Making Sustainability an Issue in Applied Horticultural Research

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Let us maintain and further develop the potential of applied horticultural research for contributing to world food supply, prosperity and well being!

If Not Now Then Never ....

The International Horticultural Congress 2002 at Toronto may have been the last opportunity where sustainability could have been launched at a conference, and, for the contributing societies of horticultural science to be made an explicit issue in the discipline of applied agricultural research.

Sustainability has in the last years been treated as a key issue by many professional institutions associated to agricultural research or to many other professional branches contributing to economic development, for example in construction, city planning, the chemical industry etc. The issue of sustainability has been taken up by these branches for addressing future needs to support the development of their respective profession.

In my view. sustainability will soon have lost the taste of novelty in agricultural research, which of course does not mean that it will be of less potential importance for the development of horticulture. The reverse is true. But if horticulture does not participate increasingly in the sustainability discussion and does not play a leadership or pacemaker role in addressing the needs of developing sustainable agricultural systems, it loses funding potential for third level programs. The loss of these programs will weaken the essential basis for sustainability and its adherents in rural households and businesses.

Up to recently, the leaders of the discussion on the sustainability of agricultural systems have been mainly food crops with high energy content, such as e.g. cereals and potato but to a much lesser extent by horticultural crops. This may be, because the world faces frightening population prospects. Increases from 5.9 billion people at 1998 to 7.5 billion by 2020 and 8.4 billion by 2050 are projected by the UN population Fund, and 84% of the world's population will then be in those countries that currently make up the non-industrialized, so called 'developing' world. The cities will grow, the landscape will probably be continuously depopulated. However, more food will be expected to be produced per unit area in the traditional growing areas on soils of compromised quality; and/or acreage will be increased by starting cultivation of marginal areas with limited productive potential. More pressure is therefore expected on natural resources as population grows and food insecurity will also grow (Pretty, 1999). The availability of water for agriculture will decrease, and these things will happen while climate is changing. Some studies have concluded that, even with potentially severe local effects of climate change on agriculture, global agricultural production can be sustained and that global environmental problems such as ozone depletion and global warning contribute much less to health risks and economic productivity than dirty water, inadequate sanitation, air pollution and land degradation (Rosenzweig and Parry, 1994). However great uncertainties remain and few, if any, agricultural policies have been called specifically appropriate in addressing issues of climate change (Reilly, 1995).

I feel that, until now, sustainability discussions have focused on the main agronomic crops; these, after all, are the crops that provide immediate relief from hunger, yet such a narrow focus neglects issues of nutrition and long-term human health. Horticultural crops have been largely forgotten! Oram and Hojjati (1995) state in an interesting paper, that 'most projections of future supply and demand for food concentrate on the cereals, as if other food crops did not exist. While cereals provide about 80 percent of total food supply in developing countries as a whole, the contribution of roots and tubers, food legumes, oilseeds, and horticultural crops to dietary energy, protein balance,

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vitamins, and minerals is not negligible, and in the more humid ecozones of Africa, Latin America, and Southeast Asia, it is crucial. Legumes provide essential amino acids not available in cereals.' It seems, that the same may be stated for fruit crops even if the data to support this is currently lacking. It is also clear, that non-food crops such as ornamentals contribute immensely to the well being of societies and to the economic viability of countless businesses.

Sustainability has been addressed in the last decade mainly by studies on non-horticultural crops. This is a mistake, I believe, since sustainability goes beyond the immediate need of filling the belly, and extends to long-term effects on health, society and the environment. Prevention from starvation by combating immediate hunger seems to me – even if a necessary and very honorable effort – not to be a strategy for addressing the problem of food supply and well being in a sustainable manner. Addressing the energy demand of food supply must be balanced by the many other aspects of human diet, and by the economic activities that are needed to meet the holistic demand of a healthy and prosperous society.

Horticultural Technology Is Viewed as not Being Particularly Sustainable

In many agroecosystems, horticultural crops require a more intensive, and investment-dependant technology and management than other crops. This is true for the full range of horticultural crops from ornamentals through fruits and vegetables, and is often reflected in terminology: These are the world's "intensive" or "special" crops.

