

Review Article

The Teaming Initiative: Establishing of New European Centers of Excellence in Plant Biology and Medicine

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Introduction

The European Commission considers Research and Innovation (R&I) as a key driver of social and economic prosperity, as well as environmental sustainability. The EU budget of the EU framework programmes has steadily increased: from 76.4 billion EUR in Horizon 2020, the 8th framework programme, to 95.5 billion EUR in Horizon Europe, the current 9th framework programme (<https://scienceeurope.org/our-priorities/eu-framework-programmes/>). However, sharp R&I disparities between member states exist. In order to reduce the R&I gap between the member states, the European Commission introduced a new funding instrument, the Teaming, aiming at establishing new or substantially upgrading existing Centers of Excellence (CoE) located in the so-called Widening countries; countries with R&I index below 70% of the EU average.

(https://ec.europa.eu/research/participants/portal4/doc/call/h2020/common/1617618-part_15_spreading_excellence_v2.0_en.pdf).

The new centers are established with coordinating institutions in the Widening countries and advanced partners in regions with high R&I index. Teaming is the flagship EU scheme of the Horizon 2020 and Horizon Europe Spreading Excellence and Widening Participation programme. In addition to Teaming, other measures such as ERA Chairs, Twinning, and COST were also implemented to support the Widening countries. The total budget of the widening measures in Horizon 2020 was 935 million EUR, most of which dedicated to the Teaming projects (390 million EUR in total) (Table 1). In Horizon Europe, new widening

Abstract

The Teaming programme is a new funding instrument of the European Commission aimed at closing the research and innovation gap between the leading and lagging EU countries by establishing new research centers. The new centers of excellence are located in the so called widening, countries, and are created in partnership with advanced institutions from European regions with high research and innovation index. Here we describe the new research institutes in the field of plant biology and medicine from the first two Horizon 2020 Teaming calls. We analyze the financial investment by the European Commission through the Teaming instrument, as well as the Governmental co-funding and the contribution of the advanced partner institutions and local authorities. With these collective efforts, these institutes have quickly become the drivers of scientific and socio-economic developments of their respective countries.

Keywords: Centers of excellence; Horizon 2020; Teaming; Widening countries

measures such as Excellence Hubs, Hop-on-Facility, and ERA Fellowships were introduced (Table 2), in addition to the existing ones, and the total budget of the widening measures increased to 2.95 billion EUR (3% of the Horizon Europe budget).

Establishment of such Teaming centers is a collective effort of the European Commission, the Governments of the respective widening countries, and local authorities. In addition to the Horizon 2020 grants for the Teaming phase 2 projects, local Governments invested 784 million EUR complementary funding

(https://www.eca.europa.eu/Lists/ECADocuments/SR22_15/SR_Horizon_2020_Widening_EN.pdf). Furthermore, local municipalities or/and partner organizations are contributing with buildings or land for construction of new research complexes.

The reasons for these massive investments are the high expectations of the new European centers of excellence. They are expected to contribute to the following:

- Changing the research landscape in many of the Widening countries. The new CoEs, which are expected to be as much independent as possible, stimulate national, international, and systemic reforms.
- Substantially increasing R&I in their countries (higher number of research publications in scientific journals, more collaborative projects, new partnerships with industry, leading educational roles), taking into account the smart specialization

strategies of the respective Widening countries.

- Higher level of internationalization, by strengthening the mutually beneficial collaboration with partners from leading scientific institutions from abroad.
- Development and promotion of new research stands in relevant areas, development of enhanced research and innovation capacities and advanced technologies for the benefit of academic organizations, companies, and other stakeholders in the region.

Here we describe the establishment of Teaming centers in plant biology and medicine from the first two calls of Horizon 2020 framework programme. Ten out of 24 Teaming Phase 2 projects funded by Horizon 2020 were with research focus on plant biology or medicine, which is 41.7% of all Teaming Phase 2 projects in the first two Horizon 2020 calls. These centers of excellence are already making a huge impact in Europe by reducing the research and innovation gap between the Widening and the advanced countries and by promoting the scientific and socio-economic developments of their respective regions.

