The need for sound strategy based research cooperations

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A topic stimulated by the XXX International Horticultural Congress (IHC2018)

The motto of the XXX International Horticultural Congress (IHC2018) from August 12-16, 2018 in Istanbul was 'Bridging the World through Horticulture'. Congress colloquia were to bridge industry with research and production and form a platform to share experiences from different disciplines and actors of society to envision the future. One of the colloquia had the title: "Technologies for meeting the challenges of the future – the role of a research cooperation strategy". Its key message: in public applied research institutions, strategy-based cooperation development and implementation is a vital "technology" to meet the up-coming challenges particularly in technology and knowledge intensive, sustainable horticulture. This colloquium motivated the present article.

Applied research and development in the early days

Science has been a driver of success of modern societies and in particular of agriculture over the past 150 years. Research became the tool for achieving the scientific understanding of problem contexts and for problem solving. Justus von Liebig's book "Organic Chemistry in Its Applications to Agriculture and Physiology", published in 1840, represents the dawn of the development and exploitation of agricultural science for boosting productivity in agriculture. Industry took care of market rewarded aspects of this development, while governments across the world established national institutes for applied agricultural R&D to address aspects that were not taken care of by the private sector and institutions for fundamental research. Private and public institutions achieved remarkable breakthroughs with their *intra muros* R&D. Horticulture was always at the forefront and a driver of this development, often because horticulture is producing close to market with comparatively little regulation from governments, and because problem-solving pressure was, and still is, particularly high in horticulture due to challenging quality standards of fresh and processed produce. For decades and until the middle of the 20th century, the existence of these institutions *per se* was an achievement and an important driver for adapting fundamental ground-breaking innovations, e.g. in plant nutrition, soil fertility management, crop protection or plant breeding and selection, to meet regional requirements. Often, visionary leaders were at the head of such institutions, with a remarkable footprint of their leadership at the national and international level. Only two examples of the many outstanding, pioneering research personalities of these days are mentioned here: Hermann Müller-Thurgau, a plant physiologist, breeder, phytopathologist and microbiologist and the first director of the Swiss Federal Research Station Wädenswil. He was the breeder of the grapevine cultivar 'Müller-Thurgau', which is worldwide still the most widespread modern cultivar for white wines, but also a driver of alcohol free beverage research. Another such example is Nihat Şevket İyriboz, founder and first director of the Turkish Plant Protection Institute at Izmir Bornova and later Minister of Agriculture, who was successful at introducing and using parasitoids against insect pests in the early 20th century, e.g. in figs.

Diversity now!

The institutional setting of science, and particularly of applied R&D in agriculture, has changed dramatically in the last three to four decades. The above mentioned development allowed for a stunning increase of food production. However, negative impacts on the environment and the need for a more holistic view of agriculture than the principally technology driven approach mentioned above has led to the creation of further private, non-industry driven R&D institutions since the middle of the 20th century. Globalisation and digitalisation led to a further diversification of the agri-food R&D landscape, thanks to an increasingly knowledge-based society and to increasingly affordable emerging new technologies, Small and Medium-sized Enterprises (SMEs) and non-governmental organisations engaged in applied R&D. While knowledge and technologies became increasingly specialized and developed increasingly rapidly, the science community got into difficulties in communicating effectively with the public and with decision makers. New types of science are emerging nowadays, e.g. citizen science, intending to deliver outputs to the public, with a simple and objective vocabulary, for reinforcing the collaboration between public and research actors (Brito et al., 2012). Eventually, the institutional landscape of R&D actors and approaches became very diversified, dynamic and complex. Government funded national research institutions have in many countries lost their role as the almost exclusive provider of progress-relevant knowledge and innovation. In the dynamic evolution of problem-related contexts, they compete or collaborate with other sources of new knowledge and innovation in delivering solutions for pressing challenges of the horticultural sector.

