The Horizon 2020 CAPSELLA project: Collective Awareness PlatformS for Environmentally-sound Land management based on data technoLogies and Agrobiodiversity

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Abstract

Only agricultural and food systems with reduced use of external inputs can meet the challenges of sustainability. Agrobiodiversity is key to this, being the basis for improving agricultural production through smart utilization of the functionalities that agroecosystems offer. Improving food systems where consumers play an active role in driving produce demand and offer is also crucial. Alternative, agrobiodiversity based agricultural models are more likely to be supported by open, horizontal and dynamic Agricultural Knowledge and Innovation Systems in which research, education, extension, support systems and farmers, citizens and consumers, are gathered in networks. Just like the tiny yet sturdy little plant it takes the name from, the Horizon 2020 CAPSELLA project (www.capsella.eu) will deepen the roots of sustainability in agri-food systems by harnessing scientific and local knowledge, people's energy, motivation and innovation skills around the theme of agrobiodiversity by making use of novel, improved and demand-driven ICT solutions. CAPSELLA will focus on two complementary domains (agrobiodiversity and the food supply chain) through participatory bottom up data collection and top down data integration to develop solutions. The project will build from scratch open data repositories concerning regional agrobiodiversity, and build upon and enhance existing data sets on the agrobiodiversity and food domains. Based on these, the project will develop a number of community-driven data powered ICT solutions, which will be tested by the communities engaged in the project and will result in a number of pilots running around three multidisciplinary, community-driven use cases: the field, seeds, and food scenarios.

CAPSELLA and the EU institutional framework

With over 77% of the European territory classified as rural (47% farmland and 30% forest) and around 12 million full-time farmers, agriculture is a vibrant and important sector of the EU economy and welfare. Agriculture and agri-food account for 6% of the EU's GDP, comprising 15 million businesses and 46 million jobs.

In this light, the European Union has always put high priority to its rural development policies considered key drivers of social and economical development and wealth. The main tool by which Member States implement their policies for agricultural development is the well known Rural Development Plan (RDP), one of the two pillars of the the Common Agricultural Policy (CAP). Through the CAP, Europe is increasingly recognizing the value of farming for the conservation of agricultural biodiversity and the provision of ecological services in farmland, including some of paramount global importance, like the mitigation of climate change.

EU farmers are facing multiple challenges to meet increasing demands from consumers and the civil society. Besides their traditional role of food, feed and fiber producers, farmers are nowadays requested to provide other ecosystem services, such as the production of renewable energy, the conservation of biodiversity and the environment, landscape and rural cultural heritage, and the mitigation of climate change. Basically, there is an undeniable increasing awareness that all these demands can be met by the conservation and wise use of agricultural biodiversity, or 'agrobiodiversity'.

To meet the present goals of EU agricultural and agri-food systems and to foster knowledge on the importance of agrobiodiversity among EU stakeholders and actors, the use of novel ICT solutions is key. Targeted and tailored-made ICT-based solutions can promote innovative, knowledge-intensive farming systems and methods based on the optimization of local natural resources and on reduced use of external inputs. On top of this, ICT can greatly contribute to bridging the digital divide between urban and rural areas, thus creating a more inclusive society for the benefit of all actors involved.

In the light of the aforementioned concepts, under the Horizon 2020 programme, the CAPSELLA (Collective Awareness PlatformS for Environmentally-sound Land management based on data technoLogies and Agrobiodiversity) project was funded and took its first steps on 1 January 2016.

CAPSELLA's ambitious goals are to raise awareness about existing ICT solutions and the benefits of their adoption, the understanding and collections of farmers and networks needs and requirements in order to develop and deliver tailored made ICT novel solutions, foster understanding and, hopefully, sharing of open data among farmers, which shall lead to build a sustainable technical prototyping platform, a meeting environment for innovation that democratizes access to big data, cloud computing, open data, open software and pilots.

How CAPSELLA will support and facilitate transition to agrobiodiversity

CAPSELLA is grounded on the scientific vision that diversification whether in agriculture, land management, food retail or business models, supported by smart, open and distributed ICT tools, can have significant impact on environmental and socio-economic sustainability. There are two ways by which this can occur. First, ICT can be used as a communication platform for information, experience and best practice sharing[1]. For example, agricultural biodiversity can make substantial use of novel ICT solutions that harness the power ICTs are offering, while keeping a clear local and bottom-up approach that serves the needs of networks, communities and small producers. The creation of open, bottom-up ICT tools, which are tailored made, on the farmers' and communities needs and requirements that will be collected, and dedicated to biodiversity for food and agriculture would result in collaborative virtual work spaces in which innovative, diversity-based strategies of resources management, production, distribution and consumption can overcome their current case-by-case success status and concretely contribute to the construction of a sustainable decentralized agricultural model.

