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Report on critical agrobiodiversity data needed to support agricultural sustainability

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Executive summary

Starting from the definition of sustainability in agriculture, we list the foundation concepts that set the philosophical framework of CAPSELLA. A series of gaps in data organization, management and accessibility that hinder the application of key measures towards sustainability are presented. CAPSELLA will support the engaged communities to overcome part of these lock-in situations with tailored ICT solutions.

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List of Acronyms

CBD: Convention on Biological Diversity

CSA: Community Supported Agriculture

FAO: Food and Agriculture organization of the United Nations

ICT: Information and Communication Technology

IPM: Integrated Pest Management

IPR : Intellectual Property Rights

ITPGRFA : International Treaty on Plant Genetic Resources for Food and Agriculture

IWM: Integrated weed management

PDO: Protected Designation of Origin

PGI: Protected Geo-graphical Indication

WP: work package

1. Introduction

Since the end of World War II, European agriculture has changed dramatically. Productivity increased due to new technologies, mechanization, chemical use, improved varieties and policies aimed to maximize yields ('Green Revolution').

The concept of sustainability was applied to the agricultural sector since the 1980s, as a response to the degradation of the environment associated with modern agriculture. Afterwards, the question of agricultural sustainability was expanded to the social, cultural, political and economic dimensions together with the original environmental aspect. The complexity of each single aspect makes it difficult to provide a single, generally accepted, definition of **agricultural sustainability**. Still, the concept of sustainability, although controversial due to existing conflicting definitions and interpretations, is useful because it captures a set of concerns about agriculture.

Often, sustainable development refers to satisfying present needs without reducing the possibility of future generations to satisfy theirs. However, in the view that CAPSELLA is engaged with, sustainable development further requires that resources should be used at a rate that allows their renewal and wastes should be produced at a rate which allows the environment to absorb them.

In order to decline this concept in the actual agricultural practice, we can identify three major challenges to agricultural sustainability: (a) climate change, (b) energy availability, and (c) global economic insecurity.

The most common manifestation of climate change is the intensification of extreme climate events such as floods, droughts, and heat/cold waves that are jeopardizing agriculture in many areas around the world. Agricultural science and practice are asked to provide solutions to both mitigate the effects of climate change and increase adaptation of cropping/farming systems. Fossil fuels are becoming short in supply and increasingly inaccessible, with resulting increased prices. Consequently, it seems wiser to reduce external energy use and increase energy efficiency in agriculture. Like extreme climate events, price fluctuation of agricultural food commodities (e.g., wheat, corn, or rice) has been intensifying in the latest decade. Farmers producing for the global market are particularly vulnerable, because they are facing increasingly unpredictable market trends whilst cost of agricultural inputs is rising following the rise in oil price and/or market structure.

Agroecology provides the framework to assess the complexity of agroecosystems and exploit their properties to address sustainability challenges. The idea of agroecology is to go beyond the use of alternative practices and to develop agroecosystems with the minimal dependence on agrochemical and energy inputs, emphasizing complex agricultural systems in which ecological interactions and synergisms between biological components provide the mechanisms for the systems to support their own soil fertility, productivity and crop protection. The understanding of the ecology of agricultural systems is a key tool for developing new management options tuned with the objectives of a truly sustainable agriculture. In this context, the conservation and use of **agrobiodiversity** at genetic, species and ecosystem level is a fundamental for reducing the external inputs needed in food production.

In our opinion, European farmers and the civil society, if sufficiently empowered, can strongly influence the application of such strategies directed to address the sustainability challenges of our times.

CAPSELLA aims to supply European farmers in their work and citizens - in their daily life as food consumers - with ICT services capable of boosting the application of sustainable measures derived from agroecology and agrobiodiversity.

2. List of concepts used as indicators of biodiversity based agriculture for CAPSELLA objectives' implementation

Table 1 gathers the core concepts around which CAPSELLA grounds its work with the engaged communities in the scenarios (WP3), develops the services to address specific knowledge/data gaps (WP4) and collects open data in the platform (WP5). These concepts represent the indicators of the agronomy theory on which CAPSELLA's scenarios are based and of the theoretical background for the definition of sustainability on which the awareness-raising objective is pursued.

Some of the definitions are the foundation of the conceptual framework and do not have any indication of available datasets. Other terms will be useful in the development of the demonstrators and carry associated information about available datasets from which to extract information or guidelines for the development of the tools.

Table 1 Key concept used as indicators of biodiversity based agriculture for CAPSELLA objectives' implementation*

TERM**	DESCRIPTION	SOURCE/REFERENCE	DATA SETS and/or knowledge repositories	CAPSELLA SCENARIO
Access and benefit sharing	According to either the Convention on Biological Diversity and/or the International Treaty on Plant Genetic Resources for Food and Agriculture, those interested in a genetic resource for research must respect access rules and be prepared to share the benefits arising from any commercial product developed from the resource itself, with the provider (country and/or farming community).	Rete Semi Rurali	NA	Seed
Adaptation	In biology, process by which an animal or plant species becomes fitted to its environment; it is the result of natural selection's acting upon heritable variation. Even the simpler organisms must be adapted in a great variety of ways: in their structure, physiology, and genetics, in their locomotion or dispersal, in their means of defence and attack, in their reproduction and development, and in other respects.	https://www.britannica.com/science/adaptation-biology-and-physiology	NA	Seed
Agricultural knowledge systems	Agricultural Knowledge Systems (AKS) is a term used to define a set of public and private organisations dedicated to research, education and extension, and includes their interaction with knowledge users (generally farmers). The organisation of AKS is the basis of a paradigm shift in agricultural production models.	Rete Semi Rurali	NA	Seed, Field, Food
Agrobiodiversity	The variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-	http://www.fao.org/docrep/007/y5609e/y5609e01.htm	European Learning Network for Functional Agro-Biodiversity: http://www.eln-fab.eu/ Organic eduNet: http://www.organic-edunet.eu/en	Seed, Field, Food

	ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems.			
Agroecology (1)	The integrative study of the ecology of the entire food systems, encompassing ecological, economic and social dimensions.	http://www.tandfonline.com/doi/abs/10.1300/J064v22n03_10	Videos, courses, info: http://www.osez-agroecologie.org/index.php	Seed, Field, Food
Agroecology (2)	The science of applying ecological concepts and principles to the design and management of sustainable food systems.	https://www.crcpress.com/Agroecology-The-Ecology-of-Sustainable-Food-Systems-Second-Edition/Gliessman/p/book/9781498715577	NA	Seed, Field, Food
Agroecology (3)	The study of the interactions between plants, animals, humans and the environment within agricultural systems; ... integrative studies within agronomy, ecology, sociology and economics.	http://www.sciencedirect.com/science/article/pii/S016788090300152X	NA	Seed, Field, Food
Agroecosystem	An agricultural system understood as an ecosystem.	http://www.agroecology.org/glossary.html	NA	Seed, Field, Food
Agroecosystem service	Ecosystem services are defined as “the benefits provided by ecosystems to humans”. Many key ecosystem services provided by biodiversity, such as nutrient cycling, carbon sequestration, pest regulation and pollination, sustain agricultural productivity. Promoting the healthy functioning of ecosystems ensures the resilience of agriculture as it intensifies to meet growing demands for food production. Climate change and other stresses have the potential to make major impacts on key functions, such as pollination and pest regulation services. Learning to	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/biodiversity/en/	NA	Seed, Field, Food

	strengthen the ecosystem linkages that promote resilience and to mitigate the forces that impede the ability of agro-ecosystems to deliver goods and services remains an important challenge.			
Agro-environmental indicator	Generic term designating a range of indicators aiming at giving synthesised information on complex interactions between agriculture and environment. Common agri-environmental indicators are those that provide an assessment of impacts of agriculture on water quality, climate change, soil or landscape structures.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	Indicators from Eurostat: http://ec.europa.eu/eurostat/web/agri-environmental-indicators/indicators-overview	Seed, Field, Food
Agroforestry	Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. Agroforestry systems are multifunctional systems that can provide a wide range of economic, socio-cultural, and environmental benefits.	http://www.fao.org/forestry/agroforestry/80338/en/	NA	Field
Beneficial insects	Beneficial insects are predators, parasites, or competitors of insect pests, helping to regulate pest populations without harm to crops.	http://www.agroecology.org/glossary.html	For pollinators: http://www.atlashymenoptera.net/	Field

Bio-cultural diversity	Bio-cultural diversity is the interweave of humankind and nature, cultural pluralism and ecological integrity. It arises from the continuing co-evolution and adaptation between natural landscapes and ways of life, and between biological processes and cultural endeavours.	https://www.christensen-fund.org/about/key-concepts/	NA	Seed, Field, Food
Biodiversity	Biodiversity is the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend. This diversity is often understood in terms of the wide variety of plants, animals and microorganisms.	https://www.cbd.int/2010/biodiversity/	NA	Seed, Field, Food
Common Agricultural Policy (CAP)	Since its creation in 1962 the CAP has played a key role in the EU's development. The progressive implementation of Common Market Organisations, which cover the overwhelming bulk of the EU's agricultural production has been accompanied by structural policies which reflect the various facets of the CAP including the important social role of agriculture in the European Union, its regional and national diversity and the need to take account of consumer and environmental concerns. The reform of the CAP in 1992 and subsequently has shifted somewhat the previous dominance of market measures towards the provision of a greater role for rural development. The new focus is on meeting the challenges posed by the depopulation, abandonment of many rural areas and environmental impacts.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	NA	Seed, Field, Food
Climate	Conditions of the atmosphere at a particular location over a long period of time; it is the long-term summation of the atmospheric elements (and their variations) that, over short time periods, constitute weather. These elements are solar radiation, temperature, humidity, precipitation (type, frequency, and amount), atmospheric pressure, and wind (speed and direction).	https://www.britannica.com/science/climate-meteorology	NA	Seed, Field

Community seed bank	Community seed banks are places of storage where local varieties are conserved and managed by community members. These conservation sites are intermediate between institutional <i>ex situ</i> and on-farm (<i>in situ</i>) conservation strategies, providing farmers with free and easy access to traditional seeds under the condition that a farmer returns twice the amount of seeds he or she borrowed (if possible depending on harvest) and as much information as possible on the performance of the seeds. They not only reduce farmers' dependence on seed companies but also help conserve the agro-biodiversity of local territories.	Rete Semi Rurali	NA	Seed
Community Supported Agriculture (CSA)	CSA is a partnership between farmers and consumers in which the responsibilities, risks and rewards of farming are shared. The approach can vary. Consumers, often described as CSA members, are closely linked to the farm and the production of their food, and provide support that goes beyond a straight forward marketplace exchange of money for goods. This involvement may be through ownership or investment in the farm or business, sharing the costs of production, accepting a share in the harvest or providing labour.	http://www.communitysupportedagriculture.org.uk/	NA	Food
Competition	In ecology, utilization of the same resources by organisms of the same or of different species living together in a community, when the resources are not sufficient to fill the needs of all the organisms.	https://www.britannica.com/topic/competition-biotic-interaction	NA	Field
Conservation variety	Definition created in 1998 by the European Union to regulate local varieties or modern varieties no longer included in the national register, cultivated in traditional farming systems and threatened by genetic erosion. In 2008, Directive 62 was published which defines methods and terms for the commercialization of these varieties for agricultural species and potatoes; in 2009 Directive 145 on the	Rete Semi Rurali	NA	Seed

	same varieties for vegetables (amateur varieties); in 2010, Directive 60 was introduced to regulate the marketing of seed mixtures of fodder for the preservation the natural environment.			
Convention on Biological Diversity (CBD)	CBD is a global agreement addressing all aspects of biological diversity: genetic resources, species, and ecosystems. It stems from the Rio de Janeiro global meeting in 1992. Its objectives are conservation, sustainable use and equitable sharing of the benefits arising from such use.	www.cbd.int	NA	Seed, Field, Food
Cover crop	A cover crop is a crop planted primarily to provide agroecosystem services like management of soil erosion, soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agroecosystem.	http://www.tandfonline.com/doi/abs/10.1081/FRI-100100285	http://web3.wzw.tum.de/oscar/toolbox/dabase/index.html Licence: © 2014 The OSCAR Project. All rights reserved	Field
Crop rotation	The successive cultivation of different crops in a specified order on the same fields, in contrast to a one-crop system or to haphazard crop successions.	https://www.britannica.com/topic/crop-rotation	http://www2.warwick.ac.uk/fac/sci/lifesci/wcc/research/nutrition/eurotaten/	Field
Crop wild relative	Wild and spontaneous species, genetically similar to a cultivated crop from which the latter is derived through natural and human selection. Crops and their wild relatives are often interfertile.	Rete Semi Rurali	NA	Seed
Crop-associated biodiversity	Crop-associated biodiversity (sometimes simply 'associated biodiversity') is the sum of non-crop living organisms found in agroecosystems. This includes the range of organisms above and below ground that can harm or help agriculture, such as pests, diseases, and weeds; pollinators and biological control organisms;	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/biodiversity/cab/en/	NA	Seed, Field

