Encouraging Sustainability in Agriculture: Institutional and Measurement Considerations

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ABSTRACT

The concept of sustainability in resource use arises from a growing concern about the impacts of production systems on environmental quality. We analyse sustainability by first discussing definitions of sustainability and how it can be measured. Second, we discuss in general how a society can achieve sustainability. Third, we assess the implications for shifting agriculture towards sustainability and, in particular, focus on issues that address achieving sustainability in soil conservation in New Zealand. Finally, we suggest actions that will help to further place New Zealand on the path to sustainability.

I. INTRODUCTION

Green advocates in New Zealand (and elsewhere) embrace sustainability as a central set of principles for "a new order of things." According to the supporters of sustainability, those who choose to ignore sustainability principles invite disaster - environmental, economic, or political. Indeed, support for sustainability has spread beyond the realm of traditional environmental advocates. Journalists write about the concept. Members of Parliament expound on the virtues of sustainability and attempt, at least, to enshrine it in new environmental legislation.

Despite such broad support, the implementation of sustainability principles has proceeded only at a snail's pace. Perhaps those who profit by the current order stand to lose a great deal if principles of sustainability are followed. Perhaps the supporters of sustainability fear their adversaries. Or perhaps there is a lack of understanding of what sustainability can and cannot accomplish. But the real truth probably lies deeper: the incredulity of mankind regarding the benefits of sustainability has precluded the evolution of a convincing argument which demonstrates the need for sustainability.

This occurs in the first place because many people still do not experience the real ravages of unsustainable use of the environment. In the second place, many people are uncertain about the definition of sustainability and what it will do for them. Mankind would like to experience sustainability first (and its benefits and costs) before being convinced that this should become the new order. Deep down, mankind's utilitarian disposition nags society's collective conscience about the potential effects of sustainability and slows the process of decisions which will lead to a wholehearted endorsement for change. This disposition is encouraged by the economic system that guides resource allocation and much behaviour in our society.

General agreement exists that sustainability calls for change towards a new order of things. But what exactly is that new order of things? Is it "sustainable resource usage," "sustainable growth," or "sustainable development?" What is to be sustained - a standard of living, the natural resource base, or local communities? Unless more precision is found for the concept, the term sustainability will be used by "developers" to justify exploiting and by "environmentalists" to justify preserving environmental resources (O'Riordan, 1988). For example, the New Zealand government has provided subsidies to clear marginal lands and enhance agricultural output in the name of sustaining agricultural communities and export growth. Rivers can be dammed, lands irreversibly changed by "developers," and excessive environmental safeguards demanded by "environmentalists" - all in the name of sustainability.

In short, the uncertainty which surrounds the definition of sustainability, the need for sustainability, and the potential costs and benefits which would arise from implementing sustainability, combined with a utilitarian philosophy, form the essence of the difficulties associated with implementing sustainability.

In this paper, we first look at definitions of sustainability and how it can be measured. Second, we discuss in general how a society can achieve sustainability. Third, we assess the implications for agriculture and, in particular, discuss achieving sustainability in soil conservation in New Zealand. Finally, we suggest actions that will help to further place New Zealand on the path to sustainability.

II. SUSTAINABILITY

What is sustainability?

The imperative of sustainability places the satisfaction of basic needs as a fundamental objective, with ecological development allowed in location/culture specific applications, and with sustainable utilisation of natural resources as the "common sense" mechanism for application (O'Riordan, 1988). A sustainable approach takes cognizance of the needs of those currently dependent on the environment and its resources, but in so doing also recognizes the needs that future generations will place on the same resource base. Under the terms of sustainability, today's actions must not foreclose opportunities for those who will live in the future.

But sustainability also recognizes that resources should sometimes be left unused simply because they currently exist and provide value. This value may not relate directly to use, but may be intrinsic or spiritual in nature.

Sustainability addresses natural resource use and non-use - development and preservation - within a broad social framework shaped by ethics, justice, and economics. Pearce, et al (1989) write about "sustainable development," where development refers to achieving a set of desirable goals or objectives for society, which in turn are shaped by values that include those held by or ascribed to non-human systems or structures.

