INNOVATIVE APPROACHES
TO EMBED DIVERSITY IN FOOD SYSTEMS
DIVERSFOOD OUTCOMES FROM FIELD TO PLATE


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Booklet #6

This booklet presents and describes 10 novel ideas and approaches that support innovation embedding diversity in food systems from the field to the plate.

DIVERSIFOOD

DIVERSIFOOD aims to embed diversity in the food supply chain and to foster multi-actor networks to promote local high quality food systems.

CONTENT

INTRODUCTION

Underutilised crops are offering opportunities to diversify and improve farming and food systems as a response both to climate change and to social changes in food culture and uses. The choice of seed greatly determines farming practices and all stages of the food supply chain right up to the consumers' plate. Based on DIVERSFOOD outcomes, this Booklet #6 proposes a number of thought-provoking concepts, methods and tools. It aims to inspire stakeholders who wish to develop diversity in food systems.

DIVERSIFOOD (2015-2019) is a H2020 European project aiming to enrich cultivated biodiversity by testing, renewing and promoting underutilized or forgotten crops, species and varieties. Using the multi-actor approach, it supports the dissemination of a new food culture, based on diverse, tasty and healthy food.

DIVERSIFOOD aims to embed diversity in the food supply chain and to foster multi-actor networks to promote local high quality food systems. To achieve this aim, the research process itself has been embedded in its environmental and social context: decentralised and participatory.

DIVERSIFOOD has explored the diversity of more than 15 species, showing how to broaden the genetic base of cultivated plants, from landraces or underutilised species to new farmers' varieties. Complementary approaches connected with crop diversity for resilient sustainable food systems have been developed:

- Underutilised/forgotten crops: multi-actor on-farm evaluation
- New approaches to breeding plants for diversified and sustainable farming systems
- Community management of agrobiodiversity
- Embedding diversity within food systems based on new relationships among actors
- Paradigm shift for multi-actor and transdisciplinary research

This booklet presents and describes **10 novel ideas and approaches** that support innovation embedding diversity in food systems from the field to the plate.

1 DEFINING UNDERUTILISED CROPS

WHY "UNDERUTILISED CROPS"

Throughout history, thousands of plant species have been domesticated and used in agriculture. Most are now underutilised. DIVERSIFOOD considers these underutilised species as opportunities to diversify and improve farming and food systems. We have conceptualised a working definition of *"underutilised crops"* rooted in our experimental work and documentation, which aims to provide replicable conceptual tools. Our working definition is not intended to be included in dictionaries, but should help to address a challenge in an effective way. The focus is not on the plants, but rather on the process of building opportunities across a wide range of neglected or unexplored resources.

THE DIVERSIFOOD **WORKING DEFINITION**

In DIVERSIFOOD, an underutilised crop is:

1. **A plant genetic resource…**
   Be that either a species or a germplasm, or a crop genetic structure,
2. **…with limited current use…**
   having been either forgotten or abandoned, or not yet explored,
3. **… and potential to improve and diversify …**
   the focus is on the advantages we expect,
4. **… cropping systems and supply chains …**
   able to improve system resilience and sustainability, as well as to diversify diets and markets,
5. **… in a given context.**
   the real geographic, historic, social, and economic world, in which the case for the underutilised crop is embedded.

After working for two years on several case studies, a DIVERSIFOOD workshop involving the whole consortium was organised with the aim to

identify and characterise three distinct categories of challenges related to underutilised crops:

Promoting the introduction of novel, **"outsider" species**, e.g. quinoa in the UK

- Reviving the cultivation of **old, *"forgotten"* species**, e.g. rivet wheat in France
- Promoting the cultivation of ***"neglected"* germplasm** of common species, e.g. Open Pollinated Varieties (OPVs) of broccoli

In different contexts, a *"crop"* may fall into different categories, or even not be *"underutilised"*.

THE WAY FORWARD

In DIVERSIFOOD, *"Underutilised Crops"* represent a series of innovation processes involving plants, farmers, processors and consumers outside the mainstream. Identifying and contextualising the challenges of (re)introducing a underutilised crop is the first step in diversifying and improving agriculture, market and diets, and their sustainability.

Outsider species

How can they be adapted to different climates?

How can a production system, be shaped from seed to post-harvest?

How can knowledge and know-how be produced?

Neglected species

How can they be made to fit a standardised environment?

Why have they been neglected?

How can the knowledge associated with their cultivation and use be re-created?

Neglected germplasm of common species

How can this germplasm fit environments and markets shaped around genetic monocultures?

How can knowledge associated with their cultivation and use be re-created?

