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BIODIVERSITY CONSERVATION: STUDIES IN ITS ECONOMICS AND MANAGEMENT, MAINLY IN YUNNAN, CHINA

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China's Agricultural Sustainability and Conservation of Biodiversity: Competing Policies and Paradigms

by

Clem Tisdell

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China's Agricultural Sustainability and Conservation of Biodiversity: Competing Policies and Paradigms[1]

by

Clem Tisdell[2]

May 1996

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Rural nature reserves can have negative as well as positive spillovers to the local region and policies need to be implemented to maximise the net economic benefits obtained locally. Thus an 'open' approach to the management and development of nature conservation (biodiversity) programmes is needed. The purpose of this study is to concentrate on these economic interconnections for Xishuangbanna National Nature Reserve and their implications for its management, and for rural economic development in the Xishuangbanna Dai Prefecture but with some comparative analysis for other parts of Yunnan

The Project will involve the following:

1. A relevant review relating to China and developing countries generally.
2. Cost-benefit evaluation of protection of the Reserve and/or assessment by other social evaluation techniques.
3. An examination of the growth and characteristics of tourism in and nearby the Reserve and economic opportunities generated by this will be examined.
4. The economics of pest control involving the Reserve will be considered. This involves the problem of pests straying from and into the Reserve, e.g., elephants.
5. The possibilities for limited commercial or subsistence use of the Reserve will be researched.
6. Financing the management of the Reserve will be examined. This will involve considering current sources of finance and patterns of outlays, by management of the Reserve, economic methods for increasing income from the Reserve and financial problems and issues such as degree of dependence on central funding.
7. Pressure to use the resources of the Reserve comes from nearby populations, and from villagers settled in the Reserve. Ways of coping with this problem will be considered.
8. The political economy of decision-making affecting the Reserve will be outlined.

Commissioned Organization: University of Queensland

Collaborator: Southwest Forestry College, Kunming, Yunnan, China

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Agricultural Sustainability and Conservation of Biodiversity: Competing Policies and Paradigms

1. Introduction

Sustainability issues and matters involving the conservation of biodiversity are no longer new subjects for environmental policy. Nevertheless, they are of continuing interest, there are always new dimensions to consider and unresolved questions remain. In fact, it may only be now that we are starting to have a satisfactory overview of these subjects which have been intensively considered for around two decades. This paper provides an overview of this subject, paying particular attention to agriculture.

In it the following are considered:

1. Different broad approaches to policy-making and implementation applied to environmental policies.

2. Different concepts of and views about sustainability- and biodiversity and their dissimilar policy implications.

3. Agricultural sustainability as a concept and as a goal, and policies to achieve agricultural sustainability.

4. Important relationships between agriculture and the conservation of biodiversity.

5. Reasons for sustaining biodiversity, possible methods for doing so, and their implications for agriculture.

Let us consider each of these matters in turn.

2. Different Broad Approaches to Policy-Formation and Implementation and their Application to Environmental Policies

To a considerable extent mainstream approaches to economic policy, including development policies, have tended to be technocratic. To some extent, this is a natural consequence of econometric model-building and the use of mathematical economic models of a relatively deterministic nature. Such models make no allowance for the unexpected and they implicitly

suppose a high degree of knowledge on the part of the model-builders. Such models can easily become the handmaiden of top-down policies and generate mechanistic approaches to economic growth, economic development and environmental policy with unfortunate consequences. The economic literature is not lacking in examples (see Tisdell, 1990, Ch. 3, for some examples).

With growing interest in economics of sustainable development, in ecological economics, and in evolutionary economics and with the progressive acceptance that individuals (organizations and groups) are bounded in their rationality (Tisdell, 1996a), the limitations of the technocratic approach to policy-making and implementation of policies have become more obvious. These considerations have highlighted irreversibility and hysteresis, uncertainty and learning, institutional arrangements, the degree of motivation of actors, and several other factors as having an important bearing on successful policy formulation and implementation. Such factors, often overlooked in mainstream economic theory, frequently play an integral part in the success or failure of environmental policy and suggest the relevance of models of an organic rather than a mechanical type.

Those who produce and try to implement policy recommendations in a mechanical manner face serious shortcomings, especially in relation to environmental policy and development. This is clear from recent demands for greater participation of local people in devising environmental policies affecting them, especially if they are required to implement these policies in their local area. Demands for the increased political empowerment of local communities and groups affected by policy-making have become commonplace in recent times and academics have become increasingly interested in communitarianism (e.g. Etzioni, 1991).

Appropriate links between the local community and central policy-makers may be important for several reasons. For example, such links may be required to improve the environmental knowledge set of both parties, be needed to motivate the carrying-out of policies as planned, and may be required to provide appropriate feedback of knowledge between the groups involved and to supply effective governance.These links between policy-makers and those affected are important from a motivational and a networking point of view. At the same time, it must be realized that costs are involved in networking and in participatory approaches to policy-creation and implementation. Consequently, from a restricted economic viewpoint, participatory policy approaches should only be carried to the point where the additional

benefits from these equals the additional cost of such institutional arrangements (cf. Baumol and Quandt, 1964; Cease, 1937). From a slightly wider perspective, participation might however, be carried further, e.g. when account is taken of factors such as self-esteem, sense of belonging. There is still much to be learnt about this area of policy-making.