On the one hand, sustainability forces us to consider the nature of the values we hold regarding the environment, future generations and their needs, and our own generation and our needs. On the other hand, sustainability relies on science and technology to explain the causes of environmental degradation, species extinction, and global environmental problems. Science and technology also help to formulate constraints on natural resource activities and set minimum standards for environmental quality.

Although many of the issues so crucial to the kind of planet we create for ourselves relate to science and technology, these disciplines by themselves cannot resolve questions of values. Also, science and technology frequently cannot provide clear answers to questions asked. For example, answers to questions on the amount of species diversity the world should maintain, the amount of climate change that is acceptable, the level of poverty, the amount of wetlands that should be drained, or whether the deep ocean should be used for hazardous waste disposal are technically uncertain but also depend on values.

Current members of society must make the difficult choices and future members of society must live with the consequences of the choices (Clark, 1989). Within a society, individuals will hold a diversity of values which can lead to different answers regarding the desirability of solutions to the questions posed. Thus, the definition of sustainability has necessarily remained fuzzy.

However, some researchers have attempted to find common ground. Barbier (1989) identifies the more narrowly defined concept of environmentally sustainable development as maximizing the net benefits of economic development, but subject to maintaining the services and quality of natural resources. Maintaining does not refer to keeping the physical stock of resources intact, but rather holding the value of the services of resources at

some approximately constant level while allowing the stock of exhaustable resources to decline. For this value of resources to remain constant, however, a decline in the stock of natural resources can only occur under strict conditions (Barde, 1990). For many natural resources, in truth no artificial substitute exists. For example, ecosystems such as tropical forest, marshland, oceans, and certain animal and plant species have no effective substitutes.

In Our Common Future, the World Commission on Environment and Development (1987) defines sustainability as a broad concept of social and economic progress to meet the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs. This definition may become codified as New Zealand law by the proposed Resource Management Bill, currently under review by the new government.

Measuring sustainability

To understand sustainability, we must understand where we are, where we came from, and where we are going with respect to the stock and use of natural resources. Measurement should tell us something about what we currently do with our environmental resources and whether this use provides benefits to society. Both issues need to be addressed if effective management of the natural environment is to achieve sustainability. For example, certain policies on logging may either enhance or decrease the services and quality of the stock of indigenous forest but these policies may or may not lead to benefits for society.

Natural resource accounting is one recently developed method that can help answer questions regarding the stock and benefits obtained from the use of natural resources. This method is a further development of national income accounts, which are seriously flawed as a measure of development success, particularly with regard to the environment. The income accounts uncritically combine all market expenditures, irrespective of whether those expenditures are due to social "goods" or "bads"; ignore nonmarket goods; only address flows rather than the asset value of natural resource or other economic stocks; and undervalue those environmental services and resources which are common property goods. Therefore, environmentally degrading activities can increase national income, but the loss in environmental services from natural resources is not reported. In terms of sustainable development, national income cannot tell us if society's activities have led to true economic benefits, nor can it identify if the services and quality of the natural resource stock has been maintained.

Pearce, et al (1989) provide a comprehensive summary of the various approaches to natural resource accounting. One method used by several countries focuses on physical resource accounts. Although useful and informative, the preparation of these accounts requires a large amount of data and the use to which the natural resources are allocated may not be completely evident. Construction of these accounts is also more difficult for renewable resources than for nonrenewable resources. Thus, a country may find it useful to concentrate on developing only some physical resource accounts, particularly for those resources under immediate threat.

An extension of this method carries physical resource accounting a step further and attempts to place monetary values on the resource stocks so that annual increases and decreases to the stocks can be measured. These changes are then incorporated with the estimate of national income so that a country

can understand its welfare losses due to environmental degradation or depreciation as well as the income it has earned.