Author: *Ambrogio Costanzo, ORC*

SUGGESTED READING

- **Food and Agriculture Organisation of the United Nations.** The State of the World's Plant Genetic Resources for Food and Agriculture. Rome (IT) (1997). ftp://ftp.fao.org/docrep/fao/meeting/015/w7324e.pdf
- **Kell S, Rosenfeld A, Cunningham S, Dobbie S, Maxted N.** Benefits of Non-Traditional Crops Grown by Small-
- **Scale Growers in the Midlands** – Final Report of the "Sowing New Seeds" Project. 2013, Garden Organic.
- **Ryton, Coventry (UK).** See also http://www.garde-norganic.org.uk/sns-resources.

2 ASSESSING ON-FARM UNDERUTILISED CROPS WITH SMART PRACTICES


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Underutilised crops[1] are offering opportunities to diversify and improve farming and food systems as a response both to climate change and to social changes in food culture and uses. In DIVERSIFOOD studies, the focus was not on the plants, but rather on the process of building opportunities for a wide range of neglected or unexplored resources. To that end, we developed smart practices for on-farm evaluation of underutilised crops[2], a approach whose key features are presented below.

SOURCING SEEDS

The process of activating the *"untapped"* diversity in gene banks for living agriculture involves several steps: (1) collecting information about the history of the crop, (2) gathering a large panel of samples of accessions from diverse origins, (3) multiplying and observing them for at least two years at one location using basic phenotypic traits (seed multiplication, starting adaptation), (4) creating new diversified populations by bulking several complementary accessions (which share traits of interest) for on-farm evaluation. The originality of the DIVERSIFOOD approach is that, from the moment they exit the seed banks, genetic resources are not necessarily kept separate from one another. In fact, the final aim is not limited to select a small number of *"entries"* and discard the others, but rather to make use of as much diversity as possible as a source to create the base for novel genetic resources adapted to a diversity of contemporary cropping and food systems.


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ASSESSING CROP PERFORMANCES

Yield is often considered as a proxy of whether a crop fits the environment. However, in DIVERSIFOOD, we addressed environmental fitness from different angles. In addition to yield, we looked at the performance in the agro-ecosystem, such as weed competitiveness, resistance to pests and diseases and tolerance to abiotic stress. In some cases, the focus is very narrow, e.g., resistance to a specific disease. The main outcome was that agroecosystem performance of the same genetic resource can vary greatly depending on where it is grown. This reinforces the importance of using and testing genetic resources on many different farms rather than at centralised research stations.

1 - Definition in chapter 1
2 - Cf. DIVERSIFOOD Booklet#2 for more details

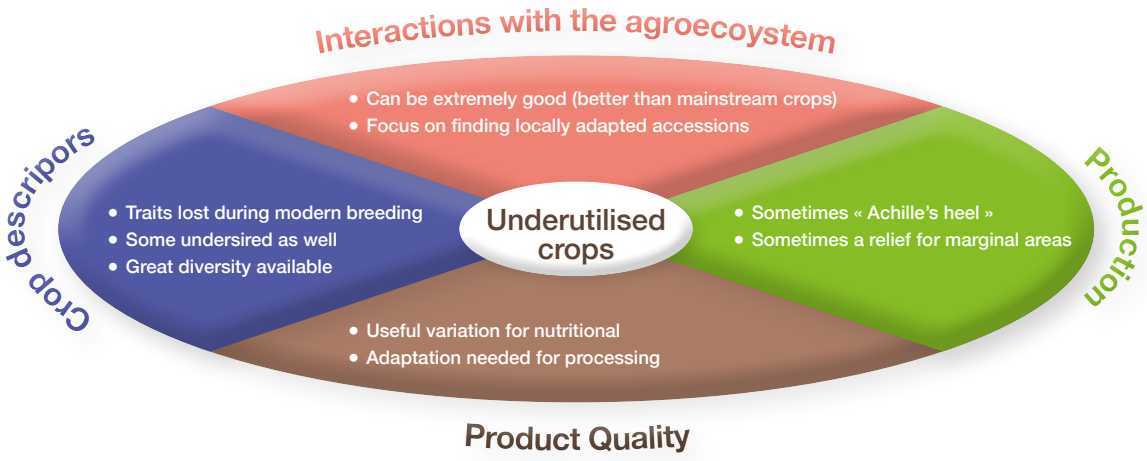
Productive performance assessment highlighted a perhaps expected trend: the yield of underutilised crops can be a serious limiting factor, as a crop may be either low-yielding or difficult to harvest. On the other hand, in many cases, underutilised crops can be grown in marginal conditions. One of the expected key benefits of underutilised crops: is that they are a valuable option for areas that would perhaps be abandoned if only widely available seeds are used.

Quality performance was also evaluated from different angles: (I) processing quality, (II) nutritional and health-promoting quality, (III) organoleptic quality and (IV) cultural identity. The main highlight here is that a diversity of crops can trigger a diversity of products that require both the processing and the methods and concepts used to assess their quality to be adapted. This is not to be seen as a limitation in itself. What is not suitable for industrial processing may be an opportunity for artisanal processing methods that add value to highly nutritious raw materials. Last but not least, *"intangible"* value is something that is cannot measured but is nevertheless important as it builds on the *"cultural identity"* of a product and can therefore support the development of production and supply chains with values other than yields and revenues.

