Agricultural Sciences in Transition from 1800 to 2020: exploring knowledge and creating impact

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Transitions in agricultural sciences are brought about by incorporating new findings and insights emerging from biological, chemical and biophysical sciences, by more advanced ways of experimentation and last but not least by quantitative methods and models for data analyses and processing. Major breakthroughs occurred from 1800 onwards when new insights on photosynthesis and mineral nutrition were incorporated in the theory on the growth of crops. It took almost half a century before the old humus theory was replaced by a more sound theory on mineral nutrition.

The publication by Darwin on domestication in 1868 and the rediscovery of Mendel's laws in 1900 gave a boost to genetics underlying classical plant and animal breeding, which was mainly based on crossing and selection. A major accomplishment of the evolutionary synthesis was the compatibility of Mendelian inheritance with Darwinian natural selection. The discovery of the DNA-structure in the mid-fifties of the 20th Century on modern plant breeding showed already impact within some decades. To assess the wide diversity of plant traits for the performance of plants in yield and quality of the produce advanced phenotyping method under controlled conditions has become popular. Genome-wide selection for environments with multiple stresses, however, does require phenotyping in situ.

Since 1800 the transition from observations on the plant, field and farm towards dedicated experimentation took place. During the 19th and 20th Century the methods for experimentation and data analyses were strongly improved. It took until the mid-20th Century before the importance of experiments under controlled conditions was recognized. Studies of plant processes under controlled conditions provided the building blocks for mechanistic modeling of crop growth and production. A systems approach combining knowledge at different scales and incorporating cutting-edge findings from the basic sciences into applied sciences will become important for making a great leap forward in developing agricultural science with impact.

Transitions in agricultural research will continue to depend on progress made in the related basic sciences and the capacity for agricultural research and innovation. Therefore, an adequate public funding is required to maintain or even accelerate progress in sciences. This requires the support of the public at large. Public-private partnerships will be needed to bridge the gap between science and innovation.

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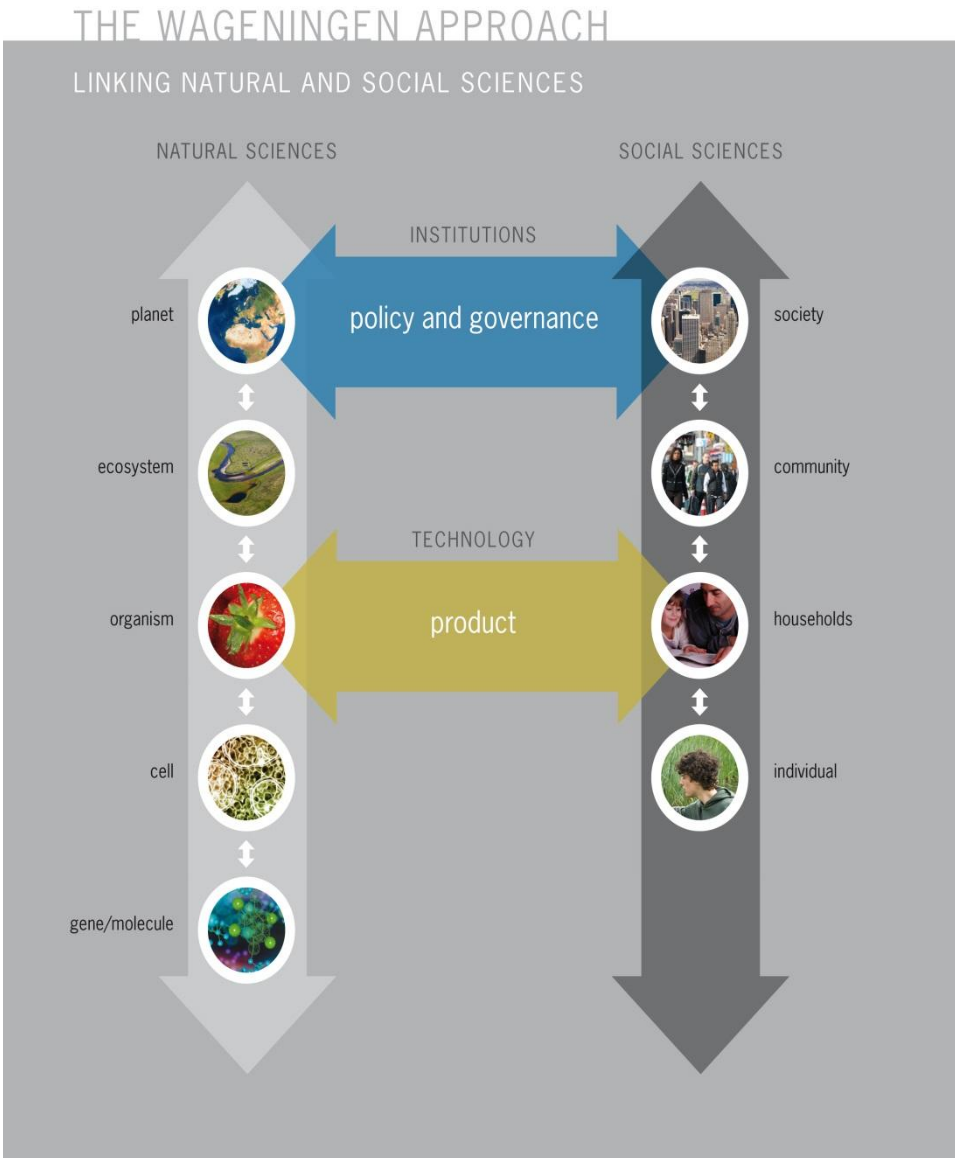
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organism
cell
gene/molecule
society
community
households
individual