This leads to the second way ICT can be used, i.e. directly by using data to better manage the various steps along the food system. This includes, for example, the reduction of external inputs to industrial agriculture using the approaches of Precision Agriculture/Farming; the use of various data driven technologies based on local sensors, remote sensors, meteorological data, water consumption and reduction etc. to better manage crops; the use of local social networks to

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[1]   This is already happening with the widespread use of Twitter especially in Anglophone farming communities (http://www.farmingfutures.org.uk/resources/how-use-twitter and http://www.theguardian.com/environment/blog/2014/jan/12/felfie-farmers-social-media).

reduce food waste; the use of smartphone apps to track and better inform consumers about the history or background of individual foods, etc. This can be seen as a continuum of various applications of ICT ranging from those purely industrially focused to those most social/environmentally focused.

Methodology

CAPSELLA will focus on two complementary domains: agrobiodiversity and the food supply chain, in order to address the challenges of sustainability. The driving force of the project is its **bottom up approach**, which aims at ensuring that the involved communities', networks' and clusters such as ESAPODA in Italy, Aegilops and Ars Natura in Greece, Arc2020 in the UK and others, needs and requirements are suitably and effectively addressed. Communities will first lead the decisions on what type of tools and pilots are going to be developed and will then evaluate and validate them.

At the centre of the work are three community-driven use cases/scenarios that will be addressed following an iterative approach:

1. **Field scenario**, addressing ecological intensification and functional agrobiodiversity in cropping systems;

2. **Seeds scenario**, addressing on-farm genetic diversity conservation and management, seed networks and informal seed systems;

3. **Food scenario**, addressing the food chain by bringing more transparency in the processes related to the production, distribution and consumption of quality food.

These use cases are transdisciplinary and will result in a number of bottom-up generated pilots with concrete value for the networks and communities involved. All these activities will be supported and linked together by a data integration and analytics platform that will enable a series of key functionalities for the user communities. These will include among others (a) data capture via smartphones (e.g. recording of crop choices, growing patterns, and other relevant biodiversity data points), (b) unstructured data/update sharing with selected community members, (c) wiki-like facilities to provide space for construction of narratives about food varieties (biodiversity) or food qualities. A further set of functionalities will be developed in collaboration with our target users as a response to their custom needs. The platform will integrate seamlessly with web-based and smartphone based delivery formats.

Finally, having in CAPSELLA a strong focus on innovation and creation of concrete results, hence societal impact, already from the beginning several activities able to turn ideas into applications and businesses have been implemented. The requirements collection and solution development will rely on innovative tools such as hackathons, able to generate in a collective way bottom-up solutions. In the last 12 months of the project CAPSELLA will incorporate an even stronger "lab to market" approach, offering concrete incubation support and opportunities to ICT solutions developed within the project (Fig. 1).
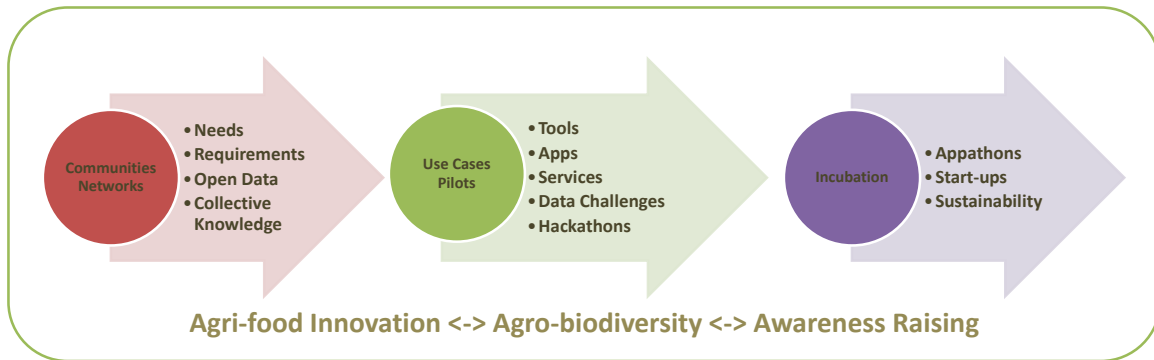
Fig. 1: Flow chart of CAPSELLA's activities.

