

## VIII ISHS SYMPOSIUM ON PROCESSING TOMATO

DEVELOPING AN ENVIRONMENTAL MANAGEMENT SYSTEMS FRAMEWORK FOR PROCESSING TOMATOES

### **Literature Review of Sustainable Agriculture to June 2001:**

#### **Part A -Theoretical Considerations**

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#### **Abstract:**

**Literature dealing with the subject of sustainable agriculture is reviewed, conceptual models are considered and the state of research and development into the achievement of sustainable land use systems is presented. It was found that major challenges in the areas of semantics, research methodology and a coordinated and balanced investment of effort into the components of sustainable agriculture, have yet to be addressed. A set of conclusions and recommendations is presented.**

#### **INTRODUCTION**

In January 2000 Unilever Australasia began a unique research initiative to identify the environmental impacts of growing processing tomatoes in Australia. As the first step in designing and implementing this Sustainable Agricultural Project (SAP), a literature review was made of the current thinking about sustainability and some of the approaches being applied in rural industries today. *This paper is a précis of some of the theoretical considerations as presented in a formal (150 page) literature review report submitted to Unilever Australasia and Horticulture Australia Ltd, the research partnership that funded SAP.*

The review sought to identify potential environmental indicators of sustainability spanning the different components of tomato processing field environment plus an appropriate methodology for monitoring them at a farm level. Associated with this review was an effort to determine the work in progress on environmental indicators by Australian agencies, governments, institutes, and organizations with particular reference to field monitoring at a farm level.

#### **MATERIALS & METHODS**

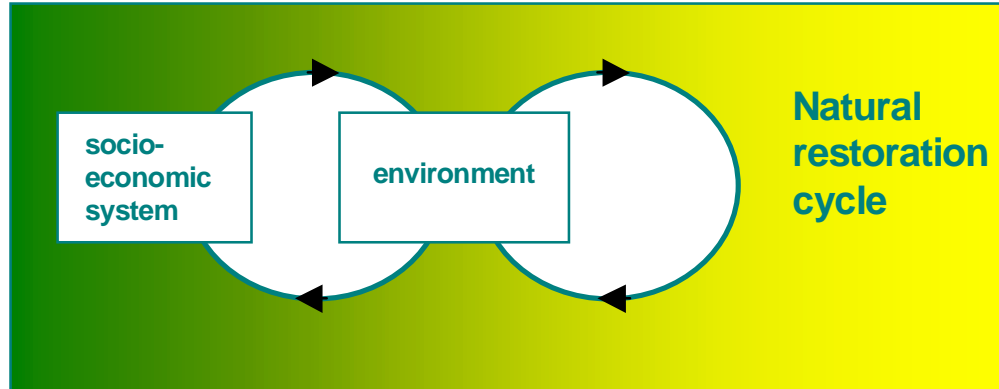
The literature survey was undertaken by using the University of Adelaide library catalogue and a search of known internet web sites which embrace sustainability issues; a total of 325 references, 55.7% of which were published in the period 1998-2001, were examined, copied and evaluated and reported, supported by 35 figures and 17 tables of information.

#### **RESULTS**

The issue and concept of sustainable development was popularised globally by the Brundtland Commission report “*Our Common Future*” in which sustainable development was defined as economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Since the tabling of that report (Hall J.P. 2001), sustainable development has captured the imagination of the public, as well as policy makers at local, national and international levels. Sustainable development is now accepted as a desirable objective for all individual enterprises, institutions, economic sectors, societies, and for the global community at large.

### *The Concept of sustainability*

A simple conceptual model of the environment is shown in Figure 1 and consists of: objects, such as the socio-economic system and the environment represented by rectangles; two-way interactions between the objects represented by arrows; and processes that relate to one object only.



**Figure 1: The Environmental Cycle**

The main concept Bakkes et al (Bakkes J.A. et. al.1994) offer in Figure 1 is the interaction between the environment and the socio-economic system in that the socio-economic system changes the environment:

- Through use and management of resources (right-to-left arrow); and
- By restructuring the environment (left-to-right arrow) through: physical, biological and chemical changes; depositing waste; and counter-measures against earlier disturbances (the social response).