Appendix: *Declaration of Hamburg - ICSC, 22 August 2000*

The third International Crop Science Congress highlighted the fact that sustainable development of plant production and resource conservation is essential for achieving and maintaining food security. This requires a better and more comprehensive insight into ecologically sound crop production processes, especially in fragile environments and resource-poor countries.

Concerns and prospects:

1. **Crop sciences** provide the key-knowledge base for increasing the production and quality of human food, animal feed and biomass for industrial use and the provision of energy. Crop sciences play a vital role in improving the quality of life for all human beings by producing food and renewable resources in a sustainable and safe way that meets the needs and the standards of the Global Village.

2. **Food security** continues to be a growing concern globally, due to widespread poverty and the need for more and better quality food for a fast growing population, particularly in developing countries. The world's food supply depends in many regions on the **availability of land and water**, which is becoming increasingly scarce as demands for it increase. Water saving strategies and a better adaptation of crops to limited water and nutrient availability in semi-arid regions are key issues for research.

3. To overcome the large losses due to **pests and weeds** and to reduce the use of pesticides and herbicides, advanced technologies for integrated crop management and ecologically based sustainable cropping systems should become available.

4. When developing new crops and cropping systems knowledge of **genetic resources** and **plant-biotechnology** should be developed and applied with a focus on sustainable and efficient plant production. An integrated and multidisciplinary approach to crop science is needed for innovations and improvements in agricultural production and resource conservation at the field, farm/household, regional and global level.

5. To meet the concerns of society, participation of scientists in the public debate on the potential benefits and risks of the application of **modern technologies** should be encouraged by all public and private research organizations.

6. For the sake of human health, a high priority should be given to improvement of the quality and monitoring of the **safety of human food and animal feed** throughout the production, storage, processing and delivery chain of plant produce.

7 To bridge the **gap in knowledge and modern technologies** between developed and developing countries, more financial resources should be made available for education, training, access to public and private research as well as for technology transfer.

8 To strengthen the role of farmers in the **stewardship** of the rural landscape, natural resources and environment, more emphasis should be given in research and education to forms of land use other than agricultural production.

9 To foster a greater understanding of **environmental impacts**, and to promote efficient **resource use,** knowledge and research tools in crop science should be combined with advances in information and communication technologies, such as GIS and DSS.