Seconds to twelve - Time to benefit a rich selection of sustainable technologies. Integrated Crop Management - An approach for sustainability

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Sustainability is not just a buzzword of modern times born by environmental concerns and discussions on world population growth!
The concept of sustainability has been well known for hundreds of years. *"Agri cultura ... est scientia, quae sint in quoque agro serenda ac facienda, quo terra maximos perpetuo reddat fructus"* - "Agriculture is a science, which teaches us what crop are to be planted in each kind of soil, and what operations are to be carried out, in order to that the land may produce the highest yields in perpetuity." This is a passage in *'Rerum rusticarum'*, one of a number of Latin treatises written by Marcus Terentius Varro, a Roman landowner of the first century BC. He defined for the first time the idea of sustainability.
In the 18th century sustainability was a common concept in forestry and will continue to be an agricultural buzzword well into the new millennium.
There have never been so many global conferences, discussions and approaches on sustainabillty as in the last 10 years.

WHAT ARE THE REASONS FOR THESE EFFORTS?

The world population is increasing at an ever rapid speed. Round about 1850 the number of people on this planet was approximately 1 billion, and during 1999 the number reached 6 billion. Mean estimates indicate that by 2025 the world population will have risen to more than 8 billion. However, this numerical increase is not the main problem for future world food supplies and the safeguarding of these supplies; a much greater impact will be by rapid economic growth in key regions of our planet. By 2050 the world economy is projected to be five times larger than it is today (1). This economic development will very quickly alter world eating habits and increase total food consumption - first of all regionally, and then throughout the world.
And if we now look at the food requirements and food production of the world as a whole, we will find that we have a slight "surplus". The world "surplus" suggests that we already have more than enough. But this is not so:
At the moment only 0.26% more food is being produced than is actually consumed. And in the next 30 years we will have to produce more food worldwide than over the last 10,000 years.
Our first priority must be to create the sustainable technical basis for producing as much calorie and energy-rich food as is needed throughout the world. We must bear in mind that over the next 30 to 50 years world food requirements will more than double, and this will make it necessary to double – and even treble – agricultural production and supplies. At the same time, we will have to compensate for the loss of arable land, water shortages and the switch from plant-based to meat-based diets.
Serious impacts caused by safeguarding the food supply for a growing population reveal the condition of rainforests. We are seconds before losing Earth's greatest treasures, just as we are beginning to appreciate their true value. Rainforests once covered 15% of the Earth's land surface; now they cover a mere 6% and experts estimate that the last remaining rainforests could be consumed in less than 40 years. The immediate causes of rainforest destruction are clear. The main causes of total clearance are agriculture and in drier areas, fuel-wood collection. The main cause of forest degradation is logging. The felling of one's selected trees, tears down with it climbers, vines, epiphytes and lianes. A large hole is left in the canopy and complete regeneration of this natural system takes hundreds of years.
Apart from its direct impact, logging plays a major role in deforestation through the building

of roads which are subsequently used by landless farmers to gain access to rainforest areas. These displaced people, also named 'shifted cultivators', then clear the forest by slashing and burning to grow enough food to keep them and their families alive, a practice which is called subsistence farming. Shifted cultivators are currently being blamed for 60% of tropical forest loss. The reason these people are referred to as shifted cultivators is that most of them have been forced off their own land. One of the primary forces is the inequitable distribution of agricultural land (2). In some South American countries 40 to 70% of cultivated land is owned by a mere 1% of the population. Once displaced, the 'shifted cultivators' move into forest areas, often with the encouragement of their government. One single landless peasant who cuts down rainforest to feed his family and then moves on from one patch to the next as soon as the nutrients in the soil have been used up, will destroy more species of trees and insects than are native to the whole of Europe. And he will go on felling trees as long he cannot earn his living in any other way. It is evident that the shifted cultivators "have become the agents for destruction but not the cause" (3). Rainforests are being destroyed because the value of rainforest land is perceived as only the value of its timber by short-sighted governments and land users.

Undisturbed and logged rainforest areas are being totally cleared to provide land for food crops, tree plantations or for grazing cattle. A lot of these products are exported to rich industrialized countries and in many cases crops are grown for export while the local populace goes hungry. The land is farmed in such an unsustainable intensity that it is of no value any more, just after one short period of use. The land is exploited, stripped of nutrients and left barren, and they move on, destroying more and more rainforests.