New Teaming Centers of Excellence in Biology and Medicine from Horizon 2020

Horizon 2020 Projects as Seed Money for Establishing the Centers of Excellence

Teaming instrument of Horizon Europe invested 147.3 million EUR in projects related to plant science, biology, and medicine during Phase 2 (Table 1). This was the 38% of the overall Teaming budget. This significant amount, underlying the importance of these new flagship projects, was just the initial investment (the seed money) that catalyzed the formation of these centers. In addition to the Teaming grants, it was expected that similar amount would be invested by the local Governments. Indeed, the Governmental co-funding was at least equal, and in some cases, exceeding the EU funding. In addition, in some cases the coordinating institutions themselves invested their own money or/and donated buildings for the (initial) start-up of the newly established centers. This was exactly the philosophy of this initiative, which was envisaging a self-catalyzing process that will nourish the new Centers of Excellence during and beyond the life time of the Teaming projects.

Altogether, 25 Teaming projects were funded from the first two calls in Horizon 2020 (Table 3). The first Teaming call funded 11 projects, four of which were related to plant biology or medical sciences (ANTARES, HCEMM, PlantaSYST, and THE DISCOVERIES CTR.). The Teaming Phase 2 for these projects started in 2017. Some of these projects are already successfully completed or will soon be completed. The second Teaming call funded 14 projects, five of which are related to plant biology or medicine (BBCE, BIOPOLIS, CY-BIOBANK, MIA-Portugal). They started in 2020 and are on-going. The distribution of the Teaming projects in different scientific areas is given in Figure 1.

Because of their earlier start, the first Teaming projects are much more advanced and the centers of excellence established or by them are already fully integrated in the research and innovation ecosystems of their respective countries. Moreover, the first four centers of excellence are now leading European institutes in their fields.

The projects established with the initial funding of the two Teaming calls from Horizon Europe are given in Table 1 (in alphabetical order): ANTARES, BBCE, BIOPOLIS, CETOCOEN, CY-

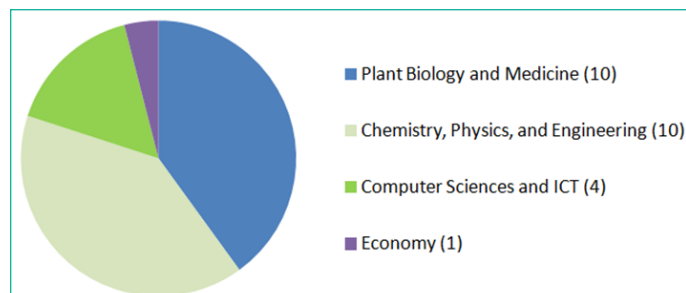


Figure 1: The number of Teaming projects from the first two Horizon 2020 calls, distributed in different scientific areas (plant science, biology and medicine; chemistry and physics; computer science, information and communication technologies; economy).

Source: CORDIS (<https://cordis.europa.eu/>).

BIOBANK, HCEMM, MIA-Portugal, PlantaSYST, SANO, and THE DISCOVERIES CTR. These Teaming projects, with the exception of the last one (prematurely terminated on the 20th of August 2020), have successfully established new centers of excellence in plant sciences, biology, and medicine, described below.

ANTARES, with coordinator the BioSense Institute (Serbia) and advanced partner Wageningen University (The Netherlands), aims to transform the BioSense institute into a world-class research center for advanced technologies in sustainable agriculture and food security (<https://antaresproject.eu/>). This is one of the two Teaming projects with focus on plant biology and agriculture. The project received 15 M Teaming grant and 20 M co-funding from the Government. Its success is evident by the fact that the BioSense institute is now the leading plant science organization in Serbia, with more than 80 projects in addition to ANTARES. The BioSense institute has become a vital link between academia, industry, and the end users (farmers) in Serbia, offering advanced digital solutions to all stakeholders.

The BBCE project aims at establishing the Baltic Biomaterials Centre of Excellence in Latvia (<https://bbcentre.eu/>). The coordinator is Riga Technical University, with partners Latvian university and research institutes, as well as advanced partners from Germany and Switzerland (Table 1). The research focus of BBCE is bioengineering of tissues is bone regeneration and repair [1-3]. As this project started recently (2020), it is still gathering pace but already delivering promising results.