	and the many organisms controlling nutrient cycling. Hence, crop and crop-associated biodiversity is an intrinsic and important part of agricultural ecosystems, which can be planned or unplanned.			
Cultural landscape	The term 'cultural landscape' is the subject of much debate in science and business practice. It becomes obvious in such debate that different notions exist beyond the generally accepted fundamental consensus that 'cultural landscape' is a landscape that has been changed by humans. By 'culture', in contrast to 'nature', we generally understand the shaping effect of humans and, consequently, 'cultural landscape' is referred to in order to distinguish it from the term 'natural landscape'. Since humans have left their mark on nature almost everywhere in Central Europe, this differentiation has more of a rhetorical meaning (Schenk 2002). Even the frequently used term 'landscape' usually refers to 'cultural landscape' in the Central European context. The way in which humans perceive the space around them and how they develop certain concepts of it, 'appropriating' it, has a considerable impact on the respective purport of the term 'landscape' (Anders 2006). Ecological aspects relating to the natural area and different social meanings are therefore combined in the concept of 'cultural landscape'.	http://openlandscapes.zalf.de/open-LandscapesWIKI_Glossaries/Cultural%20Landscape_(Landscape%20Science).aspx	NA	Seed, Field, Food
Disturbance	Ecological disturbance, an event or force, of non biological or biological origin, that brings about mortality to organisms and changes in their spatial patterning in the ecosystems they inhabit. Disturbance plays a significant role in shaping the structure of individual populations and the character of whole ecosystems.	https://www.britannica.com/science/ecological-disturbance	NA	Seed, Field
Diversity	Various different objects. Conversely to heterogeneity, it does not consider relations between them. Diversity relies on two components: richness and evenness.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	NA	Seed, Field, Food

Ecosystem	In Ecology, ecosystem, 'means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'.	Original text of Convention on Biological Diversity, 5 June 1992 http://openland-scapes.zalf.de/Lists/GlossarDefinitions/ViewDef.aspx?name=Ecosystem (Environmental%20science)&WikiID=393&abfrage=Ecosystem (Environmental%20science)	NA	Seed, Field, Food
Ecosystem biodiversity	The OECD definition of ecosystem diversity embraces three components: (a) the diversity in farming systems and cultural practices and their change in time and space, (b) the ratio between land utilized for agriculture and for other uses (e.g., natural or urban areas), and (c) the interactions between agroecosystems and nearby ecosystems. It must be noticed that this definition extends well beyond biodiversity per se, including elements of agroecosystem structure and management. This is very much in line with a functional approach to agrobiodiversity, as envisaged in agroecology.	https://books.google.it/books?hl=en&lr=&id=ONYZm_J0gr8C&oi=fnd&pg=PA3&dq=functional+agrobiodiversity+definition&ots=hy1tzKrlpC&sig=W7kf9q7ibXqvncQUbudC8cdfUFw#v=onepage&q=functional%20agrobiodiversity%20definition&f=false	Data set with ecosystem types in Europe: http://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe Licence: http://www.eea.europa.eu/legal/copyright	Field
Ecotype	Group of individuals within a species, genetically adapted to a particular environment (usually geographically limited).	Rete Semi Rurali	NA	Seed, Field, Food
Emergent property	A characteristic of a system that derives from the interaction of its parts and is not observable or inherent in the parts considered separately.	http://www.agroecology.org/glossary.html	NA	Seed, Field, Food
Evolutionary population	Mixture of hybrids from natural or artificial crosses between many different varieties of the same crop, released into farmers' fields in early stages (F1 generation) to allow and speed up adaptation through the augmented diversity they contain,	Rete Semi Rurali	NA	Seed

	thanks to natural and farmer selection which leads to new varieties or subpopulations.			
Evolutionary processes	Populations evolve over time and space through four evolutionary processes: 1) selection by natural factors (climate, biotic pressures, etc.) and farmers' practices; 2) genetic drift due to sampling of gametes and seeds to constitute the next generation; 3) genetic or epigenetic mutation; 4) migration.	Rete Semi Rurali (EU-RTD FP7 SOLIBAM project, www.solibam.eu)	NA	Seed
<i>Ex situ</i> conservation	The conservation of components of biological diversity outside their natural habitats.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Farmers' privilege/farmer-saved seed	Rights to hold germplasm, covered by plant variety protection, as a seed source for subsequent seasons. Considered as optional for governments to include in their legislation. Synonym: farmer-saved seed.	Fao Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Farmers' rights	Rights first recognized by Resolution 5 of the 1989 FAO Conference as 'rights arising from the past, present and future contributions of farmers in the conservation, improvement and the making available of plant genetic resources'; this item became an attachment to the 'International Undertaking on Plant Genetic Resources'. The binding 'International Treaty of Plant Genetic Resources for Food and Agriculture' that resulted from the renegotiations of the Undertaking makes provision for the Farmers' Rights in Article 9.	ITPGRFA, www.planttreaty.org	NA	Seed, Field, Food
Food culture	The practices, attitudes, and beliefs as well as the networks and institutions surrounding the production, distribution, and consumption of food.	https://www.lexiconoffood.com/definition/definition-food-culture	NA	Food