THE WAY FORWARD

The evaluation of underutilised genetic resources in DIVERSIFOOD triggered innovation on at least two levels: (I) the distribution of a wide range of genetic resources and (II) the evaluation of these resources to a wide range of farming environments and communities where they can be used to create added value. Diversifying agriculture and food systems cannot happen all at once: it needs to be a continuous and collective process. Our hope is that more communities will want to become involved in this learning curve and share in distributing diverse genetic resources and embedding their evaluation in sustainable cropping systems and supply chains.

Figure 1 - **The four dimensions of the evaluation** of underutilised crops corrections needed to the figure



Authors: *Ambrogio Costanzo, ORC and Frederic Rey, ITAB*

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- **Costanzo A., Serpolay E. Villard AL. Bosi S., Chable V., 2018.** Recommendation on smart practices for on-farm evaluation of underutilised crops. Booklet#2. DIVERSIFOOD Project.
- **Estelle Serpolay, Edwin Nuijten, Adanella Rossi, Véronique Chable, 2018.** Toolkit to foster multi-actor research on agrobiodiversity. Booklet#1. DIVERSIFOOD Project.
- **Goldringer I., Rivière P. 2018.** Methods and tools for decentralized on farm breeding. Booklet#3. DIVERSIFOOD Project.

➤ **DIVERSIFOOD booklets are available at www.diversifood.eu/publications-old/booklets-and-reports**

3 DESIGNING NEW VALORISATION STRATEGIES FOR BIODIVERSE PRODUCTS FROM SEEDS TO PLATE

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Increasing cultivated biodiversity in the field but also on peoples' plates is essential to increase the resilience and health of our food systems. To that end, new valorisation strategies for biodiverse products were being explored during DIVERSIFOOD and new approaches co-developed by food system actors involved in the project.

THE NEED FOR A COMPREHENSIVE STUDY

DIVERSIFOOD studied examples of valorisation strategies for biodiverse products across Europe using different approaches (Padel et al., 2018). Based on a systemic approach (Rossi et al., 2016), we analysed supply chains created around biodiverse products in eight countries (Fig.2). We focused here on initiatives that aim at enriching agrobiodiversity in food systems and are promoted by hybrid networks, including farmers, other supply chain actors, scientists, facilitators, advisors, and, in some cases, public authorities. We also gathered information about the best strategies to communicate the added value of a product to consumers through.


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3 - See DIVERSIFOOD Booklet #7: Handbook for the marketing of products from biodiverse crops

labelling (Holzherr et al., 2018). We conducted a survey in four countries to assess consumer awareness of agrobiodiversity (Oehen and Meier, 2018). Keskitalo (2018) investigated a potential link between crop diversity and the diversity of food available to consumers. Based on the results of this research, we have developed recommendations for new valorisation strategies for biodiverse products from seeds to plate[3].

VALORISATION STRATEGIES BASED ON INTERACTION

The valorisation strategies for biodiverse products require the involvement of a variety of actors from breeders, farmers, processors, retailers, to consumers, as well as researchers, facilitators, advisors, and, in some cases, public authorities. Links with similar but external networks represent further opportunities to valorise agrobiodiversity.

The DIVERSIFOOD study highlighted how crucial interactions between different actors within networks and across different dimensions (technical, organisational, cultural, social, economic, institutional, legal and political) are. In

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- **Brunori G., Rossi A., D'Amico S. (2018)** A comprehensive and participatory approach to the valorisation of biodiverse products In Troisi M., Isoni A., Pierri M. (eds) Food Diversity Between Rights, Duties and Autonomies. Legal Perspectives for a Scientific, Cultural and Social Debate on the Right to Food and Agroecology - Springer. In Legal Issues in Transdiscplinary Environmental Studies – vol. 2.
- **Holzherr et al. (2018)** Communication and Label Concept for Underutilized Crops: Checklist. Poster presented at the DIVERSIFOOD final congress, Rennes Keskitalo (2018)

a collaborative environment, actors share different forms of knowledge, views and expertise, as well as define common goals, and, in so doing, contribute to the internal coherence, the robustness and the effectiveness of the networks. It also allows farmer engagement and capacity building.

This exchange among different actors makes it possible to tackle and overcome challenges. In supply chains, such challenges range from difficulty in finding seeds or problems with seed quality, to technical problems in producing and processing the crop varieties, or to low yields and the lack of proper markets.

Cooperation and exchange again have a role to play in establishing connections with other networks, both local and in broader contexts. These connections have proven to be important to strengthen the individual networks, to make it possible to grasp new opportunities and to further develop collective awareness, identity and agency around agrobiodiversity management issues.