In the development studies literature reference is sometimes made to 'top- down' and to 'bottom-up' approaches to policy with the latter being preferred by those desiring to empower local communities or other social groups. Another possibility is a 'side-by-side' approach which involves a joint effort by (central) government and local communities in the policy arena (Tisdell, 1995b). These three types, are however gross simplifications. Nevertheless even if we keep to the possibility of only 'top-down' or 'bottom-up' governance, a number of different situations can be imagined once it is realized that a dichotomy is possible between policy formulation and its implementation. For example, policy may be formulated centrally but may be required to be implemented locally. Four possibilities are indicated in Table 1.

Table 1: Central and local responsibility for policies affecting local communities: an initial classification of possibilities

Combination	Party responsible for policy formation	Party responsible for policy implementation
1	Central	Central
2	Central	Local
3	Local	Local
4	Local	Central

Possibility one shown in Table 1 is the most centralized one and may show little or no regard to the wishes of the local community. However, Table 1 should be extended by taking into account a side-by-side approach as an additional possibility. If this is done, the additional cases set out in Table 2 could arise. In this table, Case 5 involves the greatest degree of joint participation by groups.

Table 2: Combinations to be added to those in Table l to allow for side-by-side approaches to policy

Combination	Responsibility for policy formation	Responsibility for policy implementation
1	Side-by-side	Central
2	Side-by-side	Local
3	Central	Side-by side
4	Local	Side-by-side
5	Side-by-side	Side-by-side

It should be noted that this classificatory system glosses over a whole range of complexities, many of which should be taken into account in refined analysis of the issues involved. Nevertheless, it makes it clear that even at a relatively superficial level, we need to go beyond the 'top-down' and 'bottom-up' classification in order to assess the desirability of alternative systems of government and policy creation.

Both for sustainable development, sustainability of land use and conservation of biodiversity, involvement in and empowerment of local communities in policy matters is seen as very important by conservation groups. They believe that such involvement will promote sustainability and be a positive force in conserving biodiversity. In reality, however, the empirical evidence is mixed. For example, with the devolution of control over protected areas from central to local authorities with the demise of the Soviet Union, economic exploitation of these areas has been commenced by some local authorities. Some 'protected' areas are being used for the grazing of livestock and timber is being extracted from others for example. Decentralization of government has proceeded quickly in the Philippines. There is fear that some local politicians will use their enhanced political power to exploit (to their advantage) local natural resources unsustainably. On the other hand, the CAMPFIRE programme has been a success in some parts of Zimbabwe as far as the conservation of elephants is concerned. This programme involves controlled devolution of power and provision of economic rewards to local communities for nature conservation. Loss of local political power has undermined conservation in some countries. Mishra (1982) for example, reports that the replacement of village control over forests by cent al control exercised by the Forestry Department in Kathmandu undermined forest conservation in Nepal. Therefore, it is clear from the conflicting empirical evidence that centralization versus decentralization is only one factor influencing the likelihood of policies being adopted which favour sustainable

development and the conservation of nature. Yet it is an important consideration from a conservation point .of view. Consider another environmental example.

There is growing interest in social forestry in a number of developing countries and the possibility of harmoniously combining forestry, agriculture and even aquaculture in an integrated system designed to enhance sustainability of land use and counteract unfavourable externalities from agriculture, such as soil erosion. This is especially important on sloping lands. It is of considerable policy significance in many parts of Asia, e.g. Northern India and Southwest China.

In China, as in many other countries, afforestation has often been a centralist initiative involving top-down decisions and implementation Plans to afforest hilly areas above the planned Three Gorges Dam on the Yangtze River are of this nature. Such schemes may have little support at the local village level because they are seen as imposed and they may not be designed with local benefits in mind or may be drawn up without adequate assessment of methods to maximise these benefits. In the longer term, social forestry and agriculture schemes are likely to be more sustainable and effective in achieving the conservation goals being sought than state imposed forestry. This will be especially so if local people have economic incentives to sustain social forestry and agroforestry projects.

China appears to be moving towards a less centralist (top-down) position in designing and implementing environmental conservation projects. For example, with World Bank support, China has undertaken rapid rural appraisal in Xishuangbanna Prefecture, Yunnan, to identify development projects that may be valued by villagers living near Xishuangbanna State Nature Reserve (Xiang, 1995). It is proposed to use this appraisal to identify projects likely to be welcomed by villagers and to offer government aid for these. It is hoped that in return for such aid that villagers will agree to refrain from .illegal exploitation of the Nature Reserve.• Furthermore, assuming that the projects are an economic success, they will increase village incomes and thus reduce the economic need of villagers to use the reserve illegally.

One cannot be certain yet whether this new policy will be a success. However, the discussion has raised holistic dimensions of environmental policy which are normally not given much attention in conventional economics. In the final analysis, all policy proposals need to be assessed on a holistic basis.

3. Sustainability and Biodiversity: Alternative Concepts and their Policy Implications

Many concepts of sustainability relevant to economic theory and environmental policy exist in the literature and the majority require a holistic approach to policy-making. Furthermore, even the concept of biodiversity is not cut and dried. Depending on the measures chosen and on the dimensions of biodiversity stressed different policy consequences may follow. The same is true of sustainability.

