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Strategies for Organic and Low-input Integrated Breeding and Management

Solibam

10 SOLIBAM **key concepts** - cultivating diversity

Concept 1: Resilience

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Definition

Resilience is the capacity of an ecosystem to respond to a perturbation by resisting damage and recovering quickly. A resilient system will reorganize while undergoing change 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.

How SOLIBAM deals with resilience

Diversity is an element of the resilience of ecosystems. **SOLIBAM** is trying to make the best use of crop plant diversity, management practices and the associated wild biodiversity to increase the resilience of systems. It concerns, for example, crop competitiveness against weeds, improved crop establishment under increasingly more variable weather conditions and more effective/efficient use of nutrients and water.

It also analyses and identifies traits, management practices and breeding methods that provide the most resilient crops in organic and low-input agriculture. Diverse breeding methods address the different needs of organic and low input systems considering their varied geographical, cultural and economic situations.

Concept 2: Robustness

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Definition

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.

How SOLIBAM deals with robustness

One of the **SOLIBAM** hypotheses is that diversity can be a tool to provide robustness through genetic diversity and diversity of breeding methods.
Genetic diversity allows evolution and adaptation of crops across time and systems, which leads to stability of performance.
Diversity of breeding methods answers the different needs of the diverse organic and low input systems considering different geographical, cultural and economical situations.

Photo © A. Coulombel

Concept 3: Functional biodiversity

Definition

Functional biodiversity is the fraction of the total biodiversity composed of clusters of elements (at the gene, species or habitat level) which provide the same (agro)ecosystem service and it is driven by within-cluster diversit. In other words, various different genes/organisms/habitats that have a similar function in the agroecosystem, are needed to provide the best services. Only one or few genes/organisms/habitats are not efficient enough to optimally fulfil a service.

How SOLIBAM deals with functional biodiversity in tomato crop

In order to reduce reliance on external inputs, **SOLIBAM** is testing the efficiency of increased functional biodiversity in the cropping system, e.g. on tomatoes. Crop genetic diversity, diversity of crops and associated species are therefore managed with the aim of improving soil fertility and range of host plants for beneficial insects. Sowing leguminous cover crops preceding the tomato crop aims to eliminate the need for additional fertility and sowing multi-functional flower strips is intended to increase the presence of pollinators and beneficial insects, as well as crop yield. By managing cropping system diversity in a functional way, external inputs can be reduced and crop yield increases or remains stable. Crop variety choice is also crucial in determining the magnitude of the effect of functional diversity.

Concept 4: Yield stability

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Definition

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).

How SOLIBAM deals with yield stability

SOLIBAM introduces more diversity into agricultural systems in order to promote high, consistent yields *(stable yield)* in widely different environments. This is achieved by extending genotype diversity and by developing within-crop diversity *(e.g. populations)*. The increased diversity is tested in novel cropping systems across environments. Integrating these breeding and agronomic approaches should improve stability and reduce differences between the three types *(1-3)*.

Concept 5: Specific adaptation

Photo © R. Bocci

Definition

For thousands of years, farmers selected the crops best adapted to their own specific soil, climate and end-uses, with the result that a large diversity in space was created because each farmer selected for **specific adaptation**. Specific adaptation and diversity are, therefore, 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.

How SOLIBAM deals with adaptation

SOLIBAM is 're-using' the concept of specific adaptation in breeding as an alternative to wide adaptation. This latter concept is the result of conventional scientific breeding approaches used during the last 80 years, which are based on homogeneity and are, in many cases not suitable for organic and low-input systems. In order to achieve specific adaptation, **SOLIBAM** research focuses on two approaches: 1) including farmers in the research process *(participatory approach)* and 2) doing research directly on working commercial farms, rather than research farms *(decentralization approach)*.

Photo © A. Coulombel

Concept 6: Intercropping and associated crops

Definition

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 *(e.g. 2 cash crops, cash crop plus living mulch)*.

How SOLIBAM deals with Intercropping and associated crops

SOLIBAM focuses on the genetic diversity of the species used in intercropping systems to improve their associations *(i.e. we study the impact of this genetic diversity on the combination of the different crops*). Several varieties and genetic structures of each crop are assessed for their complementarity. For example, wheat pure lines, landraces, cultivar mixtures or composite cross populations are cultivated together with different species of legume living mulches *(cover-crops)*.

Concept 7: Sustainability

Definition

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.

How SOLIBAM deals with sustainability

In **SOLIBAM** we assess sustainability of innovative strategies based on participation and diversity at three system levels: the cropping system, the farm and the chain from breeder to farmer *(plant breeding and legal aspects)* and to consumer *(the food supply system)*. Specific focus is on resource use efficiency, environmental impacts and socio-economic assessments. A number of case studies are chosen to produce quantitative context-specific evaluations.

