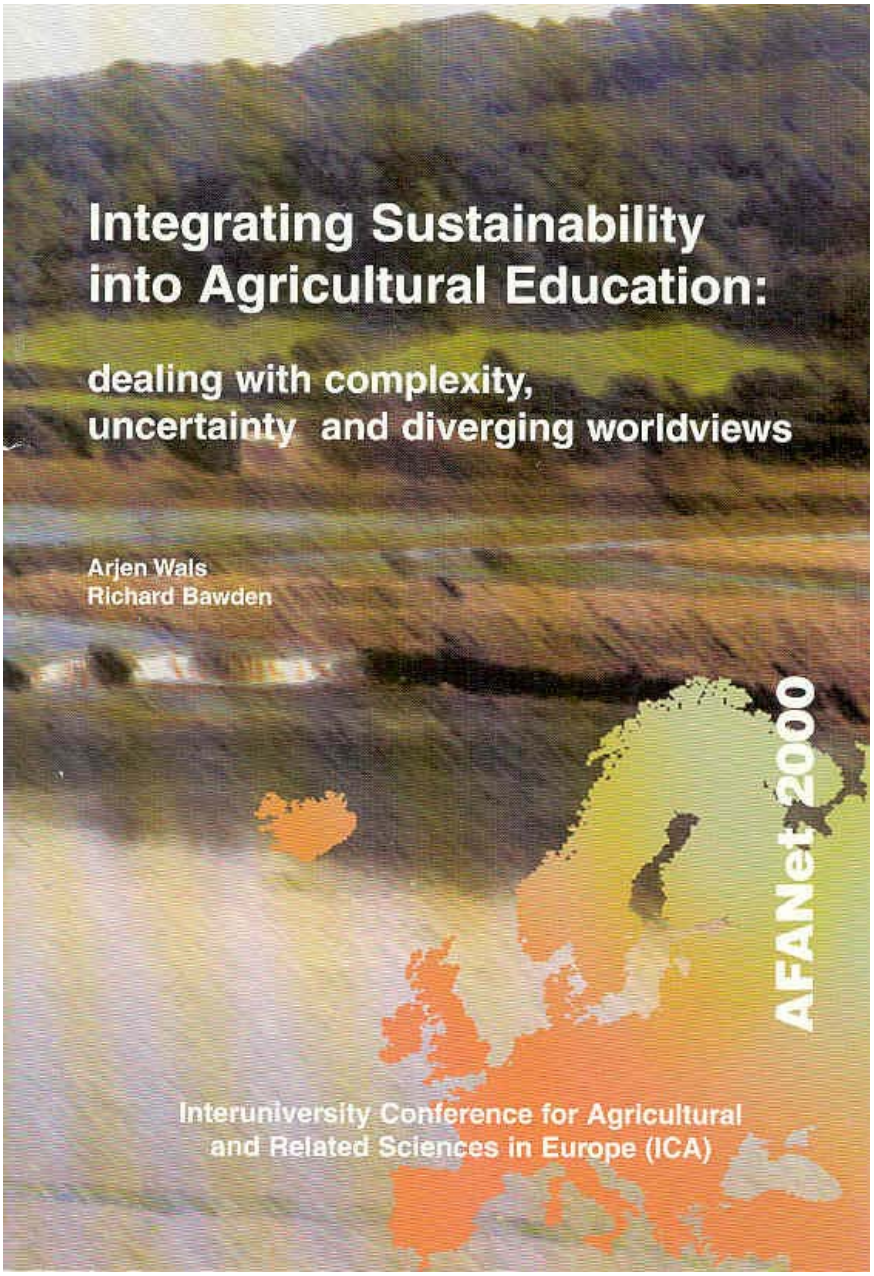
Integrating Sustainability into Agricultural Education:
dealing with complexity, uncertainty and diverging worldviews
Arjen Wals
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AFANet 2000
Interuniversity Conference for Agricultural and Related Sciences in Europe (ICA)

Integrating Sustainability into Agricultural Education is a compilation and synthesis of five major papers and/or presentations the authors have recently contributed to (Bawden 1993; 2000; Dreyfus & Wals, 2000; van den Bor, Holen, Wals & Filho, 2000; Wals, Alblas & Margadant, 1999; Walker, Thomas & Wals, 2000). This position paper has been written as one of the outcomes of the 1999-2000 dissemination phase *of the EU Socrates Thematic Network for Agriculture, Forestry, Aquaculture and the Environment (AFANet)* from the work-package focusing on the integration of sustainability in higher education.

Integrating Sustainability into Agricultural Education

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Preface

This text represents a position paper on the integration of sustainability in agricultural education as one of the main outcomes of a key activity carried out within the framework of the EU Socrates Thematic Network for Agriculture, Forestry, Aquaculture and the Environment (AFANet)[1]. AFANet aims to develop both a European dimension to education and co-operation between universities and colleges in Europe that offer degree programmes in agriculture, forestry, aquaculture and the environment.

This aim is being achieved by addressing the following key structural and academic issues:

- Analysis of current issues in agriculture, forestry, aquaculture and the environment with the objective of influencing curriculum innovation in AFANet partner institutions,
- Support for the shared development of curricula with the objective of developing a European dimension to curricula in AFANet partner institutions,
- Support of internationalisation in teaching and learning within the partner institutions, and
- Identification and dissemination of good practice in collaboration between institutions of higher education in the shared delivery of courses and degree programmes.

Although not a new topic, the integration of focus sustainability is an issue that has clearly gained momentum over recent years within the agricultural industry at large, as well as specifically within institutions of agricultural research and higher education. Between 1997 and 2000 the AFANet has developed a number of initiatives to promote the integration of the concept and praxis of sustainability into the curricula of higher education in agriculture, forestry, aquaculture and the environment. These activities have included: (i) two workshops for teachers and curriculum coordinators from agricultural universities focusing on conceptual issues and practical challenges with regards to the integration of sustainability, (ii) an extensive

[1] For more information see http://www.clues.abdn.ac.uk:8080/demeter

compilation of cases and conceptual analyses originating in a wide number of countries from around the globe and (iii) an on-line discussion of some of the main outcomes of the workshops and the compilation as published in the book *Integrating concepts of sustainability into education for agriculture and rural development* edited by Bor, Holen, Wals and Filho (2000).

In preparing this position paper the aim was to capture some of the main outcomes of the activities carried out over the past three years and look for cross-fertilisation with the authors own recent work and experiences. With it, the authors seek to capture the outcomes and essence of earlier discussions, reflections and experience, while at the same time seeking to encourage further discussion, reflections and action The main challenges addressed in the paper are summarised under two main headings: 1) conceptual and thematic challenges and 2) implications for teaching and learning and these are addressed respectively in Part I and Part II.

We gratefully acknowledge the following colleagues who have contributed to the project in a number of ways: Peter Holen, Wout van den Bor, Amos Dreyfus, Art Alblas, Marjan Margadant, Robert Macadam, Roger Packham, and Sri Sriskandarajah.

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Introduction

The urgency to address sustainability issues is increasingly being reflected in the manner in which institutions of higher education around the world are giving priority to the teaching, research and practice of sustainability (Walker et al., 2000). Many universities now recognise that they have a critical role to play in helping with the creation of sustainable futures through the education of the current and future generation of professionals, through their research agendas, and through their own institutional practices (see, for example, Ali Khan, 1992; Cortese, 1998).

Sustainability apparently has features that makes it an attractive concept to teachers, students and administrators (van den Bor et al., 2000) and, as a reflection of this, many institutes of higher education are adopting mission statements that embrace aspects of sustainability. As a concept it provides a focus for the building of bridges between different disciplines and between divergent interests and values. It also presents opportunities for fundamental reforms of curricula that involve the exploration of non-conventional epistemologies and ontologies, as well as non-traditional pedagogical practices that include more experiential or issue-based strategies, more interdisciplinary studies, and more applied practices.