For some, the wide range of concepts of sustainability present in the literature have become a source of confusion and have led to doubts about the value of such concepts. Indeed, some use the term 'sustainability' in a value-laden way and propagate the idea that things which are sustainable are desirable. This is clearly unsatisfactory because there are evil or unsavoury things such as poverty and disease which few would believe it desirable to sustain. On the other hand, there are characteristics the sustainability of which might be welcomed such as sustainability of levels of income or of biodiversity. The concept of sustainability only gains meaning when it is related to an object, e.g. level of income, level of returns, biodiversity, community.

Sustainability relates to the ability of a characteristic to maintain itself, that is not to decline with the passage of time. An unsustainable characteristic or variable may decline in varied ways or for varied reasons and the difference between these can be policy relevant.

The decline might for example be due to endogenous factors and might be regular, e.g. a regular decline in crop yield due to falling soil fertility because of nutrient-mining as a result of the type of cropping engaged in. Or, it might only occur after an exogenous shock. For example as suggested by Conway (1985, 1987) as a result of ecological stress or an environmental shock, the yield from an agricultural system may be depressed and fail to recover fully once the shock has passed. Such systems are said to lack *resilience*. However, resilience is clearly not the only factor to be taken into account when assessing the sustainability of a system, e.g. yield or returns from an agricultural system.

An equally important characteristic may be the *robustness* of the system, that is the ability of a system to withstand a shock without being deflected from its path or being significantly deflected from its path (Tisdell, 1994a). Some systems require larger minimum sizes of

shocks to be deflected than others, deflect differently and.so on. It is possible for a system to be robust and not to be resilient or to be resilient but not to be robust. If one has to choose between such systems, how will one choose from a sustainability point of view? The point is that in comparing the desirability of techniques or systems sustainability characteristics additional to resilience should be taken into account. For emphasis, Table 3 sets out the four possibilities as far as the resilience and robustness of systems are concerned. However, additional complications can also be considered some of which are mentioned in Tisdell (1994a).

Table 3: Resilience and robustness of a characteristic of a system

Possibility	Resilient	Robust
1	Yes	Yes
2	Yes	No
3	No	Yes
4	No	No

Knowledge of the sustainability or otherwise of welfare or value-significant variables can be of practical policy-importance from several viewpoints. If, for example, sustainability of such a variable is of positive value and if the variable is predicted to decline, this information may allow

1. defensive measures to be searched for and taken to avert the decline or
2. if no such measures can be found, and lack of sustainability is inevitable, the information may allow planned adjustment to the decline.

In some cases, both responses may be activated by the knowledge of sustainability problems. Methods may be sought which moderate the decline in a target variable and forward planning may occur to adjust to unavoidable decline.

Again, biodiversity, like sustainability of a variable, is not a straightforward concept and is multidimensional. It may refer to genetic diversity, species diversity, or ecosystem variation and there is far from complete agreement about how biodiversity is best measured (see Pearce and Moran, 1994, Ch. 1). Again the concepts have varying policy consequences. For example, if a trade-off is required between ecosystem and species diversity, which should be preferred? Depending upon the type of measurement of biodiversity selected, the focus of

policy for biodiversity conservation is likely to be different. If for instance, genetic variability (within species) is stressed more than that variety of species, species may be more likely to be sacrificed (if necessary) to conserve genetic variability within surviving species. Methods of measurement by directing the focus of attention of researchers to particular characteristics often coincidently bias their policy prescriptions.

The concept of sustainable development and the related concept of ecologically sustainable development continues to be an important backdrop to environmental policy-making. For some individuals, conservation of biodiversity is a prerequisite for sustainable development. However, even if we take the most common definition of sustainable development used in economics (namely that it is development ensuring that the incomes, or more generally living standards, of future generations are no less than those of current generations), the concept needs to be fully comprehended if it is to result in appropriate policies. This is so even leaving aside some philosophical difficulties involved in the concept and inadequate attention to the population variable by its exponents (Tisdell, 1993, Ch. 10).

Taking the economic concept of sustainable development as given, much of the policy debate has become centred on determining the types of capital stock that might allow sustainable development to be achieved. In particular to what extent can man-made capital stock be substituted for natural environmental stock and sustainable development still be achieved? Man-made capital stock can include physical capital, knowledge, human capital and institutional capital. All of these involve an investment which may be 'funded' by reducing the natural capital stock. In addition, physical capital normally embodies a part of the natural environmental stock. The following question is important: to what extent can man-made capital be substituted for the natural environmental stock and sustainable development still be achieved?

As is well known, a spectrum of views exist about this matter. On the one hand, some believe that the process of substitution of man-made capital for the natural environmental stock can continue without any significant threat to sustainable development. Supporters of this view place relatively *weak conditions* on conservation of the environment but often include the prescription that environmental externalities or spillovers should be taken into account. Indeed, it is possible that some on this side of the spectrum see continuing conversion of natural environmental resource stocks to man-made capital as essential for sustainable development.

