questions, but informed interdisciplinary research will be possible only when participants have a clear sense of where they stand with respect to one another. It is also worth stressing that a narrowly biological approach even to functional integrity is quite likely to overlook social and cultural dimensions that can cause failure in livestock systems.

Research on sustainability should begin with an open-ended search of all dimensions, with attempts to specify both functional integrity and resource sufficiency conceptions of sustainability. It should be committed to a full airing of the social or human dimensions, as well as agro-ecology. It should then undertake a systematic articulation of the values that would be advanced most readily by adopting one approach, one system model, rather than another. If possible, these values should be debated, not only among researchers but among affected parties. Eventually it will become necessary to converge on operational definitions and, in some cases, technological solutions. Convergence that comes too soon violates the functional integrity of science itself, and makes our solutions unsustainable.

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