Concept 8: Evolutionary processes


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Photo © R. Bocci

Definition

Populations evolve over time and space through four evolutionary processes: 1) selection by natural factors *(climate, biotic pressures…)* 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 *(pollen flows or seeds exchange between farmers).*

How SOLIBAM deals with evolutionary processes

Population-varieties, mixtures and composite cross populations, in comparisons against purelines, are the basis of all **SOLIBAM** breeding programmes. Populations are selected under various environments and practices, and molecular tools are used to analyse evolutionary processes. **SOLIBAM**'s objectives are to better understand the impacts of natural and farmers' selection on the evolution of agronomic and quality traits and to develop breeding strategies that maintain diversity.

Photo © F. Rey

Concept 9: Organoleptic quality

Photo © R. Lebrun

Definition

Organoleptic means “that which affects sensory organs”. Organoleptic quality typically includes the sensory properties food *(taste, appearance, colour, aroma, flavour, texture)* but also takes into account sensations induced by food in the mouth or any other sensations linked to the consumption of the food.

How SOLIBAM deals with organoleptic quality

SOLIBAM scientists are trying to better understand parameters controlling the organoleptic quality using a global approach, by taking into account the genetic resources, environment, crop management practices, processing factors *(e.g. baking)* and consumers’ expectations etc. For bread, this “from grain to loaf” approach is initiating the development of local solutions for an optimized and diverse production. Another important **SOLIBAM** activity is to develop tools that can be used by farmers or breeders to develop selection on specific organoleptic quality parameters.

Concept 10: Participatory research

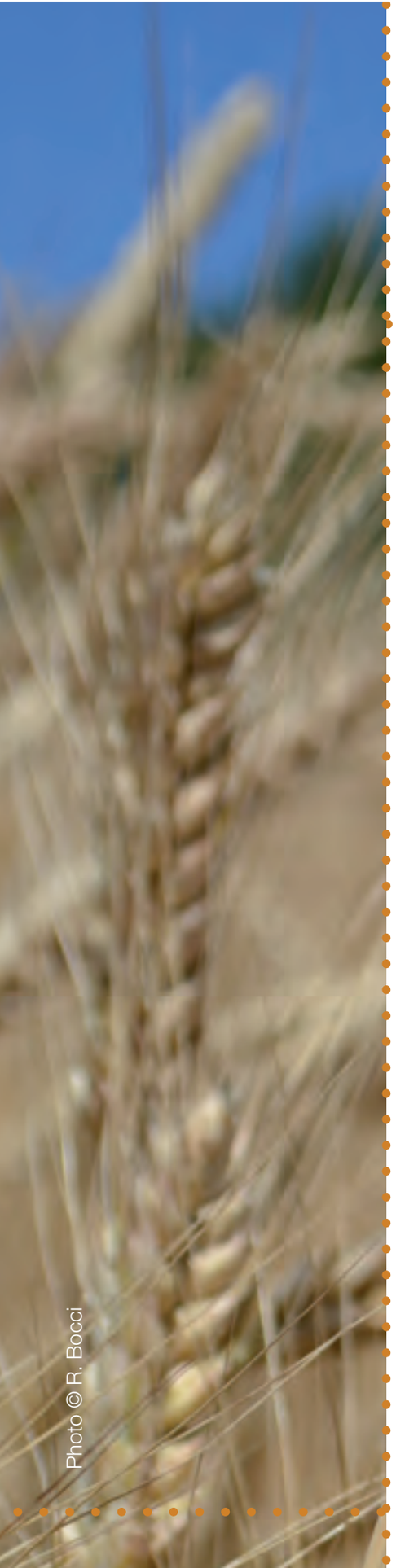
Definition

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.

How SOLIBAM deals with participatory research

SOLIBAM supports on-farm participatory plant breeding and management *(PPBM)* for practice-oriented research: 1) to enhance and evaluate diversity, 2) to increase the sustainability and performance of food systems, and 3) to improve product quality.

Participatory plant breeding aims to enrich crop genetic background to allow adaptation to diverse environments and practices, and to create new farmer-selected populations. Quality assessments involve input from farmers, end-users, consumers and researchers.



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Diversity is the set of different biological entities that exist around us. *'Entity'* in this context means not only species*, but also varieties within species and individuals within varieties. Accordingly, agricultural biodiversity is the diversity of species cultivated for human food, animal feed, medicine, industrial uses etc and even includes farmers' associated knowledge. Agricultural biodiversity is the sum of the differences between species, between varieties within species and between individuals within varieties.

* a species is generally defined as the set of individuals which can intercross freely to produce unlimited fertile offspring.

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