On the other side of the spectrum are those who see continuing conversion of the natural environmental resource stock to man-made capital as a serious threat to sustainable development. They point out that the life of man-made capital is relatively short, e.g. physical capital, compared to the natural environmental resource stock.[1] Furthermore, the natural resource stock itself provides productive services and in many cases consumptive ones. The destruction of natural capital will inevitably lead to loss of these services and undermine incomes both

1. directly because fewer environmental services are available for direct consumption and

2. indirectly because the productivity of man-made capital is likely to be reduced once the relative size of the natural environmental resource stock is significantly reduced. In other words, increasing imbalance between factor proportions (an increase in man-made capital *relative* to natural environmental capital) will eventually result in reduced productivity and income.

Some supporters of the above view claim that already the substitution process has reached this critical stage, and believe that *strong sustainability* conditions should be imposed to conserve the remaining natural environmental stock. They argue that it is not sufficient to make sure that environmental externalities are fully taken into account. They would favour externalities being taken into account in project evaluation but in addition, usually want environmental *offset* policies to be implemented so as to keep the environmental resource stock constant.

Pearce (1993) describes those who favour weak sustainability conditions as growth optimists and those who favour strong sustainability conditions as ‘dark greens’. However, this does not effectively distinguish between different types of ‘dark greens’. Strong sustainability conditions may be supported for one or both of the following reasons:

(a) They are believed to be necessary to ensure that the incomes of future generations do not fall below those of the present. This is a positive basis given that the intergenerational equity objective is accepted and that only human beings are to account.

(b) Strong sustainability conditions may be supported for a *normative* reason. Some

individuals believe that mankind has an obligation to help conserve God's natural creation, especially the living environment. Those holding this view usually support strong sustainability conditions. They are increasingly likely to do so as the availability of natural environments is reduced.

There are a number of variants on the capital substitutability theme. In one simplified version, no serious problem occurs until environmental resources are reduced to a core. However, once the core is reached serious problems arise for sustainability. If the theory is correct, the problem is .to identify the core. To what extent for example is biodiversity in the core? To what extent can biodiversity be foregone and incomes be sustained? What is the nature of the core? Is it fuzzy or not, changeable or not? Are there regional cores and a global core? Can they be identified?

As will be noticed, the type of problem being raised here is the nature of the functional relationships involved when man-made capital is substituted for the natural resource stock. For instance are the effects on the sustainability of income continuous or discontinuous, positive, positive up to a point and then negative and so on? The nature of the relationship is of considerable importance from the viewpoint of policy. Furthermore, the fact that the relationship itself is uncertain can have policy implications. Consider for example, the precautionary principle. If one believes that preservation of an environmental core is necessary for economic .sustainability, but cannot determine the core exactly one may be inclined to adopt the minimax loss strategy of conserving the environmental stock to a greater extent than is strictly necessary so as to make sure that it contains the core. As time goes on, greater knowledge may be obtained about what constitutes the core. This strategy retains flexibility which is likely to be optimal if irreversibility is present and if learning is expected to take place.

Turning to a slightly different matter, much has been made of, the total economic valuation concept. In some respects possibly too much, even though it is a considerable advance on earlier narrower economic practice in relation to valuation. The main problem, as I see it, is the naive belief that it is imbued with superior moral standing. In reality, however, it is limited in its moral dimensions. It is essentially man-based and the measuring rod of money used is subject to distortions. It does not satisfy those 'dark greens' who believe that mankind has a moral obligation, at least to some extent, to conserve nature independently of man-centred wishes. This group also presumably believes that economic sustainability is not a

supreme virtue and in fact, if necessary, would be willing to sacrifice economic sustainability to some extent for conservation of nature. In other words, restrictions on satisfaction of man-centred economic welfare are favoured on moral grounds to preserve nature if a trade-off is required, as some believe is necessary.

The total economic valuation concept encounters, difficulties also when individuals possess dual or multiple utility or preference functions (Margolis, 1982; Kohn, 1993). For example, it is conceivable for an individual to have a self-centred preference function and another incorporating a wider moral dimension(s) (Etzioni, 1991). In relation to valuation, which of these should be afforded primacy? They could have very different policy implications. An interesting side issue is which of these multiple utility functions will politicians try to satisfy? Will the focus of their attention on the different utility functions of individuals change with time and circumstances? What factors determine the formation of such functions and their changing importance over time?[2] What is the consequence of different political arrangements and institutional setups for the influence on policy of these moral dimensions? If it is accepted that multiple utility or preference functions exist for the same individual based on different moralities, then it is clear that it is necessary to go beyond the total economic valuation concept.

4. Agricultural Sustainability

Considerable discussion of agricultural sustainability and of sustainability of rural communities has occurred in the literature. However, whether sustainability of agricultural activities (or those of any particular industry) is desirable is a moot point. If sustainable development is adopted as the main goal (e.g. in the sense that the incomes of future generations should not be less than those of present generations), agricultural activities or other activities will only be considered desirable from a social point of view if they contribute to the main goal. Nevertheless, they could be important from the viewpoint of agricultural communities and could be policy relevant in practice. Politically, policy-makers may be forced to give special attention to the situation of agriculturalists, e.g. because of the nature of the voting system.

Sustainability of agricultural characteristics may be of relevance to policy- makers from at least two points of view:

1. If lack of sustainability of an agricultural characteristic, e.g. yields or incomes, is predicted it may be possible to adopt .measures to avoid these, for instance commence research to discover ways to avoid the problem.

2. If agricultural sustainability cannot be achieved, then knowledge of this may enable suitable adjustment policies to be devised.