Food innovation	Traditional concept: new or improved products, services, processes, or improved organisational or marketing strategies. Novel concept: the ability of individuals, companies and entire nations to continuously create their desired future (Innovation Nation, 2007).	http://ec.europa.eu/research/bioeconomy/pdf/greek-food-conference/13-be-ate-kettlitz_en.pdf	NA	Food
Food miles	Food miles are a way of attempting to measure how far food has travelled before it reaches the consumer. It is a way of looking at the environmental impact of foods and their ingredients. It includes getting foods to the consumer, but also getting waste foods away and to the landfill. The effects of food miles can be measured in the pollution that is caused. It includes the distance travelled and how that distance was covered (e.g. plane, boat, road).	http://www.foodmiles.com/	NA	Food
Food ways	The study of what, how, and why we eat with emphasis on food events as much as the food itself. The study of food ways is important to cultural studies, and encompasses issues of race, class, gender, economy, environment, geography, and history, among others.	https://www.lexiconoffood.com/food-action/foodways	NA	Food
Formal seed system	The formal seed production schemes use organized channels under the supervision and quality control system provided by public or private institutions, in accordance with special rules and regulations. This system is able to meet the demands of modern agriculture and complies with the seed industry's requirements. The formal seed system is market-oriented and characterized by a continuous varietal replacement as a mechanism of technology transfer and as a market strategy. Seeds of most cash and horticultural crops, particularly hybrids, are supplied by the formal seed system. More recently, since agrochemical multinationals have started to dominate the seed market, the formal seed system has been undergoing a tremendous transformation with the advent of transgenic seeds.	http://www.fao.org/3/a-y5706e.pdf	NA	Seed

<p>Fragmentation (of landscape)</p>	<p>Refers to the division of geographical space into numerous land cover patches. High density of linear features (e.g. infrastructures) can cause landscape to be fragmented.</p>	<p>http://ec.europa.eu/agriculture/publi/landscape/gloss.htm</p>	<p>http://ec.europa.eu/eurostat/cache/metadata/en/t2020_rn110_esmip.htm</p> <p>Licence: http://ec.europa.eu/eurostat/statistics-explained/index.php/Copyright/licence_policy</p>	<p>Field</p>
<p>Functional biodiversity</p>	<p>That part of the total biodiversity composed of clusters of elements (at the gene, species or habitat level) providing the same (agro)ecosystem service, that is driven by within-cluster diversity.</p>	<p>http://www.sciencedirect.com/science/article/pii/S0167880908000674</p>	<p>Info about plant traits at: BiolFlor http://onlinelibrary.wiley.com/doi/10.1111/j.1366-9516.2004.00106.x/full</p> <p>Licence/Copyright: http://www2.ufz.de/biolfior/info/impressum.jsp</p> <p>LEDA Traitbase http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2745.2008.01430.x/abstract</p> <p>ECOFLORA http://www.ecoflora.co.uk/</p> <p>Ellenberg values for the Italian Flora, Flowering periods for the Italian Flora (Pignatti, Menegoni & Pietrosanti (2005),</p>	<p>Seed, Field</p>

			<p>data retrieved from http://luirig.al-tervista.org/</p> <p>Mycorrhizal intensity data base</p> <p>http://onlinelibrary.wiley.com/doi/10.1890/11-1749.1/full</p> <p>MycoFlor1</p> <p>http://www.esapubs.org/archive/ecol/E094/123/</p> <p>Copyright: http://www.esapubs.org/archive/copyright.htm</p> <p>You can retrieve data via R/TR8</p> <p>https://github.com/GioBo/TR8</p>	
Gene (resources) conservation	The conservation of species, populations, individuals or parts of individuals, by <i>in situ</i> or <i>ex situ</i> methods, to provide a diversity of genetic materials for present and future generations.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Genebank	Institution in which collections of species and varieties are stored in the form of seeds or less frequently tubers or <i>in vitro</i> samples. The seeds - suitably treated - are maintained under controlled conditions (under vacuum , at very low temperatures). Periodically, the collections are regenerated: the seed is reseeded to get a new production which will be replaced with the present reserves in the freezer.	Rete Semi Rurali	NA	Seed
Genetic agrobiodiversity	Genetic agrobiodiversity refers to any variation in the nucleotides, genes, chromosomes, or whole genomes of organisms, i.e., it deals with within-species diversity. In the OECD definition, genetic agrobiodiversity includes variation within species of crops, livestock, and their wild relatives. Conservation and use of locally	https://books.google.it/books?hl=en&lr=&id=ONYZm_J0gr8C&oi=fnd&pg=PA3&dq=functional+agrobiodiversity+definition&ots=hy1tzKrlpC&sig=W7kf9q7ibXq	Ex situ plant collections maintained in Europe: http://eurisco.ipk-gatersleben.de/apex/f?p=103:1:.....	Seed

adapted cultivars of major crops, of neglected and underutilized crop species, and of livestock breeds has a value in itself because it contributes to save overall biodiversity. However, its main value is that a wider genetic pool in crops and livestock ensures adaptation to a changing environment and provides useful traits to be used in genetic breeding programmes.

[vncQUbudC8cdfUFw#v=onepage&q=functional%20agrobiodiversity%20definition&f=false](https://www.capsella.eu/vncQUbudC8cdfUFw#v=onepage&q=functional%20agrobiodiversity%20definition&f=false)

Central Crop Databases:
<http://www.ecpgr.cgiar.org/resources/germplasm-databases/ecpgr-central-crop-databases/>

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SeedStor:

<https://www.seedstor.ac.uk/search-panel.php>

Germplasm Collecting Missions Database:

<http://bioversity.github.io/geosite/>

International multicrop databases:

<http://www.ecpgr.cgiar.org/resources/germplasm-databases/international-multicrop-databases/>

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Registered plant varieties in EU:

http://ec.europa.eu/food/plant/plant_propagation_material/plant_variety_catalogues_databases/search/public/index.cfm

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			<p>National multicrop databases : http://www.ecpgr.cgiar.org/re-sources/germplasm-databases/national-multicrop-databases/ Licence: https://creativecommons.org/licenses/by-nc-nd/3.0/</p> <p>European genebank integrated system: http://www.ecpgr.cgiar.org/aegis/european-collection/ Licence: https://creativecommons.org/licenses/by-nc-nd/3.0/</p>	
Genetic diversity	The heritable variation within and among populations which is created, enhanced or maintained by evolutionary or selective forces.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed, Field, Food
Genetic equilibrium	When in the course of successive generations, in the presence of random intersec-tions, a population is kept constant in its allelic frequencies.	Rete Semi Rurali	NA	Seed
Genetic erosion	Loss of genetic variability within an ecosystem (species loss), a species (loss of breeds and varieties), a population (loss of alleles). Often for crop species it is a consequence of the emergence of a few varieties obtained by methods of genetic improvement and the consequent abandonment of local varieties/landraces.	Rete Semi Rurali	NA	Seed
Genotype	Genetic constitution of an individual as it results from all of its genes. The interac-tion between genotype and environment gives the phenotype .	Rete Semi Rurali	NA	Seed