The level of 'intensity' is, however, sometimes hard to judge since, for example, pesticide statistics are gathered not on an individual crop but rather on several that share the same crop protection chemical, sometimes in use against different organisms. Internet searches and searching scientific databases have yielded very little definitive information and I sense that a comprehensive study would be needed to get reliable, world-wide figures.

An example is, however, provided by a case-study from Switzerland. In an attempt to estimate the relevance of pesticides for the management of different crops and their potential contribution to an environmental risk in Switzerland, Fried and co-authors (1993) listed crops according to their acreage and number of applications that are commonly used in a professional production system. Fungicide and an insecticide indexes were calculated by multiplying the number of applications for a crop x its acreage. The calculation for fungicides (Table 1) showed grape vines with the second highest fungicide index just after wheat, despite the relatively low acreage (about. 15,000 ha vs. 97,000 ha of wheat), because of the elevated number of applications (8 vs. 1.4). Apple shows up in fourth place (only approx. 5'000 ha but 13 applications). Other fruit crops and vegetables are ranked before many other crops. For insecticides (Table 2), grape vines and apple are ranked first and second.

Clearly, agroecological conditions and acreage's which apply to this study are particular to Switzerland and differ from the many production zones of apples, grapes and vegetables throughout the world. The results of such a study will unquestionably vary between regions. However, I believe the figures for many other countries may be similar, and the outcome is the same: Farmers need to handle more pesticides, and invest more in horticultural crops than would be required with other crops. The perception of the public and politicians is that production of horticultural crops is indeed intensive, requiring a high level of technical skill. Where skills of workers and managers are not well-developed it seems clear that horticultural crop production can pose risks to the environment.

Scientific Studies on Sustainability in Horticulture

There are few quantitative studies that deal with the sustainability of horticultural systems. As one of the very few systematic initiatives to document the development of the sustainability of production systems, the university of Essex database which is part of the SAFE-World research project (The Potential for Sustainable Agriculture to Feed the

World) provides much interesting information about known cases of improvements (Pretty, 1999). The data, chosen for its geographic variety, provides sound information on processes and outcomes (Pretty, 1999), but does not deal with horticulture. The final report of the "SAFE-World" research project on reducing food poverty with sustainable agriculture is exemplary. It does not include horticultural crops, but recognizes that "intensive horticulture and related systems are of vital importance as sources of income for some farmers in some countries, as well as being large consumers of pesticides and fertilizers" (Pretty and Hine, 2001).

Horticulture - The Origin of New Agricultural Developments

While the literature reports few studies that address sustainability issues of horticultural crops in a quantitative way, horticulture has, in the past, often contributed to agricultural development.

Integrated production systems and associated technology provide an example of how research has addressed the problems of intensive horticulture, its potential effects on the environment and the public perceptions of those problems. In Switzerland, for example, several such systems have been developed, from which standards have been set, and have had significant influence on the development of similar technology in cropping systems for maize, wheat and other agronomic crops. Pest forecasting models and pheromone technology are examples of system components that have developed from research in grape vines and other fruit crops and which then have also been adapted to other cropping systems. Given the aforementioned intensity of horticultural crop production, it is to be expected that market and political demands will lead to further refinement of the integrated models, and a movement towards full 'organic' production. This may be the next large challenge for horticultural research. Overall, the issues surrounding crop production sustainability are ones that are well represented in horticultural research and development.

The Present and Future Profile of Horticultural Crops

Horticultural crops, are generally low in fat and provide vitamins, minerals and other essential and desirable components of a balanced, healthy diet. Policy makers have traditionally promoted consumption of products from these crops as essential to human health. Could these, so far almost exclusive "pros" of fruits and vegetables, become obsolete through he development of so called "designed food", e.g., vitaminized rice obtained my genetic modification, artificially vitaminized energy drinks, etc? Perhaps this is too pessimistic. Why indeed would anyone forsake tasty fruits and vegetables for other less attractive, if nutritionally equivalent, alternatives? Yet the possible substitution is something that we should contemplate and discuss now before it overtakes us. Better to take up the challenge now to address sustainability, and the continued appeal and health benefits of horticultural crops and crop products

What Is Sustainability?