Breakthroughs needed and potential solutions

The agricultural value chain is confronted with several megatrends, all of which have their particular importance and expression in specific national and regional contexts. Population growth and demographical changes, changing societal demands and consumption patterns, climate change, increasing pressure on natural resources, increasing food demand and food waste, globalisation, fast technical developments and increasing systemic risks are such megatrends among others. An exemplary, very comprehensive and recently published report on the challenges of agri-food research (The National Academies of Sciences, Engineering, Medicine, 2018) defines nine future key research challenges, two of which relate to animal production, while horticulture is related directly with the following seven: 1) increasing nutrient use efficiency in crop production systems; 2) reducing soil loss and degradation; 3) mobilizing genetic diversity for crop improvement; 4) optimizing water use in agriculture; 5) early and rapid detection and prevention of plant and animal diseases; 6) early and rapid detection of foodborne pathogens;

and 7) reducing food loss and waste throughout the supply chain.

These challenges seem to ask for the impossible: produce more food quantity and quality with fewer resources while not impairing the environment, increasing biodiversity, avoiding losses and paying the price needed to the agri-food sector for covering cost and improving rural livelihoods! Luckily, an increasing number of studies provide further clarity: solutions are at hand, the potential for breakthroughs exists! The chosen production system makes a big difference in terms of land use, deforestation, pesticide use, water use, greenhouse gas emissions, N- and P-surplus and other indicators. Sustainable production methods may feed 9 billion people by 2050, but only if consumption patterns change (Muller et al., 2017). This is supported by further studies on how food's environmental impact may be altered through producers' and consumers' behavioural changes. Interestingly, many horticultural foods can contribute beneficially to lowering greenhouse gas emissions and to reducing land use, terrestrial acidification, eutrophication and scarcity-weighted freshwater withdrawals (Poore and Nemecek, 2018). However, no single measure, such as dietary change towards more plant-based diets, improved technologies and management, or reductions in food loss and waste, will be able to keep negative effects within boundaries that define a safe operating space for humanity. A synergistic combination of measures is needed (Springmann et al., 2018).

Agriculture and more specifically horticulture will play an important role in feeding the world sustainably while addressing the above mentioned challenges, if we want to meet the following goals: 1) improving the efficiency of food and agricultural systems; 2) increasing the sustainability of agriculture; and 3) increasing the resilience of agricultural systems to adapt to rapid changes and extreme conditions (The National Academies of Sciences, Engineering, Medicine, 2018). To address these three goals, convergence is needed, i.e. an "approach to problem solving that cuts across disciplinary boundaries for achieving the necessary breakthroughs", as the report states. Consequently, the principal breakthrough that is required is applying a systems approach, based on the understanding of the nature of interactions among the different elements of the food and agricultural system, which then can be leveraged to increase overall system efficiency, resilience, and sustainability. In terms of research methodology, such systems approaches, involving transdisciplinary science, are recommended as priorities in solving agriculture's most vexing problems.

This is easier to identify than to effectively practice it. What does this mean specifically for a scientist? How do I practice a systems approach with transdisciplinary science? Progress in this respect will depend on how well we succeed in developing robust and simple protocols for coping with such a systems approach. While still many questions remain open, it is evident that an individual researcher or a single institution or a single research discipline will not be able to deliver the expected progress. That's where cooperation, between scientists and institutions and disciplines, comes in!

A cooperation strategy is vital

Cooperation is particularly indispensable for a public applied research institution. They are operating in a complex stakeholder environment and are implicitly and explicitly confronted with many divergent expectations from this environment. They need to deliver solutions to science-based problems in a way that often goes beyond their competence and capacity. A prioritization of problems to be addressed and decisive collaborations needed is unavoidable in being able to develop useful solutions based on the institution's limited competences and capacities, combined with those of the cooperation partners. In other words: a cooperation strategy is needed.

A strategy is a plan of action designed to achieve a long-term or overall aim (English Oxford living Dictionaries, 2018). Cooperation partners usually change dynamically for each research project, while also, for certain research topics or disciplines, some complementary cooperation partners may be identified for a long-lasting strategic alliance. The plan, i.e. strategy, shall define which partnerships are to be built up in the coming years, while some existing cooperation partnerships should be consolidated.