Geographical indication	A geographical indication (GI) is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin. In order to function as a GI, a sign must identify a product as originating in a given place. In addition, the qualities, characteristics or reputation of the product should be essentially due to the place of origin. Since the qualities depend on the geographical place of production, there is a clear link between the product and its original place of production.	http://www.wipo.int/geo_indications/en/	NA	Food
Habitat	The particular environment, characterized by a specific set of environmental conditions, in which a given species occurs.	http://www.agroecology.org/glossary.html	Classification of habitats in Europe: http://www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification Licence: https://creativecommons.org/licenses/by/2.5/dk/deed.en_GB	Field
Heterogeneity	Diverse character of a designated group of different objects.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	NA	Seed, Field, Food
Hybrid seed	In plant breeding, used colloquially for seed produced by specific crosses of selected pure lines, such that the F1 crop is genetically uniform and displays hybrid vigour. As the F1 plants are heterozygous with respect to many genes, the crop does not breed true and so new seed must be purchased each season.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Industrial food	Any food that has been modified and processed to make it a better product, but not a better food.	https://plus.google.com/+SpartandietOrg/posts/1ZwohiKuY19	NA	Food
Informal seed system	Informal, or on-farm seed systems, varying among countries, regions and crops. They rely on seed-saving practices, that is, keeping part of the harvest for planting	http://www.fao.org/3/a-y5706e.pdf	NA	Seed

	in the next season. The system usually plants local varieties of seed kept from the previous year's harvest or obtained from neighbours and/or the local market. This is the predominant system for food crops in subsistence agriculture or for organic, non-conventional agriculture in both developing and developed countries			
<i>In situ/on-farm conservation</i>	The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings. In the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties (on-farm).	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Integrated Pest Management (IPM)	IPM is a sustainable approach to managing pests by combining biological, cultural and chemical tools in a way that minimises economic, environmental and health risks.	http://www.endure-net-work.eu/about_ipm/endure_s_definition_of_ipm	Side effects database: http://www.ipmimpact.com/pages/side_effects Terms of use: http://www.ipmimpact.com/pages/terms_of_use	Field
Integrated Weed Management (IWM)	An IWM approach to land management combines the use of complementary weed control methods such as grazing, herbicide application, land fallowing, and biological control. The resulting combinations provide the best possible solutions to weed problems for land managers. By studying the impact of each of the above methods individually as well as in combination, sustainable management systems can be devised to suit different regions and catchment areas.	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/integrated-weed-management/iwm-what/en/	NA	Field
Intellectual Property Rights (IPR)	IPR on seeds and plant varieties can be of different forms in different countries, depending on national legislation (plant breeders' rights, patents). All impose some limitation on the use that can be made of seed.	Rete Semi Rurali	NA	Seed

Intercropping	Intercropping is the practice of growing different crops simultaneously in the same field. The different crops cultivated are chosen to be complementary for their use of resources. This type of cultivation provides advantages for soil structure, productivity, quality and associated biodiversity. Different types of intercropping exist depending on the cropping objectives.	Rete Semi Rurali (EU-RTD FP7 SOLIBAM Project, www.solibam.eu)	NA	Field
International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)	The ITPGRFA facilitates the exchange of seeds and other building blocks of the genetic diversity of the world's food crops, stimulating research that is essential in the development of climate-smart agriculture, and, therefore, also to food security. In a world where most countries depend strongly upon crops originating elsewhere, the Treaty facilitates the exchange and conservation of crop genetic resources amongst member nations, as well as the fair sharing of benefits arising from their use.	ITPGRFA, www.planttreaty.org	NA	Seed, Field, Food
Land cover	Land cover corresponds to a (bio)physical description of the earth's surface. It is that which overlays or currently covers the ground. This description enables various biophysical categories to be distinguished - basically, areas of vegetation (trees, bushes, fields, lawns), bare soil, hard surfaces (rocks, buildings) and wet areas and bodies of water (watercourses, wetlands).	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	NA	Field
Land use	Land use corresponds to the socio-economic description (functional dimension) of areas: areas used for residential, industrial or commercial purposes, for farming or forestry, for recreational or conservation purposes, etc. Links with land cover are possible; it may be possible to infer land use from land cover and conversely. But situations are often complicated and the link is not so evident. Contrary to land cover, land use is difficult to 'observe'. For example, it is often difficult to decide if grasslands are used or not for agricultural purposes. Distinctions between land use and land cover and their definition have impacts on the development of classification systems, data collection and information systems in general.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	Land quality in south Europe: http://www.eea.europa.eu/data-and-maps/data/land-quality-southern-europe Licence: https://creativecommons.org/licenses/by/2.5/dk/deed.en_GB	Field

Landrace	A dynamic population of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems.	Camacho Villa et al. 2005	NA	Seed
Landscape	Complex concept encompassing several definitions. The one adopted here is considering landscape as an area containing a mosaic of land cover patches. Third dimension of space and its effect on visual perception are not taken into account. Only the spatial configuration is considered which however influences landscape physiognomy.	http://ec.europa.eu/agriculture/publi/landscape/gloss.htm	NA	Field
Multiple cropping	The cultivation of two or more crops in succession or with some overlap in the same field within one year. Double cropping of rice after wheat is an example. When crops overlap in time, multiple cropping is a form of polyculture.	http://www.agroecology.org/glossary.html	NA	Field
Non chemical weed control	Control of weeds with tools other than herbicides.	NA	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4480327/ Copyright: https://www.ncbi.nlm.nih.gov/pmc/about/copyright/	Field
Organic agriculture	Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.	http://www.ifoam.bio/en/organic-landmarks/definition-organic-agriculture	Organic farming statistics: http://ec.europa.eu/eurostat/statistics-explained/index.php/Organic_farming_statistics Copyright: http://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics_Explained:General_disclaimer	Seed, Field, Food