BIOPOLIS, another project from the second Teaming call, aims at upgrading the Research Centre in Biodiversity and Genetic Resources from the University of Porto to a Centre of Excellence for agrobiodiversity, conservation and competitiveness of local genetic resources and farming systems, as well as environment and biodiversity assessment and monitoring (<https://www.biopolis.pt/en/>) [4,5]. The Portuguese coordinator partners with organizations in Portugal and France (Table 1). In addition to the 15 M EUR Teaming grant, the project receives a generous funding of 85 M from the Government. This will undoubtedly secure bright future for this center.

CETOCOEN, coordinated by the Masaryk University in the Czech Republic and advanced partners from Austria, Switzerland, and UK, will support the Research Centre for Toxic Compounds in the Environment (RECETOX) (<https://www.recetox.muni.cz/>). The research focus on this center is studying the complex impact of the environment, lifestyle and socio-economic status on human health by long-term epidemiological and clinical studies [6]. It received 14.3 M from Horizon 2020 and additional 26 M from the Government. The research outcomes of this center will deliver exciting information how to

Table 1: Teaming phase 2 projects aimed at establishing new centers of excellence in the areas of plant sciences, biology, or medicine. Source: CORDIS (<https://cordis.europa.eu/>).

Project acronym	Field	Name of the Center	Coordinator	Other Partner Organizations	Budget Million EUR
ANTARES	Agriculture, Food sciences	BioSense Institute https://biosens.rs/en	BioSense Institute, Serbia	Wageningen University (the Netherlands), Ministry of Education (Serbia)	14 M H2020 20 M Government
BBCE	Medicine	Baltic Biomaterials Centre of Excellence (BBCE) https://bbcentre.eu/	Riga Technical University, Latvia	Latvian Institute of Organic Synthesis (Latvia), RSU Institute of Stomatology (Latvia), AO Research Institute Davos (Switzerland), Riga Stradins University (Latvia), Friedrich Alexander University Erlangen Nuremberg (Germany)	15 M H2020 20 M Government
BIOPOLIS	Biology	CIBIO – Research Center in Biodiversity and Genetic Resources https://www.biopolis.pt/en/	Biopolis Association, Portugal	University of Montpellier (France), PBS (Portugal), CNRS (France), ICETA (Portugal), Research Institute for Development France, C.I.R.A.D. EPIC (France), National Research Institute for Agriculture, Food and Environment (France), University of Perpignan (France), Ecole Pratique des Hautes Etudes (France)	1 M H2020 85 M Government
CETOCOEN	Environmental health science	Research Centre for Toxic Compounds in the Environment (RECETOX) https://www.recetox.muni.cz/	The Masaryk University, Brno, Czech Republic	University College London (UK), Swiss Federal Institute of Technology Zurich, St. Anna Faculty Hospital Brno (Czechia), Medical University of Graz (Austria), Oncological Institute Masarikuv (Czechia), BBMRI-ERIC (Austria)	14.3 M H2020 26 M Government
CY-BIOBANK	Medical and health sciences	Biobank https://biobank.cy/	University of Cyprus	Medical University of Graz (Austria), BBMRI-ERIC (Austria) RTD Talos Ltd (Cyprus)	15 M H2020 23 M Government
HCEMM	Medical and health sciences	Hungarian Centre of Excellence for Molecular Medicine (HCEMM) https://www.hcemm.eu/	Hungarian Centre of Excellence for Molecular Medicine (HCEMM), Szeged, Hungary	EMBL (Germany), Szeged Biological Center (Hungary), Semmel Weiss University (Hungary), University of Szeged (Hungary), National Research Development and Innovation Office (Hungary), University of Debrecen (Hungary)	15 M H2020 37 M Government and founding institutions
MIA-Portugal	Medicine	Multidisciplinary Institute of Ageing	CCDRC, Portugal	University of Coimbra (Portugal), University of Newcastle upon Tyne (UK), University hospital Groningen (The Netherlands), Institute Pedro Nunes (Portugal)	15 M H2020
PlantaSYST	Plant Sciences	Center of Plant Systems Biology and Biotechnology (CPSBB) https://cpsbb.eu/	Center of Plant Systems Biology and Biotechnology (CPSBB), Plovdiv, Bulgaria	Institute of Molecular Biology and Biotechnology (Bulgaria), University of Potsdam (Germany), Max Planck Potsdam-Golm (Germany), Maritsa Vegetable Crops Research Institute (Bulgaria), IMicB-BAS (Bulgaria)	15 M H2020 15.3 M Government
SANO	Computational Medicine	Center for Computational Personalized Medicine https://sano.science/	Center for Computational Personalized Medicine, Krakow, Poland	The University of Sheffield (UK), Fraunhofer Institute (Germany), AGH University of Krakow (Poland), LifeScience Cluster Kraków (Poland), Research Center Jülich GmbH (Germany), RWTH Aachen University (Germany), National Center for Research and Development (Poland), Sheffield Teaching Hospitals NHS Foundation Trust (UK), NCBR+ (Poland)	15 M H2020 15 M Government
THE DISCOVERIES CTR	Regenerative medicine, Precision medicine	The Discoveries Centre for Regenerative and Precision Medicine	University of Minho, Braga, Portugal	University College London (UK), University of Porto (Portugal), University of Aveiro (Portugal), New University of Lisbon (Portugal), University of Lisbon (Portugal), The Discoveries Centre for Regenerative and Precision Medicine (Portugal)	€ 15 M H2020 Project terminated on 28 August 2020

