Deutscher Tropentag, October 9-11, 2002, Witzenhausen

"Challenges to Organic Farming and Sustainable Land Use in the Tropics and Subtropics"

Strategic Challenges to Higher Education in Agricultural Sciences for Sustainable Land Use Systems Development

Hartmut Gaese, Sabine Höynck

University of Applied Sciences Cologne, Institute for Technology in the Tropics, Germany

Abstract

In response to the challenge to secure food production, with regards to the accelerated population growth in the last decades, the achievements of the various disciplines of agriculture have been impressive. Since the 1950s, the rate of agricultural production increase has always been ahead of population growth. However it has become obvious, though, that the land use in the tropics and subtropics shows a tendency of exploitative use of resources and inappropriate extension, resulting partly in irreversible damage to ecosystems.

A lack of knowledge about appropriate agriculture and forestry practices — including the extraction of natural substances or medicinal plants from non-cultivated land — and lack of understanding of the highly complex conditions of the ecosystem frequently result in the application of destructive land use practices. The increasing concern for worldwide environmental deterioration up to the destruction of sensitive ecosystems as a consequence of population growth (man/land ratio) creates a common interest of all agricultural disciplines to respond on scientific level to the complexity of human-ecological systems which requires to establish an interdisciplinary network. Solutions for land use systems to bring overexploitation to a standstill are urgently required (BMBF, 1998).

Nowadays, generally new scientific findings with a potential for practical application in land use systems can only be generated at the interfaces to other disciplines. The focusing on specialization in science has rather hampered technical progress in some areas. Lately, a change of paradigm is in progress: Until recently, the focus has been on splitting the world down to the basic components within an ordinative framework; only now are we beginning to be more concerned with the mechanisms of interaction of all components.

The following tasks should be emphasized:

- The development of concepts for sustainable land use and protection of tropical ecosystems,
- The elimination or improvements of existing environmental problem situations,
- The strengthening and further development of institutions and institution networks engaged in applied tropical ecology research,
- The education and training of scientists in new methodologies applied in joint research projects combining disciplines in a system oriented approach.

What should appropriate land use systems look like, resp. Which characteristics should they assume to comply with the requirements for sustainability? Timothy G. Reeves, Director General of CIMMYT concluded with a view to plant production systems (certainly applicable to husbandry and integrated farming systems as well): Sustainable crop production systems have to be funded in principles of economics, environmental soundness, social

Contact Address: Hartmut Gaese, University of Applied Sciences Cologne, Institute for Technology in the Tropics, Betzdorfer Straße 2, 50679 Köln, Germany, e-mail: hartmut.gaese@fh-koeln.de

equality, and political feasibility. If we aim at intensifying land use systems, specifically agricultural production systems, research has to search for new holistic approaches. We have to connect new technologies and traditional knowledge more effectively and we have to better integrate farmers and community into research, development and transfer. This approach is described with the formula G × E × M × P, whereas the factor G is the "Genotype", factor E "Environment", factor M "Management", and factor P "People".

Agricultural enterprises as the major basic element of land use systems are "open systems" within a flow of change caused by the above mentioned factors. Farms, clusters of farms, micro regions and macro regions — according to the scale of observation — are subject to persisting "adjustment pressure" constantly moving the "point of equilibrium". This is commonly referred to as the "dynamic equilibrium" of economic units which has to be maintained for a sustainability status, e.g. in terms of potential productivity of soils. This dynamic equilibrium can be determined as the respective equilibrium from which an increase (aggregation) or a decrease (degradation) is possible. The emerging question is: Which reference value is useful in a long-term view, considering the continuous change of the mentioned environmental factors and thus all related production functions and their interactions?

To allow long-term assessment of the economic development potential (considering economic sustainability and carrying capacities), external factors have to be internalized by including the ecosystem as cost and yield factors in addition to the economic-technological development. Within ecosystems and economic units exploiting resources have to be recognized as one system in both, the time and the spatial dimension, and the path of change of this system as a unit has to be considered. The increasing "relative" scarcity of land — ultimately stipulated by increasing population density and growing demands for agricultural production (provision of food, but also export production to obtain foreign exchange) — leads to an intensification of cropping and husbandry systems. These intensification processes result in differing development paths, depending on the respective ecosystem: Within humid ecosystems "ambulant production systems" (shifting cultivation) are being transfered into permanent systems of soil exploitation, requiring supporting energy input different from those required by production systems evolving in the arid tropics, where, for instance, irrigation plays a major role. The higher the trade-off between land-use system and natural environmental conditions, the higher are the demands for supporting energy (in a wider sense for all inputs) and for the kind of technical progress for the farming systems in a dynamic equilibrium or even aggregation. Growing scarcity of land requires technical progress accompanied by increasing labor and capital intensity to maintain the dynamic equilibrium. If system factors are not adapted within the dynamic equilibrium, destructive biases might evolve.

Modern agricultural research for sustainable land use in the tropics and subtropics has therefore to follow the above mentioned formula of Reeves by forcing the association of individual disciplines within a network for modeling research. The freedom of scientific reason is the freedom of critical conscience; the prerequisite for critics is always a pluralism of independent partners who are jointly able to attain a higher level of awareness. Since collective awareness is a reflection of the institutions, in which it is generated, this awareness has to be institutionalized in higher education.