In other words, 'to be forewarned is to be forearmed'. Thus agricultural sustainability, in various forms, is relevant for policy purposes.

Several attempts have been made to specify agricultural sustainability with precision, provide criteria for its evaluation and suggest measures for it. The results have been mixed. There has been a tendency for writers to concentrate on the sustainability of different characteristics. • Those chosen in many cases seemingly reflect the values of the individuals involved in choosing them. Given that (agricultural) sustainability often involves a variety of characteristics, simple measures of it usually fail to receive widespread support.

Lynam and Herdt (1989), for example, attempt to measure the sustainability of an agricultural system by the trend in the ratio of the value of agricultural output from the system divided by the value of inputs used by it. If the trend is non-declining, the system is said to be sustainable. This indicator will be non-declining if the value of output *minus* the value of input is not declining, that is, if net income from the system is not declining.

This measure has a number of limitations (Tisdell, 1996b). Firstly, past trends cannot necessarily be extrapolated. Second, economic viability depends upon biophysical and market factors. It is possible for yields to be declining and for profitability to be improving for market reasons. For some, this might *not* be regarded as a sustainable system.[3] In any case, in this circumstance the system would most .likely violate strong conditions for sustainable development. Third, it is unclear from the Lynam and Herdt (1989) formula how opportunity cost and opportunity return are taken into account. For example, the net income from use of a technique may be non- declining but it may he relatively unprofitable to continue with its use because an alternative technique gives a higher net income or rate of return. Use of the former technique fails to be sustained for economic reasons.

It is useful to consider the Framework for the Evaluation of Sustainable Land Management (FESLM) suggested by the Food and Agricultural Organization (FAO) and the International

Board for Soil Research and Management (IBSRAM). The FESLM Working Party declared that:

> "Sustainable land management combines technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously:
>
> - maintain or enhance production/services (Productivity)
> - reduce the level of production risk (Security)
> - protect the potential of natural resources and prevent degradation of soil and water quality (Protection)
> - be economically viable•(Viability)
> - and socially acceptable (Acceptability)".

[quoted in Smyth, Dumanski et al., 1993, p. 7].

As indicated above, it would be possible for Lynam and Herdt's (1989) criterion to be satisfied and for FESLM not to be. It is *possible* for productivity to decline and economic viability not to decrease; or for natural resources to deteriorate and economic viability to be sustained. On the other hand, such deterioration could lead to lack of economic viability of an agricultural system. It all depends!

A common claim is that if an agricultural technique is to be sustainable, it must be simultaneously sustainable from a biophysical, economic and social viewpoint. In reality, however, agricultural techniques may remain economically sustainable for a very long period at the same time as biophysical characteristics are declining. Furthermore, a technique that is not entirely socially acceptable may be economically viable and in some cases, as time passes, may become more acceptable socially (social transformation occurs). This is not to suggest that holistic dimensions involved in agricultural sustainability should be ignored. Not at all. Nevertheless, one should be careful about drawing hasty conclusions about what is needed for sustainability.

There has been considerable debate about the sustainability of different categories of agricultural techniques, and their environmental impacts. It is worthwhile considering briefly

some of the issues. Categorisations include:

1. modem versus traditional techniques,
2. conservation farming versus conventional farming,
3. high-external-input agriculture (HEIA) versus low-external-input agriculture (LEIA),
4. organic agriculture versus non-organic,
5. and extensive versus intensive use of land for agriculture.

These classifications overlap to some extent but not entirely.

In order to place the discussion of these alternative agricultural systems in context, note that agricultural activities may prove to be economically (and in some cases, biophysically) unsustainable because of the type of techniques used or because of the nature of activities engaged in on a property (that is because of *internal* effects) or because of *external* effects. External impacts can include waterlogging and salination of land from irrigation schemes, reduced water availability to particular properties due to demands by competing users and lack of appropriate methods for allocation of the water and so on. A large number of examples could be catalogued but I shall not do that here. Agricultural practices on particular properties may affect other agriculturalists, those engaged in other industries, or impact on consumers directly as a result of environmental spillovers. And other industries and consumers (individuals) can have adverse environmental consequences for agriculture. Overall economic efficiency in satisfying human wants and long-term sustainable development requires that external effects be accounted for in policy-making. (However, because of the scale factor, this is not sufficient.) I shall not, on this occasion discuss the type of policies which might be adopted to cope with externalities because they have been the subject of a major part of economic research on environmental policy design.

Returning to alternative agricultural methods categorised above, consider the following matters:

1. Conway (1987) argues that traditional agricultural systems are less sustainable than traditional ones. While this may be broadly so, there are exceptions. Minimum till and no-till systems for example are a modem type of technique and may be more

sustainable than some tillage systems especially those which leave ploughed land to fallow, thereby exposing the soil to the elements. Trickle irrigation systems and irrigation systems using moisture sensors (modem techniques) add to conservation of water and may promote sustainability of yields. Furthermore, it is quite possible that 'modern' techniques will be discovered which greatly reduce non-point pollution from fertilizer. Already slow release pelletized fertilizers help do this. In any case, traditional agricultural systems are sometimes not sustainable or become unsustainable with changing socioeconomic conditions. Schultz (1974) has identified some modem agriculture systems which, seem more environmentally sustainable than traditional ones. In reality, the sustainability of a technique does not depend solely on whether it is modem or traditional.