The above discussion seem to justify that sustainability be made a key issue in future applied horticultural research. I have assumed a general understanding of the nature of sustainability. However, one might indeed ask the question: What is meant by the term 'sustainability'?

The keynote lecture presented in this symposium by Professor Vinus Zachariasse (Zachariasse, 2004) and published in this volume tells us more about this and provides insights in his views and concept of what sustainability means to company and farm management.

The Brundtland Report from 1987 defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The report highlighted three fundamental components to sustainable development: environmental protection, economic growth and social equity.

Sustainability means much more than reducing pesticide input or any other possible negative impact of an activity. To be sustainable, practices must make a positive impact on natural capital (Pretty, 1999). But what does this mean particularly in horticulture?

Addressing the Need for Studies with "Quantitative Sustainability"

Accepting that policy makers, research managers and researchers need transparent quantitative data which address the sustainability of horticultural systems raises the question as to which parameters are to be measured for describing the sustainability of a system.

This question may be addressed by what is sometimes known as "quantitative sustainability", the applied science that describes the principles and dynamics of sustainable development. Are we on the eve of the appearance of a new branch of applied science? Could this be analogous to the moment when plant pathologists decided that an effort was needed for developing the study of epidemiology of pathogens into 'quantitative epidemiology'. The time seems appropriate now to start talking about 'quantitative sustainability'. Some of it might be very close to what is called 'ecological economics' and a thorough analysis might show, whether the latter does indeed include all that is needed. Aspects of fundamental research may be part of this branch of science, together with impact-oriented, applied studies that address pressing development needs in horticulture. Large-scale on-farm studies, especially those that involve several disciplines and engage farmers and growers are needed as much as smaller experiments at research stations and universities

But how can sustainability be appreciated, perceived, quantified? In the 1970s and 1980s, energy use was seen by many as an appropriate measure for assessing the benefits and costs of a particular intervention in an agriculture system. It was evident that sustainable production systems are much more energy efficient than high-input systems. The environmental economics of the 1980s and 1990s have established a scale of costs for assessing sustainable systems (Pretty, 1999). But it seems that upon further reflection, studies are needed for finding parameters that take the multi-faceted nature of costs and benefits and the holistic nature of agricultural systems into account, and these studies need to focus on horticultural problems.

The symposium for which this paper serves as an introduction, conducted at the XXVIth International Horticultural Congress in Toronto took steps to develop appropriate methods to identify and/or fill the knowledge gaps.

How Should Sustainability Be Addressed in a Symposium?

The development of the sustainability symposium at the International Horticultural Congress 2002 challenged us to first develop criteria and parameters for discussion. The questions were: How should sustainability be addressed? How should sustainability be monitored, what are the most interesting 'stories' to be told in this context?

In structuring the symposium, the "assets-based model of agricultural systems" (Figure 1) by Jules Pretty from the University of Essex served as a guideline for the program structure. Pretty's model for agricultural systems addresses the farm, livelihood and community systems, that rely on the total stock of renewable natural, social, human, physical and financial capital. These five assets are transformed by policies, processes and institutions to give positive or negative outcomes that, in turn either increase or reduce the asset base. Based on these assets, Pretty developed a typology of improvements for sustainable systems (Table 3) that goes into more detail on how sustainability may be described. Further integrative and holistic methods should, no doubt, be developed to support this relatively new branch of applied science, but Pretty's concept has been useful to generate structured thoughts on quantitative sustainability that provided a major focus for the symposium program.

The proceedings of the symposium follow the order of the program. The opening paper by Prof. Levinus Zachariasse reflects on the nature of sustainability. Another symposium presentation explored how sustainability may be affected <u>if</u> - in the words of

Pretty's model - a contextual factor, e.g.. climate changes, and potentially endangers, sustainability ("a problem case study"). A second case study provided an example of how a new technique (application of geographical information systems) may be attributed, according to Pretty's model, to the physical capital, and how this could contribute to developing more sustainable systems ("a solution case study" that is unfortunately not included in this volume

These introductory papers are followed, in subsequent session chapters, by papers that center around subjects representing some of the assets established by Pretty's model. Yet, due to time restraints, the presented studies do not represent all assets established under Pretty's concepts.