			<p>Organic farming statistics http://www.organic-europe.net/europe-statistics/statistics-eurostat.html Copiright: Research Institute of Organic Agriculture (FiBL). All rights reserved.</p>	
Organoleptic quality	Organoleptic means 'which affects sensory organs'. Organoleptic quality typically includes the sensory properties food (taste, appearance, etc.) but also takes into account sensations induced by food in the mouth or any other sensations linked to the consumption of the food.	Rete Semi Rurali (Solibam)	NA	Food
Participatory research	Participatory research in the agricultural context brings together several actors sharing a common vision of concepts, methods and means for designing and developing new food systems, based on the strong interrelationships between multidisciplinary scientific knowledge and the know-how of practitioners. Research actions are performed jointly from conception through to dissemination.	Rete Semi Rurali (Solibam)	NA	Seed, Field, Food
Phenotype	The visible expression of the individual's genotype. It depends on the interaction between genotype and the environment.	Rete Semi Rurali	NA	Seed
Planned agrobiodiversity	Planned agrobiodiversity includes crops and livestock purposefully introduced and maintained in an agro-ecosystem.	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/biodiversity/cab/en/	NA	Seed, Field
Plant breeding	The process of sexual reproduction and production of offspring. Farmers and researchers can direct breeding by choosing parents, performing controlled crosses and selecting only the best offspring from one generation to the next, obtaining plants better responding to their needs and preferences. Plant breeding acts as	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed

	bridge between the conservation in genebanks and the seed systems that deliver improved varieties to farmers.			
Plant genetic resources	Genetic material of actual or potential value.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed, Field
Polyculture	Polyculture is agriculture using multiple crops in the same space, providing crop diversity in imitation of the diversity of natural ecosystems, and avoiding large stands of single crops, or monoculture.	https://en.wikipedia.org/wiki/Polyculture	NA	Field
Protected Designation of Origin (PDO)	In the EU regulation, the PDO is the name of an area, a specific place or, in exceptional cases, the name of a country, used as a designation for an agricultural product or a foodstuff, which comes from such an area, place or country, whose quality or properties are significantly or exclusively determined by the geographical environment, including natural and human factors, whose production, processing and preparation takes place within the determined geographical area. In other words, to receive the PDO status, the entire product must be traditionally and entirely manufactured (prepared, processed and produced) within the specific region and thus acquire unique properties.	https://en.wikipedia.org/wiki/Geographical_indications_and_traditional_specialities_in_the_European_Union#Protected_designation_of_origin_.28PDO.29	NA	Food
Protected Geographical Indication (PGI)	PGI covers agricultural products and foodstuffs closely linked to the geographical area. At least one of the stages of production, processing or preparation takes place in the area.	http://ec.europa.eu/agriculture/quality/schemes/index_en.htm	NA	Food
Pure line	Set of individuals obtained by self-fertilization by a homozygous parent.	Rete Semi Rurali	NA	Seed
Resilience	Capacity of an (agro)ecosystem to respond to a perturbation by resisting damage and recovering quickly. A resilient system will reorganize while undergoing change	Rete Semi Rurali (Solibam)	NA	Seed, Field

	so as to still retain essentially the same function, structure, identity and feedbacks. Thus resilience is linked to the adaptive capacity of a system in the face of change.			
Robustness	Robustness is defined as the ability to maintain performance in the face of perturbations and uncertainty. Robust plants will thus have high levels of resistance and tolerance to pests and diseases, high competitiveness with weeds, improved crop establishment under increasingly more variable weather conditions, more effective and efficient use of nutrients and water. Robust plants are one of the components required for resilient systems.	Rete Semi Rurali (Solibam)	NA	Seed, Field
Seed	Reproductive element of sexile plants, i.e. the matured ovule without accessory parts. Colloquially, anything which may be sown; i.e. seed potatoes (which are vegetative tubers); seed of wheat (caryopses) etc.	FAO Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Seed certification	Necessary for the marketing of agricultural species seeds that have a Variety or Register Catalogue. In most countries with a certification system, certification is delegated to an approved inspection body and consists in a number of steps starting from seed produced by a maintainer (Core) and a number of certified categories such as Pre-Basic (PB), Basic (B), 1st reproduction (R1) and 2nd reproduction (R2). Outside of these categories seed cannot be sold for re-sowing purposes. For species that do not have an official catalogue or register (for example, many vegetable crops, lentils, emmer, etc.) marketing of seed defined 'standards' is possible, for which the manufacturer declares the species, the name of the variety or of the population, the origin, the year of seed production. In this case there is no control by the inspection body.	Rete Semi Rurali	NA	Seed
Seed savers	Seekers, conservers and users of landraces or varieties of older constitution usually subject to genetic erosion.	Rete Semi Rurali	NA	Seed

Seed system	The combination of channels, actors, means and approaches to conserve, exchange, sell, distribute and adapt seeds and more in general plant genetic resources.	Rete Semi Rurali	NA	Seed
Soil health	Soil health, also referred to as soil quality, is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. This definition speaks to the importance of managing soils so they are sustainable for future generations.	http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/	<p>EU resources on soil: http://eusoils.irc.ec.europa.eu/resource-type/datasets Copiright: https://ec.europa.eu/info/legal-notice_en</p> <p>SmartSoil Tool: on online tool developed by a 7th Framework Programme project to model the soil organic matter: http://geofionau.dk/projectnet/smartsoildst/Default.aspx?Language=en-GB</p> <p>An open source modeling tool about soil and crop modeling: http://www.ntsg.umt.edu/project/biome-bgc</p> <p>An R packages to modeling soil dynamics: https://cran.r-project.org/web/packages/SoilR/index.html</p>	Field
Species agrobiodiversity	For the OECD, species agrobiodiversity includes the variation between wild species that are directly or indirectly relevant to agriculture. These are grouped in three	https://books.google.it/books?hl=en&lr=&id=ONYZm_J0gr8C&oi=fnd&pg=PA3&dq=functional+agrobiodiversity+definition&ots=hy1tzKrlpC&sig=W7kf9q7ibXq	Pan-European species nomenclature : http://www.eu-nomen.eu/portal/	Field