Major problems still exist in how best to operationalize resource accounting and how to incorporate it into policy. Complete correction of national income accounts to reflect natural resource depletion is not yet possible due to the lack of appropriate prices and values (Goodland and Ledec, 1987; Repetto, et al, 1989). Work continues in many countries, including New Zealand, to refine the process of resource accounting such that it can be useful for policymakers.

Measurement of natural resource stocks and use is important not only at the macro level, but also at the micro level. Any decision to impose a sustainability constraint on the development of natural systems needs to deal with scientific uncertainties. And the ability of science to detect or prescribe sustainability is severely limited by these uncertainties, which can have four adverse effects on attempts to achieve sustainable development:

1. It may be difficult to tell whether a given resource use pattern is sustainable, simply because the natural variation is so great and statistically significant data are expensive or impractical to obtain.

2. Uncertainty recommends and justifies a more cautious and expensive environmental policy, even if the condition created by resource exploitation might be reversible.

3. Thresholds exist in some natural systems beyond which catastrophes or irreversible degradation occur, and the uncertainty about threshold values may rule out development options which are otherwise economically attractive.

4. Since calculations of sustainability assume stationary or continuity of fundamental environmental conditions, the likelihood of baseline changes such as climate and the uncertainties about their degree or even direction create additional problems (Carpenter, 1990).

Thus, sustainability can be considered an experiment with incremental advances, midcourse corrections, and constant feedback of measurements about the environment (Asian Development Bank, 1990).

Measurement is needed so that decision makers can evaluate tradeoffs, particularly short-run versus long-run, and make their decisions as transparent as possible. For example, when decisions with regard to natural resource use attempt to compensate for uncertainties when striving for sustainable development, economic costs will increase in the short-run. To stem the short-run increase in costs, the uncertainties need to be reduced. And this can best be done by increasing the effort placed in measurement.

III. TOWARDS ACHIEVING SUSTAINABILITY

A key element to achieve sustainable development is to bring about change in the way we view and use natural resources. This will require:

1. a clear set of values consistent with the consciousness of sustainability,

2. established motivations that will support the values, and

3. institutions that will effectively apply the motivations.

It is clear from the recent worldwide surge in environmental activism that values are changing. However, this does not imply that societies have moved wholeheartedly away from the unsustainable economies that have generated wealth and relative comfort for about one fifth of humankind. As Ruckelshaus writes, "with a few important exceptions, the environmental protection movement in those nations, despite its major achievements in passing legislation and mandating pollution control measures, has not had a substantial effect on the lives of most people. Environmentalism has been ameliorative and corrective - not a restructuring force." (1989, p.116)

The change in values will still have to go further. We need to see more clearly that the human species is a part of nature. Humans need to work with nature rather than try to dominate it. The continuation of nature requires more than a few minor actions - it needs a major change in direction. This will require a change in objectives away from purely a materialistic growth orientation to one of sustainability, where the standard of living (for the present and future generations), and the continuance (or even enhancement) of the natural system are given equal weight.

For example, the ethical justification for preserving species and ecosystems (such as biological diversity) is that human beings should not exercise their power to obliterate other species at will, even species not known to have any practical value to humankind. From this perspective, nonhuman species have their own intrinsic value independent of any utilitarian value they may have for humans. Whether or not one accepts this view, it is irrefutable that to eradicate other species deprives future generations of options and, thus, fails in the duty of stewardship towards the earth (Goodland and Ledec, 1989).

Mere acceptance of a changed value structure will not necessarily generate the required changes in resource use. Environmental degradation can be the result of inadequate social organisation, flawed legislation, and improper policies that impose constraints, limit opportunities, alter incentive structures, or misdirect capital and labour flows among sectors and regions.

Therefore, achievement of sustainability requires, in the first instance, that government explicitly identifies sustainability as a goal and that this goal becomes the overriding concern of government in macro as well as micro policy. If the macro policies such as those directed at trade, exchange rates, and energy are not correct, society will not shift away from production processes that are typified by a decreasing labour/output ratio, an increase in capital intensiveness, and a long-term increase in the use of energy and raw materials per unit of output. This kind of production pattern is not sustainable in the long-term - this pattern has led to environmental degradation and ecological stress in the past and will continue to do so in the future.