2. Many traditional agricultural systems are typified by a low level of external inputs (LEIA) whereas many modem ones exhibit a high degree of reliance on inputs external to the farm or village (HEIA). At first sight, some may .believe that LEIA is very sustainable (cf Reijntjes et al., 1992). However this is not necessarily the case. With growing population LEIA can intensify and result in an expanding area of land being cultivated. For example, swidden or shifting agricultural systems (called *jhum* in Northeast India) involve a low level of external inputs. However, as population increases and the need for providing greater economic needs makes itself felt, cycles of shifting agriculture become shorter and larger land areas are exposed to the elements as a result of this form of cultivation. The consequence is rapidly declining soil fertility, severe soil erosion and escalating loss of biodiversity. Such systems eventually become uneconomic and are unable to maintain the incomes of a rising population.[4] The dynamics of overall social change cause them to become unsustainable.

3. Agricultural conservation techniques, such as the use of hedgerows with alley cupping on steep slopes, can add sustainability to agricultural yields and reduce adverse externalities. However, they are often not as economic as other methods and frequently involve an initial capital investment which farmers in less developed countries find difficult to make. There are traditional conservation methods using integrated methods and crop rotation but some conservation methods have been or are being developed in modem times. These modem conservation techniques do not

necessarily rely on organic methods and need not involve low external inputs. Nevertheless they can be the source of considerable environmental improvement.

4. Interest in organic agriculture has grown, especially In Germany mainly because of its perceived health benefits for humans (Lampkin and Padel, 1994). In some quarters, there also appears to be a presumption that organic agriculture is environmentally benign or favourable. However, it is possible for organic agriculture to be intensive and not favourable to nature conservation. Furthermore, if organic agriculture results in reduced yields (which it need not do in the longer term), then for the same output it will require a larger land area to be used for agriculture so the environmental impact of agriculture will be more widely felt.

5. It.is true that most modem agriculture is intensive and reliant on a high level of external inputs, several of which are non-renewable. Several advocates of increased nature conservation support a return to more extensive systems of agriculture, especially in Europe (Hampicke, 1996). In some countries, however, reliance on extensive systems would result in agriculture spreading over a larger land area. Even extensive agriculture can cause serious disruption to natural ecosystems. Extensive grazing by cattle and sheep in many parts of Australia has substantially changed natural ecosystems and has been implicated in the disappearance of at least one native species, a small marsupial or wallaby.[5] When extensive systems of agriculture replace intensive ones in a given .area, biodiversity may increase and greater conservation of nature can occur. However, extensive systems often spread onto marginal lands with very adverse environmental consequences. Furthermore, if the choice. is between (1) a small area under intensive agriculture with the remaining area not used for agriculture but left in a relatively natural state and (2) extensive agriculture over the whole area, which is best? In Australia for instance, some conservationists have supported the establishment of plantation forests on the grounds that this will reduce harvesting pressure on natural forests. It may do so but the economic benefits from increased economic productivity are not always utilised for greater conservation of nature (cf. Tisdell, 1994b). They are often used to raise exploitation of nature even more.

I am sorry if the above makes simple suggestions for environmental improvements in agriculture appear to be problem-ridden. However, it seems short- sighted to ignore the type

of issues raised above. Nevertheless, I accept that much of modern agriculture is over dependent on high external inputs, too intensive, gives less attention to •conservation methods than is desirable and could make greater use of organic materials. However, there appears to be a strong argument for some use of artificial fertilizers but on a smaller-scale than hitherto and in a way which reduces their leaching from the soil. Nevertheless, it is of concern when less developed countries like China try to indicate their agricultural progress by their rate of use of artificial fertilizer.[6]

5. Agriculture and the Conservation of Biodiversity

There are at least three angles from which we might be interested in agriculture and the conservation of biodiversity. These are:

1. The impact of agriculture on biodiversity conservation.
2. The benefits to agriculture from conservation of biodiversity.
3. The constraints placed on agriculture by decisions and policy measures to conserve biodiversity.

Let us consider each.

The intensification and spread of agriculture has been a major source (probably the prime source) of loss of biodiversity. This has mainly occurred because of destruction of wildlife habitat as a result of the conversion of wildlands to agricultural use and the increasing intensity of use of lands already used to some extent for agriculture. Where wild species of animals and plants compete with domesticated ones, they are seen as pests by the fanner and destroyed where possible.

Sometimes biologists see farming as a way of saving endangered species, e.g. farming of turtles and of giant clams. If a commercially viable industry can be established farming is an effective possible means of saving a species. However, profitable farming, depending upon its nature, may result in increasing displacement of the farmed species from the wild. Areas suited to fanning the species concerned may also be the habitats favoured by the wild species. These may consequently be appropriated for farming displacing wild members of the species and in some cases thereby endangering their continued existence in the wild. There may also

be other mechanisms which result in farming of species endangering wild stocks of the same species (see Tisdell, 1991). Furthermore, many of those who favour the retention of biodiversity do not consider domesticated stocks of a species to be an adequate substitute for wild stocks.

