Cutting Edge Science & Technologies towards Food, Environment and Health

Focus: Encouraging Young Scientists

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May 2013

Abstract

Agriculture, the mother of all sciences, has always been, and continues to be, one of the ways in which humankind has improved the basis of human existence on earth. The key challenge for the mankind are sustainable agriculture and the need to resolve the conflicting claims of food production, energy supplies, urban habitats and ecosystem services. Increasing dependence on decline resources such as land, water, energy will shape agriculture worldwide in future. The central topic for the agriculture of the future will be resource efficiency and effectiveness of production in a rapidly changing world, where climate change is a key driver in the field.

Sustainable (functioning, efficient, essential, significant, effective, impressive, long lasting) development means continuous innovations, improvements and utilization of environmentally friendly technologies with the aim of reducing environmental impact and consumption of resources. Improving sustainable agriculture means dematerialization, de-carbonization and re-arrangement of resources or with other words: "Do more with less – better, and in time!"

An outlook is given concerning new technologies developed and implemented in agriculture 2013/2025/2050. By doing this, young people should be encouraged to go for science and cutting edge technologies in order to feed the population of the world, to safeguard global peace and to improve life on earth.

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Vision Paper

Global Symbol for Science

The key challenges for the mankind are sustainable agriculture and the need to resolve the conflicting claims of food production, energy supplies, urban habitats and ecosystem services. Increasing dependence on declining resources such as land, water, energy will shape agriculture worldwide in future. The central topic for the agriculture of the future will be resource efficiency and effectiveness of production in a rapidly changing world, where climate change is a key driver in the field.

For more than 10,000 years imagination and use of agrotechnologies (from wooden plow, water-wheel, ridge drill, improved seeds, new horticultural crops, horse-drawn vehicles, dung, fertilizers, hybrid seeds, plant protection agents, tractors and combine harvesters to genetic modified crops, and satellite-controlled tillage and harvest) have contributed to the availability of food for seven billion people. Nevertheless, in the next thirty years we will have to produce more food worldwide than over the whole of the last 10,000 years. And we will have to do all this in a sustainable and environmentally compatible way.

Genetics – modifying the building blocks of life, **R**obotics – building autonomous machines to do our bidding, **A**rtificial **I**ntelligence – machines that learn, **N**anotechnology – building things atom by atom are prerequisites of the acronym **G-R-A-I-N** (Mulhall, D., 2002). This megamerger of super sciences may transform who and what we are.

Moving the entire front forward is the challenge in front of us. Key questions moving the technology front forward have to be answered in time:

- How are innovations likely to change our economics and our societies?
- Who is able to realize innovations in time?
- What must policymaker consider when approaching new technologies?
- What does it mean for the user of new technologies?
- What does the cutting-edge technology mean for citizens and consumers?
- What responsibility do science, the media and other leaders have towards citizens in new technologies?

The specific question "How can we maintain and improve sustainability of agriculture is directly linked to three other key questions":

- How fast can agricultural research provide technologies to increase productivity of arable land?
- How fast can politicians and regulators cope with technological progress?

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- How prepared are societies to accept new technologies in food, feed, fiber, fuel, and bio-material production?

Today, it is becoming increasingly difficult to develop and apply cutting-edge technologies and to implement innovations in time. The reasons for this are multifunctional and multicomplex. Science and technology, cutting-edge technologies and the use of technologies, e.g. the use of nanotechnology and biotechnology, are matter of controversial discussion between many stakeholders.

The future of the world will significantly depend on effective and efficient new technologies and are the most powerful instruments for solving the resource and climate change problem. Cutting-edge technologies determine the way of life and technology illiteracy is a danger for the society as a whole. This will be relevant for further progress in science and in implementing new technologies.

If we want to shape the future with the aid of new technologies, we will have to convince people, establish confidence, and communicate with people – we must communicate science and technology as early as possible (Kern, 2003/2004). Actually, this issue is very well outlined in the book titled "Communication Challenges and Convergence in Crop Biotechnology" edited by Navarro and Hautea in 2011.