There is now a firm awareness of environmental hazards (Smith K. 1996) in our community and a concern to avoid them. A consequence of this concern has been commitment to find a non-destructive way to use our natural resources and hand them over intact to the following generations of resource users (intergenerational justice) – Sustainable Agriculture is a fruit of this concern! Accordingly successful agriculture is seen to be based upon an ability to manage ecosystems to meet social and economic needs, where measure of success include obtaining sustained production and profitability while meeting food or shelter requirements, maintaining the resource base and protecting the environment.

### *Principles of Sustainability*

Sustainability is argued to have three pillars: ecological sustainability, social sustainability and economic sustainability and some would argue for a fourth pillar of cultural sustainability (Yencken D., & Wilkinson D., 2000). The idea of sustainable development grew out of a need to combine the goals of ecological responsibility with the goal of material well being through economic development.

### *Definition of Sustainability*

The term “sustainability” has stimulated worldwide discussion at the conceptual level and efforts are being made to apply it to agricultural and other aspects of food production and environmental management. From the time it was articulated, sustainability has been accepted by farmers as a valid on-farm strategy (Granatstein D. 1988). The notion of sustainability is not a constant or absolute concept since environmental, social, ethical and economic context will influence interpretation and so it may change with time (Robertson, in Field S. [Ed.]1996). Definitions vary but include: The use of farming systems and practises, which maintain or enhance - the economic viability of agricultural production, the natural resource base and other ecosystems which are influenced by agricultural activities (RIRDC publication [Australia] 1997).

### *Current thinking in - US/Europe*

That there is some confusion about what the meaning of sustainable development has to do with the various interpretations of the terms “sustainable” and “development” that have been proposed in the scientific and policy-oriented literature. It also results from the fact that the terminology is being used for different purposes in scientific and political realms. Generally “sustainable” is used in an environmental/ecosystem sense and “development” is used in a socio-economic sense. Thus “sustainable development” is used here as a shorter way of referring to ecologically

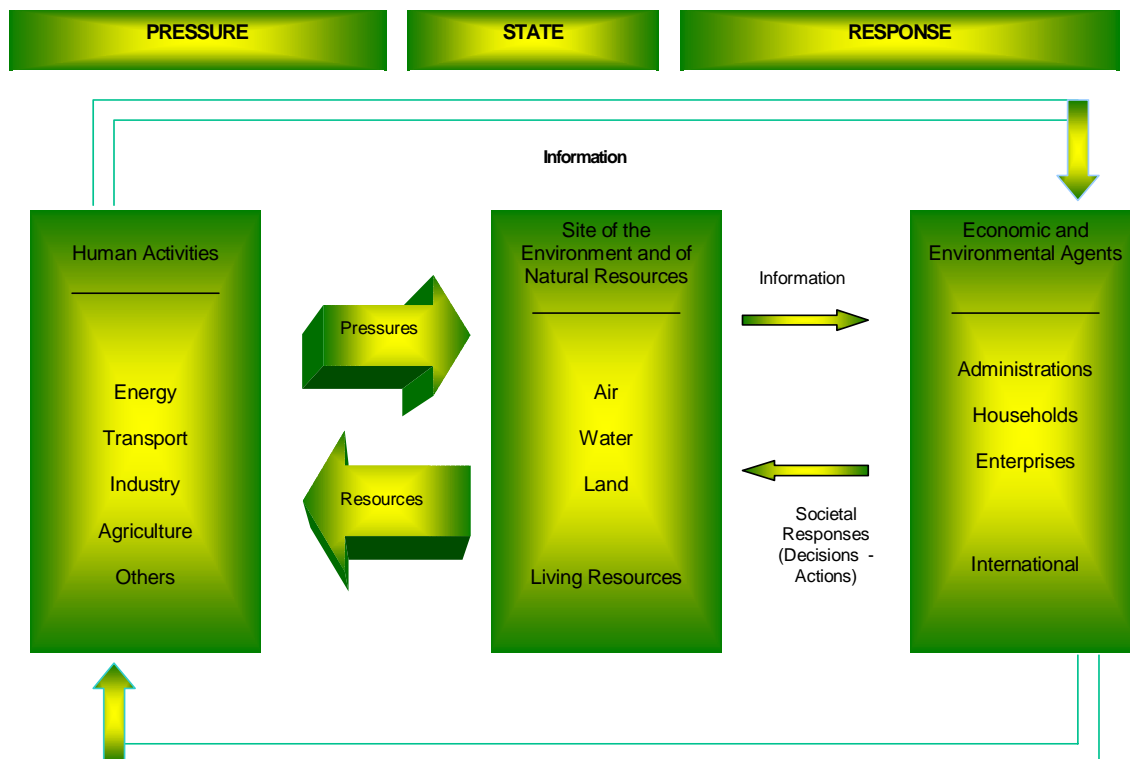
sustainable economic development; some take the term and insert/build-in other meanings and interpretations (Hoff M.D. [Ed.] 1998), so that there appears to be no agreed semantics held to by common convention. It is clear that “sustainable development” will mean one thing to an economist and something quite different to an agriculturalist.