nourish a healthy society.

The project HCEMM, coordinated by the National Research, Innovation and Development Office, combines the efforts of several Hungarian universities, the Biological Research Center of the Hungarian Academy of Sciences, and the European Molecular Biology Laboratory (EMBL) to create the Hungarian Centre of Excellence for Molecular Medicine (HCEMM) (<https://www.hcemm.eu/>). Applying the highest standards adopted from its advanced partner EMBL, the HCEMM is working on research and development related to healthy ageing [7-9]. In ad-

dition to the 15 M Horizon Europe grant, additional 37 M EUR is attracted from the Hungarian Government and the founding institutions. In 2020, HCEMM received a status of a National Laboratory. HCEMM is a “game changer” organization in Hungary, as it was established as a non-profit Ltd.: catalyzing profound changes in the Hungarian research ecosystem.

MIA-Portugal, with a Portugese coordinator and advanced partners from The Netherlands and UK, aims at establishing the Multidisciplinary Institute of Ageing (MIA) (<https://www.uc.pt/mia/>). MIA is another center of excellence in Europe focused on

Table 2: Widening measures under Horizon Europe. Source: European Court of Audits.

(https://www.eca.europa.eu/Lists/ECADocuments/SR22_15/SR_Horizon_2020_Widening_EN.pdf).

Measure/Instrument	Available Budget (Million EUR)	Share of widening budget
Teaming	743.6	26%
Twinning	486.2	17%
ERA Chairs	343.2	12%
COST	400.4	14%
Excellence initiative for universities	286.0	10%
Excellence Hubs	257.4	9%
Brain circulation	143.0	5%
Support package	57.2	2%
Hop-on facility	143.0	5%

Table 3: Teaming projects in Horizon 2020, distributed by countries.

Source: CORDIS (https://cordis.europa.eu/).

Country	Proposals submitted	Proposals funded	Success rate
Cyprus	41	6	15%
Portugal	21	3*	14%
Czechia	28	3	12%
Poland	32	3	9%
Latvia	14	2	14%
Hungary	17	2	12%
Bulgaria	28	2	7%
Estonia	11	1	9%
Slovakia	18	1	6%
Slovenia	20	1	5%
Serbia	30	1	3%
Lithuania	9	0	0%
Romania	44	0	0%
Croatia	16	0	0%
Malta	9	0	0%
Luxembourg	2	0	0%

* Includes a project that was terminated in 2020 (before the end of its implementation).

healthy living, reflecting the importance of this to our society [10]. Established in 2020 with the 15 M seed money from Horizon 2020, MIA set ambitious goals such as: improve health life expectancy, reduce the socio-economic burden of age-related diseases, and perform fundamental and translational research, ultimately becoming one of the top European centers in biology of ageing.