TRANSLATING THE VALUES OF GENETIC DIVERSITY INTO PRACTICES

Despite the fact that the valorisation strategies for agrobiodiversity differ, a common feature is the need to translate the values of genetic diversity into coherent practices, from field to plate. This includes the adaptation of farming and processing technologies to the characteristics of the varieties or crop species. The management of the qualitative attributes may require fine-tuning and implementing different tools and arrangements along the chain (e.g. codes of practice, norms and standards, rules, protocols, agreements).

When informed, consumers are interested in biodiverse food and there is an increased willingness to pay. Regarding communication to consumers, the study identified a range of possible solutions, with regard to the use of logos and product signs, and the practices adopted in the different market channels.

THE NEED FOR AN ENABLING ENVIRONMENT

The DIVERSIFOOD study also highlighted the importance of an enabling external environment. This refers to suitable regulatory frameworks for genetic resources management, concerning breeding and seed production and circulation, for example. More favourable policies are also needed at breeding, farming, marketing, and consumption level, based on an integrated and multi-actor approaches. In this regard, we believe cooperation among the different actors involved in the production and valorisation of biodiverse products is crucial for the development of more resilient and healthy food systems.

Figure 2 - **The action areas in the case studies**

Mobilisation of genetic resources, definition of specific quality, marketing and communication, interaction with other networks/projects, effectiveness and sustainability – and the various dimensions involved (see Innovation factsheet 6)

Authors: *Bernadette Oehen, FiBL and Adanella Rossini, UNIPI*

- **Oehen B, Meier C., Philipp Holzherr, Iris Förster (2018).** Strategies to valorise agrobiodiversity. Session V: Sustainable agrifood systems, value chains and power structures. Proceedings of the 13th IFSA Symposium, Chania 2018.
- **Padel S., Rossi A., D'Amico S., Sellars A., Oehen B. (2018)** Case studies of the marketing of products from newly bred lines and underutilized crops. Deliverable 5.1 of DIVERSIFOOD.
- **Rossi A., Padel S., Brunori G., Gerrard C., Oehen, B. (2016)** Framework for socio-economic analysis of case studies. Internal Project Report for DIVERSIFOOD (MS 27).

4 IMPLEMENTING THE MULTI-ACTOR APPROACH IN FOOD SYSTEMS


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MULTI-ACTOR APPROACH FOR FOOD DEMOCRACY

To embed crop diversity in the food supply chain and to promote local high quality food the research process itself needs to be integrated in its environmental and social context in a horizontal way. The research results can be implemented immediately meaning every actor is a beneficiary of the research process. The multi-actor approach helps create conditions for food democracy because the actors participate actively in shaping their food systems.


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WHAT IS MULTI-ACTOR RESEARCH?

Multi-actor research is a research process in which different types of actors are actively involved and contribute their knowledge and experience in different ways. Thanks to their different perspectives inherent to their diverse professions (different types of practitioners, researchers, policy makers, etc.) as well as skills (agronomy, farming, breeding, processing, economics, food quality, nutrition, etc.), this type of research can create and apply a broader, holistic approach.

The different actors involved in such a research process have a common question to answer and, to that end, a common desire to work together. In DIVERSIFOOD project, multi-actor research is conceived as the broadening of participatory research developed in collaboration with all actors of the food chain.

In multi-actor research, the actors engage in a collective, iterative and mutual learning process, in which the different types of knowledge are used, integrated and continuously questioned. This process generates new questions hand in hand with their translation into new practices (Fig. 3). The research question needs to be defined with -or by- the local actors involved.

Figure 3 - **Iterative and mutual learning process** in multi-actor research

CONDITIONS FOR SUCCESSFUL INTERACTIONS AND RESEARCH

A multi-actor research project is concomitantly implemented by several actors, with different skills, thereby providing complementary resources, methods and tools. Crucial elements for a collaborative multi-actor approach are building of trust, creating an open atmosphere to allow open communication, and developing a common language to improve mutual understanding. This process takes time and needs to be carefully nurtured. Successful interactions can take place if sufficient key elements (building blocks) are implemented:

- Common will
- Common vocabulary
- Trust
- Transparency
- Facilitation
- Resources for the experiment and research process
- Appropriate distribution of work

Decision making is an important part of such an iterative process, and is itself a continuous process which can take different forms. Technical approaches may be based on compromise, while the rules of the process need to be based on consensus.

Experimental design - It is important to adjust the experimental design (and adapt the statistical methods accordingly) to involve as many people as possible and to increase participation.

Intellectual property rights: The question of intellectual property rights has to be considered right at the beginning of a project, even if nobody thinks it could be a problem.

Interpretation of the results: The results may be subject to different ideological interpretations by different kinds of actors. All the participants involved need to be aware of this possibility, and find a way to deal with it together.