To avoid dissipation of resources and efforts and make efficient use of the often shrinking resources of public applied research institutions, a sound cooperation strategy is a decisive success factor, particularly in the above mentioned challenging context. The strategy-based management of partnerships may be understood as "technology" needed for success, like any other technology. This applies, not exclusively, but particularly to highly specialized technology and knowledge intensive horticulture. However, what are the important earmarks related with a successful cooperation strategy?

The cooperation strategy development process – a success factor

How to develop a strategy? And what is a strategy? In the present case we define the term strategy as a plan of action designed to achieve a long-term or overall aim. It provides guidelines and orientation for management and scientists to move toward a defined aim in the increasingly complex environment of national and international research and research cooperation. A simple and classic strategic planning approach may be used to develop such a research cooperation strategy (Figure 1).

The figure shows the three basic steps of a strategic planning process. Before launching a strategy development process, a clear statement of purpose and overall goal should be defined and approved by the management board. This is of great importance in making sure that the strategy will be supported by the institution and may create

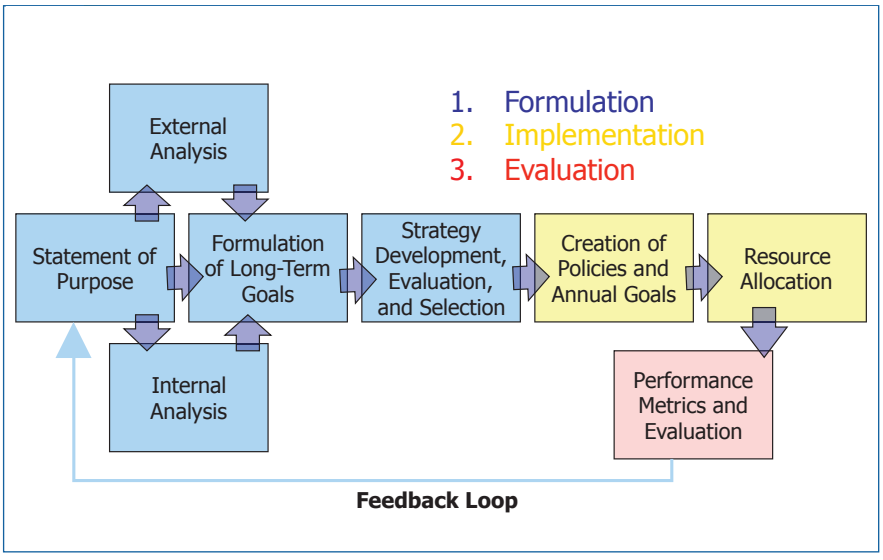

Figure 1. The strategic planning process. Source: Slezak (2018), adapted from Bryson and Roering (1987).

Table 1. Incentives to engage in research cooperation for scientists and research managers in public applied research institutions. Summarized from Beaver (2001), Bertschinger (2017), Bozeman and Corley (2004), and Seongkyoon et al. (2014); adapted from Guimon (2013).

Incentives	Externally controlled factors
Reputation Attractive objectives New knowledge and skills set, novel instruments, tools and methods Additional resources Attractive collaboration and project type Attractive research support services	Incentivising policy instruments being part of the innovation and R&D policy of public and private bodies (e.g. grant design, matching grants, tax-incentives, innovation vouchers, reward systems, technology transfer offices (TTO), spin-off facilitation)
Cooperation instruments	**Internally controlled factors**
Mutual visits and colloquia Researchers' exchange Participation in conferences and research group activities Seed money Performing cooperation support	Advocacy and policy influencing Establishing a powerful research cooperation support Management briefs on innovation and grant policies Consequent fund raising and cooperation policy

impact later on. The first step then is an internal and external analysis, meaning that the internal and the external environment of the institution are studied. Classically, a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) can be the result of this step. It makes sense to involve the perspectives of internal and external stakeholders. Furthermore, the expected purpose and goals of research cooperation represented in the strategy under development have to be defined.

