SUSTAINABILITY OF AGRICULTURE

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Summary

Sustainable agriculture is a core part of the concept of sustainable development. Given the forecast in population increase, sustainable agriculture has to achieve food security in combination with economic viability, social responsibility and have as little effect on biodiversity and natural ecosystems as possible. Based on Agenda 21 , signed at the world summit in Rio de Janeiro 1992, sustainable agriculture takes a truly global perspective.

This concept requires a thorough understanding of agro-ecosystem functions. The protection of soil and water is one necessary prerequisite as well as the efficient use of mineral and organic fertilizers. This might be achieved by means of improved

technology and better understanding of the basic processes in soils. In the context of sustainable agriculture, also water quality and water availability are important issues, where technology and organization of irrigation posing major challenges for the future. As a tool to achieve a number of positive effects, conservation tillage systems increasingly come into focus. Besides reducing the risk of soil erosion and compaction, conservation tillage also leads to reduced costs for labor and fuel, hence being environmentally and economically viable in most cases. However, special attention must be paid to potential build up of weeds, pests and diseases in reduced tillage systems.

1. Concept of Sustainable Agriculture

1.1. Challenges Lying Ahead

The concept of sustainable agriculture - or rather the concept of sustainable development in agriculture - has become a widely accepted and supported scheme, encompassing both environmental and developmental aspects. Brought up first by the Brundtland Report, the topic of sustainable development has meanwhile become a central issue in national and international policies. Based upon a definition in the Brundtland Report it is normally described as follows: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Securing the food supply of a rapidly growing world population will increasingly gain importance. For that reason, agriculture has to play a major role within the concept of sustainable development. Apart from food supply, also the demand for renewable resources and crops for industrial use has to be met on a world-wide scale. But sustainable agriculture goes much beyond production. Besides "food and fiber", such a challenge is the conservation of biodiversity in the agricultural landscape with regard to wildlife and plants but also with regard to the crops used by agriculture itself.

Even if the issue of energy crops and other renewable resources is put aside, with the increasing food demand there is still an enormous challenge lying ahead: While only 1.6 billion people inhabited the earth at the beginning of the 20^{th} century, the number has risen to over 6 billion in the meantime, and a further rise up to 8.5 billion is predicted for the next 25 years. More than two thirds of this 8.5 billion people will live in the countries of the South, further aggravating the already difficult situation of food supplies in Africa, Asia and South America. There is a general scientific consensus that agriculture has the capability to meet the food needs of 8 - 10 billion people while substantially decreasing the proportion of the population who go hungry, but there is little consensus on how this can be achieved by sustainable means. Besides the dramatic increase of the population of underdeveloped and developing countries, an additional demand for food and fodder arises in countries in south east Asia such as China, Indonesia and Thailand, where a considerable increase in income and wealth is currently leading to a dramatically growing meat consumption, thus putting additional pressure on the world grain market.

Increases in the total global production of food, fodder and renewable resources such as

energy crops for example through a further extension of the area under cultivation will be very limited. Even in the last decades, food production has already been competing with the conservation of valuable wildlife habitats in many places. There is little chance to cultivate additional arable land without cutting down on priceless biotopes such as tropical rain forests or other ecosystems. However, the land under cultivation today is also at risk. Soil erosion due to wind or water and salinization are destroying formerly fertile land at an alarming rate in the world's tropical, subtropical and arid regions. Therefore a further increase in production per hectare on the land used today is imperative in the decades to come in order to fulfill the objectives of a global sustainable development.

A number of indicators describing the world food situation underline the dramatic developments of recent years. Growth rates in the world's cereal production have been comparably low; they have not been able to compensate for the increased demand of the growing world population.

On average, the arable land available per capita has decreased in recent years. In the 1990s, the world's cereal stocks have reached an all-time low. Supplies of maize, wheat or rice have sometimes fallen below a 50-day level. Since the „Green Revolution", the overall productivity of many farming systems world-wide has hardly increased at all. And other food resources hold out little prospect for relief. After the fishing harvest increased in the nineteen fifties from 8 to 17 kilograms of fish per head of world population, the catches of international fishing fleets have stagnated or even decreased for about the last 15 years. The old formula which projected increases in food production with increasing efforts is no longer valid. However, it is difficult to predict to what extent population growth or consumption patterns will change - or will have to change - in the future.