Knowledge is the resource of the future. Knowledge – is power (Francis Bacon) – when applied, means taking risks – when increased, means responsibility – when shared, is a source of joy – needs contextual knowledge – develops culture – is change. Knowledge is often understood to be a sort of problem solving competency, a "know-how". But this is not enough. Knowledge has to be linked to education.

Education is not knowledge and not the summation of knowledge. Education is more than the capability and the application of instrumental, purpose-rational research. Education is not identical with the professional acquirement and practical use of handling techniques. Education has something to do with the weighing-up and evaluation of knowledge. However, evaluations are actions and achievements of human beings. Evaluations are invariably dependent on moral and ethical ideas or criteria. However much knowledge we may possess, it is useless if we do not know for what purpose it is to be used, or even whether this purpose is ethically acceptable (Rohrhirsch, 2003). Knowledge improvement has to go hand in hand with education in order to inspire the young generation to be creative and to work courageously in the fields of sciences and new technologies.

Creativity, ideals and courage of the youth of the world should be mobilized … to ensure a better future for all was claimed in Principle 21 of the Earth summit in Rio de Janeiro, 1992. This is more relevant than ever!

Creativity, what does it mean? Creativity comes from people, combines/creates new and useful tools, requests the ability to take risks, is breaking generally accepted rules or even stretching them, is often downright subversive, takes confidence, requires enormous concentration, is a source of economic value, requires diversity, is open for differences, makes a difference and triggers the process of destroying one's … in favor of a better one.

Creative persons have above-average motivation, respond more to optical stimuli, are sensitive to trickiness, quibbles and nuances, they like interconnections, interfaces, and free scopes. Creative persons do not think in traditional terms, shift benchmarks, assume risks, do what they want, and do it the way they want. They desire to achieve something of permanence and seek recognition; they need coordinates and fixed points, need confidence and contribute to the question: "What is man?"

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Nevertheless, some very personal questions for research scientists are highly important in order to do the right things in the right way:

- Why I'm working in this field of science and research?
- What are the reasons for doing research?
- What is the focus of my research?
- Do I work on real relevant challenges?
- What is the relevance of my research work?
- What I'm contributing to the society?
- What skills I have for doing research?

Going for academic work is one way, i.e. theoretical or speculative work without practical purpose or intension, having no practical meaning or usefulness. **The other way is to put science into practice.**

Innovation and entrepreneurship is requested more and more at the beginning of the 21st century. Concept of innovations refers to the putting into practice of inventions. Innovations have to result in new products or new production, new processes, new markets and new business. Entrepreneurs absorb and adapt international technological knowledge and enable a better resource efficiency. They play an important role in catch-up and growth in a local, regional and global economy and contribute to local, national and global welfare. Nevertheless, entrepreneurs have to overcome barriers, but they have to follow ethical standards; they have to be protected and need political reliability as well as public acceptance and support.

Modern Sciences need "Serendibity" and "Maveriks." We must admit that rationality in scientific research is not everything. We should make full use of the opportunities opened to us by random discoveries. This will increasingly become an attribute of scientists in the 21st century. Therefore we should always welcome creative unconventional thinkers, or „mavericks", who notice what others overlook, who perceive, absorb and wonder, who ask questions and reflect, who question the status quo, break with familiar habits and take a sceptical look at things, who venture, risk and act, who foresee, search and discover, and who have the feeling for "how everything works". Scientists will need an optimistic holistic vision of what the future can be, and we must propeller the development of holistic sciences.

We will continue to extend the boundaries of our knowledge at an ever-growing rate. Our motto should be: **Venture courageously to the uttermost limit of necessity"**.

Let me quote three key equations from Paul Collier (2010), which is setting the frame:

- Nature + Technique + Rules = Prosperity
- Nature + Nature + Technique - Regulation = Plundering
- Nature + Regulation - Technology = Hunger

Sustainable (functioning, efficient, essential, significant, effective, impressive, long lasting) development means continuous innovations, improvements and utilization of environmentally friendly technologies with aim of reducing environmental impact and consumption of resources. Improving sustainable agriculture

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means de-materialization, de-carbonization and re-arrangement of resources or with other words: **"Do more with less! – better, and in time!"**

Concerning the role of science and technology in the 21st century let me quote Andre and Jean Mayer (1974): "Few scientists think of agriculture as the chief, or the model science. Many, indeed, do not consider it a science at all. Yet it was the first science – the mother of all sciences; it remains the science that makes human life possible; and it may well be that, before the century is over, the success or failure of Science as a whole will be judged by the success or failure of agriculture."