The growing interest and investment into sustainable agriculture and the sustainable use of natural resources more generally has led to the need to establish conventions in terminology which will be accepted across a range of disciplines.

Two ethical concerns underlie the quest for sustainable development. One has to do with intergenerational justice and the second concern is based on an eco-centric perspective of biodiversity, especially living nature and leads to the objective of preserving diversity, from species to ecosystems.

Ecological principles are now being offered to land managers (Dale V.H. et.al 1999). Sets of indicators have been resolved by a range of organizations including OECD, UNECE, UNEP, IUCN and countries such as Norway, The Netherlands, Canada and Denmark (Bakkes J.A. et. al.1994). Such indicator sets now include the influence of changes in the atmosphere upon ecological changes to resources of economic as well as environmental value (Brydges T. 2001), and methodologies for atmospheric evaluation are being developed (Gobiet A. et.al. 2000).

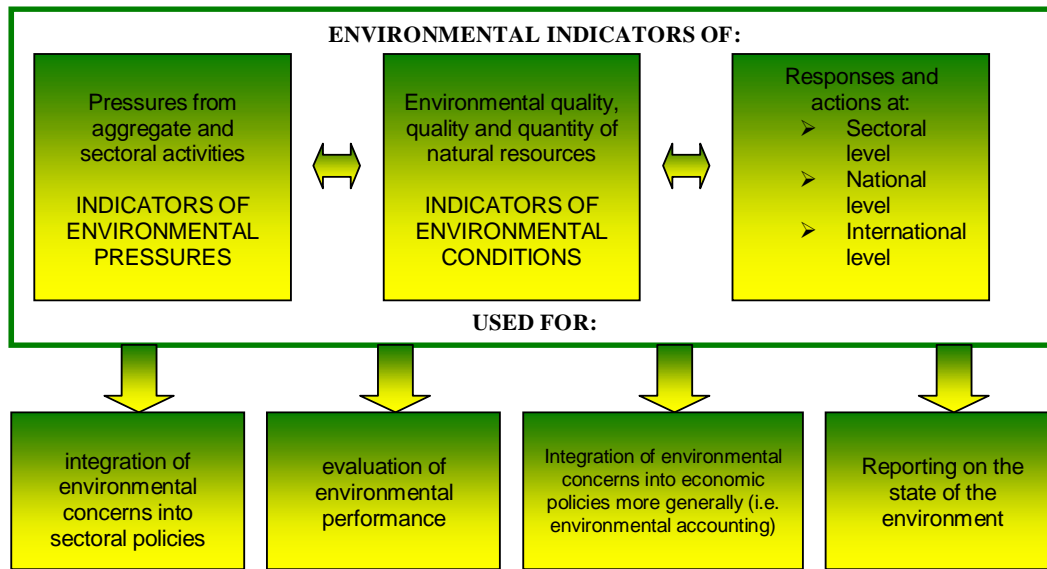
In 1991, the OECD Council approved a recommendation on Environmental Indicators and Information, instructing the OECD Environmental policy Committee to “...further develop core sets of reliable, readable, measurable and policy-relevant environmental indicators” (OECD Core Set 1994). This was reiterated in several Economic Summits of Heads of State and Government of the G7. The OECD Council recommendation spells out three major purposes of indicator development which are directly reflected in the work programme of the OECD group on the State of the Environment, namely: (1) Indicators for the measurement of environment performance; (2) Indicators for the integration of environmental concerns into sectoral policies; (3) Indicators for the integration of environmental concerns into economic policies more generally, mainly through environmental accounting.