Just as the development of innovations and techniques used in economic production involve evolutionary aspects (Tisdell, 1996a) and introduce inflexibility and hysteresis into systems, so can the development of the farming of species. Those species which have begun to be farmed early in the history of mankind tend to be increasingly advantaged for commercial purposes over others (cf. Swanson, 1994). This is because considerable learning and accumulation of knowledge about the capacities of such species in a domesticated situation takes place, which is reinforced today by formal research. Furthermore, the farmed species are selectively bred over a long period of time to become fitter for the tasks which human beings have assigned to them. In addition, their products become well known to consumers who discover an increasing range of ways to use them, e.g. varied recipes, find their use increasingly to be socially acceptable and develop personal tastes in their favour. All of these factors make it very difficult to develop economically the farming of a species not previously farmed, e.g. kangaroo farming, giant clam farming or the growing of a new crop. At the same time, the fact that one species is used commercially at an earlier stage than another may be to a large extent a matter of chance. The selection of species and techniques for use being in part myopic is often not the optimal from a long-term human viewpoint. This occurs for many innovations (Tisdell, 1996a).

While agriculture has been, and in many parts of the world continues to be, a major force destroying biodiversity, it can also be an economic beneficiary from the conservation of biodiversity. It is claimed that genetic diversity within species can provide a valuable bank to be drawn on to conserve the viability of cultivated plants and domesticated animals. Many cultivated crops depend on a narrow genetic base and from time to time, due to occurrence of diseases and other factors, lose their vigour and economic viability. By drawing on a wide gene bank, new varieties of a species can often be developed by scientists which at least for a time, show resistance to the problem.

Nature conservation can widen the scope for agriculture, .sometimes species and their varieties without no apparent use now tum out to be useful in the future and profitable to cultivate or to husband. In so doing, they extend the range of agricultural possibilities or

future options for agriculture.

It is, however, very difficult or impossible to place an exact value or even possibly a reasonable approximation, on the economic value of conserving biodiversity.[7] Nevertheless, we do know that if for genetic reasons, one of our major crops such as wheat or rice should fail to survive, or fail to survive productively from an economic viewpoint, that the economic costs would be phenomenal. It is of course possible to give estimates ex post of the benefits of certain species having survived. Rubber for instance could be taken as an example. Rubber plays a very important role in modem transportation and although synthetic rubber exists, natural rubber is an essential component of radial tyres, and has many other uses. I understand that the rubber plantations of Southeast Asia were only saved from a disastrous disease by drawing on genetic reserves present in the rainforests of Brazil.

Given that there are demands from the public for the conservation of biodiversity and rare species, agriculture activity is being increasingly constrained to help accommodate their demands. For example, in many countries agricultural properties are more frequently subject to preservation orders. The clearing of land or of habitat suitable for particular species is more and more restricted. In Australia, grazing of livestock on protected or relatively natural areas is increasingly banned or severely restricted. Furthermore, land-use on many agricultural properties is subject to mounting limitations. Therefore, growing environmental concerns are imposing extra costs on at least some sections of the agricultural community. Agriculturalists are finding if necessary to adjust to this changing social climate.

6. Socio-Economic Methods for Sustaining Biodiversity and their Agricultural Implications

With the general increase of interest in the state of the environment, there has been growing interest in how economic and social mechanisms can be used to sustain biodiversity and attain environmental goals.

Substantial attention is being given to the possibilities for using economic incentives, to extending property rights, and to harnessing markets to conserve biodiversity and natural resources. Indeed, in some quarters there is a state of euphoria about the likely effectiveness of these policies.

However, in relation to biodiversity, market-related systems are liable to be very selective saving of species (Tisdell, 1995a). Those species that can favourably be used for economic purposes in the relatively short-run are liable to be favoured. Often this is at the expense of other species and as in agriculture, this can result in a reduction in biodiversity.[8] Transaction costs are likely to hamper the creation of property rights and the effective operation of market systems in conserving biodiversity and uncertainty further adds to market failures. Even methods which reward local communities according to economic use of species, e.g. rewards for use of elephants locally for trophy hunting, can lead to selective conservation of species. Whether such methods truly conserve biodiversity is therefore arguable. My own view is that considering the situation overall, they reduce biodiversity.[9]

If biodiversity is at least considered in part to be a type of merit good (or to some extent a type of public good) then there is a role for the state in financing its provision and/or in helping to supply protected areas and services supporting conservation of biodiversity. Furthermore, if biodiversity conservation is the goal, efforts to make multiple use of protected areas need to be resisted if the likely consequence of such multiple use would be to make for more uniformity of environments. In general, diversity of environments is needed to support biodiversity.

There is increasing pressure to establish biosphere reserves. These can assist in the conservation of biodiversity provided that they are not used as a means to reduce the size of core protected areas. Biosphere reserves do, however, place increasing restrictions on land use, for example, by agriculturalists. Furthermore, both the presence of protected areas and the use of biosphere reserves can result in increased populations of species regarded by many fanners as pests. This is a serious problem for farmers when these- species are protected and farmers are either not compensated for the damage caused or are inadequately compensated, as is often the case.