There are those who value the broad-based international political impacts of a sustainability focus in bringing environmental issues to the forefront of both scholarly and practical concerns. Others see sustainability as a way to improve the image of the university within society, and even, among the more cynical, a vehicle to increase enrolments. Others again see the opportunity that a focus on sustainability brings for reflecting on the role that the academy has to play in contemporary society, while behaving as a microcosm of a sustainable community itself in which the quality of the lives of employees and students alike, in parallel with the environment in which they work and live, are paramount concerns. At the same time however, voices can also be heard that are rather critical of the sustainability trend. Some even suggest that it is a dangerous 'hype' that masks power struggles and ideological differences (see for examples: Hesselink et al. (2000); Wals & Jickling (*in press*).

It is not surprising that institutes engaged in agricultural education – both at the vocational and academic level – are particularly sensitive to the emergence of sustainability. After all, one of the most fundamental threats to sustainable world peace is the Malthusian nightmare of the growth in food supply falling behind ever-increasing global demand. There are already some indications that the world food supply, if not (yet) in actual decline, is not increasing sufficiently rapidly to assure equitable access to, what can be described as, the basic of all human needs. Ironically, one of the most serious threats to further advances in the development of food production systems, is the degradation of both the bio-physical and socio-cultural environments in which it is conducted, and for which present and past agricultural practices are, to a large degree, themselves responsible. There are complex issues here of ethics, aesthetics and other human values, as well as issues of science and technology and economics. In the face of this emerging systemic complexity, the prevailing paradigm for agricultural development, with its narrow focus on production and productivity (productionism), is proving to be seriously inadequate.

Under such circumstances, it is not surprising that there are calls for a new paradigm that has as its context, the search for sustainable approaches to the responsible development of the global food production system/rural environment complex. The challenge here is profound, as such a paradigm must indeed allow for the inclusion of practices which are as ethically defensible as they are technically productive, as ecologically congruent as they are socially desirable, and as aesthetically appealing as they are economically attractive. Given these dimensions, the centrality of the participation of a broad spectrum of stakeholders in debates and discourse about the quest for sustainable food production systems, and in the design and management of such systems, is clearly critical. Such a spectrum includes not only agricultural producers, and the technologists and the scientists that support them, but also the consumers of agricultural products, as well as all others who are affected directly or indirectly by the impacts of agricultural practices on the 'environment' – in essence, all of mankind. Arguments are thus mounted in support of Ulrich's call for 'critical systems thinking for citizens'(Ulrich, 1993) and a number of approaches have evolved over recent years in a number of institutions of

higher learning, that respond to this systemic challenge. One such approach, derived from work on 'systemic learning' and participatory environmental education in Australia, is described and presented here, as a framework for considering new strategies both for sustainable rural development in practice, and for pedagogical approaches that facilitate the acquisition of competencies relevant to that. The logic of the approach and of the conceptual model that underpins it reflects the view that the 'citizenry' will only effectively embrace systemic ideas once they have achieved particular 'states of mind' themselves which appear to be triggered most effectively through experiential strategies and critical reflections. Thus it follows that such strategies and critical reflections need to become an integral part of the teaching and learning environment in agricultural education.

This position paper consists of two parts. Part I focuses on conceptual issues with regards (a) to contemporary agricultural practices, (b) to matters of globalisation, (c) to sustainability itself, and (d) to the meaning of education within these contexts. Part II focuses on the challenge of translating these conceptual issues into curricular strategies and practices within institutes of agricultural education. Specific 'anchor-points' for rethinking both the content and process teaching and learning for agriculture and rural development are presented.

Part I: Carsonian concerns, sustainability and education

Farming and Globalisation

Farmers of have long appreciated the fact that their practices have had unintended, or at least unwanted impacts on their surrounding environments as well as on the resource base of their own farm, and have recognised the prudence of minimising the negative consequences of their actions. As the industrialisation of agriculture has proceeded apace however, the scale of these impacts has increased to now achieve global significance; global both in the sense of the spatial distribution of such impacts, as well as a growing universality of public awareness of the phenomena. The media have been extremely important in this regard, with the publication of Rachel Carson's book The Silent Spring in 1962 (Carson, 1962), which detailed the global and accumulative impacts of pesticide usage, being seminal in illustrating the conjunction of these two aspects of globalisation. This book could be seen to have played a seminal role in increasing the appreciation of the connections between, and concerns about, the global environmental impacts of local agricultural activities. It can also be argued that it played a significant role in triggering appreciation of the need to seek systems of food production that would be sustainable into the future.

A generation later, and the ultimate paradox of agriculture would reach 'formal' levels of recognition with the Chairman of the World Commission on the Environment and Development declaring that "Our agricultural practices are both a cause of global degradation and a prime victim of its effects. Agriculture will therefore be an integral part in our efforts to achieve sustainable development both nationally and globally" (Brundtland, 1987). The increasing recognition of these global complexities by the citizenry, and their growing calls for things to be 'better', are leading to significant critiques of the productionist paradigm itself, and of those who promulgate it. Thus the institutions responsible for its persistence, are being increasingly subjected to what one writer has referred to as "a Greek chorus of criticism" for seemingly ignoring calls to

address issues ranging from "environmental degradation; concerns for animal welfare, impacts on the health and safety of farmers, agricultural workers and consumers; adverse nutritional effects of production and processing technologies; the extrusion of smaller family farms from agriculture; the erosion of rural communities and the concentration of agricultural production and economic wealth; inadequate conservation and commercial exploitation of fragile lands that should not be in cultivation" (Buttel, 1985). Of particular significance is the further extension of the "Carsonian concerns" of the globalisation of biophysical impacts, to include unwanted consequences of the globalisation of agricultural trade and the large-scale social transmigrations. All of these phenomena are together creating situations where many of these 'global impacts' are "fundamentally non-linear and discontinuous in both their spatial structure and temporal behaviour" (Hollings, 1994) and thus not only uncertain but inherently unpredictable. As a consequence, we must change our approaches to development, for as Hollings warns "human responses that rely on waiting for a signal of change and then adapting to it will not work".

Taken together, these issues represent really complex social, political, economic, ecological, aesthetic, and ethical aspects, and together they are clearly dictating the need for a more sustainable approach to the development of food production systems which embrace concern for the integrity of cultures and communities across the globe, and of the global ecology including a respect for the intrinsic value of nature, as well as the productivity of the systems themselves. Dealing with complexity, uncertainty, conflicting norms, values and interests in a globalising world, requires a radical transformation of agricultural practices and thus an equally fundamental transformation in the competencies required to be gained by students of agriculture and rural development. In Part II of this position paper we will sketch the kind of transformation that, based on the AFANet sustainability project and our own experiences, we feel is needed, in terms of mission, goals, content and learning process. But before we get to this we need to have a closer look at the matter of 'sustainability' and how it relates to education.

Divergent views on Sustainability and Education

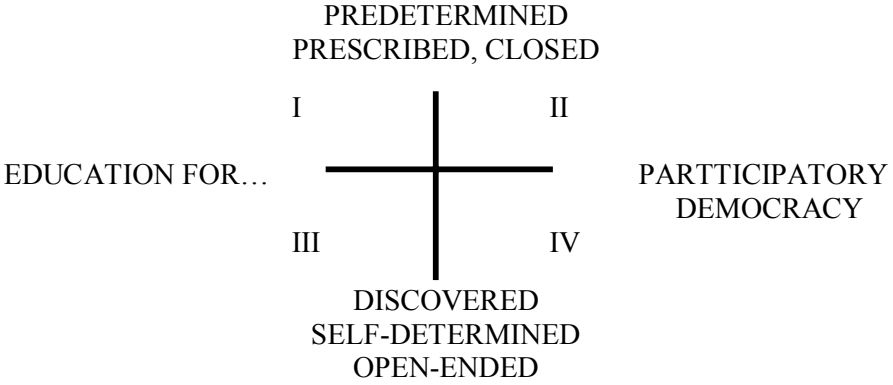
There are many definitions, descriptions, meanings and interpretations of sustainability. Some argue that this makes it a weak concept positing that when a concept can mean so many different things, it cannot be 'surrounded', measured and used as a base for comparison, policy-making, scientific inquiry or as a teachable (scientific) concept: At base here is the belief that 'When something means so much, it means nothing in the end'. There are also those who are critical of the ease with which different groups in society, often with opposing ideological backgrounds, jump on the sustainability bandwagon. They point out that sustainability can mask ideological differences and can promote 'feel-good environmentalism'. Jickling (*in press*) speaks of Orwellian double speak when people use phrases like sustainable economic growth. He suggests that 'sustainability talk' can lead us in the direction of Orwell's (1989) famously satirical notion of "doublethink" whereby ordinary citizens can increasingly hold in their minds contradictory meanings for the same term and accept them both. Seen this way sustainability tends to blur the very distinctions required to thoughtfully evaluate an issue (Jickling, *in press*).