**Figure 2: Pressure – State – Response Framework (OECD Core Set 1994)**

In large parts of its work, the group on the State-of-the-Environment uses the Pressure-State-Response (PSR) framework. The PSR framework (Figure 2) is based on a concept of causality: human activities exert pressures on the environment and change its quality and the quantity of natural resources (the “state” box). Society responds to these changes through environmental-, general economic- and sectoral- policies (the “societal response”).

While the PSR framework has the advantage of highlighting these links, it tends to suggest linear relationships in the human-environment interaction. This should not obstruct the view of the more complex relationships in the ecosystems and in the environment-economy interactions.



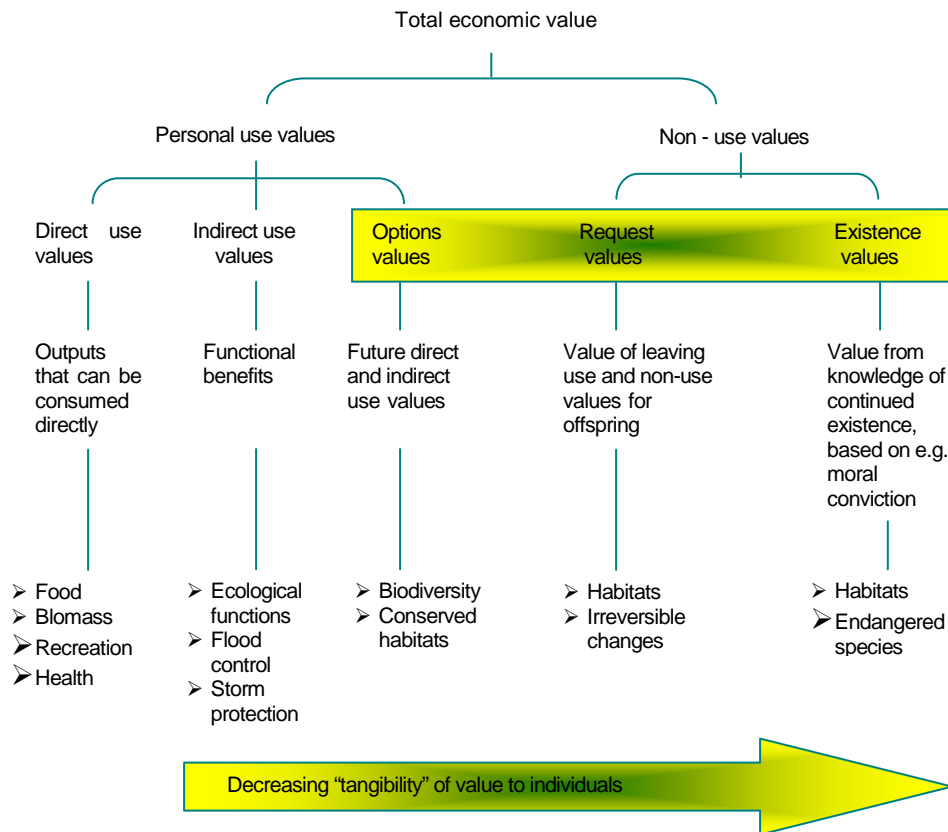
**Figure 3: Nature and Use of Environmental Indicators (OECD Core Set 1994)**

The United Nations Environment Program commissioned a study to resolve a framework and methodology for integrated environmental reporting and assessment (Swart R.J. et. al. 1995). The result included environmental indicators and models describing the human system, the environmental system and their interaction (Figure 3). A hierarchical set of indicators was proposed which could be developed for different geographical, regional and global levels but consensus building was needed to resolve reference values for interpretation.

From the point of view of environmental economics, the environment is regarded as a composite asset that provides a variety of services. As with other assets, the desire of the manager is to prevent undue depreciation of the value of the asset so that it may continue to provide aesthetic and life sustaining services (Tietenberg T. 1988). The environment provides the economy with both raw materials, which are transformed into consumer products by the production process, and energy, which fuels the transformation. Ultimately these raw materials and energy return to the environment as waste products. The economic appraisal of environmental projects and policies (Winpenny J. T., 1995; Kiely G. 1997; Acutt M. and Mason P. [Ed.] 1998; Hanley N. and Spash C.L 1993) is an area where progress is being made in addressing the “intangibles” associated with non-sustainable agriculture as illustrated in Figure 4.