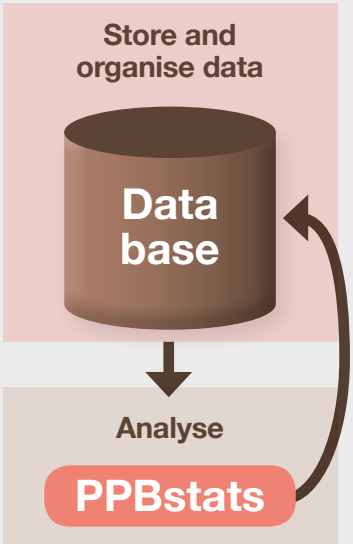
Authors: *Edwin Nuijten (LBI), Frédéric Rey (ITAB), Estelle Serpolay (ITAB), Adanella Rossi (UNIPI), Véronique Chable (INRA)*

SUGGESTED READING

- **Estelle Serpolay, Edwin Nuijten, Adanella Rossi, Véronique Chable, 2018.** Toolkit to foster multi-actor research on agrobiodiversity. Booklet#1. DIVERSIFOOD Project. www.diversifood.eu/publications-old/booklets-and-reports
- **EIP-AGRI Brochure Horizon 2020 multi-actor projects, October 2017,** https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-brochure-horizon-2020-multi-actor.

5 DEVELOPING SUITABLE TOOLS TO SUPPORT PARTICIPATORY PLANT BREEDING

Workflow between a database, which organises and stores the data, **and PPBstats,** which analyses the data. Results of the analysis can be stored in the database



PARTICIPATORY PLANT BREEDING PROGRAMMES GATHER DATA TO BE ANALYSED

Participatory plant breeding (PPB) is based on the decentralisation of evaluation and selection in farmers' fields. All the actors, i.e. farmers, researchers, facilitators, consumers, etc. are involved in the decision-making process at all stages of a PPB programme. This kind of involvement empowers all actors and responds to their needs. In PPB programmes, experiments are carried out and different types of data are produced which have to be stored and analysed in order to support actors in their selection. These data cover the history of seed management (circulation, mixture, reproduction, selection, etc), agronomic trials, organoleptic tests and molecular data. During the DIVERSIFOOD project, tools including databases and statistical software were developed to manage these kinds of data and their analysis.

DATABASES TO STORE INFORMATION

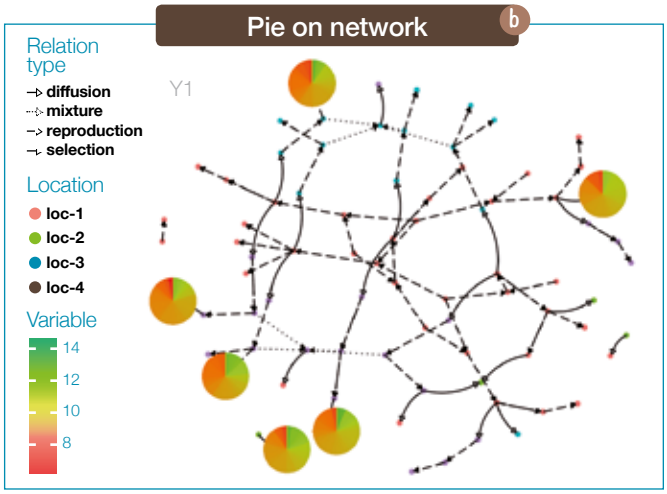
Databases are efficient tools to store and manage information in Community Seed Banks[4]. A survey was conducted to identify how DIVERSIFOOD seed savers´ and farmers´ networks are managing their data. Results of the survey showed that the organisations are dealing with a wide diversity of crop species, with local varieties, landraces or new farmers' varieties/populations. The Community Seed Banks are using databases with different objectives. Firstly, they all manage data on varieties cultivated in several different locations and years, and according to local needs. Secondly they store various kinds of data including agronomic data, organoleptic data, personal data on the farmer, country of origin, information on sources (origin, date, local name, associated knowledge), photos and/or history of seed lots within the network. The databases are often used for daily business (see DIVERSIFOOD Innovation Factsheet IF#19 for more details).

4 - See DIVERSIFOOD Innovation Factsheet IF#1 for a definition

STATISTICAL SOFTWARE TO ANALYSE THE DATA

Once the data are organised in a database, they can be formatted for analysis by statistical software. To this end, DIVERSIFOOD developed a new software: PPBstats, which is available free of charge. It is based on R software that analyses the data collected during PPB programmes at four levels: the seed management network, agronomic trials, organoleptic tests and molecular analyses. One objective of PPBstats is to be a single package capable of performing all analyses required for PPB programmes with comprehensive documentation.