CAPSELLA's ambition

CAPSELLA advocates and strongly believe and support the idea that a focus on **diversification**, either in agriculture, land management, food retail or business models, supported by smart ICT tools, will have significant impact on sustainability. Agricultural biodiversity requires novel ICT solutions that harness the power that data driven solutions are offering, while keeping a clear local and bottom-up approach that serves the needs of networks, communities and small producers. The ambition of CAPSELLA is to establish agrobiodiversity as the key element to foster long-term sustainability in the EU agriculture and food sectors, and the EU environment through long-lasting collaboration between farmers, farmers organizations, agricultural extension services, citizens, scientists, entrepreneurs, public servants and policy makers generated from bottom-up participatory action boosted by targeted, on-demand novel ICT tools and solutions.

ICT tools have played an active role in agriculture since the 1960s and have been applied within the food and agricultural industries for improving efficiency and productivity in established food systems. It has been recognized that ICT holds the key to the successful coordination and implementation of a more sustainable agri-food system (Schiefer 2004). The use of ICT could result in secure sustainable food systems, through the application of innovative digital technologies that take into account the interactions within and between food and agriculture systems, and with broader industrial systems. ICT could play a pivotal role in improving communication between different parts of the supply chain[2], as well as through the use of data driven technologies and other innovative digital technologies to improve the efficiencies of the overall food system – from sustainable production through to reduction of waste in supply chains and on the consumer's table (Kaloxylos 2013). Since agriculture and food chains are complex decision spaces, multidisciplinary research and user orientation are essential for a successful progress in ICT (Kuhlmann & Brodersen 2001).

Agricultural production is required to increase while reducing its impact on the environment. This challenge is most effectively addressed through 'ecological intensification' (e.g. Tittonell 2014), according to which agricultural production is based on an optimized management of agrobiodiversity and ecological processes, therefore creating a highly knowledge-intensive production system (Doré et al. 2011). Equally importantly, we need to ensure a fairer distribution of food, which calls for investments in family farming, value chains and markets that enhance food security at all levels. The high level of complexity and unpredictability of the context of agricultural production and food chains (Gianpietro 2003) brings us to the centrality of the

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concepts of 'adaptive management' and 'co-management', i.e. *'a continuous problem-solving process, rather than a fixed state, involving extensive deliberation, negotiation and joint learning within problem-solving networks'* (Armitage et al. 2009, Carlsson and Berkes 2005).

Open data are key to the achievement of these goals. There is an enormous amount of knowledge available from a lot of different sources: the practices of indigenous communities, new technologies developed by research institutions, tacit knowledge, knowledge transferred between generations, policy implementation, the use of products by consumers. Access to these data can help us understand all aspects of food production: soil conditions, land use, the dynamics of the value chain and to identify gaps in data. It has been claimed that open data sharing/hybrid solutions, including crowdsourcing, can create comprehensive, accurate and cost-efficient knowledge bases to support food security (See et al. 2015).

CAPSELLA's impact

(i) Innovation

Multi- or transdisciplinary teams are an essential driver for innovation. This is ensured in the CAPSELLA project through the active involvement and the continuous interaction of several communities and networks working in agriculture, agrobiodiversity, agri-food data innovation, food quality, ICT, hackathons, startups and incubation/business support. Their continuous interaction during the project duration will ensure:

● Innovative research impact through the integration and sharing of the best scientific and practical knowledge regarding agrobiodiversity, its applications across the food chain (in informal seed systems, agroecological field management and food quality), and its contribution to sustainability.

● The expression and prioritisation of the innovation issues that communities and networks consider most important regarding (i) agrobiodiversity knowledge, (ii) ICT tools that could foster knowledge sharing, strengthen interactions between various actors within and between communities and channel their message to a wider audience (farmers and their organizations, scientists, agricultural extension services, NGOs, EU, national and regional policy makers, etc.) in a European context hence demonstrating the capability to reach a critical mass and to transpose the proposed approach to other application areas related to sustainability.

The expected impact above will be further enhanced through the CAPSELLA events, which will allow the project to link with other networks and communities, and also through the opportunity provided by the developed pilots tested also by other communities.