Compellingly, the strategy for research cooperation must be deduced from, and harmonized with, the general strategy of the organization. The first step also includes the development and evaluation of different strategy options. It leads to the selection of the preferred strategic option for cooperation and to the choice of cooperation partners.

In a second step, an implementation plan is developed and the needed resources are allocated. The implementation plan may be documented as a road map with action lines (e.g. management of the strategy, building strategic alliances, etc.) that are specified with work packages that define aims, foreseen actions and the team involved.

Because most research organizations act in an environment with proliferating internal and external complexity, the content of the strategy for research cooperation can't be set in stone for years. That's why the third step comprises the evaluation of the results of all actions undertaken. This evaluation is the basis for a feedback loop for adjusting purpose and overall aim of the strategy, if appropriate, representing the next iteration of the strategic planning process. Typically, there is an evaluation of the strategy and revision every year or every second year.

Traditional vs. evolutive strategy development process

The ambiguity of future developments leads to the necessity to diversify the responses to the various strategic risks. Hence, it's recommended that a portfolio of different strategic actions be pursued, not just one single direction of action. These different actions may be smaller but broader (portfolio of strategic action lines/pilot schemes). This might not be the most efficient way to implement the strategy, but it is the most resilient and therefore successful one, with the advantage of absorbing more potential risks that emerge unexpectedly and enabling the institution to reacting in a timely and appropriate way.

Malik's visualization of traditional and evolutive problem solving represents well the above mentioned approach (Malik, 1996) (Figure 2).

Defining and implementing a strategy for research cooperation has several advantages, as long as it is based on an iterative process that involves management board and selected key actors of the institution:

- it's a guideline for management and for scientists of the organization;
- it strengthens a deliberate focus on important partnerships and avoids unnecessary dispersal and consequently dissipation of efforts;
- it is a reference and guideline for positioning project ideas on the "our-job-not-our-job"-matrix;
- it has a steering effect and thus allows for relieving the system from unnecessary efforts;
- it leads to less "micro-management" and less administration.

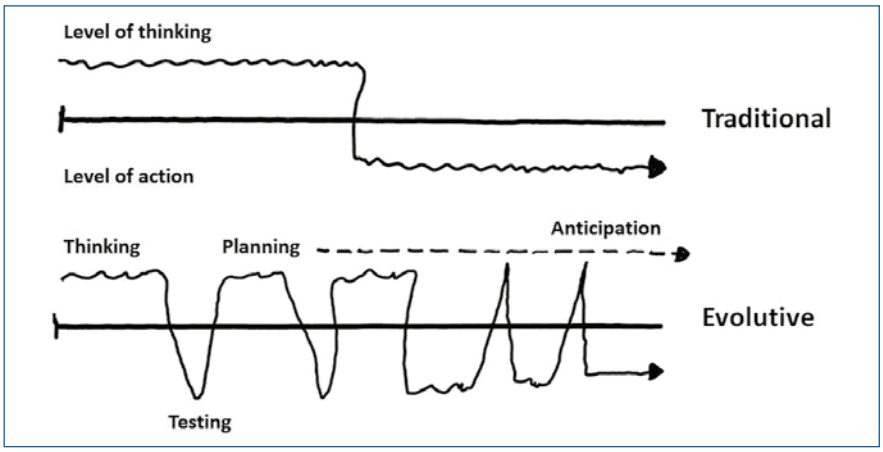

Figure 2. Methodologies of problem solving (adapted from Malik (1996)).