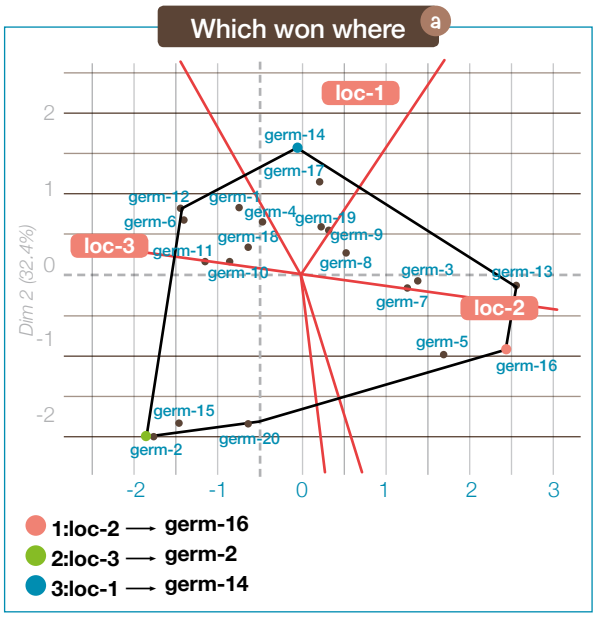
A decision tree was developed to select the most appropriate experimental designs and methods according to the objective (see IF#11 for more details). A website dedicated to PPBstats and a comprehensive tutorial on how to use the package can be found at: https://priviere.github.io/PPBstats_web_site



CREATING A COMMUNITY TO EXCHANGE AND IMPROVE TOOLS

Beyond better knowledge on the use of the database by Community Seed Banks and the development of an R package, another objective is to create a community working on data management and data analysis. This community could improve software, exchange know-how on how to process data from PPB programmes and develop smart practices. Information regarding contributions to PPBstats can be found on: https://priviere.github.io/PPBstats_web_site/contribute.html

Example of PPBstats outputs



Author: *Pierre Rivière, RSP*

SUGGESTED READING

- **DIVERSIFOOD Innovation Factsheet:** www.DIVERSIFOOD.eu/publications-old/innovation- factsheets/
  - **IF#1:** COMMUNITY SEED BANKS
  - **IF#11:** Smart methods for decentralized on-farm breeding
  - **IF#19:** Data management in Community Seed Bank
- **Goldringer I., Rivière P. 2018.** Methods and tools for decentralized on-farm breeding. Booklet#3. DIVERSIFOOD Project.

6 EMBEDDING AGROBIODIVERSITY MANAGEMENT IN MULTI-ACTOR NETWORKS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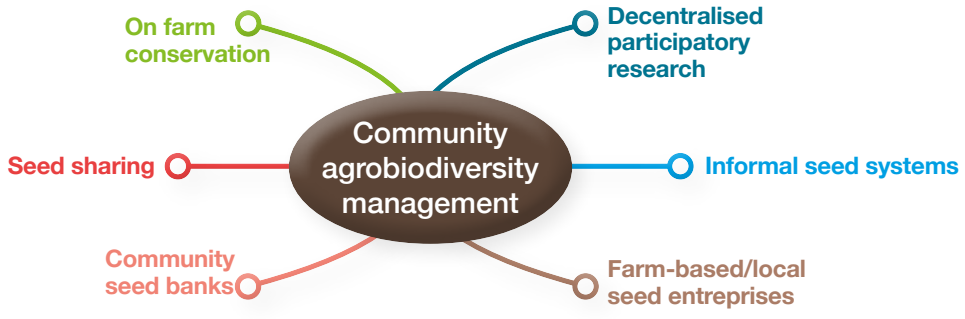
FROM ON-FARM CONSERVATION TO COMMUNITY AGROBIODIVERSITY MANAGEMENT

The DIVERSIFOOD project focussed on a new approach for the conservation of plant genetic resources for food and agriculture (PGRFA), aimed at increasing overall diversity within farming systems, not only a single variety conserved by the a farmer. For this reason, we based our action on a new paradigm concerning how diversity is managed in agroecosystems and not focussed only on conserving a given level of diversity (at variety or species level). In this framework, special attention should be paid to the social relationships among the different actors involved in Community Agrobiodiversity Management (CAM). The advantage of using CAM instead of on-farm conservation to describe initiatives dealing with PGRFA is that it includes not only traditional on-farm conservation (e.g. landraces in their environment) but also innovation and research (e.g. participatory plant breeding - PPB), seed swaps and sharing (e.g. through community seed banks), and the marketing of seeds (e.g. farm-based/local seed companies).

Figure 4 - **Components of Community** Agrobiodiversity Management



THE IMPORTANCE OF NETWORKS

DIVERSIFOOD case studies and outcomes confirmed the important role played by different actors in the management of agrobiodiversity by communities. These multi-actor networks are based on interactive and iterative processes to monitor their actions, usually with rules and norms which are socially approved by the participants. Their motives in working together and embedding agrobiodiversity in their practices can be summarised in four points:

1. **Using diversity** in farming systems, especially in organic and low input systems, is one way to reduce production costs but also a strategy to cope with uncertain market prices and climate change. Moreover, starting new PPB projects offers organic farmers the possibility to breed new adapted varieties they cannot find on the existing seed market;

2. **Creating alternative food chains** based on diversity is seen as a way to regain independence in their dealings with input suppliers and big retailers;

3. The return to diversity in alternative food chains is one way to meet the new consumer demand for healthy quality food;

4. **The actors involved in the initiatives** are conscious of the limits and impacts of the intensive agricultural model. They would like to create alternative food chains, based on the *"seed to the plate"* concept, with internal coherence all along the chain.