A year such as 2004 gives evidence that the present potential productivity could be sufficient to cover the present demand if only yields and grain quality were consistently high, secure enough and evenly distributed. Yet the thread of climatic changes projected for the future gives little reason for such an optimistic approach. More than every other sector in the national and international economy, agriculture is directly affected by alterations in the environment, climatic conditions being very prominent examples for environmental change. However, also heavy metal deposition, sealing of arable soils or expansion of landfills have a strong impact on the quantity and quality of agricultural products. It is the combination of all those developments mentioned, which will put an enormous pressure on the agricultural production in the years to come.

Besides these „external" threads to agricultural production and productivity, agriculture itself, being by far the largest user of land, has a special responsibility for protecting limited resources. Among the actors in the national economy, it is therefore those in the agricultural sector in particular who are giving increasing thought to the development of sustainable production systems. Closely linked to this are questions regarding the productivity and efficiency of agricultural production systems on the one hand, and food quality as well as the impact on natural and near-natural ecosystems on the other.

Any reflections about the sustainable development of agriculture must therefore take a

global view. The creation of islands of bliss for a few people cannot be the aim of sustainable development or sustainable agriculture. On the contrary, no single region, state or continent can be exempted from responsibility for the global food situation and protection of land, water and air.

1.2. Agenda 21

The UN Conference on Environment and Development held in Rio de Janeiro in 1992 can be considered as a direct consequence of the Brundtland-Report. A series of documents and international agreements were produced as a result of this conference, one being the Agenda 21. This Agenda 21 was signed by 178 states, thus demonstrating their willingness to achieve sustainable development in general and sustainable land management in particular.

Most of the Agenda's directions for action are addressed to both industrial and developing countries. Like the Brundtland-Report, Agenda 21 emphasizes the global orientation with a clear focus on world-wide food security. Chapter 14 of the Agenda - promoting sustainable agriculture and rural development - presents in detail the objectives and measures suggested for the agricultural sector. "Agriculture has to meet this challenge [of a growing world population], mainly by increasing production on land already in use and by avoiding further encroachment on land that is only marginally suitable for cultivation."

And: "The priority must be on maintaining and improving the capacity of the higher potential agricultural lands to support an expanding population. [...] The main tools of sustainable agriculture and rural development are policy and agrarian reform, participation, income diversification, land conservation and improved management of inputs".

With regard to agriculture, Agenda 21 includes the following program areas:

(a) Agricultural policy review, planning and integrated programming in the light of the multifunctional aspect of agriculture, particularly with regard to food security and sustainable development;
(b) Ensuring peoples participation and promoting human resource development for sustainable agriculture;
(c) Improving farm production and farming systems through diversification of farm and non-farm employment and infrastructure development;
(d) Land-resource planning, information and education for agriculture;
(e) Land conservation and rehabilitation;
(f) Water for sustainable food production and sustainable rural development;
(g) Conservation and sustainable utilization of plant genetic resources for food and sustainable agriculture;
(h) Conservation and sustainable utilization of animal genetic resources for food and sustainable agriculture;

(i) Integrated pest management and control in agriculture;

(j) Sustainable plant nutrition to increase food production;

(k) Rural energy transition to enhance productivity;

(l) Evaluation of the effects of ultraviolet radiation on plants and animals caused by the depletion of the ozone layer.

Without going into the details of the Agenda's directions for action, it may be said in summary that the realization of sustainable agriculture, including an environmentally compatible application of biotechnologies (chapter 16.37), is mainly a matter of permanently crosslinking economic production processes and the carrying capacity of ecological systems. Based on the Latin word "rete" for net, the Council of Environmental Advisors in Germany has described such an approach of networking as "the principle of retinity", thus referring to the fact that no new procedures have to be introduced but rather all existing individual measures should be integrated into a consistent master plan with clear targets.

Since the earth summit in Rio a huge number of international agreements have been signed and a number of supra-national institutions have been established which deal with various aspects of sustainable development. Sustainable agriculture is very often one of the major aspects in those negotiations. On top of that, the concept of sustainable development has been incorporated in a number of constitutions all around the world.

1.3. The Forward-looking Concept

There is an abundance of definitions of "sustainable agriculture". However, there are six key aspects which are common to most definitions, covering

- The ethical component (intergenerational equity),
- The protection of resources such as soil water and air and thus preservation of the production base,
- Conservation of biological diversity (no further cultivation of natural or near-natural areas and habitats for wildlife),
- Ensuring the economic viability of agriculture (on the scale of the individual farm),
- The role of agriculture with regard to food supply and food quality
- And the global context (of trade relations etc.).