The human factor: particularities of public applied research institutions

Public applied research institutions are so-called "expert organizations". These are generally characterized by some particular characteristics (Mintzberg, 1983; Egloff and Bogenstätter, 2016) that must be taken into account for the strategy development to be successful. Such organizations are based on the knowledge and skills of well-educated, often self-reliant research experts with a high intrinsic motivation. A high recognition in such an organization is often based on professional technical competence. Experts have

much autonomy at their own command in their daily business. The project organization is based on technical criteria, with a management structure that is usually quite flat.
These characteristics are of great importance for the success of the development of a cooperation strategy. The involvement of researchers in the strategy development process is mandatory. It is an inevitable bottom-up-component that ensures an immediate connection to research community and on-going research activities, while the inevitable top-down-component comes from the management of the organization. To launch the development of a cooperation strategy, management needs to define a mandate with clear objectives. This will ensure that the research cooperation strategy is embedded properly into the general strategy of the organization and also other relevant partial strategies (e.g. infrastructure strategy or fundraising strategy). Both components are essential. The bottom-up and bottom-down processes ensure the necessary quality of the process and its results. It's not the fastest way to define a research cooperation strategy but it's the best way to ensure suitable and relevant results, particularly if effective implementation of the strategy is needed.
Such a process may be seen in an expert organization as a change process. Expert organizations have their own terms (Egloff and Bogenstätter, 2016) that need to be respected to ensure a productive strategy development process (adapted from Häfele (2009)):

- transparency;
- clear setting in terms of timing, resources and expected results;
- mutual respect among involved actors;
- participatory process involving researchers and management;
- coherent process design with regard to involved human and organizational actors (goals, interests, potentials);
- building on strengths instead of circumventing weaknesses;
- continuous learning attitude (learning organization).

The win-win-win needed

Another aspect to be respected when developing the strategy is the fact that this process must be of mutual benefit, i.e. for the institute's management, for its administration, as well as for the researchers. To make this happen, the strategy development must not only be motivated by a management decision and a participatory process (see above), but also needs to offer incentives for the involved actors (management, administration, researchers). The strategy must be seen as something supportive to those who must eventually implement it. Incentivising the implementation of the strategy strengthens the strategy's impact.
Scientist and research managers are encouraged to engage in research collaborations for various reasons. It is recommendable to build on these when developing an implementation plan for the cooperation strategy and to allocate the necessary amount of resources.
Table 1 summarises, from several sources, how scientists and research managers may be encouraged to engage for research cooperations.

Conclusions

To cope with the demands of future societies in a healthy environment, horticulture needs breakthroughs in agro ecology, mitigation and adaptation to climate change and the digitalization of its value chains. Nowadays, the institutional landscape of R&D actors is very diversified, dynamic and complex. A steadily accelerating technological and cost intensive innovation process is an important driver of the knowledge-based economy. Nowadays, R&D institutions need resilient and flexible cooperation with competent complementary actors for impactful science-based problem solving. In public R&D institutions, such cooperation must be based on a sound cooperation strategy to invest the often shrinking resources efficiently and effectively.
Strategy-based cooperation development and implementation may be seen as a technology like any other technology needed for knowledge intensive, sustainable horticulture. The development of such a strategy must meet certain prerequisites in order to be successful: 1) the strategy must be a sub-strategy of the institute; 2) a clear mandate from the management board is needed to launch the development of such a strategy; 3) the strategy must meet the needs of the institute's management, administration and researchers (win-win-win) and be developed in a participatory process. Hence, a cooperation strategy simplifies the management of the organization. Actors from management to the project level are provided with a clearer orientation as to what extent a specific cooperation is important and desirable for the organization from a strategic point of view. A strategy allows a focus on few actions and fostering strengths, while not exclusively restricting the institution on one sole aspect. It maintains flexibility and the capacity needed for a resilient organization, resulting in a focused, but nevertheless broad portfolio. The strategy must provide incentives for researchers and management, as well as administration, since the support of all three actors is needed in order to implement the strategy. Continuous questioning of the strategy and flexible adaptation are vital to address a changing reality. Strategy development and implementation need resources that must be considered from the outset. Not taking them into account is a common reason for lack of strategy implementation.

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