In these locally developed processes, two elements appear to be important for their long term sustainability and success: **(I)** the role of facilitators/brokers, which is played by advisors or other entities such as civil society organisations engaged in the agrobiodiversity; **(II)** sharing the vision, values and beliefs among the actors involved. Both elements are paramount in terms of trust, willingness to cooperate, mutual support and shared commitment. Lack of alignment around values and beliefs may lead to divergences of opinion or even to conflicts in the ways in which the different actors, holders of different knowledge and visions, interact.

THE WAY FORWARD

DIVERSIFOOD project is developing specific policy recommendations aimed at providing an enabling environment for Community Agrobiodiversity Management. With regard to the facilitation/brokering role, there is the need for more detailed research to recognise and support this key role by identifying appropriate forms of support.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Author: *Riccardo Bocci, RSR*

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- **De Boef W.S., Subedi A., Peroni N., Thiyssen M., O'Keefe E. (eds.), 2013,** Community Biodiversity Management, Routledge, New York.
- **Jarvis D., Hodgkin T., Brown A.H.D., Tuxill J., Noriega I.L., Smale M., Sthapit B., 2016,** Crop genetic diversity in the field and on the farm, Yale University Press, New Haven & London.
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7 INTEGRATING SOCIAL ASPECTS IN THE STANDARD GxE INTERACTION

WHAT DOES THE "E" IN GxE INTERACTIONS STAND FOR?

Most breeders would agree that Genotype x Environment Interactions (GEI) are one of the main problems affecting the efficiency of plant breeding programmes, namely their ability to deliver the right benefits to the right people at the right time, even when they make use of genomic selection.

In fact, GEI has been at the centre of the debate between advocates of *"wide adaptation"* and of *"specific adaptation"*. This debate is partly due to the confusion about E: in the literature, E can refer to location (L), or year (Y) or, even worse, a combination of L and Y. Yet, as long ago as 1964, Allard and Hansche specified that GxY and GxL cannot be combined, because the former is largely unpredictable while GxL is to some extent predictable. While decentralised selection can make positive use of GxL interactions by selecting for specific adaptations, the solution for GxY is varieties that are well buffered against unpredictable environmental fluctuations. This can be achieved through individual and population buffering. While individual buffering is a property of specific genotypes, particularly of heterozygotes, population buffering arises from interactions among different genotypes within a given population, beyond the individual buffering of the specific genotype. The advantage of heterogeneous populations is that they exploit both individual and population buffering.

THE COMPLEXITY OF "E" AND THE EXPLOITATION OF POPULATIONS

In the case of GEI, and given the difference between GxL and GxY, it is important to underline that L is not an abstraction but is properly defined as a sample of the target locations addressed by a breeding program. Therefore, with the exception of studies conducted at research stations, L is a real place, inhabited by real people practising agriculture in a given agro-climatic, economic and social context. Consequently, in the GxL component of GEI, L is not only a physical place identifiable on a map, so GxL may actually mean different things depending on how we characterise L. For example, L is usually characterised by soil type, elevation, climate data, but could be also characterised by social/economic indicators such as the poverty index, gender, employment rate, and mean income. The participatory approach, which DIVERSIFOOD emphasized in different WPs is an ideal way to expand the concept of GxL to introduce a social dimension, depending on how well the participants are sampled and characterised. It should be noted that, put in this way, it is worth maintaining L in its customary agro climatic connotation, and in adding S to the formula G x Y x L, which then becomes G x Y x L x S, to explicitly indicate the socio-anthropological component in GEI.

THE WAY FORWARD

The science of evolutionary plant breeding (also known as bulk breeding) dates back to 1929 (Harlan and Martini 1929) and has been the subject of extensive research, which has demonstrated the ability of evolutionary populations and of mixtures to evolve in the direction of higher yield, higher stability (lower GxY) and greater disease resistance. However, despite all the scientific evidence, with very few exceptions, evolutionary populations and mixtures never became widely grown. DIVERSIFOOD emphasized the importance of social interactions in plant breeding, promoting the practical exploitation of populations in agriculture. Building on what already began with the EU project SOLIBAM (2010-2014, www.solibam.eu), on one hand, DIVERSIFOOD is extending the investigation on evolutionary population on a wide range of crops, and on the other, is encouraging farmers to use evolutionary populations as crops.

