Towards truly sustainable cropping systems from a soil science perspective

L. Bergström, H. Kirchmann, Y. Cohen and R. Andersson

Dept. of Soil and Environment, Swedish University of Agricultural Sciences, P.O. Box 7014, 75007 Uppsala, Sweden.

Introduction

Agricultural practices based on 'back-to-nature' ideas lead to drastic decline in yields, undermine the development of new and efficient production methods, and ultimately jeopardize the survival of mankind. For example, biological nitrogen fixation and use of biological pest management are often suggested as alternatives to chemical options. Such "ecosystem services" should be cautiously used as a complement as they are often associated with negative side effects such as increased nitrogen leaching, higher emissions of greenhouse gases, and production of harmful bio-chemical substances. We must go beyond the ideas of organic agriculture and create systems that are truly sustainable over the long term (Kirchmann and Bergström 2008). Such agricultural systems must produce sufficient food of good quality for a growing world population with as little negative disturbances on the environment as possible. Sustainable production requires the following conditions (Kirchmann and Thorvaldsson 2000): (i) prevention of agricultural soils from being degraded by erosion, salinization, pollution, compaction, loss of fertility, and uncontrolled urbanization; (ii) nutrient recirculation and equitable redistribution; (iii) control of soil-bound pathogens and pests; and (iv) management of soil-water status suitable for crop production. It also presumes efficient use of all types of production inputs.

List of key components for sustainable development

The following examples are identified as key components in future crop production systems with focus on soils:

- extraction of nutrients from urban wastes to produce inorganic fertilizers, which contributes to closing nutrient cycles and guarantees fertilizer quality;
- improving fertilizer use efficiency especially of phosphorus to optimize the use of a limited resource;
- separation of Cd from phosphorus fertilizers being achieved by metal extraction during fertilizer production;
- use of renewable energy for N fertilizer production;
- minimizing agricultural non-point source pollution of N and P by tailored mitigation measures; and
- development of pesticides that guarantee no toxic effect except for the target organisms.

Implementation

To reach long-term sustainability in agricultural production, we must go beyond the ideas of organic agriculture. Although 'ecosystem services' are important, research cannot ignore the need for a production increase, since food is not sufficiently provided for everyone today. This will certainly also be more critical in the future. In order to reach this critical goal for mankind, we must incorporate the message outlined in this presentation into political decisions made in society. Furthermore, we need a change in the public opinion that agriculture does not necessarily have a negative impact on the environment. It has often been proposed that many more people can be fed through a vegetarian diet, which is true. However, on-farm nutrient recycling is decreasing in systems without animals. This is very critical for organic crop production, which to a large extent is relying on recycling of animal manure for nutrient supply. In other words, a vegetarian diet requires use of inorganic fertilizers or more land, which is not available in the world. Use of more land for agricultural production will undoubtedly be in conflict with preservation of biological diversity. We have to recognize that all agricultural systems are man-made irrespective if they are organic or conventional. Therefore, to mimic natural systems does not automatically mean that we create sustainable cropping systems. Solutions may therefore not be found in nature. To develop truly sustainable systems, we need to consider the complete set of conditions outlined above, and find creative scientifically-based solutions as the only guiding principle.

References

Kirchmann H, Bergström L (2008) Organic crop production – ambitions and limitations. Springer Science and Business Media. 244 p.

Kirchmann H, Thorvaldsson G (2000) Challenging targets for future agriculture. *Eur. J. Agron*. **12**, 145-161.