Appraising new technologies in the food system described in the report titled "The Future of Food and Farming: Challenges and choices for global sustainability" published by The Government for Science (2011) are summed up here:

- New technologies (such as the genetic modification of living organisms and the use of cloned livestock and nanotechnology) should not be excluded *a priori* on ethical or moral grounds, though there is a need to respect the opinions of people who take a contrary view.
- Investments in research on modern technologies are essential in the light of the magnitude of the challenges for food security in the coming decades.
- The human and environmental safety of any new technology needs to be rigorously established before its deployment, with open and transparent decision-making.
- Decisions about the acceptability of new technologies need to be made in the context of competing risks (rather than by simplistic versions of the precautionary principle); the potential costs of *not* utilizing new technology must be taken into account.
- New technologies may alter the relationship between commercial interests and food producers, and this should be taken into account when designing governance of the food system.
- There are multiple approaches to addressing food security, and much can be done today with existing knowledge. Research portfolios need to include all areas of science and technology that can make a valuable impact – any claims that a single or particular new technology is a panacea are foolish.
- Appropriate new technology has the potential to be very valuable for the poorest people in low-income countries. It is important to involve possible beneficiaries in decision-making at all stages of the development process.

Sustainable production of food, feed, fibre, fuel, freshwater and industrial products will depend for its success on a future-oriented, knowledge-based, resource-conserving, and added-value agriculture – that, finally, will eradicate hunger, enable freedom and safeguard global peace.

Key challenges ahead of scientists: We have to deliver "value" to agricultural production systems, to the society and the environment!

A vision: By pressing the ®evolution forward in agriculture through cutting-edge technologies by creative young scientists, the changing world will be able to address "**Factor F**^{n} ("**FFFF FFFF FFFF FFFF**"): **F**uture **F**arming, **F**ood, **F**eed, **F**itness, **F**uel, **F**iber, **F**lowers, **F**reshwater, **F**ishery, **F**orestry, **F**lora, **F**auna, **F**un, **F**ortune, **F**reedom, which are milestones on a roadmap for tackling the challenges of the 21st Century.

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Last, but not least: What will be the twenty-first century of the discovery of the electron and of DNA?

PS: Paul Root Wolpe (2012) published a paper titled "Science needs a universal symbol". He suggested some criteria in the design of the symbol for "Science": a single unified symbol, simple and versatile, instantly recognizable, encompass all of science, easy to modify and to identify a subject area. Please, have a look at the symbol put in front of the vision paper a new universal "Science" symbol is created.

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Remarks: Opinions expressed in this contribution are those of the author.

The paper is in press and will be published in the Proceedings: Cutting-Edge Science and Technology for Food, Environment and Health, Eds: Asif, A.R., Behl, R.K. and Merbach, W., Agrobios International, Jodpur India, 2013.

About the Author of this Issue

Dr. Manfred Kern, biologist, futurologist, managing director of agriExcellence GmbH, did work in the chemical crop protection industry for Hoechst AG, AgrEvo GmbH, Aventis CropScience AG and Bayer CropScience AG in leading functions in science and technology, strategy, marketing and communications during the last 30 years.

Since 1995 he is running a project "Future of Agriculture: Vision 2025/2050", a comprehensive study on the safeguarding of world food supplies. Dr. Kern has more than 150 publications to his credit and has given over 1,000 presentations at international/national congresses, conferences, symposia and workshops in more than 70 countries.

He was awarded by different organisations for significant accomplishments in the field of innovations in agriculture. In 2007, the secretariat of UNCCD (United Nations Convention to Combat Desertification) recognized Dr. Kern by upholding his title as *"Eminent Person"*. Actually, he is nominated for the International ENI Award 2013.

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