Others however, perceive a strength in the very ill-defined and apparent political impact of the notion of sustainability. It allows for the contextualisation and the joint exploration of meaning. In other words, through dialogue, discourse, negotiation, joint fact-finding, mediation, etc. people can arrive at their own interpretation of sustainability as contextual and relevant to their own situation within a broader context of ecological responsibility and ethical defensibility. From this perspective, it is argued that given that we do not know what comprises the right or best 'sustainable lifestyle', it would be wrong for 'technical experts' or the government to prescribe to citizens how they should behave. Teaching for sustainability, from this position is only a legitimate educational goal when the learners are given space for autonomous thinking and self-determination to decide for themselves what counts as sustainable living.

The latter position suggest that educating *for* something (peace, biodiversity, sustainability), unlike educating *about* something, is essentially political and has to do with democracy and participation. Preconditions for education *for* sustainability then, should include a focus

on: transparency of power relations, communicative competence of the participants, diversity of perspectives, values and interests entering the learning process, equal opportunity and access for all learners, and room for creativity and space for alternative, deviant and non-conforming outcomes (Hart, 1997; Wals & Jickling, 2000).

These notions about democracy and participation can also be applied to processes for making decisions about the content and direction of the learning to take place. They generate questions that need to be addressed such as: To what extent are learners and facilitators of learning involved in such decisions? To what extent does education for sustainability respond to the challenges identified by the community? To what extent is the learning process and content sensitive to the ideas, values, interests and concepts embodied by the learners themselves? Figure 1 represents an attempt to position different conceptualisations of education within the force-fields described.



I = Education as reproduction, no participation
II = Education as reproduction, participation as tokenism
III = Education as discovery learning and problem-solving focusing on predetermined and predefined issues & options, no participation in democratic decision making and making key choices
IV = Education as human development, genuine participation

Figure 1 Positioning education in two force fields *(source: Wals & Jickling, 2000)*

It is clear that a discussion of the integration of sustainability in education will need to include a critical reflection on both the meaning of sustainability and the meaning of education. Let us now return to education for agriculture and rural development.

Sustainability in agriculture: towards an analytical framework

In spite of the increasingly strident calls, over the past decade or so, for changes in the way food production systems are designed and organised, the search for 'more sustainable methods of development' of agriculture and rural communities, has not gained a very significant momentum to date. As emphasised by various contributors to the recent publication entitled 'Integrating Concepts of Sustainability into Education for Agriculture and Rural Development (van den Bor et al. 2000), one of the essential reasons for this is the power of the prevailing paradigm of productionism and the impact it is having on interpretations of sustainable development. The debate about the future of agriculture also reveals divergent meanings of sustainability.

In an important book exploring agricultural sustainability in a changing world order, Douglass (1984) introduced the essence and significance of different interpretations of the concept of sustainability. To those who we have been thus far labelling productionists, sustainability relates to the sufficiency of food, with agriculture being regarded by such a paradigmatic constituency, as primarily "an instrument for feeding the world". From this perspective, sustainable agriculture means the sustained capacity of technological innovation to continuously increase agricultural productivity; nothing more, nothing less. A second group, in contrast, recognises sustainability within an ecological context, extending their paradigmatic concerns to embrace the need to reduce "non-harmonious practices" to minimise disruptions to "biophysical ecological balances". To a third group, the concept of sustainability is extended even further include "promoting vital, coherent, rural cultures, and encouraging the values of stewardship, self-reliance, humility and holism which have been most associated with family farming" (Douglass 1984). The work of Cotgrove (1982) and Miller (1983) on 'cognitive styles and environmental problem solving', suggests a fourth, 'mystic' position on sustainability which can be added to this list, and where environmental problems caused by

agricultural (mal)practices can be envisaged as being "rooted in individual consciences and morality; a reflection of our twisted mentalities" (Miller 1983). Given the differences in the domain in their focus - their centricities - these four worldviews on sustainable agricultural development can be labelled: *technocentric, ecocentric, holocentric* and *egocentric* respectively (Bawden 1997).

These differing worldviews on the nature of sustainability, present a fertile ground for investigating issues that are at the very heart of the sustainability debate, for they obviously differ very significantly with regard to the focus that each assumes, and the manner by which they address the two key questions of any development: "What constitutes an improvement?" and "Who decides"? There is thus much more to these differences than merely the different levels of complexity that each embraces. At base, each of the respective worldviews can be perceived as representing particular sets of assumptions about (a) the nature of nature (ontology) and (b) how that nature is known (epistemology). The particular conjunctions of epistemological and ontological assumptions with which we will be involved here, are indeed so different from each other across the four perspectives, that they represent aspects of some of the most profound matters of contemporary philosophical tension, as well as containing within them, the seeds of enormously important social conflict and social-ecological disharmony.

An exploration of these differences is an apt entry point for exploring what we will refer to as the systemic/epistemic connection: The connection between systemic ways of thinking and acting, and particular epistemological/ontological competencies.

Worldviews as conceptual windows on the world

The four worldview interpretations of sustainable agriculture identified above, can be 'mapped' on to a conceptual framework which discriminates between profoundly different ontological and epistemological assumptions (Figure 2).

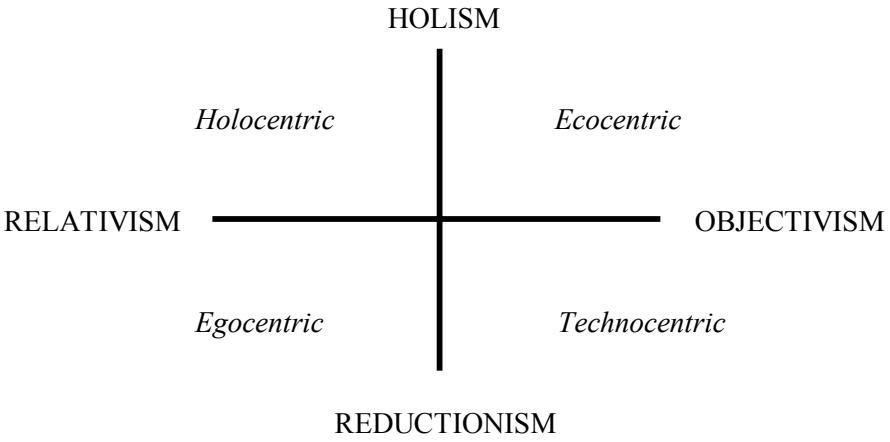


Figure 2: Four conceptual windows on the world *(source: Bawden, 1993)*

These distinctions have been incorporated into, what has become known as, the Hawkesbury Critical Learning Systems model, as 'windows on the world' symbolically at the 'interface' between the observer and the observed (Bawden, 1993; 2000). Their explication in discourse is a fundamental aspect of the Hawkesbury approach to the participative development it espouses, and the distinctions that have been chosen in this particular matrix, reflect this practical focus. Thus while it draws particularly on notions presented by Miller (1983), on the role of psychological dimensions in cognitive styles, and on Burrell and Morgan (1979) on sociological paradigms of organisational development, it has its own idiosyncrasies. In particular it draws seminally on systems principles as frameworks not just for understanding the complexity of the human/environment interactions that are involved in agriculture and rural development, but also of the complexities of the processes involved in learning about them. Particularly those involving ontological and epistemological distinctions, and how these come to be appreciated by learners (Bawden 1990).