Correcting the operations of a free market for externalities and public goods is a step in the right direction to move onto a path of sustainable development and resource management. But this is not enough to help reallocate resources and change consumption habits to stave off a worsening of the greenhouse effect, acid rain, or deforestation; to allocate clean water in some of our last remaining wild and scenic rivers to passive recreation; or to preserve some of the remaining indigenous forests or wildland. Many of the environmental values associated with these issues do not appear in the

decision making equation of resource users and consumers. Resources will be undervalued and ecological constraints will be ignored.

Economics (and the free market) has not come to terms as yet with ecological conditions for sustainability. As Pearce and Turner note (1990), economics does not have an "existence theorem" which enables it to ensure that whatever system we devise will be ecologically sustainable. To achieve sustainability, a commitment is required at all levels but particularly from society's leaders, to enhance sustainability (for ourselves and for those coming after us) even at a cost to the current generation.

The best way to demonstrate concern for future generations may be to reduce and ultimately eliminate the major source of unsustainability in the areas of demand, production systems, behaviour, and value structures. A desirable management system to achieve that should emphasize decentralised decision making, and make extensive use of economic incentives to internalise environmental externalities (Carpenter, 1990). Many market instruments are available that will encourage individuals to internalise the social costs and benefits of actions (for a survey, see Meister, 1990; for a specific application to a global environmental problem, see Bertram, et al, 1989).

A major question is whether the developed countries with a free market system (and they are the ones that need to provide leadership) will be able to overcome political constraints (such as vested interests, political lobbies, or conflicting interests) to bend the market system toward long-term sustainability (Ruckelshaus, 1988).

The achievement of sustainable development therefore will require understanding of the economic system, why it fails, how it fails, and of the roles of government and the market to correct these failures and move the whole production, growth, and resource use process in a direction of resource saving and sustainability. This smacks very much of "reformist environmentalism," and it is. But it is not that alone. To achieve sustainability, simple correction of market failures (although that represents an immediate practical and politically feasible approach) is a necessary but not sufficient condition. Also required is a conscious redirection of the growth path in light of society's values and the desire to achieve long-term sustainability.

This conscious redirection may require drastic actions. One source of advocacy for such action arises from the deep ecology philosophy, which is revolutionary in its metaphysics and epistomology. According to this philosophy, to change society and protect the environment,

> humanistic values systems must be replaced by supra-humanistic values that bring all plants and animal life into the sphere of legal, moral and ethical consideration. And in the long run, whether anyone likes it or not, force will eventually have to be brought to bear against those who would continue to desecrate the environment. (Devall, 1980, p.302)

IV. IMPLICATIONS FOR AGRICULTURE

In considering the case of agriculture, we note that sustainability in agriculture will not be achieved through a set of prescriptions for exactly how agricultural systems should operate. Rather, sustainability will be an outcome of farmer behaviour, where farmers make decisions, in light of information and appropriate incentives, to change agricultural practices from those that degrade to those that maintain and enhance the environment.

More specifically, we identify the following impediments for farmers to move towards sustainability:

1. Most farmers in many countries still operate under a system of price supports and subsidies.
2. Because farmers are largely exempt from liability arising from off-farm damages, they have no particular incentive to shift to practices which decrease those damages.
3. A certain amount of farming risk may be transferred to government through programmes such as crop insurance. These programmes serve to limit the set of responses that farmers may adopt to manage risk, such as crop diversification.

To address these problems, any policy scheme that attempts to influence farmer behaviour faces three major problems:

1. Heterogeneity. Every farmer faces a different set of choices.
2. Lack of information or asymetric information. It is not clear in advance how farmers will respond to a change in policy. Also, there is usually a high degree of uncertainty about the effect a change in policy will have on the environment.
3. Enforcement. Monitoring farmer compliance with new policies can be expensive and inaccurate.