Two chapters address specifically organic farming (OF), mainly for fruit-growing. While integrated production systems may address many of the elements of Pretty's typology for sustainable systems, OF potentially addresses more of these elements. The development of OF particularly for intensive horticulture demands a critical evaluation of how Pretty's elements of sustainability can be applied to these systems. Such evaluation requires discussion and planning, so the possibility of forming an ISHS-working group on OF was discussed in session 6 of the symposium.

Economical aspects are addressed in another chapter. The final chapter synthesizes the information and draws attention to two further examples of how the assets of horticultural systems, and their sustainability, might be enhanced through further research. In conclusion the results from the discussions are summed up in the "Toronto 2002 sustainability declaration" on "Research needs for a continuous development of sustainable horticultural systems for the 21st century".

The symposium sought to stimulate critical and constructive discussion on sustainability in horticulture with an overall aim of launching productive new research activities. We look forward to reporting on the outcome of many of those activities and their influence on sustainable horticulture at the next International Horticultural Congress and at other meetings over the next several years. that will come up to contribute to continuous knowledge build up and adequate development of horticulture.

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Tables

Table 1. Index for fungicide treatments in Swiss integrated production (translated from Fried et al. 1993).

Crop	Acreage 1990 (ha)	Fungicide treatments (ea.) [1]	Fungicide-index (treatments x acreage)
Wheat	97'185	1.4	136'059
Grape vine	14'823	8	118'584
Potato	17'796	6	106'776
Apple	4'918	13	63'934
Barley	60'036	0.9	54'032
Pear	878	10	8'780
Salad	1'806	4	7'224
Sugar beats	13'783	0.5	6'892
Cherry	471	5	2'355
Carrot [2]	1'092	2	2'184
Brassica [2]	1'112	1	1'112
Celery [2]	289	3	867
Natural pastures, meadows	638'904	0	0
Sown pastures	90'338	0	0
Etc.			

[1] Source: Expert group FOA (Federal Office of Agriculture), expert group integrated production, 1992.
[2] Acreage = harvested accrue of open field vegetables.

Table 2. Index for insecticide treatments in Swiss integrated production (translated from Fried et al. 1993).

Crop	Acreage 1990 (ha)	Insecticide treatments (ea.) [1]	Insecticide-index (treatments x acreage)
Grape vine	14'823	3.0	44'469
Apple	4'918	6.0	29'508
Rape	16'464	1.3	21'403
Maize	66'179	0.3	19'854
Sugar beats	13'783	1.0	17'384
Wheat	97'185	0.1 [2]	9'719
Brassica [3]	1'112	6.0	6'672
Salads [3]	1'806	2.0	3'612
Potato	17'796	0.3	3'559
Pear	878	4.0	3'512
Carrots [3]	1'092	1.0	1'092
Cherry	471	2.0	942
Peas	2'630	0.3	789
Barley	60'036	0.0	0
Etc.			

[1] Source: Expert group FOA (Federal Office of Agriculture), expert group integrated production, 1992.
[3] EPIPRE trial results 1998-1992.
[2] Acreage = harvested accrue of open field vegetables.

Table 3. Typology of improvements for sustainable agriculture (summarized from Pretty, 1999). Have this table all on 1 page.

Improvement type	Description	Elements [1]
Type 1	Finance	- Access to credit, grants, subsidies - Increased return on sales of produce - Attract new sources of money for natural capital (e.g. eco-tourism, hunting of wildlife)
Type 2	Better use of non-renewable inputs and technologies	- Precision-farming, patch spraying, targeted inputs and slow-release for pesticide and fertilizers - Low dose (and non-toxic) sprays - Veterinary services - Pheromones, sterile males - Resistant crop varieties and livestock breeds - Etc.
Type 3	Better use of available renewable resources (natural capital)	- Water harvesting - Soil and water conservation - Composting - Habitat management for pest-predators - Bio-pesticides and bio-fungicides - Etc.
Type 4	Intensification of single sub-component of farm system	- Double-dug beds - Vegetables on rice bunds - Fish ponds - Etc.
Type 5	Diversify by adding new productive natural capital and regenerative components	- Legumes in cropping systems (cover crops, green manures) and pastures - Trees in cropping systems, including woodlots - Natural enemy releases for pest control - Habitat management e.g. hedgerows, beetle banks, flowering strips - Etc.
Type 6	Social and participatory processes that lead to organized group action for making better use of existing resources and development of new skills	- Farmers' research and experimentation groups - Resource management users' groups (e.g. irrigation) - Credit groups - Horizontal partnerships between external sectorial agencies (e.g. government and NGOs, private-public)
Type 7	Add value by processing to reduce losses and increase returns	- Post-harvest technologies - Processing primary produce for sale (e.g. dried fruit, ...) - Fuel-efficient stoves
Type 8	Add value by direct or organized marketing of produce to consumers	- Farmer' markets - Box schemes, farm shops and direct mailing - Producer groups for collective marketing - Etc.