7. Concluding Comments

New approaches to environmental policy-making are needed which are less mechanical and more organic than some neoclassical approaches appear to be. Concepts of sustainability and of biodiversity are complex but useful. It was observed that sustainable agricultural systems need not promote sustainable development as such. Low external-input agricultural systems, as well as traditional ones, are not necessarily sustainable, especially when dynamic

exogenous changes, such as rising human population, occur. Extensive agricultural systems are not necessarily favourable for biodiversity conservation although on the same land-type, more extensive systems can result in greater preservation of biodiversity than intensive agricultural systems.

While agriculture is in some respects a beneficiary of biodiversity conservation it is also disadvantaged by it in a number of ways pointed out above. Consequently, many equity or income distribution problems are raised by biodiversity conservation.

That use of policies involving market mechanisms, economic incentives and property rights for protection of nature has significant limitations for conservation of biodiversity. This is not to say that advantage should not be taken of such mechanisms but state intervention to conserve biodiversity by direct means is still required .given merit good and public good arguments, the presence of fundamental uncertainties and the occurrence of unavoidable market failures.

8. Notes

1. In addition, note that the natural environmental resource stock is to a large extent self-reproducing or sustainable but this is not true of man-made capital in the same way. It lacks the degree of autonomy of natural capital in perpetuating itself.

2. It is recognized that institutions may mould preferences to some extent (Kelso, 1977). What exactly is their role in this regard? Do they help to establish ‘extra’ preference functions for individuals or change the degree of dominance or prominence of particular sets of preference functions which an individual may have?

3. This is true for the Framework for Evaluation of Sustainable Land Management outlined below.

4. Ramakrishnan (1992) has shown that for *jhum* cycles of 20-25 years, slash-and-bum agriculture in Northeast India is both very economic and sustainable. However, because of pressures, mainly as a result of rising population, the length of these cycles has in many cases fallen to 4-5 years. The method is now relatively uneconomic, biophysically unsustainable, a source of very serious adverse externalities and a major source of biodiversity loss.

5. Possibly a more dramatic example of the biodiversity loss due to extensive agriculture is the clearing of the tropical rainforest of the Amazonian Basin for cattle ranching; the so-called hamburger connection.

6. China is now using artificial fertilizer at one of the highest rates in the world and appears not to be recycling organic wastes including human excreta to the same extent as in the past. The latter is partly a result of increased urbanisation of China. For this and other reasons, water supplies in China have become nutrient-rich; high in nitrates, phosphorous and organic matter. The increasing frequency of 'red tides' in the China Sea is partly blamed on discharge of such water. Many other adverse environmental effects are also being generated by this problem. It is surprising that a country which traditionally-emphasized balanced agricultural systems and polyculture should have allowed this modem trend to proceed so far. In the end (even now) it endangers its very large aquaculture industry (the largest in the world); a significant source of animal protein for its people.

7. Pearce and Moran (1994, Ch. 6) provide some monetary estimates for the value of conservation of diversity of medicinal plants in rainforests. The estimates, however, are very uncertain and problematic. This is especially true of those forecasts involving value of human lives saved or income loss avoided. Value is dominated by the needs of those in high income countries; OECD countries. In effect the lives of those in higher income countries are more valued than those in lower income countries. The effect could be to save the genetic pool which most favours higher income earners. This type of ethics disturbs me. It appears inequitable and unjust. It would for example violate Rawls's principle of justice (Rawls, 1971) and would not appear to accord with the Christian principle that all are basically equal in the sight of God.

8. Maximisation of economic benefit can lead to the rational elimination of some species. Discounting of economic gains, for instance favours the elimination of species which increase in value at a slower rate of growth than the interest rate (Clark, 1976). Other things equal, these are slower growing or slower reproducing species. Observe however that opportunity rates of return provide another economic rationale for extinguishing selected species. Where for example, two species are in competition for the use of the same resources and both are of commercial value, the one with the highest rate of return will be favoured. This will be so even if the internal rate of return from both is well in

excess of the rate of interest. Elimination can occur in many ways e.g. by directly destroying the population of the economically less favoured species or altering habitats to favour the economically more profitable species. In practice, the latter has had the greatest impact in reducing biodiversity.

It might be thought that the above failure of the market mechanism to conserve a species is a consequence of their not being total economic evaluation of a species. However, even if total economic valuation takes place and discounting or the estimated monetary flow occurs both of the above types of situation can occur within the extended framework. Economics can support the elimination of species of relatively low total economic value. Such a recommendation is anathema to many conservationists. I personally do not accept the total economic evaluation test as a final arbiter of whether a species should survive. Its ethical foundations are too narrow. It does not sit well with strong (or even relatively strong) conditions for sustainability and is being increasingly challenged in terms of community values.

9. There is no guarantee that increased commercial use of wildlife or the greater commercial appropriation of total economic value will foster biodiversity. In my view the opposite is more likely as those species come to be favoured for which the largest total of economic value can be appropriated. However, the situation is complex. Nevertheless, I want to make it quite clear that I dissent from the blanket view that greater economic appropriation of total economic value of species and of their varied forms should be encouraged from a policy point of view in order to conserve biodiversity; it can lead to the opposite result.

   A further observation may be in order. Some economists (e.g. Hampicke, 1996) suggest that species conservation might be a non-economic decision but that economists can nevertheless be involved in terms of cost-effectiveness analysis. While this may be so up to a point, the cost of saving some species may be the disappearance of others. So it is not clear that cost minimisation can be divorced from evaluation after all.

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