If the ethical component is seen as an overriding principle of global responsibility, the question arises whether potential increases in productivity will lead to long-term effects on resources which then in turn might affect or even reduce productivity. Particularly with regard to the application - or banning - of biotechnology, such long-term effects have been discussed rather controversially in the recent past. This discussion seemingly leads to the conclusion that there are ethical borderlines for the use of new technologies as well as ethical responsibilities for not using potentially helpful tools and strategies. At present, it seems impossible to define a general and commonly accepted "code of

conduct" for biotechnology in general and genetically modified crops in particular.

Various schools of thought reflect major aspects of sustainable agriculture and the respective underlying definitions of sustainability. As a starting point, responsibility for future generations is imperative. In addition, economic, ecological and social aspects are integrated. However, depending on the ideological and scientific background of individual authors, the single aspects of sustainable development are often weighed differently in the definitions.

Apart from the different focus of the definitions, their scale is also important. Different hierarchical levels of a society require clearly differentiated standards and criteria to allow for adequate consideration. For sustainable agriculture these levels are

- The field level (agricultural sustainability)
- The farm level (micro-economic sustainability) and
- The global level (macro-economic sustainability).

Most authors stress that depending on the level in question, sustainable development can be defined differently. There are common interests and conformity of objectives, but due to negative interactions there are also considerable restrictions on different levels. It is therefore important to clearly indicate the according reference level of any statement with regard to sustainability in general and sustainable agriculture in particular as there are significant political implications of such a differentiated approach: if a smaller scale is chosen, the sooner regional or even local developments will come to their limits. In addition, the extent to which an interregional division of labor is allowed has to be clarified as well.

1.4. A Matter of Scale

As mentioned before, sustainable development is a global issue. Disregarding this global scale in sustainability schemes will lead to important consequences with regard to the assessment of production schemes. Any small-scale or regional approach easily neglects the aspect of production volume. Besides, the results from an assessment on a regional or even local scale can be easily determined in advance by merely selecting one region or another, by a certain state or a community of states. Other than such a potentially predisposed approach, the concept of sustainable agriculture or sustainable development dwells on the global perspective in order to develop measures or bundles of actions, even though for reasons of practicability, evaluations have to be limited to smaller geographical units, single farms or even single fields.

In the recent past, some definitions of sustainable development in agriculture have been formulated that, unlike earlier proposals, emphasize the process level. According to these concepts, material fluxes have to be managed as efficiently as possible in order to maintain the productivity as well as the buffer function and regeneration capability of the system. For Europe, a prominent example was given by the EUROPEN INITIATIVE FOR SUSTAINABLE DEVELOPMENT IN AGRICULTURE with their "Obligations for Integrated Farming". These obligations define and describe Integrated

Farming as an agricultural production system which uses a holistic approach to agriculture in general and to on-farm practices in particular as the way towards sustainable land use and production practices for the majority of farmers on the European level. These obligations highlight prerequisites of a sustainable farming scheme. At the same time, they provide clear management rules including instructions on management plans and practices, fertilization procedures, crop rotation, crop protection, livestock management and various social and employment issues etc.

All in all, the most comprehensive definitions of sustainable agriculture cover five of the aforementioned criteria (the ethical component, the protection of resources, the conservation of biological diversity, ensuring the economic viability of agriculture and the role of agriculture with regard to global food supply and food quality. The last-mentioned aspect, i.e. the global component of sustainable development, is usually quite a different matter. Most authors, however, do not reflect on the global dimension.

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Biographical Sketch

Andreas Frangenberg, born in 1958, is scientific coordinator, author and publisher at the Institute for Agriculture and Environment (ilu) in Bonn. Following a two years agricultural apprenticeship, he studied agriculture at the University of Bonn from 1981 until 1983, at the University of Knoxville, Tennessee, USA, from 1983 until 1984, and then again at the University of Bonn achieving his master's degree in 1987 (thesis: Measures to Reduce Erosion in US Corn Production). In 1988, he became an assistant at the Institute of Crop Science, Bonn, and began working on his doctoral thesis (Effects of Green Fallow on Selected Soil Physical Properties) which was completed in 1994. In the Fall of 1993, he started working as a freelance agricultural and scientific journalist for various clients before taking charge of the newly founded Institute for Agriculture and Environment, Bonn, in 1997. Main fields of work currently are "Biodiversity", "Soil Fertility and Soil Protection", "Indicators / Indicator Models" and, as a thematic frame, "Sustainable Agriculture".