Ontological distinctions

The ontological distinctions are based on assumptions about profoundly differing belief positions about the 'nature of nature'. For the purposes of the arguments being elaborated here, a *holist* ontology represents the belief

that whole entities have emergent properties that are unique to themselves as such entities, and that are lost once the wholeness is compartmentalised into its component parts (Varela et al. 1991). Holism finds theoretical support and practical application in so-called systems approaches or systemics. The *reductionist* position, in contrast, is grounded in a rejection of such 'neo-vitalism', arguing that any whole entities are but sums of their component parts, and any 'surprises' that do emerge at the 'level' of the whole, are manifestations of incomplete knowledge rather than of intrinsic properties.

Epistemological distinctions

The epistemological assumptions draw on distinctions elaborated by Bernstein (1983). *Objectivism* here relates to the basic conviction that "there is or must be some permanent, a historical matrix or framework to which we can ultimately appeal in determining the nature of rationality, knowledge, truth, reality, goodness or rightness". In contrast, contextual *relativism* is the basic conviction that the nature of all of these concepts "must be understood as relative to a specific conceptual scheme, theoretical framework, paradigm, form of life, society or culture." Using these distinctions, it is now possible to explore in greater detail, the four sustainability stereotypes for agricultural development, identified earlier.

An egocentric worldview of sustainability.

From an egocentric worldview, more sustainable practices of food production are focussed on the satisfaction of the needs and wants of individuals, and the constitution of improvements, grounded in personal conscience and morality. The search for improvements from such a perspective is thus most likely to assume the characteristics of almost mystical introspections. The emphasis on development will therefore be on the betterment of self, relative to prior or existing states, rather than to the state of others, and on individual interpretations of what constitutes improvements from the perspectives of personal utility and morality. It is possible to aggregate this individualistic worldview to communities, societies, indeed to the entire human race, without loss of the essential reductionism or relativism of this perspective. Thus anthropocentricity can be presented as an egocentric worldview when human concerns are exclusive to the agenda of development, and any emergent properties

resulting from interpersonal collaboration, if recognised at all, are regarded as mere artifact.

A technocentric worldview of sustainability.

A technocentric worldview of sustainable development, emphasises the importance of objective knowledge about the characteristics of those plants and livestock animals which can be manipulated to improve their production potential, as well of biotic and abiotic elements that can also influence production potential. Sustainability then becomes a function of the capacity of scientists to continue to discover more and more scientific truth about the nature of nature, and about how such truth can be used by technologists, to design interventions which continue to enhance the yields of crop, pasture and livestock enterprises across an extraordinarily diverse planet. The reductionism at the heart of this worldview lies squarely with the proposition that improvements to yield will come with the discovery and removal of the next limit to growth. This is regarded as the unquestioned and unambiguous moral commitment of the technoscientific enterprise, while any other values which cannot be included into such an objective position, can be ignored altogether.

An Ecocentric Worldview of Sustainability.

The ecocentric worldview, the first of the two systemic perspectives, rejects the reductionism of technocentricity, while continuing to share its respect for the objectivity of knowledge, truth, and goodness. There is an acceptance here of the basic inter-connectedness of nature, as expressed through the objective findings about the nature of bio-physical ecosystems by ecologists, and about socio-technical systems by many social scientists, especially economists. Goodness is a measure of the value of the outputs of the system. Of particular interest here, is the emerging congruence between ecologists and economists in the search for objective manifestations of the intrinsic value of nature, beyond the utilitarian notions of nature as a resource for human use. The search for sustainable improvements in food production systems from this perspective, focuses on the objective search for methods of increasing the productivity of systems (with money or energy as the currency) without threatening their integrity. Interestingly enough, it is only in recent times that ecologists and economists alike have begun to seriously include the environment in the deliberations of the systems under their review.

A holocentric worldview of sustainability.

The holocentric worldview is pertinent precisely because people hold on to different worldviews! Improvements in the complex situations involving agriculture and its environments outlined in some detail at the start of this paper, emerge only through discourse involving all of those affected by the present situation, and accommodating debates about desirable and feasible change to that. This worldview presents the challenge that the discourse about development be holistic in both intent and process, while recognising the importance of distorted communication, asymmetric relationships of power, and multiple perspectives on what really constitutes 'better'. The commitment is to what we might call a communal rationality, identified through the shared learning of individuals co-operating with a sense of what Bernstein (1983) refers to as "affinity, solidarity, and those affective ties that bind individuals together into a community". Development from this perspective is represented by the notion of researching systems seeking to apply systemic thinking and practices in order to improve the relationships between people and their environments which are regarded as inextricably inter-related.

Both the ecocentric and holocentric perspectives, with their holistic ontological foundations, are systemic in nature. Conceptually, the holocentric system is a network of conversations - a critical discourse in which the criticality includes appreciation of the systemic nature of such discourse. In this manner, holocentric systemicity reflects Checkland's (1988) idea of the shift in systemicity from the world itself (the focus of ecocentric worldviews) to the process of inquiry into matters of that world which are considered somewhat problematical. Holocentric dialogue will embrace critical concerns about our assumptions in making systemic judgements (Ulrich, 1993) as well as the need to think critically about both the social consequences of systems designs (Jackson, 1995) and, most obviously from all that has been said about them, their impacts on 'nature'. It is vitally important to stress the notion that each of these four perspectives on sustainability is legitimate and can reveal vital insights into the process of development when employed carefully. The essential element of that care, is appreciation of the boundary conditions of each perspective, and an accommodation of the different positions held by others, no matter how paradigmatically intransigent they may seem to be.

Thus for instance, an egocentric appraisal will allow a reconstruction of personal needs and goals which, even though not intended, could markedly reduce the pressures on particular production systems. Similarly, it will be those with a technocentric orientation, who will inevitably be needed to continue to research new technologies, within contexts however, established by those who are viewing the world ecocentrically. These contexts in turn, will reflect the more embracing perspectives of holocentricity, and be informed by the insights which can arise when whole communities learn together about what sustainable development can really mean from an holistic/relativistic perspective.

The aim then is not to replace one perspective with another, but to use each to inform the others. We need to move, as Bernstein (1983) has it, "beyond objectivism and relativism", and by the same logic, beyond reductionism and holism. We need not to see these dimensions as incommensurable philosophical dichotomies, but as heuristic devices to inform practical rationality or praxis. From a holocentric perspective, each of these four perspectives can be construed as sub-systems within a system of perspectives, and thus there is a strong case for arguing that this particular perspective is the most liberating. Once we learn to think from such a critical systemic perspective we can reconstrue the whole concept of perspectives through that memorable insight of von Bertalanffy (1981) as captured by his "glorious unity of opposites".

It is vital to emphasise at this point, that the ability to assume systemic worldviews and, even more significantly, to hold on to different worldviews at one and the same time, are difficult to achieve in practice, involving as they do, what is referred to as epistemic development – or more dramatically, paradigmatic revolutions. This has very important implications for those philosophies and pedagogical practices being recommended here for 'educational strategies for sustainability'.

We have stressed the importance of contextualising sustainability and the virtue of multiple realities or perspectives and the conflicts to which they lead. Emphasis has been placed on the human development aspect of education, rather than on the instrumental use of education in trying to alter people's behaviour in a pre- and expert determined direction.

Furthermore a plea has been made to complement more traditional ways of looking at the world with more systemic frameworks which can help learners deal with complexity and uncertainty and can open alternative ways of knowing and valuing. In part II of this position paper we will look at some of the ramifications of fostering such a view on education and sustainability for education for agriculture and rural development.