The core networks represented in CAPSELLA but also the extended network of interactions and events between the actors will ensure the effective involvement of citizens and relevant (and new) actors as well as the establishment of durable interdisciplinary collaborations in concrete application areas related to sustainability.

Having by design a community-driven approach (engagement of communities and networks in building up scenarios and testing the pilots) and a bottom-up methodology for collecting requirements and working on solutions (hackathons, appathons, collective online platforms), CAPSELLA will be able to propose new bottom-up, open and distributed approaches exploiting network effects.

Last but not least, an important asset of the CAPSELLA partners and collaborators is their willingness to participate in open data innovation activities. In fact, several of them are heavily

interested in new models of participatory innovation based on open software, open data and open hardware, already having experience in the field. The building of open data catalogues from scratch, based on the networks and communities data, and the cloud based platform that will support the development and use of Internet of Things (IoT) applications in the fields, will contribute a great deal to further exploit participatory innovation models.

(ii) Scientific advancement

CAPSELLA will significantly contribute to opening up the potential of (a) agrobiodiversity at all levels (genetic, species, habitat and management) and (b) related open data to improve sustainability in the agri-food system. The best knowledge and success stories available from science and practice will be collected from within and outside the expertise of networks and communities, digested in the participatory activities set forth in the scenarios, classified and made available for use by the widest possible range of actors in the European arena through improved ICT solutions and enhanced data open data sets. The ultimate aim of these will be the evidence based understanding of the techno-social issues related to key aspects of the networked society. Results will encompass:

- Bottom-up identification of knowledge gaps and their prioritization in further research activities at national and EU level, with special emphasis on multidisciplinary issues.

- Archiving of the best solutions using agrobiodiversity at field, farm and landscape scale, clearly showing their effects on the provision of (agro)ecosystem services and their relevance to the sustainability of agri-food systems.

- Awareness raising of citizens on key issues related to the relationships between agrobiodiversity, food quality and (agro)environmental sustainability.

As such, CAPSELLA may have a significant impact in shaping ongoing and future EU agricultural and research policies, contributing to all policy and research planning initiatives, as well as further promoting the discussion of sustainability and agriculture.

All the above will be further enhanced by the open data policy adopted for developing and enhancing all CAPSELLA datasets, and the open access policy to all material and publications, including data collected in field trials organized by the pilots, taking due consideration for data privacy and ethics.

(iii) Society

CAPSELLA will foster the awareness of agrobiodiversity and its importance for (agri)environmental sustainability through bottom-up participatory action supported by targeted, on-demand novel ICT tools and solutions. Through participatory work in scenarios and pilot trials, CAPSELLA will demonstrate how collaborative approaches using the Internet can offer solutions to societal and sustainability challenges, specifically by making use of the commons, collective problem solving, knowledge sharing, social exchange and community-wide participation at local and global scale. The CAPSELLA data platform is another example of the collaborative approach and knowledge sharing within the project, as it will integrate data from different communities and networks, and including already available registries like CIARD-RING, and will offer them enhanced back through the use of standards, thus enabling a larger degree of knowledge/data sharing and community participation.

Collective awareness on the importance of agrobiodiversity for sustainability generated in CAPSELLA through the use cases and pilots, the numerous events and online activities, will ensure scalability, re-usability of results and general applicability of proposed solutions at local or

regional level, through the engagement of multiple actors, including regional, national, EU and international networks and policy makers.

Bottom-up priorities and solutions emerging from CAPSELLA will be further voiced to policy bodies in order to support active citizen participation in decision making and collective governance. Incubation activities will lead to the co-creation of new business ideas and opportunities in agriculture and other domains, producing also new business and economic models and thus ensuring their long-term viability.

CAPSELLA will increase cooperation among citizens, researchers, public authorities, private companies, non-profit, non-governmental and any other civil society organizations around agrobiodiversity and sustainability issues. Improved ICT solutions designed in the scenarios and tested in the pilots and validated by the CAPSELLA communities and networks will foster the development of new sustainable and collaborative consumption patterns and new lifestyles, the creation of innovative products and services and information delivery.

We are aware of the challenges that they will face throughout the 30 months of the CAPSELLA lifespan. Nevertheless, we do believe that there is momentum in the EU to take up these challenges and to contribute to shaping a biodiversity-based agriculture through new avenues given by co-constructed novel ICT solutions.

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