

Agricultural Sustainability - Securing Food Supply and Income in Rural Areas

Prof. Dr. Bruno Moerschbacher, Department of Plant Biochemistry and Biotechnology, University of Münster, Germany

Even under the optimized conditions of modern agriculture about one third of the potential annual crop harvest is lost to pathogens, pest, and competing weeds. Large scale losses in cereal production in the 1950s due to devastating fungal epidemics triggered the Green Revolution, culminating in the development of disease resistant, high yielding crop varieties. These, however, typically require extensive irrigation, fertilization, and chemical plant protection. While the Green Revolution has helped combat hunger worldwide - and nowhere more efficiently than in India - we are currently entering a situation in which the growing world population once again faces decreasing crop productivity. This is in part due to a combination of decreased availability of irrigation water, increased irrigation-caused soil salinity and soil nutrient exhaustion - all of which appear to be more pronounced in tropical and subtropical compared to temperate regions. The situation is further aggravated by the increasing occurrence of novel fungicide-resistant or highly virulent pathogen strains, global trafficking of crop diseases, global climate change, loss of arable land by urbanization, increasing meat consumption in countries such as China and India, and the increasingly large scale production of energy plants. Clearly, a new and more sustainable Green Revolution will be required to meet this challenge. We strongly believe that this time, the concept must and can come from the emerging tropical and subtropical countries themselves, rather than from the developed temperate countries.

A joint effort of German and Indian researchers will certainly have the potential to develop sustainable solutions far beyond the immediate needs of our two countries. To be successful, this approach will need to integrate the best - i.e. the most efficient, the most environment friendly, the most consumer safe, the most sustainable - solutions offered by biology, biotechnology, and agrochemistry. Agrochemistry may supply functional plant protectants, plant strengtheners, plant safeners, and fertilisers. Biotechnology may supply disease resistant plants, plants with enhanced salt or draught tolerance, and enhanced nutrient or water use efficiency. And biology may supply plant growth promoting rhizobacteria, bio-control agents, and bio-fertilisers. It will be of paramount importance to integrate these approaches in an interdisciplinary way, at the same time making use of the large potential of international collaboration, e.g. mobilizing the advanced agrochemistry resources in Germany, the advanced research avenues into biologicals in India, and the rapidly evolving biotechnology potential of both countries.

As an example, we propose to develop a sustainable approach to plant protection based on bio-control agents synergistically combined with advanced techniques of protein and polysaccharide engineering and biotechnology. This project would rely on ample prior research of partners from Academia and Industry in Germany and India, partly individual and partly joint Indo-German projects, financially supported in the past by both national and international agencies, aiming at realising the largely untapped nanobiotechnological potential of chitosan - an added-value product that can be generated from e.g. shrimp shells, i.e. from a problematic waste by-product of the fishery industries. The enzymes needed for the upgrading of raw chitosan into bio-engineered speciality chitosans with known and

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reliable physico-chemical properties and biological functionalities can be found in a number of recently identified novel sources of biodiversity found in India.

To be successful, such a research project will need to have a strong local, bottom-up approach that takes into account regional diversity in both biology and sociology. There will also be the need for a transdisciplinary approach including the people directly involved in the planned use of the research results, both from industry and from agriculture. Therefore relevant stakeholders from biotech companies and local farmers should participate in the project from its planning stage so as to ensure smooth technology transfer into practical use.