Part II: Implications for agricultural education

Introduction

Now that we have reflected on the ill-defined nature of sustainability and the merits of taking a more participatory, democratic, pluralistic, and systemic approach to sustainability, we are better able to discuss the implications of taking such an approach for agricultural education. Some emerging tasks of agricultural education are; to help students learn how to appreciate the differences between particular worldview perspectives on agricultural and rural development, to help them learn to achieve systemic competencies in their application, and in particular, to help them learn how to facilitate discourse which allows 'clients' to do the same. Each of the perspectives on sustainability and development elaborated earlier, has particular strengths, and students are encouraged to explore and understand what these are

Two main questions will be addressed here:

- What are the didactical and methodological implications for teaching sustainability from a genuinely transformative educational perspective and for the adoption of systemic worldviews?
- Which operational and institutional conditions are necessary to anchor systemic perspectives of sustainability in a revised curriculum?

Here we will again return to the main outcomes of the book 'Integrating Concepts of Sustainability into Education for Agriculture and Rural Development (van den Bor et al. 2000) and of the three year AFANet project focusing on sustainability in higher agricultural education. Six lessons learnt during from the AFANet activities appear particularly relevant to and highly compatible with the position described in part I[2]:

[2] We wish to acknowledge the input of Wout van den Bor and Peter Holen who have been instrumental in distilling the lessons learnt from various AFANet activities that took place within the topic 'Integrating Sustainability in Higher Agricultural Education'. These lessons learnt can also be found in van den Bor, Holen and Wals (2000).

1. *Integrating sustainability pre-supposes the re-thinking of institutional missions*

The integration of sustainability will never lead to anything fundamentally new if the institution is not prepared to re-think its academic mission. This mission debate should involve all actor groups in the university. It should lead to the re-formulation of the aims and objectives of teaching and research programmes and it should result in a commonly accepted strategy at the macro-, meso- and micro-level. Only then mission statements can become more than a public relations tool.

2. *It is no use crying over vague definitions*

Based on the Krakow seminar education (Wagner & Dobwowolski, 2000) we are able to distill the following features of sustainability:

- Sustainability is a *reality* (a phenomenon to be taken seriously)
- Sustainability is an *ideology* and therefore *political*
- Sustainability is *negotiated*, the result of (on-going) negotiations
- Sustainability is *contextual*, its meaning is dependent on the situation in which it is used
- Sustainability is a *vision* to work towards
- Sustainability is a *dynamic* and/or *evolving* concept
- Sustainability is controversial and the source of *conflict* (both internal and with others)
- Sustainability is *normative*, *ethical* and *moral*

It should be admitted that the ambivalent nature of the concept of sustainability can be a major conceptual impediment to those who like to work with crisp and clear, narrowly defined concepts: 'Tell me what it is and I'll teach it!' It should also be realised, however, that this vagueness has an enormous canvassing and heuristic capacity if it is systematically and systemically used as a starting point or operational device to exchange views and ideas. These ongoing discussions may generate fruitful working hypotheses for the concrete formulation of curricula, study-programmes, subject matter content and didactical arrangements.

3. *Sustainability is as complex as life itself*

The concept of sustainability is related to the social, economic, cultural, ethical and spiritual domain of our existence. It differs over time and space and it can be discussed at different levels of aggregation and viewed through different windows. Hence, a curricular review in terms of sustainability integration is per definition of an interdisciplinary, systemic and holistic nature. It concerns cognition, attitudes, emotions and skills. It does not lend itself to unilateral, linear planning or a reductionist scientific paradigm and thus involves the systemic integration between theory and practice into systemic praxis.

4. *Teaching about sustainability requires the transformation of mental models*

Teaching sustainability presupposes that those who teach consider themselves learners as well and that students and other concerned groups of interest are considered as repositories of knowledge and feelings too. Teaching about sustainability includes deep debate about normative, ethical and spiritual convictions and directly relates to questions about the destination of humankind and human responsibility. In this way it differs from a modernist and positivistic way of thinking. It incorporates notions of the possibility of the finiteness of human existence and trust in human creativity at the same time.

5. *There is no universal remedy for programmatic reconstruction*

The inclusion of aspects of sustainability in academic programmes is very much culturally defined. Also it is closely tied to the academic history and curricular tradition of the institution concerned. Consequently, there is no *panacea* for curricular reform. Some institutions will choose to add on to existing programmes, others will opt for a more revolutionary approach. The decision about the most desirable reform approach is time and space specific and can only be taken in an open and communicative process in which all actor groups play their own, respected roles.

6. *Programming sustainability demands serious didactical re-orientation*

Based on the earlier mentioned Krakow seminar education (Wagner & Dobwowolski, 2000) the following requirements, all pointing at the need for a didactical re-orientation, can be synthesised:

- Sustainability requires a focus on c*ompetencies* and *higher thinking skills*
- Sustainability requires a foundational appreciation of *holistic principles*, *critical system understandings*, and *practical systemic competencies*.
- Sustainability requires an *early start*, i.e. well before students enroll in universities (from kindergarten through high school)
- Sustainability requires *critical reflection* on one's own teaching
- Sustainability requires *self-commitment* and *taking responsibility*
- Sustainability requires *empowerment* of learners by enabling them to work on the resolution of *real issues* that they themselves have identified
- Sustainability requires appreciation and *respect for differences*
- Sustainability requires *courage* ('Dare to be different')
- Sustainability requires *creativity* as there are no recipes

Integrating aspects of sustainability cannot be realised without thinking very critically about the re-structuring of didactical arrangements. This re-orientation requires ample opportunity for staff members and students to embark on new ways of teaching and learning. For this to happen they have to be given the opportunity to re-learn their way of teaching and learning and to re-think and to re-shape their mutual relationships. These new didactical arrangements pre-suppose a problem orientation, experiential learning and lifelong learning. The following shifts in educational orientation are proposed both in the book (van den Bor et al., 2000) and by many of the Krakow participants (Wagner and Dobrowolski, 2000):

- from consumptive learning to discovery learning
- from teacher-centred to learner-centred arrangements
- from individual learning to collaborative learning
- from theory dominated learning to praxis-oriented learning
- from sheer knowledge accumulation to problematic issue orientation
- from content-oriented learning to self-regulative learning
- from institutional staff-based learning to learning with and from outsiders
- from low level cognitive learning to higher level cognitive learning

- from emphasising only cognitive objectives to also emphasising affective and skill-related objectives

Focussing on sustainability provides a wonderful opportunity for accessing higher learning (epistemic development) and new ways of knowing (the paradigmatic challenge) precisely because the concept is (a) so slippery and open to different interpretations, and (b) so complex (involving ethical, moral, aesthetic and spiritual issues as well as the more conventional technical, economic, social and cultural ones). In other words, serious attempts to integrate sustainability into higher agricultural education brings academics into whole new pedagogical worlds - experiential, epistemic, and systemic – which in turn brings them into whole new worlds of learning (and indeed researching) about agriculture and rural development. It is an ideal entrée into epistemology, ontology and ethics. But how do we move from an ideal entrée to the main course? Teachers, students, curriculum developers and study coordinators alike, after rethinking the institution's mission and learning goals, might need something of more substance to work with in redesigning both the process and the content that drives their education.

Process anchors for integrating sustainability[3]

The concept of sustainable agriculture implies a change in society's view of the role of nature in the sense that it entails a mutual, symbiotic relationship between people and nature (instead of seeing nature as being in the service of people, and seeing science as a way of achieving society's domination of nature, Mannion, 1995, p. 329). Agricultural education represents a new ideology (Harwood, 1990; Mannion, 1995), which may guide the revision of the curriculum. Educational strategies have been suggested to meet the challenge. Alblas and his colleagues (1995), for instance, suggest strategies based on high relevance to the learner, problem

3 In describing the process anchors and content anchors for integrating sustainability we make use of and build upon earlier work published in the AFANet publication that form one of the pillars of this paper (can den Bor et al. 2000). Much of this section can be found in Wals and Dreyfus (2000) which in its turn builds upon Wals et al. 1999. We wish to acknowledge the contributions made by Art Alblas and Marjan Margadant of Utrecht University and of Amos Dreyfus of the Hebrew University of Jerusalem.

solving, reflective enquiry, dialectical connection between theory and practice, and collaboration between specialists of theory and practice. They put a heavy emphasis on; a) intellectual skills that are relevant to the discussion of controversial issues in situations of social conflict, b) a deep involvement of the learner in the issues at stake and c) the inclusion of diverging interests. With an implicitly social-constructivist approach, they stress the importance of students' beliefs, ideas, and conceptions.