Within this ineffable loss, biodiversity is shrinking in a dramatically way, and this at a time where we are just starting to recognize its inconceivable opulence of vital heritable information. Experts estimate that we are losing 137 plant, animal and insect species every day due to deforestation; that equates a loss of 50,000 species a year.

HOW CAN WE MEET THESE HUGE CHALLENGES?

The need to produce an abundance of high quality and safe food products, while balancing the need to protect and conserve the environment has never been more important and more challenging than it is today. The agriculture we envision is based on sustainable, ecologically sound food production and agricultural methods, which are adapted to local conditions and fulfil human needs.

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs" is our guideline for sustainable development written in the Brundtland commission report in 1987 and prioritized in the Agenda 21: Program of action for sustainable development in Rio de Janeiro, 1992. In the developing world, as elsewhere, food security requires access for all people at all times for sufficient food for an active healthy life. To ensure such access to food in the developing world, sustainable agricultural development is required on both high and low potential arable land.

Sustainable development means continuous innovations, improvements and utilization of environmentally friendly technologies with the aim of reducing environmental impacts and the consumption of resources. Improving sustainable agriculture means dematerialization and re arrangement of resources or in other words:

"Do more with less"

A strategy which best meets the requirements of sustainable development and sustainable agriculture by managing crops profitably without damaging the environment or depleting natural resources for future generations is Integrated Crop Management (ICM).

ICM is a dynamic system, which uses the latest research, technology and experience in ways that suit local conditions to optimize food production, enhance energy conservation and minimize pollution worldwide. Through the development of new crop protection products, seeds, biotechnology and agronomic Services, such as economic pest thresholds, decision support Systems and diagnostic techniques, ICM provides farmers with valuable tools to help them to achieve a sustainable, safe and economic crop production. Achieving a balance between efficient and profitable production of high yielding, quality crops, using fertilizers and crop protection products, but without depleting natural resources or damaging the environment is the concept of Integrated Crop Management. Increasing harvest yields requires good crop management including protection against losses before and after harvesting by controlling damaging weeds, pests and diseases.

The part of ICM dealing with control of damaging weeds, pests and diseases, called Integrated Pest Management (IPM), is the best combination of cultural, biological and chemical measures that yield the most costeffective, environmentally-sound and socially acceptable insect, weed, disease and other pest management for a crop in a given situation.

The key questions for a sustainable IPM strategy are what can be done before

planting (prevention); during the growing season (observation); and how best to use control methods (intervention).
As a leading member of the crop protection industry, Bayer CropScience is committed to the principles of Sustainable Development and Sustainable Agriculture and sees it as their task to make a decisive contribution towards solving the global problem: the production of reliable supplies of affordable food with the least impact on man and the environment. Therefore ICM is part of the Bayer CropScience vision of a sustainable contribution to global food supply. During 1998 the company was involved in 150 public and private IPM projects in more than 40 countries. For example, Bayer CropScience started an ICM project in the Indian rice growing village of Damal. The Bayer ICM package incorporates all standard aspects of rice cultivation, from variety selection to sowing rate, fertilizer and plant protection management suitable for the village Damal. Direct comparison of ICM with neighboring rice fields in Damal revealed higher grain yields and net profits per acre from the ICM plot. In addition, farmers obtained help not only with their crops; livestock health was also included in the Overall development package. Another example is the IPM cotton project of Bayer CropScience in Brazil, where cotton is an important crop, cultivated over an area of about 900,000 ha, primarily by small and medium size growers. There the IPM project can be considered a success story as well. Its basic concepts are now well known to both large and small growers who have become aware of the economic and environmental benefits of rational and safe use of plant protection products. Demonstration plots under field, conditions were used to effectively spread IPM techniques to the whole community. Over 60% of the Brazilian cotton growers now adopt many of these concepts as a basis for crop management, and no significant problems with pest resistance in cotton have arisen during the last 20 years.

WHAT IS THE CONTRIBUTION OF BIOTECHNOLOGY TO SUSTAINABLE AGRICULTURE?