On the one hand, information received by farmers to induce them to alter behaviour should consist of a set of signals that indicate the true social cost of agricultural practices (both on-farm and off-farm). The signals may be either positive, for practices that minimise waste and preserve or clean the environment, or negative, to penalise practices that do not work toward sustainability. The signals can be given by means of economic signals (market instruments) or through nonmarket regulations, standards, and property right with which natural resource users must comply.

On the other hand, government must also play an important role: first, by establishing institutions that will force markets to work effectively and second, by supplying information on alternative management systems. With respect to the former, government can create new institutions to correct economic signals where market signals are incorrect and to create markets or alternatives where no markets exist. With respect to the latter, much of the research on sustainable agriculture has public good characteristics and the market will undersupply it. Therefore, a genuine commitment to sustainable management in agriculture should still see government or its delegated authority conduct research and development, extension, monitoring, and enforcement.

We still need to learn more about what sustainable management really is and what can be achieved. Although attempts have been made to develop indexes that give some indication as to how sustainable certain agricultural practices really are (for example, see Senanayake, 1989), more research needs to be done. We note that not all of this effort should necessarily be an immediate burden on the taxpayer. Where user-pays or polluter-pays principles apply, taxpayers should recover some of the costs from individuals.

We need to understand a variety of other issues related to sustainability. We need information on how farmers will respond to new signals and policy changes and on the effects the policy changes will likely have on the environment. Both sets of information are essential to to determine the efficacy of the policies and programme. We need to remember that changing costs and liabilities will result in changes in the distribution of income and property rights. The extent of this should be determined before implementing policies. We will likely need to specify a transition period before implementing full economic cost accounting. This is mainly for political acceptability and equity reasons, but sustainable management of resources must be seen in the wider concept of sustainable development, which means that, beside economic aspects, social, cultural, and community aspects should also be considered. This may mean suboptimal institutional changes in the short-term and only optimal changes in the long-term.

Shifting New Zealand Agriculture Towards Sustainability

One of the dominant unsustainable features of hill and high country livestock farming in New Zealand is soil erosion. This erosion causes on-farm as well as off-farm costs, with the latter being the largest. Soil conservation programmes have been implemented by regional councils for many years, subsidised with funds from central government. Under the recent reforms to economic policy and local government authority, regional councils have assumed the primary financial and managerial responsibility for soil and water conservation. Funds for this work will come from farmers and regional ratepayers.

Thus, a major part of achieving sustainability in soil rests with regions and not central government. In addition, regional councils must now face issues of accountability to ratepayers and efficiency in allocation of limited funds. As a result of these changes, at least two regional councils have recently undertaken efforts to address the management issues involved in soil conservation. The councils have asked questions about what it is that they want to achieve (that is, what is a sustainable situation?), how can they best achieve it, how can they measure to determine if they are successful, and who benefits and should therefore pay?

From our work with these regional councils, it has become obvious that no answers exist to any of the question raised, and that no data exist to even try to answer the questions. Even worse, scientific information which would allow a determination of levels of success is practically nonexistent. Yet, historically, much soil conservation work has been completed, all based on the simple objective that stable soil and slopes must be better than unstable soil and slopes, and the subjective rule that society should pay something like 30-70 percent of the total cost.

One regional council has conducted scientific measurements to determine the success of one soil conservation scheme. The council would like to identify the net benefits of the scheme to determine future funding allocations and ultimately devise a public choice framework to help determine how best to achieve soil conservation. As described by one report from this regional council (Bay of Plenty Catchment Commission, 1975), the goals of a soil conservation scheme for a catchment were:

1. control and prevention of soil erosion within the upper catchment,
2. control of flooding of urban and rural property within the catchment,
3. control of the levels of lakes within the catchment,

4. prevention of addition of nutrients to the lakes from human effluent, and
5. reduction of the input of phosphate from water flowing into the lakes.

In this case, the regional council actually undertook scientific research to measure the amounts and quality of soils and the quality of streams and lakes in the catchment prior to implementing various soil conservation projects in the scheme. In 1990, ten years after most of the projects were begun, the council has funded scientific research to determine the changes in soil and water in the catchment.