	categories: (a) species supporting agricultural production; (b) wild species depending directly or indirectly on agriculture and its effects, and (c) non-native species threatening agroecosystems.	vncQUbudC8cdfUFw#v=onep-age&q=functional%20agrobiodiversity%20definition&f=false		
Specific adaptation	Adaptation of varieties to a specific environment (biological, ecological and cultural). Specific adaptation and diversity are closely related concepts in plant breeding. In addition to diversity in space farmers also contributed to diversity in time because the varieties produced by their selection were not genetically uniform and therefore continued to evolve becoming increasingly better adapted to the specific area of cultivation.	Rete Semi Rurali (Solibam)	NA	Seed, Field
Sustainability	Often sustainable development refers to satisfying present needs without reducing the possibility of future generations satisfying theirs. However, sustainable development requires further that resources should be used at a rate that allows their re-formation and wastes should be produced at a rate which allows the environment to absorb them. This is an ideal situation which we can aim at but which is nearly impossible to obtain.	Rete Semi Rurali (Solibam)	NA	Seed, Field, Food
Sustainable use (of plant genetic resources)	Sustainable use of plant genetic resources for food and agriculture takes into account the wider principles of ecologically, economically and socially sound approaches. These principles address the challenges of meeting basic food needs, generating income for the rural poor, and providing a foundation for protecting the environment. It can involve different technical solutions and actions, such as intensification of production; plant breeding; characterization, evaluation and number of core collections; genetic enhancement and base-broadening; diversification of crop production and broader diversity in crops; development and commercialization of underutilized crops and species; supporting seed production and distribution; and developing new markets for local varieties and 'diversity rich'	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/compendium/tools-guidelines/what-are-seed-systems/en/	NA	Seed

	products. Sustainable use of PGRFA also includes the fair and equitable sharing of the benefits arising from the use of PGRFA and agrobiodiversity management through appropriate strategies and participatory involvement of stakeholders.			
System approach	Study of a system requires definition of goals and objectives, boundaries and the structure and function of its components. Feedback mechanisms and interactions are important features of farm system structure and operation. Farm systems can often be better understood through analysis and the study of their sub-systems; and circle or problem-cause diagrams can assist this. Farmers design their systems to make best use of the prevailing climate and soil but a wide range of technological, commercial, social, political and personal factors determine farmers' goals and management. Important characteristics of systems include: productivity, profitability, efficiency, stability, sustainability, equity, flexibility, adaptability and resilience. Efficiency of resource use should be optimised, bearing in mind Liebscher's Law of the Optimum. Efficient use of energy and water are necessary for profitable production.	NA	http://link.springer.com/chapter/10.1007%2F978-1-4020-9132-2_1	Seed, Field, Food
Territory	Land with a specified characteristic: an area of knowledge, activity, or experience.	http://www.oxforddictionaries.com/definition/english/territory	NA	Field, Food
Terroir	Terroir is the set of all environmental factors that affect a crop's epigenetic qualities, when the crop is grown in a specific habitat. Collectively, these environmental characteristics are said to have a character; terroir also refers to this character. Terroir is the basis of the French wine Appellation d'Origine Contrôlée (AOC) system, which is a model for wine appellation and regulation in France and around the world. The AOC system presumes that the land from which the grapes are grown imparts a unique quality that is specific to that growing site (the plants' habitat). The extent of terroir's significance is deliberated in the wine industry.	https://en.wikipedia.org/wiki/Terroir	NA	Food

Traditional food	Traditional food refers to foods and dishes consumed over the long-term duration of civilization that have been passed through generations. Traditional foods and dishes may have a historic precedent in a national dish, regional cuisine or local cuisine. Traditional foods and beverages may be produced as homemade, by restaurants and small manufacturers, and by large food processing plant facilities.	https://en.wikipedia.org/wiki/Traditional_food	NA	Food
Traditional knowledge	Traditional knowledge refers to the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds. Sometimes it is referred to as an oral traditional for it is practiced, sung, danced, painted, carved, chanted and performed down through millennia. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general.	CBD, www.cbd.int	NA	Seed, Field, Food
Transdisciplinarity	It entails the cooperation and coordination of all disciplines and sub-disciplines related to the field of research. It coordinates science, education, and innovation form society within one system. The systems approach is the most basic principle. Practitioners and interests from science and outside the academic world are involved.	http://www.tress.cc/delta/se-ries2.pdf#page=5	NA	Seed, Field, Food
Unplanned biodiversity	Unplanned (associated) biodiversity includes all soil flora and fauna, herbivores, carnivores, decomposers and any other species that exist in, or colonise the agroecosystem. These diverse organisms interact with each other, and with plants and animals, in a complex web of biological activity.	http://www.fao.org/agriculture/crops/thematic-sitemap/theme/biodiversity/cab/en/	NA	Field

Varietal heritage	Ensemble of local varieties passed down over time on a given territory.	Rete Semi Rurali	NA	Seed, Food
Varietal mixtures	Mixtures of different varieties of the same species used in organic farming or marginal areas to maximise resilience of the crop under cultivation and often improve the quality of the final produce.	Rete Semi Rurali	NA	Seed
Variety	A naturally occurring subdivision of a species, with distinct morphological characters. In cultivated specie, a defined strain of a crop, selected on the basis of phenotypic (sometimes genotypic) homogeneity.	Fao Glossary (http://www.fao.org/biotech/biotech-glossary/en/)	NA	Seed
Weather	State of the atmosphere at a particular place during a short period of time. It involves such atmospheric phenomena as temperature, humidity, precipitation (type and amount), air pressure, wind, and cloud cover. Weather differs from climate in that the latter includes the synthesis of weather conditions that have prevailed over a given area during a long time period—generally 30 years.	https://www.britannica.com/science/weather	http://www.ecad.eu/ http://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc/ Terms of use: http://www.ecmwf.int/en/terms-use	Seed, Field
Weed	General term for any plant growing where it is not wanted.	https://www.britannica.com/plant/weed	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4480327/	Field
Weed suppression	The ability of the crop to reduce the fitness of a competitor plant.	http://www.sciencedirect.com/science/article/pii/B9780122944529500072	NA	Field

Weed tolerance	The ability of the crop to withstand the competitive impact of neighbours and resist yield loss.	http://www.sciencedirect.com/science/article/pii/B9780122944529500072	NA	Field
Weed-crop interaction	Two aspects of cultivar competitiveness can be defined. The first is the ability of the crop to reduce the fitness of a competitor (suppression), and the second is the ability of the crop to withstand the competitive impact of neighbours and resist yield loss (tolerance).	http://www.sciencedirect.com/science/article/pii/B9780122944529500072	NA	Field
Yield stability	Yield (preferably high) stability is the ability of a variety (pure line, mixture, population) to yield consistently in different environments. Stability may be Type 1 ('static' - constant yield across environments), Type 2 ('dynamic' - yield follows the potential in different environments), or Type 3 (consistent over time at one location).	Rete Semi Rurali (Solibam)	NA	Seed, Field

*This list is not meant to be exhaustive. Some definitions have been slightly adapted from the original.