Genetic engineering offers the exciting prospects of new crop varieties, including higher-yield or improved quality crops and with value added traits like resistance to insect pests and diseases. This will become increasingly important in farm management strategies. As more crops with novel traits reach the market, Biotechnology will play an ever increasing role in agriculture and as well in Integrated Crop Management.
Potential genetic improvements are more efficient photosynthesis, energy conversion, nutrient and water utilization, strains with higher yields, quality, or tolerance to stress and hostile environments such as drought and salty soil. Crops with single gene transfer conferring tolerance to non-selective herbicides and resistance to insect pests and to diseases could be controlled by spraying just one broad-spectrum herbicide, to which the crop is tolerant, potentially reducing the number of herbicide applications required. Or varieties are being produced with built-in crop protection which requires no chemical control of those pests or diseases. These approaches are valuable additions to ICM strategies by reducing the use of crop protection products and contribution to sustainable agriculture. However, chemical pest control will remain the essential tool in combating pests in agricultural systems during the foreseeable future.

FURTHER PERSPECTIVE FOR MODERN AGRICULTURE

Integrated Crop Management needs a precise tuned management. A new strategy for supporting farmers to reach comprehensive decisions in sustainable plant production is precision farming.
Precision or site-specific farming practices include monitoring crop health, identifying crop variability, and allocating resources (e.g. fertilizer, lime, pesticides) more efficiently.
A generation ago, farm horses were not uncommon; today, satellite-controlled precision machines are used for sowing and applying fertilizers and crop protection products. This new technology together with innovations in chemistry and biotechnology are opening the way to high-yield crop production that uses up fewer natural resources and imposes less harm on the environment. Such Integrated Crop Management (ICM) techniques are enhanced by the addition of the spatial analysis and high quality map generation capabilities provided by Geographic Information Systems (GIS).
In agriculture, Global Positioning Systems (GPS) are used as a "precision agriculture" tool to navigate large machinery for differential application of fertilizers, plant protection products, lime, or seed. Input variables, such as soil characteristics, yield goals, and infestation, may be acquired from a wide range of remotely-sensed data suitable to the spatial scale of such large fields. These data include satellite imagery, air-photos, and in situ measurements from yield monitors mounted on GPS-guided combines.
"Precision agriculture", or what may more accurately be termed "site-specific farming" practices are effective and worth investing in. They must first be scaled down to suit the spatial diversity within the area. GPS is still a

useful technology when applied with certain methodologies on smaller acreage. These smaller parcels produce the more valuable commodities. With residential development competing with agricultural land-use, there is also increased public pressure to promote more efficient farming practices. This is especially serious with regard to reducing pesticide and fertilizer use, and their associated impact on agricultural run-off, which is an additional problem to ground and surface water quality.

Bayer CropScience has a cutting edge in precision farming. The company is already offering new technologies as prognostic software for implementing the right product at the right time as well as diagnostic methods for exact disease and pest detecting. Further contributions are services which train farmers in applying this satellite imageries and global positioning systems. The first remote sensing systems will be marketed in 2002.

Positive thinking people with farsightedness have recognized that agrotechnologies have a promising long-term potential and will ultimately make an indispensable contribution towards safeguarding world food supplies, alleviate poverty, avoid migrations and protect natural resources. The future must bring markedly more efficient use of land, energy and material.

In all discussions about genetically improved crops and satellite-controlled farming we should kept in mind Indira Ghandi:

"How can we urge the preservation of animals, how can we speak to those who live in villages and in slums about keeping the oceans and rivers and the air ocean when their own lives are contaminated at the source? The environment cannot be improved in conditions of poverty, nor can poverty be eradicated without the use of science and technology."

How can we bridge the gap between developing and developed countries to reach equitable solutions?

The problems of environmental degradation go far beyond scientific and technological solutions – they are prior economic. Governments need money to service their dept, squatters and settlers need money to feed their families, and companies need to make profits. Acting alone, industrial countries can't do all that is required to reverse the degradation of international waters, address climate change, promote clean energy or stop plants and animals from disappearing. Neither can they unilaterally overcome the poverty and lack of opportunity still so apparent in much of the world. But if governments, nongovernmental organizations (NGO's) and industry work together in building markets which will give economic incentives to protect sustainable resources for long term profits rather than short term gain we will have a good chance to use the remaining seconds. Let's use this opportunity.

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