The regional council is now interested in conducting an economic evaluation of the scheme and, based on that evaluation, designing a plan for how future soil conservation schemes should be implemented and funded. The potential economic benefits from this scheme include:

1. on-farm benefits (including possible forestry benefits).
2. flood control benefits.
3. recreational and aesthetic benefits from improved lake water quality.
4. wider benefits to society of quality improvements to the lakes.

We note that both farmers and other regional ratepayers will receive the third and fourth benefits, while benefit two will accrue mostly to regional ratepayers and benefit one accrues to farmers.

In order to address funding allocation questions, but also to understand attitudes and participation in a soil conservation scheme, the regional council will need to undertake a benefit-cost analysis not only at the regional level but also at the individual level for key participants (such as farmers). By estimating the division of net benefits between farmers and other regional ratepayers, the user-benefits principle can be used to allocate costs accordingly. Planning for future soil conservation schemes will require a broader public choice exercise that allows the council to rank potential future projects by economic efficiency and other criteria such as social equity and ecological standards.

But as far as this one regional council has progressed, they have not addressed the issue of what is a sustainable situation with respect to soil. The council has not adopted an explicit goal that sustainability should be the overriding principle under which the economic and ecological analysis is conducted. A variety of questions need to be addressed: Should slopes be stabilised? Do intergenerational issues exist in preserving these slopes for future generations? Do intrinsic values exist?

Thus, just in the case of soil, we have a long way to go to move agriculture towards sustainability. This will require more effort on collecting scientific information, monitoring, providing signals to farmers, and on evaluating benefits and costs. Unfortunately, very little of that is being done at the moment, since regional councils have few options to increase rates, central government has cut funds in this area, and farmers' ability to pay is limited, since low prices and high interest rates persist.

We note once again that, to successfully shift farmers towards sustainability requires information, science and technology, a change in values, an understanding of the income distributional effects and a commitment by government on behalf of society. It is possible in principle to obtain each of these, but recent experience in New Zealand suggests that progress will be slow.

V. WHERE DO WE GO FROM HERE?

The principles of sustainability begin by recognizing that humans have to satisfy basic needs. To do this requires the development and use of some of our natural resources and environmental amenities. But if we wish to ensure that future generations will also have the option of satisfying their needs, we must manage our resources to account for the needs of future generations.

To achieve sustainability, we need first to know what it is that we are trying to sustain. This requires applications of science and technology to develop an understanding of biophysical systems and an ability to measure any changes to those systems. We also need to know how we can alter human behaviour to operate within the boundaries of biophysical systems. This requires an understanding of economic systems and the best ways to satisfy human needs.

In order to require economic systems to consider biophysical systems as constraints, we need to develop analytical methods to evaluate as transparently as possible the potential trade-offs that will occur. Economics and environment are closely intertwined in that economic activities affect the environment but at the same time the environment also places limitations on economic activities.

More importantly, to achieve sustainability requires society to change its values such that they specifically address the principles of sustainability. In part, this can be brought about through the use of regulations and market instruments - a reformist environmental approach - and through listening to the challenge of the deep ecologists. Although this will be a slow and complex process, we have seen evidence that such change can actually occur.

Is a reformist environmental approach implemented with a market-oriented economic approach compatible with deep ecology? We think so. The former aims at making changes in the short-run. The latter provides the impetus to focus on the long-run and make sure that any series of short-run decisions conform to a consistent long-run sustainability paradigm.

As a practical matter, to begin operating according to principles of sustainability, we will need to critically reexamine the role of government and other insitutions. Markets do fail and government intervention is frequently the best way to correct these failures. The issue of intergenerational equity is also best addressed through government. Regional considerations are important but the regions cannot be expected to carry the majority of the burden of implementing sustainability. We have too many built in conflicts to ensure the success of sustainability if it is driven by the regions.

We can create a society that is based on sustainability. To make this a reality will depend on our willingness to change our values, behaviour, and institutions. The choice is up to all of us.

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