[1] Examples from original list, Pretty, 1999.

Figures

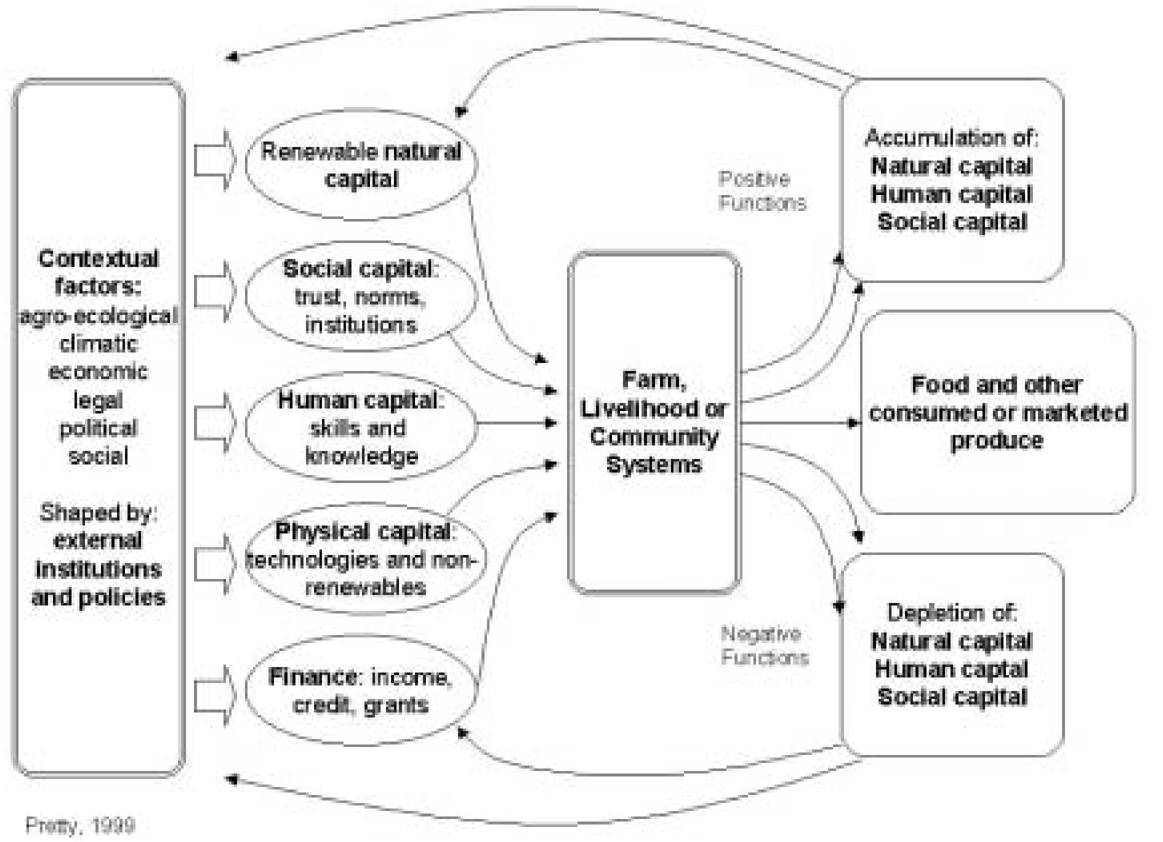

Fig. 1. Assets-based model of agricultural systems (Pretty, 1999).