Meanwhile Bawden and his Hawkesbury colleagues, while holding similar positions to these, also emphasise the significance of the development of what they refer to as 'systemic competencies' (Bawden 2000), the importance of multiple worldviews, and the need for experiential strategies as the most appropriate vehicles for such outcomes.

The above strategies emphasise the importance of establishing criteria for enhancing the quality of the learning process and selecting themes for learning that make meeting such criteria possible. We will list eight criteria that have been derived from environmental education research in the Netherlands (Wals, et al., 1999).

1. Total immersion

Learning by doing, discovery learning, hands-on learning or experiential learning all have in common that the learner becomes immersed in a multi-sensory way in a learning process that is fundamental enough to have a lasting impact on the state of mind and being of the learner. A learning experience becomes fundamental when the whole person becomes part of the learning experience (i.e. head, heart and hands).

2. Diversity in learning styles

People are not all alike. For environmental education to become a meaningful learning experience, environmental educators will have to recognise and be sensitive to the various learning styles and preferences that can be found in a single group. It is unlikely that one particular learning and instruction technique will be appropriate for all involved in a leaning process.

3. Active participation

To become involved in something requires active participation in a dialogue with co-learners and teacher-facilitators. It is through this active participation that the learner develops a sense of ownership in the learning process, its content and its course. Through dialogue, the development of ideas in a social setting, the learner can express his or her feelings or thoughts and become exposed to the feelings and thoughts of others. This confrontation is essential for meaningful learning to take place.

4. The value of valuing

In good environmental education the development of values and meaning coincide. The motivational and affective aspects of learning should be given equal attention. The process of valuing should at least have the following components or steps (Brugman, 1988):

- Putting in words what is found to be important with regards to the subject at stake (explicating personal values).
- Putting oneself in the positions taken by others with regards to the subject at stake (taking on multiple perspectives).
- Comparing one's own personal values with those of others to recognise commonalties and differences (confronting and relating personal values).
- Investigating and discussing the relationship between personal values and corresponding behaviour (or the lack thereof) (validation of personal values).
- A prime objective of following these steps is to develop in the learner a system of values and valuing which is characterised by flexibility, openness and pluralistic respect (i.e. respect for well-argued alternative values).

5. Balancing the far and near

A contemporary curriculum should reflect a society that increasingly demands the integration of environmental and other global issues. At the same time, such a curriculum should be rooted in the life-experiences of the learner. Inevitably, meeting both criteria will cause some friction. After all, issues of environment and development, for instance, are not always existentially relevant. How can we expect someone to take interest in problems that seem physically, socially and psychologically remote? Or, more specifically, how do we design learning activities that move students

from passive detachment to active involvement in environmental issues without having them feel overwhelmed or powerless?

A balance needs to be struck between the far and near of these physical, social and psychological dimensions in order for empowerment of learners to take place. Empowerment here refers to the feeling that one, albeit as an individual or as a member of a group, can shape one's own life and environment.

6. A case-study approach

Human development can be characterised by a double-edged sword with the 'objective' material conditions on one side and the subjective personal needs on the other. Both aspects are relevant for the process and content of education. The challenge is to find exemplary cases that do not only address subjective personal needs, but also address the need for a better understanding of more universal principles (Klafki, 1994). A case-study approach allows the learner to dig for meaning, as opposed to scratching the surface, by focussing on one concrete example for a longer period of time. Taking sufficient time to study a particular issue in-depth is essential and is preferred over studying multiple issues in a superficial way. The teacher needs to take an active role in stimulating learners to expand their boundaries of understanding by challenging them to look further and exposing them to alternative ways of looking at the same issue.

7. The social dimension of learning

The development of knowledge and understanding has both personal and shared elements to it. Social interaction allows one to relate or mirror his or her ideas, insights, experiences and feelings to those of others. In this process of 'relating to' or 'mirroring' (Cassel & Giddens, 1993), these personal ideas, insights, experiences and feelings are likely to change as a result. This mirroring may lead the learner to rethink his or her ideas in light of alternative, possibly contesting, viewpoints or ways of thinking and feeling. At the same time (learning) experiences, which are shared with others, are likely to gain importance. This is not to say that personal experiences, which are kept to oneself, are insignificant. But shared viewpoints or ways of thinking and feeling give the learner a sense of competence and belonging to the community of learners.

8. Learning for action

The argument for including action-taking and the development of action competence in environmental education programmes is threefold. First, one could argue that many people are overwhelmed by environmental, including social, problems as a result of their personal exposure to these problems, for instance, through the ever-present media. It is important to help learners explore environmental issues and to provide them with an understanding of the nature and complexity of these problems. However, environmental education should not be limited to this, for it then could easily feed feelings of apathy and powerlessness. It would be dangerous if environmental education would become a repetition of what many of us already know: the environment is in bad shape, our comfortable lifestyles make it worse and the complexity of environmental issues makes them hard to solve (Monroe, 1990). By bringing in the action-taking component, students can, under certain conditions, begin to take charge of some of these issues and develop a sense of power and control.

A second argument for including action-taking in an environmental education project has its roots in experiential learning thought: one never comes to fully understand a problem with all its nuances and complexities until one fully immerses oneself in the problem, identifies all the players and begins to work within the 'force field' or field of interference towards a joint solution (Wals, 1994a). In other words, we may never really understand the problem until we start to actually implement some potential solutions.

Finally, it could be argued that without the ability and willingness to act it is impossible to participate in or, rather, to contribute to a democratic society. As Jensen and Schnack (1994) point out, and as has been suggested already in part I, a concern for the environment should be connected to a concern for democracy.

Table I summarises the process anchors derived from Wals et al. 1999.

Principle	Description	Examples
1. Total immersion	Fostering a direct experience with a real-world environmental phenomenon	• Observing and monitoring environmental impacts • Managing a specific site
2. Diversity in learning styles	Being sensitive to the variety of learning styles and preferences that can be found in a single group	• Offering a variety of didactic approaches • Reflecting on the learning process with the learner
3. Active participation	Developing discourse and ownership by utilising the learners' knowledge and ideas	• Soliciting the learners' own ideas, conceptions and feelings • Consulting learners on the content of the learning process
4. The value of valuing	Exposing the learner to alternative ways of knowing and valuing through self-confrontation	• Giving learners opportunities to express their own values • Creating a safe and open learning environment
5. Balancing the far and near	Developing empowerment by showing that remote issues have local expressions which one can influence.	• Relating issues of biodiversity or sustainability to last night's dinner • Showing examples of groups of people successfully impacting the local and global environment
6. A case-study approach	Digging for meaning by studying an issue in-depth and looking for transferability to other areas	• Assigning different people to explore different angles of a particular theme and bringing the different angles together
7. Social dimensions of learning	Mirroring the learner's ideas, experiences and feelings with those of others through social interaction	• Taking time for discussion and exchange • Addressing controversy • Stimulating flexibility and open-mindedness
8. Learning for action	Making the development of action and action competence an integral part of the learning process	• Allowing learners to develop their own course of action and to follow through with it • Studying examples of action-taking elsewhere

Table I. Some Process Anchors for Integrating Sustainability in Higher Education *(source: Wals et al, 1999, p.28; Wals & Dreyfus, 2000, p. 81)*

The above process anchors appear to be sound from the point of view of psychology of learning and motivation. However, they omit two issues, related to the *content* of what is to be learned according to the new "challenge" of agricultural education: the organisation of the basis of formal knowledge to be learned, and the lack of agreement about some parts of this knowledge.