The use of appropriate accounting methods in environmental valuation helps the cause of sustainable development in several ways including: (a) Providing a truer account of the real costs and benefits of projects and policies by quantifying their environmental effects, (b) Furnishing raw data for national resource accounting, which adjusts national accounts (GNP, GDP etc.) to allow for environmental “depreciation” (soil erosion, depletion of petroleum reserves, deforestation etc.) and (c) Providing help to environmental policy through “green pricing”.

Economic techniques are now included (James D. 1994) in Environmental Impact Assessments (EIA). EIA is a generic term that embraces both an administrative process and a set of analytic techniques designed to predict and appraise environmental impacts and development proposals. EIA is widely used in Australia (Carbon B. 1995; Brown A.L. and McDonald G.T.1995) and the need to take on board the values people place on the environment is now recognised when evaluating the environmental impact of an enterprise or project (Bennett J. 1999).



Source: Munasinghe, 1992

**Figure 4: Categories of economic values attributed to environmental assets (Winpenny J.T. 1995)**

*An Australian Perspective*

Sustainable Agriculture as a viable alternative has been firmly on the national agenda since the 1980's in Australia (Wynen E. and Fritz S. 1987). Wynen & Fritz provide a useful overview of the issues motivating interest in sustainable agriculture citing health, pollution, erosion and economic components of the challenge and the policy implications associated with them. Regular State-of-the-Environment reports have been produced at both national and regional (State or territory) level in Australia since the mid 1980's in response to the recognised importance of having accurate and timely information of the state of the environment (Lloyd B. 1996).

A significant milestone in the Australian journey toward sustainable development was the 1991 report of the Commonwealth government Working Group on Ecologically Sustainable Development (Commonwealth of Australia Publication 1991), which established a set of recommendations in the context of the broad principles of : (1) improvement in material and non-material well-being; (2) inter-generational and intra-generational equity; (3) maintenance of ecological systems and protection of biodiversity; (4) global ramifications, including international spill overs, international trade and international cooperation; and (5) dealing cautiously with risk, uncertainty and irreversibility.

Recommendations (twenty seven) by the working group covered the areas of – resource management, land management, water, chemicals, education and extension, research, institutional arrangements, international aid, global warming and progress reporting.