** The terms in bold in the other sections of the documents are listed in this table. Refer to the "Description" column for the references.

2.1. Concepts related to genetic biodiversity and knowledge gaps addressed by the seed scenario

The **Convention on Biological Diversity** and **International Treaty on Plant Genetic Resources for Food and Agriculture** provide the legal framework for activities related to biodiversity in agriculture. In particular, the principles of **access and benefit sharing**, coupled with the **farmers' rights** are the foundation for the activities of informal seed systems. Informal seed systems value the use of **conservation varieties, landraces, varietal mixtures** and **populations** over **pure lines, hybrid seeds** and in general **modern cultivars** deriving from formal seed systems.

Modern cultivars and hybrids are characterized by a narrow genetic base, carrying a combination of traits which are primarily aimed at increasing yield. However, their yield potential can only be expressed in an optimized environment created by large supplies of external inputs (water, fertilizers, and pesticides). As such, these cultivars do not seem well equipped to withstand the sustainability challenge implied by the necessity to reduce energy (input) consumption and to adapt to harsher environments driven by global climate change.

Crop genetic diversity can be increased by sowing cultivar mixtures instead of a single, high-yielding cultivar. One step beyond cultivar mixtures is the use of evolutionary populations. They originate from a high number of initial crosses between several cultivars, grown in the target environment. Every year part of the seeds are saved and sown in the next season, giving rise to a composite population whose traits co-evolve with local climate and management conditions, according to **evolutionary processes**.

The assumption is that a more diverse crop stand should better cope with environmental variation deriving from climate and/or management conditions. Due to their very high genetic diversity, evolutionary populations will be able to withstand fluctuations in climate or suboptimal management conditions, which make them well suited for adaptation to climate change or to low input and organic systems. The use of landraces, cultivar mixtures and evolutionary populations gives priority to **yield stability** than to the maximum yield potential.

When evolutionary populations are the outcome of participatory research, **on-farm conservation** of genetic diversity reaches the highest involvement of local farmers and other stakeholders. This type of conservation implies a change of paradigm on how the seed system is organized and maintained. The tools, also in terms of databases, inventories, and data sharing are different from those needed in formal seed systems.

Providing adequate ICT services to the networks of informal seed systems in Europe (some of the most important ones being gathered in the H2020 project Diversifood¹) is a major challenge of CAPSELLA. Available datasets and database structures of the formal seed system will be taken into account while developing different, adequate solutions for the informal system.

¹ <http://www.diversifood.eu>

The achievement of this objective will have a huge impact on the activity of seed networks, on-farm conservation actors and seed saver organizations all over Europe and will boost the effectiveness of their activity.

2.2. Concepts related to agroecosystem management and knowledge gaps addressed by the field scenario

The transition of agriculture towards sustainability can be facilitated by the exploitation of **functional agrobiodiversity**. This implies the combination of genetic, species, and ecosystem agrobiodiversity in novel cropping systems. The optimizations of **crop rotations**, the use of **cover crops**, **living mulches**, **intercropping**, or even **polyculture** and **agroforestry** supports agroecosystem sustainability by the use of species diversity.

Biodiversity provides many **ecosystem services** (defined as ‘the benefits provided by ecosystems to humans’): nutrient cycling, carbon sequestration, pest regulation and pollination, sustain agricultural productivity. Promoting the healthy functioning of ecosystems then, ensures the **resilience** of agriculture. Climate change and other stresses have the potential to make major impacts on key functions, such as pollination and pest regulation services. Learning to strengthen the ecosystem linkages that promote resilience and to mitigate the forces that impede the ability of agroecosystems to deliver goods and services remains an important challenge.

A common philosophy among sustainable agriculture practitioners is that a healthy soil is a key component of sustainability; that is, a healthy soil will produce healthy crop plants that have optimum vigour and are less susceptible to pests. While many crops have key pests that attack even the healthiest plants, proper soil, water and nutrient management can help prevent some pest problems brought on by crop stress or nutrient imbalance. Furthermore, crop management systems that impair soil quality often result in greater inputs of water, nutrients, pesticides, and/or energy for tillage to maintain yields. In sustainable systems, the soil is viewed as a fragile and living medium that must be protected and nurtured to ensure its long-term productivity and stability. Methods to protect and enhance the productivity of the soil include using cover crops, compost and/or manures, reducing tillage, avoiding heavy machinery especially on wet soils, and maintaining soil cover with plants and/or mulches.

At the moment, tools that integrate farmers’ qualitative evaluation of soil health with laboratory soil and water quality measurements are missing.

CAPSELLA will empower the action of farmers applying sustainable management measures by giving a platform that integrates modelling of experimental data together with participatory assessments by the farmers to forecast the effect of fertilization and irrigation on soil health and therefore on the sustainability of the production.

2.3. Concepts related to agroecosystem management and knowledge gaps addressed by the food scenario

Transparency in the processes related to the production, distribution and consumption of quality food is fundamental to connect the general public to the efforts towards sustainability of biodiversity-based agriculture actors. Unlocking the agriculture system with agroecology needs the implementation of innovative food systems. The innovation necessary to support agroecology implies to take advantage of a **systems approach**. This perspective is envisioned in its broadest sense, from the individual farm, to the local ecosystem, to all communities affected by this farming system. An emphasis on the system allows a larger and more thorough view of the consequences of farming practices on both human communities and the environment. A systems approach gives us the tools to explore the interconnections between farming and other aspects of our environment.

CAPSELLA will include consumers in the process of enhancing the efficiency of the sustainable practices applied by the farmers by building a platform for storytelling on food-production: a story-database on biodiversity, sustainable farm management and local traditions based products. This platform will allow informing the broad public about the impact of agro-ecological innovations at farm level on the type of products and their organoleptic quality.

Conclusions

The two pillars of CAPSELLA are the data management and exploitation possibilities given by the ICT tools and the bottom-up approach to agronomic issues with the direct involvement of the farmers' communities. Given the conceptual framework of the project presented in this deliverable, we expect two major impacts on CAPSELLA activities, namely (i) on the work flow of the informal seed systems around Europe and (ii) on the integration of farmers' qualitative and participatory self-assessment of soil health with experimental data. These two activities will result in striking innovations supporting European farmers in using functional biodiversity for pushing their production method towards sustainability.