The purpose of project PlantaSYST is to establish the Center of Plant Systems Biology (CPSBB) in Plovdiv, Bulgaria. Coordinated by CPSBB, the project has partner institutes from Bulgaria and Germany (Table 1). CPSBB was founded in 2015 with the help of the first Teaming call and has quickly become the leading plant science organization in Bulgaria [11,12]. Initially, PlantaSYST received 15 M from Horizon Europe and a building from one of its partners, Maritsa Vegetable Crop Research Institute. Later on, CPSBB received additional co-funding from the Government and land from Plovdiv Municipality to construct its new research complex. Now, CPSBB is the most productive plant science institute in Bulgaria, in terms of peer reviewed scientific publications and collaborative projects. Like HCEMM in Hungary, CPSBB is changing the research ecosystem in Bulgaria, as it is the only plant science institute which is fully independent, not part of the Bulgarian Academy of Sciences or the Bulgarian Agricultural Academy.

The SANO project, coordinated by the Center for Computational Personalized Medicine (SANO) and supported by partner organizations from Poland, Germany, and UK, aims at developing new computer methods in healthcare and diagnosis via novel personalised approaches to patient treatment (https://sano.science/). The new center was established in 2019 with a 15 M grant from Horizon 2020 and quickly became the project coordinator. More than 100 people are now employed or associated with this center.

Support from National and Regional Authorities

The Governments of the Widening countries were fully aware of the importance of these newly established centers, hence they provided generous co-funding. Whereas the Horizon 2020 grants were mainly for personnel costs and indirect costs, the Governmental co-funding was for developing new infrastructure: constructing new buildings (or upgrading existing ones) and purchasing state-of-art equipment, which would provide technological advantage to the new centers and attract additional highly skilled scientific personnel. The funding invested by the Governments was at least equal to the Horizon 2020 grants, and in many cases much more than that (Table 1). Overall, the governmental funding was 2-fold higher than the funding obtained from Horizon 2020.

However, there are a number of issues regarding the national co-funding. In most cases, large part of it comes through the European Regional Development Fund (ERDF). The co-funding grants with ERDF were not coordinated with the corresponding Teaming calls. Whereas the Horizon 2020 projects can run until 2026, the ERDF funding can be used only until the end of 2023. Most of the Teaming projects experienced delays in the co-funding, in some cases delays with more than two years. As the complementary funding usually covers infrastructure and equipment costs, its delay results in delays in the construction of the new research premises and acquisition of state-of-the-art equipment: key factors in attracting good researchers. This was the case with the first Teaming projects, where 80% of them experienced delays in receiving complementary funding, and is especially alerting for the second group of the Teaming projects, due to the much shorter time window for spending the complementary funding.

The local authorities in the cities/the regions where the new centers were established have provided additional support in form of e.g. land for construction of the new research complexes, and logistics as well as administrative support in some cases. Indeed, the newly formed centers were of paramount importance for the local scientific development and bio-based economy. In several cases, the coordinating institutions themselves have invested from their own budgets or donated buildings to speed up the developments of the new centers.

Contribution to the Scientific and Socio-Economic Development of the Regions

The new research centers in biology and medicine are already making a deep impact on both scientific and socio-economic development of their respective regions. This is particularly evident for the two centers of excellence with research focus on plant biology: The BioSense Institute and the Center of Plant Systems Biology and Biotechnology.

The BioSense institute, established through the project AN-TARES, is performing groundbreaking research in agriculture and digital technologies, delivering state-of-art technological

Table 4: Impact of the new Teaming centers on the scientific and socio-economic development in the Widening countries.