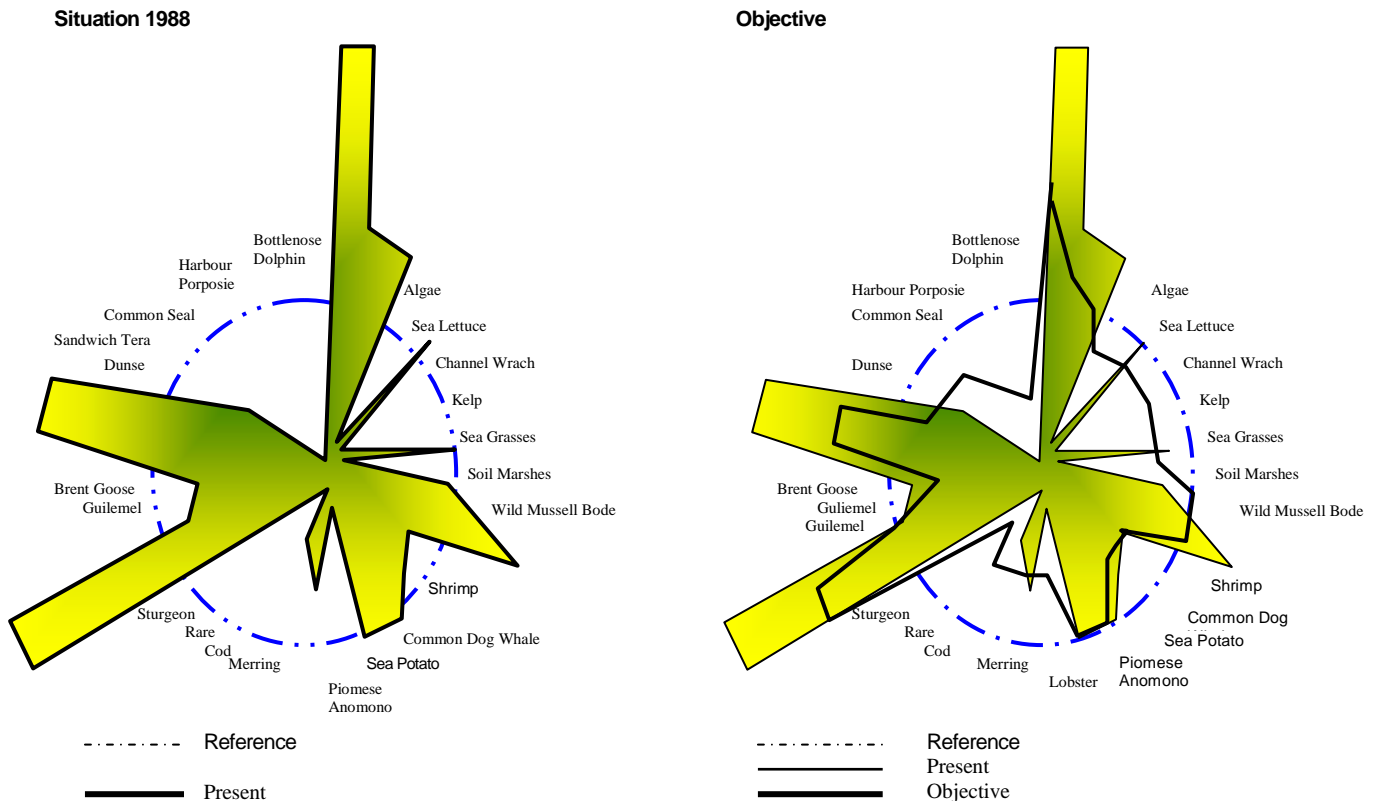
*Need for a holistic approach*

One of the issues that is yet to be addressed in the effort to achieve sustainability is that of developing an “indicator” at the ecosystem level. Scientific agriculture and conventional farming tended to drive ecology out of the input-output equation through technological monoculture and only relatively recently has an awareness of the ecosystem dimension in sustainability been recognised. There is a need to get outside the shared paradigm of traditional agricultural science methodology, which can be described as “Reductionism”, in order to develop

such an indicator.

*In the balance, these disciplines have been, and continue to be, reductionist in approach, i.e. investigation in search of explanation has tended to focus on the small portions of systems that can be conveniently isolated either conceptually or experimentally...The principal weakness of reductionist science is that an understanding of the behaviour of small components of the system is insufficient to enable confident prediction of the behaviour of the whole system. This weakness is not a problem when explanation alone is sought...the weakness is manifested, however, when the understanding and theories developed from reductionist investigation are translated into prescriptions for agricultural practices. (The Rural Development Centre [Australia] TRDC Publication No.169, page 66).*

A more holistic approach to sustainability therefore seems worthy of trial and the AMOEBA concept of Bakkes et al (Bakkes J.A. et. al., 1994) may well be a starting point in the search for a means of depicting ecosystem indicators.



**Figure 5: North Sea AMOEBA for 1998 and for a planned future objective**

The introduction of a reference system provides a standard by which an assessment can be made of the condition of a system. Preferably the reference should be an historic situation, but as data from such situations are often lacking, another area, which has been left relatively undisturbed, should be chosen as a (geographical) reference area. A quantitative comparison between the reference system and the present-day ecosystem is made using a convenient number of biological, physical and chemical target variables (indicators). The results of the comparison between the present-day ecosystem and the reference situation are visualised in the so-called AMOEBA: a circular graphical presentation with the circle representing the reference situation. Other points are then plotted to represent both the present situation and the desired future one; in each case values higher than the reference one are plotted outside the circle, and values lower than the reference one are plotted within it. The AMOEBA approach appears to be reasonable and universal in its application and in principle can be applied on all scales and for every system.

Some of advantages of the AMOEBA appear to be:

- ❑ a potentially infinite number of indicators or variables can be positioned radially across the circumference of the circle,
- ❑ standard scales and methods of assessing indicators can be employed without change or modification,

- ❑ the need to “synthesize” a subjective expression or index of the state of an environment is avoided – subjective holistic indices are unnecessary,
- ❑ standard statistical evaluation or comparison of indicators between sampled environments is unchanged,
- ❑ a holistic representation of the environment against a reference system is achieved,
- ❑ both the reference system and the magnitude of differences from the sampled system are defined and displayed.

