

Suggestions for future priorities of German-Brazilian Cooperation in Science for Sustainability in Land Use

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The global frame conditions, the market as well as the specific regional frame conditions that configure the future situation for *land use* in Germany and as well in Brazil are *endogenous drivers* within the farms and for other land users. All are continually forced to internally (i) *reduce costs* (reduced tillage, crop rotations), (ii) introduce and manage *new products* (food / feed; energy / raw materials), accept and train on *new technologies* (high-yielding, GMO, robotics), adapt the *diversity of farms* (size, structure, intensity, markets) and (v) manage, mostly reduce the *demand for labour*.

In addition the farms and companies have to react on *exogenous drivers*. They are required by the society through laws, regulations and teaching / training to (i) manage *higher efficiencies* (energy, labour, phosphorous, H₂O), (ii) to provide additional *ecological services* (CO₂, H₂O, biodiversity), (iii) to provide *sustainability* (national economy, social structures), (iv) to manage the *rural – urban relationships*, (iv) to *adapt to climate change* and (v) to provide full documentation of all their production activities for *tracing* (value added chain, contracted production).

For this development countries like Brazil and Germany urgently need success in enhancing:

- efficiency as well as (sustainable) effectiveness of crop production: (*very*) *high yields*, *adapted agro-biodiversity* (species, breeds), *highly flexible production strategies*;
- adapted production processes: *integrated nutrient and pest management*, *organic farming*, *low-input agriculture* as well as *sensors and robots*;
- diverse, *site adapted* and *multifunctional systems* of land use;
- special traits of varieties (tolerances against drought, salinity, pests, Nitrogen-efficiency, higher qualities linked with high yields) with traditional breeding activities and with gene-engineering.

Obviously the diverse impacts of land use systems reacting on such indisputable demands and expected technological developments have to be respected when considering the sustainable development of land use. Positive solutions could be developed or even are at hand and all have to be put into a positive strain. From that scheme it can be expected that land use, including the appropriate research and development could become a general and broadly accepted *template* or even a *model for Sustainable Development*.

Possible fields of a joint German-Brazilian research program on sustainable development in land use include:

New technologies:

- breeding and biotechnology (innovative tools, new traits)
- pest management technologies (bio-pesticides, nano-technology)
- information & communication (information driven crop production)
- high output & resource efficiency

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Methods & Tools for Sustainability Analysis:

- models characterizing relevant land use systems
- participial goal finding
- integrated assessment methods (*Sustainable Impact Assessment Tools*)

Training, Transfer & Dissemination:

- respecting goals and potentials of the poor and addressing aspects of gender or minorities
- supporting governance, politics and decision making
- exchanging of young scientists

Besides lacking knowledge and methodological problems, we have to accept new views onto research on sustainable development of land use. There is an increasing demand on (i) *interdisciplinary* and *socio-economic* research, (ii) on *transdisciplinary* research and (iii) on *knowledge transfer* with involvement of *small medium enterprises or the business sector* in general. On the other hand, we have to face an evolution in the general sciences that make an integrated and problem oriented view rather difficult: most fields of science are oriented heavily on disciplinary work due to the actual way of evaluating the performance of scientists or their institutions. In addition some countries, in Europe, also Germany reduced the structural capacities for agricultural research in the last two decades. To 'reinvent' agricultural research is currently a major effort of Germany and of the Commission of the European Union. A mutually successful development on that can be fostered in joint activities of Brazil and Germany towards new knowledge and new solutions in the realm of sustainable land use.

Possible solutions to enhance the collaborative development of a German-Brazilian research program on sustainability include enhancing joint research activities by (i) increasing the *transparency* on research activities and capacities, (ii) supporting the development of research *networks and integrated projects* and (iii) developing joint *technology platforms* (like in the EU: 'Plants for Future').

In general, a two dimensional research strategy should be followed:

The first level covers the necessary *transition research*, changing the orientation from the recent paradigm of efficient production and high valued output to a more consumer and society acceptance (multifunctionality, sustainability, rural development).

With the second level the new, sustainable development in land use would be nourished by (i) a very profound *high-tech research strategy* (innovations in crop production, post harvesting, processing, packaging, distributing) in combination with a (ii) *great-effect research strategy* (efficient and effective small scale and large scale farming, training, agroforestry, new agricultural structures).

As a first suggestion for joint programming between Brazil and Germany in sustainable development of land use could be to work on the fate of farms in the future: at any place in the world they increasingly have to manage information on and off their farms effectively to improve economic viability and reduce environmental impact. All three scales, in which agricultural activities need to be harmonized with economical and environmental constraints, require integrated adoption: (i) improvement of farm efficiency; (ii) integration of public goods provided by farming; (iii) relate to the environmental and cultural diversity of German or Brazilian agriculture by addressing the region-farm interaction.

To this end, integrated geo-coded data, equipment operating with geo-coded information and *land use information management systems* capable to handle geo-information are needed during decision making in the production. As in most other businesses, new farming systems

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heavily rely on information and communication technologies (ICT). The already existing and the emerging products, techniques and complex systems enhance existing measures of crop production with more information and new possibilities of applications. The main principle of such information driven crop production is applied by farming measures which take into account site and crop specific characteristics as well as ecological aspects.

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