Impact	Examples
Changing the research landscapes of the widening countries	HCEMM is a new type of research organization is catalyzing deep changes in the Hungarian research ecosystem. It is structured as non-profit company that uses the EMBL research model. CPSBB is the first fully independent plant science institute in Bulgaria, that is not part of the Bulgarian Academy of Sciences or the Agricultural Academy. Its structure and research model, resembling the Max Planck institutes in Germany, is changing the research ecosystem in Bulgaria.
Raising the scientific and innovation output	All research centers are among the most productive scientific institutions in their countries, in terms of research articles in impact factor journals and collaborative research projects. Positive examples include the BioSense institute in Serbia, CPSBB in Bulgaria, and HCEMM in Hungary.
Creating new jobs and development opportunities for young people	The new centers of excellence have employed more than 900 people and created at least ten times more job opportunities in their partner organizations, as a result of the collaborative research projects and the positive business environment.
Consolidating academia, business, and other stakeholders in the region.	The new centers are partnering with all major universities and research institutes in their regions, as well as with non-governmental associations in various areas of biology, including plant sciences, and medicine.

solutions to research organizations, companies, and farmers in Serbia and Europe (<https://biosens.rs/en>). BioSense is participating in 30 national and more than 50 international projects. The research performed at BioSense is directly linked to societal challenges. For example, its AgroSense digital platform enables farmers and extension services to monitor crops for free and plan activities using computers and mobile phones, based on the data collected from satellite images, drones, robots, various sensors, and meteorological stations. More than 15,000 registered users are an indicator of successful digital transformation. Due to the partnership with the European Space Agency, BioSense is the only distributor of Sentinel satellite imagery in Serbia. Also, the impact is spread globally through other collaborations with FAO, EBRD, World Bank and UNICEF. Currently, BioSense is employing more than 120 people

(<https://biosens.rs/en/employees>).

The Center of Plant Systems Biology and Biotechnology (www.cpsbb.eu), founded with the support of the project PlantaSYST, has quickly established itself as the leading plant science research institute in Bulgaria [12]. Currently, it is the most productive Bulgarian plant science center in terms of number of research articles in peer reviewed journals and collaborative projects [11]. CPSBB has on-going projects with more than 100 universities, research organizations, and companies throughout the world. Major research areas are molecular stress physiology, plant cell biotechnology, crop quantitative genetics, plant metabolomics (including research on metabolites with applications in medicine and pharmacy) and vegetable breeding [11]. In addition, CPSBB is providing services in bioinformatics and metabolomics, as well as digital solutions to farmers/farmer organizations in Bulgaria and Europe, thus contributing to the development of the agricultural economy in the region. CPSBB is member and as such is actively contributing to EURAXESS, EU SAGE (European Sustainable Agriculture through Genome Editing), and the International Seed Federation. Through EU SAGE, for example, the potential for genome editing is advocated and the European Commission is advised on the regulatory proposal for plants obtained by new genomic techniques. Overall, the new centers are rapidly changing the research landscapes of their countries, increasing the R&I output, consolidating the academia, business, and other stakeholders in the region, and creating new jobs by either direct employment or indirectly promoting the development of the partnership organizations in the region (Table 4).

Conclusion and future Prospective

The Teaming projects funded by Horizon 2020 are regarded as flagship projects of the European Commission. Their success prompted continuation of this funding instruments in Horizon Europe and will further continue in the 10th EU Framework Programme of Research and Innovation. The Centers of Excellence with focus on plant biology, established by the Teaming mechanism and supported by the Governments of their countries, are making a deep impact on the agribusiness and bio-economy, as well as on the socio-economic development in their respective countries. These centers have consolidated the local universities, the research organizations, and the companies in the area of agriculture, digital technologies, human healthy living, and plant breeding.

As the centers are gathering pace and receiving international visibility, the recruitment of top international researchers to bring R&I excellence is becoming more feasible. The real challenge remains achieving sustainability in the long term, beyond the life span of the Teaming grants. The Governments of the Widening countries, recognizing the importance of the new Teaming centers of excellence, are putting in place new measures in their strategic R&I programmes to help the new centers in this transition period. The future of these centers lies in further consolidating all players in the plant science field, including academia, industry, end users such as breeders/farmer organizations, and local/central government as well as policy makers (the quadruple helix). One opportunity for such clustering is the Excellence Hubs in plant science, which is a new Horizon Europe instrument (Table 2). Another future prospective are the plant bio-economy valleys, which are being created across Europe. These multi-actor partnerships will create vast potentials for research and innovation for the benefits of people and society.

Author Statements

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