While the need to investigate the challenge of sustainability in a holistic way (because of the complexity and inter-connectedness of the environment) is clear, it has not been clear how far to extend the investigation where the social dimension is concerned.

### *Social & Human Capital*

At its core, the challenge of sustainability is essentially a human one as Kirkwood and Longley (Kirkwood R.C. Longley A.J. [Ed.] 1995, page 4) remind us. Man has been both the perpetrator of environmental degradation and also its victim – a victim at both an economic and personal level. The negative economic consequences of environmental degradation have probably been the prime stimulus in motivating communities and agricultural industry to recognise and address the challenge of sustainable use of natural resources; but there has been a slower awakening to the second issue of the effects of degradation at a more personal level – the level of human health.

### *Human health*

A recent 1998 recommendation that arose from the British Medical Association’s (BMA) work on the environment called for doctors to “play an active part in managing the environment in the interests of public health” (Kirkpatrick C. and Lee N. [Ed.] 1997, page 3). Human health is now proposed as a formal component of Environmental Impact Assessment in the United Kingdom. Despite clear interdependence, since human beings can only be healthy in a healthy environment, human health and the environment have traditionally been addressed separately.

The term (and associated methodology) “Health Impact Assessment” (HIA) needs to be introduced into the sustainability debate. HIA is a methodology which aims to identify, predict and evaluate the likely changes in health risk, both positive and negative (single or collective) of a policy, programme, plan, or development action on a defined population. Ideally HIA’s should always include consideration of physical, mental and health impacts. In addition to the above, since every living person is affected by the degradation of the environment and the natural resource base, it is argued that everyone is therefore a stakeholder in the sustainability quest (the achievement of truly sustainable land- and resource- use systems) and so everyone has a role to play in its’ remediation.

## **CONCLUSIONS**

A survey of literature on the subject of sustainability showed that:

- ❑ The need to use natural resources sustainably is attracting widespread attention and is almost universally accepted at a policy level for resource management,
- ❑ Research and Development (R&D) agencies worldwide and in Australia in particular are applying the principle of sustainability as a strategic planning criterion for the future,
- ❑ There is a lack of uniformity of interpretation and understanding of sustainability across disciplines – conventions for methodology and semantics have not been established; this is partly due to the relatively recent emergence of sustainability onto the international R&D agenda and into the R&D and policy “market place”,
- ❑ While some conventions for sustainability, particularly in the bio-physical sciences, are being established at the “macro” level, the “micro” level issues for monitoring the environment at a specific site and the methods or protocol for doing so are not resolved in most cases,
- ❑ Overall there appears to be an imbalance in the investigation of sustainability worldwide in that the socio-economic aspect and energy aspects of sustainability have yet to attract a proportionate share of the R&D investment,
- ❑ Historically the issue of human health seems to be almost universally overlooked as a dimension or consideration where R&D into sustainability is concerned. Given the centrality of people and their well being to all food producing and processing activities, human health needs to be firmly placed onto the R&D

agenda for the future and attract an appropriate share of invested funds. The notion of “human capital” as an inventory item in a natural resource asset register for a local environment might be usefully explored,

- Generally a holistic approach to sustainability, while widely acknowledged in principle, rarely is applied in practice; reasons are probably the lack of suitably structured inter-disciplinary teams, the typically reductionist training of professional R&D workers and the need for new methodologies to address the environment on a holistic basis,
- The Dutch AMOEBA paradigm is recommended as a start-up convention for presenting a holistic statement about a managed environment against a chosen reference (more sustainable) system or criteria. The term “ECO-MAP” is proposed because of the negative connotations of the word “AMOEBA”.

## RECOMMENDATIONS

As a consequence of the findings of this review the following recommendations are submitted:

1. That efforts be made to convene a suitably empowered working party of key stakeholders in the international (& national) food –growing, -processing and -marketing industry with a brief to resolve protocols, R&D methodology, holistic strategies for assessing the sustainable use of resources and:
2. That a formal analysis of the human health and the social dimension of the sustainable agriculture challenge be undertaken to help redress the historical imbalance of investigations to date.

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