Content anchors for integrating sustainability

What education for sustainable agriculture requires is a radical change of the *conception* of agriculture as a practice. This means that the conception of agriculture as "sustainable" must appear to the learner at least as *intelligible, plausible and fruitful* (Posner et al., 1982) as the profit focused conception which prevails in the modern western world. The impact of the curriculum must be strong enough to cause a persistent feeling of unease among the students, bringing them to realise the importance of ecological considerations, then to search for reconciliation between the expected advantages of high-tech production (short-term considerations) and the requirements of social responsibility (long-term considerations). The students must reach a state in which they are willing and able to assess, for instance, whether the justification for using the production technologies they learn about is "outweighed by attendant dangers" (Westra, 1998), or some damage to nature cannot or should not be "traded off" for some invaluable contributions of agricultural production. In some cases, they should be able to check whether or not the environmentalist claims are exaggerated or unfounded.

The balance of plausibility and potential fruitfulness, between production and financial benefits on the one hand, and ecological considerations on the other hand, may not be easily reached in the minds of the students. The "traditional" contents of agricultural education in western countries, e.g., the "know-how" (techniques, practical skills) and its scientific, technological and economical foundations (basic knowledge to be applied), present few dilemmas of plausibility and potential fruitfulness to the learner, because they are directly relevant to the improvement of the productivity and benefits of the agriculturist. It may therefore be difficult to challenge their prevalence in the mind of the students. The same may be claimed about other objectives of agricultural education, such as

intellectual skills related to problem solving and decision making on the basis of scientific, technological, and socio-economical considerations. In contrast, the socio-ecological arguments of sustainable agriculture may appear to the students to be much less plausible and fruitful. What it actually tells them is: "You can earn so much by using X and Y technologies, but you *should* not, because you may harm the environment, and ultimately, will impair your, or the next generations' capacity to produce ....".

Environmental education has so far very seldom endeavoured, if at all, to cope with such *personal conflicts*. The existing programmes in environmental education, even when they directly and actively involve students, tend to illustrate the advantages to citizens of judicious environmental behaviour, as compared with a deplorable existing situation (see for example Wals, 1994b). The required changes in personal behaviour advocated by most programmes (e.g., the three Re's, *Re*cycle, *Re*-use, *Re*duce) imply merely a reasonable effort and very little personal sacrifice, particularly in the case of the much emphasised recycling which doesn't really challenge productionism. After all, the more people consume, the more people can recycle…'. As far as "empowerment" goes in such programmes, it refers mainly to the development of the ability, and of the feeling of ability, to influence "them", i.e., other people, such as the authorities, so that these, in turn, impose required behaviours on still *other* people, such as polluting institutions.

It is doubtful whether even the purposeful "infusion" of environmental contents into traditional curricular contents, in order to enhance the environmental literacy of the students as suggested by several authors (see for example Ramsey et al., 1992), or as used in many STS programmes (see Aikenhead ,1994; Fensham, 1988), is sufficient. What is needed is a systematic effort to confront the students with all the components of the knowledge to be acquired, simultaneously, in direct connection with each other, in relevant contexts, with equal degrees of emphasis and of cognitive demands (scientific knowledge, intellectual skills). The objective of agro-ecological vocational education is not indoctrination, but the development of the ability to weigh alternatives on the basis of equal understanding of all their components. Infusion of sustainability, however

defined, into a traditional curriculum is not enough. In addition to paying attention to the process anchors listed in Table I, attention to the systematic development of a kind of knowledge base is necessary as well. This knowledge base is purposely very broad and includes the following elements.

1. Interdisciplinary themes

Understanding the production, distribution and consumption side of agriculture from a variety of integrated disciplinary perspectives, i.e. basic natural and social sciences, technologies of production, financing, processing, marketing aspects as well as health, nutrition and consumption components, and cultural aspects of agricultural production (National Research Council, 1988; White, 1990; Dreyfus, 1994).

2. Environmental impact assessment

Understanding the *environmental* impact of the production, distribution and consumption side of agriculture. This content anchor refers, for instance, to the direct and indirect (such as influence on global warming) influence of high-input and high-energy agriculture. The inventory of such problems is impressive, and varies locally, nationally or regionally according to the agro-technical methods and the crops that prevail in the local setting. As a characteristic example, a voluminous report of the department of agro-ecology in Israel (Capua and Oren, 1998) refers to the use of chemicals ("…cides"), disposal of sewage and waste, use of fertilisers, irrigation, and aesthetic damage to the environment as a side effect of the agrotechnical activity or negligence, and bad "agricultural management". Also extremely relevant are biotechnologies, genetic engineering, transgenic methods to increase crop and animal yield, adaptation of organisms to various conditions, and the influence of agricultural techniques on the release of gases into the atmosphere (greenhouse effect). The basic knowledge in this category includes various concepts of ecology and protection of natural resources (e.g., biodiversity, attributes of ecosystems, habitats, conservation, preservation, etc.), which have so far not been central to agricultural education but are pertinent to the development of any approach to sustainability.

3. Alternative ways of thinking, doing and valuing

Understanding principles of *alternative* methods of "sustainable agriculture" and their advantages over traditional methods. This content anchor focuses on the concept of "agricultural management". It deals with (1) general factors and policies which underpin holistic views of sustainable agriculture, such as less reliance on non-renewable resources, less environmental degradation, integrated land use systems, economical viability, social acceptability, etc., (as outlined in the discussion by Mannion, 1995, pp. 329-335); (2) specific "clean" agro-technical methods which can be introduced into the existing systems of production (careful use of chemicals, of water and fertilisers, soil protection, treatment of sewage, etc.), and (3) alternative systems of agricultural production, such as organic, bio-organic agriculture, biodynamics, permaculture, eco-villages, Good Agricultural Practice, Integrated Pest Management, etc., (Harwood, 1990; Mannion, 1995; Capua and Oren, 1998; Tilman, 1998). A number of questions could be addressed here: Are there accepted (post-modern?) alternative agro-technical procedures which can be unequivocally shown to be more intelligible, more plausible, more fruitful to the practising farmer then the procedures of modern high-tech agriculture? Are there accepted solutions to the environmental damage caused by modern agriculture? Are there solutions whose advantages and feasibility can be demonstrated scientifically, without "mixing science with advocacy" (ICEE, 1997)? These all involve different ways of viewing the world and different *systems of knowing* to which students need to be exposed.

Students must also be introduced to ecological/environmental *systems of values* which will guide their decisions and the development of their attitudes (anthropocentrism, ecocentrism, conservationism, etc.), and to the civic and political systems in their and other countries (public and civic decision making at the local, regional, national level, institutions, etc.).

4. Entering socio-scientific disputes

Understanding and recognising conflicting norms, values and knowledge claims. An environmentally literate graduate of higher agricultural education should be scientifically literate enough to understand the contributions of science and technology to the creation and the solution of human problems and, vice versa, the influence of human problems on

science and technology. When seeking to produce and consume in a more sustainable way or when trying to explore sustainable lifestyles, one inevitably enters a socio-scientific dispute as to what the right way of living entails. According to Bingle and Gaskell (1994, p. 187), a socio-scientific dispute is born when uncertain knowledge associated with science-in-the-making (as opposed to the more robust widely accepted ready-made scientific knowledge) inhibits consensus as to the scientific facts. Here statements about knowledge are seen as *claims:* they are contestable and subject to revision" (Bingle and Gaskell, 1994). In such instances, citizens find themselves facing divided expertise - qualified scientific experts who have produced different scientific findings on an issue or who disagree over the interpretation of the same findings.

A socio-scientific dispute can even arise in the face of scientific consensus. Such a dispute arises when the consensus is challenged from the outside. This is the case, for instance, when the personal experience of citizens is in conflict with "scientific" evidence; when citizens feel that certain scientific knowledge is so new that any consensus on its factual nature must be considered tentative at best; or when certain interests are seen as having undue influence on the consensus position (Bingle & Gaskell, 1994, p. 188). Socio-scientific disputes are issues about which decision making is most problematic. They are in fact a main topic of education for sustainability since they are truly at the interface between science and society. Rather than avoiding controversy and shying away from socio-scientific disputes, post-modern educators should look for them and enter them into the educational process.

Sustainable agriculture studies, a multidisciplinary domain in full development, will lead the students into areas of disagreement between specialists. They must therefore be equipped with both types of knowledge, and with the awareness of the tentativeness of controversial "claims". They must learn to use both ready-made science and science-in-the making. Education towards a more rational behaviour in cases of socio-scientific disputes may be considered a main goal of vocational agricultural education. In fact, since during the professional life span of the students, socio-disputes about sustainable agriculture can be expected to remain active, some of them being replaced by new ones, the ability to

make decisions in situations of uncertain knowledge may be considered to be the main tool for the professional development of future farmers.

5. Coping with complexity

Understanding and coping with complexity without getting trapped by concerns for the details. Agricultural education, as we have argued, is by definition interdisciplinary. The addition of yet another interdisciplinary area such as "environment" may make it overwhelmingly complex. Higher agricultural education should provide students with skills that make them able to meaningfully, critically and selectively use scientific knowledge. Such use does not necessarily require a full and thorough understanding of all the concepts involved but rather a more functional and systemic understanding of what the concepts do and what they mean to us. People may have, for instance, a functional understanding of what photosynthesis does to our environment (adding oxygen, using solar energy to build organic matter, carbon cycle, etc.) without understanding the complex biochemical processes involved in it. The main idea is to show abstract principles and "theories-in-action" in a concrete situation, instead of trying to prove their existence scientifically (Olsher & Dreyfus, 1999). None of the students can be expected to become high-level specialists in all the domains of knowledge involved. The knowledge taught must be functional, so that the student can use it as a tool for thinking, problem solving and decision making (see Solomon, 1994, referring to STS education).

Systemic thinking is a key competency with respect to the ability to deal with the complexities of contemporary agriculture, natural resource management, and rural development.

To illustrate the above anchors and their interdependency let us look at an everyday dilemma many farmers face: when and how to use chemical pesticides, if at all. It can be argued that chemical pesticides are usually very effective, from a (short term) production point of view. Without them, a wide-spread world food crisis would have occurred long ago (Katan, 1993). They appear to give the farmer immediate satisfaction concerning crop protection. On the other hand, they are, certainly in the long term, very harmful to the environment. This long term environmental impact is often not directly perceived by the farmer. Alternatives to the exclusive

use of chemical pesticides consist of, for instance, types of "organic" farming or combined systems, which make use of both chemical and non-chemical tools (i.e. Integrated Pest Management). The basis for the development and use of such methods is essentially *scientific and technological*: "it encompasses many topics -- from the development of mechanisms and modes of action to the development of technologies of implementation" (Katan, 1993). It requires a radical change in the farmers' approach to pest control: eradication of the pest is not seen as a prerequisite to effective control. The operational goal, namely to reach an equilibrium at a level at which both the environment and the farmer's livelihood are sustained, is quite clear. However, managing the *complexity* of understanding and reaching such an equilibrium through alternative methods of crop protection is quite intangible. For one thing, the use of biocontrol agents (one of the main methods of non-chemical controls) is much more complex than that of chemical agents, precisely because they are living organisms and as such much more influenced by the environment. Secondly, "quality control" is often difficult to realize. Furthermore, biocontrol agents are subject to intense disputes and controversy: How hazardous are they? Are they less harmful than pesticides? How can their effectiveness be evaluated? What are the risks involved in the use of genetically engineered (highly improved) biocontrol agents (see also Westra, 1998)?

Table II summarises the content anchors generated so far.

Because large industries are involved, and because the research and development efforts require the investment of huge public resources and financial support, the implementation of non-chemical methods of pest control have important sociological, political, and economical aspects. The education of farmers who are able to keep an eye out for alternatives when directly involved in such complex issues will require an intense educational effort. Also, in view of the important socio-economic aspects of the relevant political decisions which must be made concerning the slow and difficult development of non-chemical tools, the "education for action" should clearly not be limited to the agro-technical personal decisions of the farmer, but should also empower the farmers to act on the political scene.

Feature	Principle	Examples
1. Interdisciplinarity	Looking at issues from a variety of disciplinary vantage points and seeking a synthesis.	• Looking at watershed management from the perspective of nature conservation, agricultural production, recreation and economics
2. Environmental impact	Considering the environmental impact of one's decisions and actions	• Monitoring the run-off of minerals into the ground and surface waters, and considering their impact on the watershed.
3. Eye for alternatives	Being susceptible to alternative ways of thinking, valuing and doing	• Alternative ways of applying minerals to the soil to minimise run-off while still maintaining acceptable production levels
4. Socio-scientific disputes	Recognising and coping with conflicting knowledge claims and the normative aspects of such claims.	• Critically evaluate the knowledge claims of environmentalists and sales representatives of Agro-chemical companies with regards to the use of fertilisers
5. Dealing with complexity	The wise, functional and critical use of expertise and scientific knowledge.	• Separating facts from myths and details from essentials in using information to resolve mineral run-off problems on a farm

Table II. Some Content Anchors for Integrating Sustainability in Higher Education *(source: Dreyfus & Wals, 2000, p. 86)*

The anchors in table II are content anchors in that they help a teacher select topics that are able to trigger interdisciplinarity, environmental impact assessment, alternative ways of looking at an issue, socio-scientific disputes and the need to cope with complexity. They overlap to a degree with the process anchors in table I, but the process anchors are intended to help the teacher find suitable learning and instruction activities. Of course it should be kept in mind that although the content, process and goals of education can be distinguished to emphasise a point or to clarify things, they can not be separated in educational practice. In other words: the goals, content and process of learning for sustainability need to be compatible and flow naturally out of each other, since mismatches are likely to block learning.

Conclusions

When integrating sustainability in higher agricultural education it makes sense to focus on the development of somewhat fashionable – albeit fashionable for good reasons – post-modern ideas related to things like empowerment, respect for pluralism and diversity of thought, action competence, contextual or local knowledge, grassroots decision making, collaborative and issue-based learning, systemics, and so on. Indeed, a focus on these components is useful and may eventually launch a new generation of higher education programmes and curricula: ones that are more sensitive to emancipatory learning goals and the contextual, open-ended and uncertainly-linked nature of the creation of pathways towards sustainability. The current challenge modern agriculture is facing makes clear traditional approaches to higher agricultural education fall short in dealing with uncertainty, in coping with the normative aspects of decision making and in understanding the importance of learning "on the edge", that is, learning at the crossroad of conflicting world views rooted in varying traditions, norms and values.

The topic of sustainability has great potential for post-modern higher agricultural education when considering its ill-defined meaning, its socio-scientific dispute character and its ability to link science, technology and society. Its ill-defined meaning requires specific methods and efforts on the part of both the educator and the learner to make it meaningful in a specific context. Its socio-scientific dispute character requires a procedure for dealing with controversy, uncertainty, diverging values and interests, and moral dilemmas. While its potential to explore, critique and utilise separate ways or systems of knowing and understanding and valuing requires learning processes and contents that provide for a rich context for learning.

Students must certainly keep learning how to *produce* with maximum financial efficiency. They must continue to learn to use their *knowledge* and their intuition to solve technological and economical problems. In other words, they must learn to solve problems by moving into problem spaces until they design solutions which can be explained and

demonstrated in terms of “taking knowledge for granted”. However, in view of the crucial environmental crisis threatening the world, their education can no longer ignore the issues of sustainable agricultural development. The content scope of agricultural education must be widened. Students must come to appreciate the importance of environmental arguments which may affect their way of life. They must acquire new intellectual abilities and systemic competencies. They must be educated to make decisions on the basis of uncertain, developing knowledge in various domains, and on the basis of their assessment of tentative claims made by disagreeing but equally qualified experts.

This is an ambitious task for agricultural education, but it is urgent; for sustainable development depends on education of the future citizens. Coming back to Alblas et al.'s (1995) idea of stimulating voluntary changes in behaviour, it is quite consistent with O’Riordan and Voisey's vision (1997) of “the creation of a society and an economy that can come to terms with the life-support limits of the planet. ….Individuals will have to behave as socially responsible citizens, not self-gratifying consumers, and to care for their neighbours near and far”. Agriculture is certainly one of the human activities which has a great impact on the health of our planet.

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