Authors: *Salvatore Ceccarelli and Riccardo Bocci (RSR)*

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8 ACHIEVING FARMERS' RIGHTS THROUGH COMMUNITY BIODIVERSITY MANAGEMENT

Since the dawn of agriculture, farmers all over the world have sown, harvested and selected seed and actively exchanged these resources among themselves. In so doing, they have developed an amazing abundance of crops, their knowledge and skills paved the way for the food crops we use in agriculture and breeding today. This indispensable contribution has gone largely unrewarded. Moreover, the global transformation of agricultural systems increasingly threatens their important role. That is why an entire article of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty) is devoted to Farmers' Rights (Art. 9).

THE PLANT TREATY

The Plant Treaty is a legally binding international agreement adopted in 2001, aimed at the conservation and sustainable use of plant genetic resources for food and agriculture, facilitated access to these for research, breeding and training purposes, and the equitable sharing of the benefits derived from their use. Protecting and enhancing Farmers' Rights is crucial to achieving the Treaty's objectives as it is a precondition for farmers continued contribution to the global genetic pool (Andersen and Winge, 2013). Realizing Farmers' Rights is also a central means for seed sovereignty and food security.

The Plant Treaty does not oblige countries to undertake specific measures, rather it leaves it up to national governments to define the contents and realize these rights. Important elements are proposed, i.e. **(1)** the protection of traditional knowledge; **(2)** the right to equitable benefit sharing; and **(3)** the right to participate in relevant decision making at national level. It also addresses **(4)** any rights that farmers have to save, use, exchange and sell farm-saved seed and propagules. Implementation of Farmers' Rights has been slow, due to conflicts of interest between the seed industry and farmers engaged in biodiversity management (Andersen 2008). The Governing Body of the Plant Treaty is its highest decision-making body and convenes biennially. In 2017, it decided to develop options for the realization of Farmers' Rights to guide and assist the Contracting Parties. This decision was regarded as a breakthrough for Farmers' Rights under the Treaty.

COMMUNITY BIODIVERSITY MANAGEMENT

DIVERSIFOOD project has been closely involved in the negotiations under the Plant Treaty and is represented by two members in the expert group mandated to draft the options for the realization of Farmers' Rights. DIVERSIFOOD has also studied community biodiversity management (CBM) in depth, with a particular focus on community seed banks, and organised an international side event in Kigali (Rwanda, Nov. 2017) to exchange experiences between the North and the South (Andersen et al. 2018). During this work, it became clear that the rapid development of community seed banks worldwide and related participatory initiatives, are expressions of a rapidly expanding CBM movement. Moreover, it turned out that while directly contributing to the conservation and sustainable use of crop genetic diversity, this movement is also an important platform for the realization of Farmers' Rights:

- Traditional knowledge is vital for understanding the properties of plants, their uses, their cultural significance and how to grow them. Traditional knowledge can refer to preventing their extinction as well as their misappropriation. Some CBM initiatives have provided platforms for sharing this knowledge and for defining what is needed to prevent misappropriation. Other initiatives have deepened and expanded this traditional knowledge, and as such, can be viewed as knowledge hubs.
- The right to participate in benefit-sharing is central to recognising farmers' contributions to the global genetic pool as well as to stimulate and promote their continued contributions. The most successful forms of benefit-sharing so far are facilitated access to seeds and propagules for farmers through community seed banks and seed networks and the sharing of knowledge and technology between breeders/scientists and farmers, e.g. through participatory plant breeding. CBM initiatives provide platforms for a variety of benefit-sharing approaches.
- The right to participate in national decision making is important to ensure that national policies are in line with the needs of the farmers involved in agricultural biodiversity. There are not many good examples in this regard, but CBM representatives are increasingly invited to participate in surveys and are being consulted in hearings. This points to the potential for CBM initiatives to act as platforms for participation in decision making at the national level.
- *"Any rights that farmers have to save, use, exchange and sell farm saved seed"* is the vaguest provision in the Plant Treaty, but at the same time the most important in terms of Farmers' Rights. If farmers are not allowed to continue these practices, they will not be able to contribute to the global genetic pool. Legislation on intellectual property rights, variety release and seed distribution are among the laws that represent barriers to this practice. CBM initiatives provide a platform for advocacy as well as the development of systems of practices to save, use, exchange and sell farm saved seed that may circumvent the law.

OUTLOOK FOR FULL IMPLEMENTATION OF FARMERS' RIGHTS

So far, the realization of Farmers' Rights is mostly bottom up, through CBM initiatives (Andersen and Winge, 2013). As such, these initiatives provide important examples from which options for the realization of Farmers' Rights can be derived. The challenge is to scale up the positive experiences to the national level and to mainstream Farmers' Rights in national policies and legislation, to create the synergies required for the full realization of Farmers' Rights.

Author: *Regine Andersen, FNI*

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- **Andersen R, Shrestha P, Otieno G, Nishikawa Y, Kasasa P and Mushita A (2018).** Community Seed Banks – Sharing Experiences from North and South. Paris: DIVERSIFOOD. www.diversifood.eu/publications-old/booklets-and-reports

9 RAISING AWARENESS ABOUT COMMUNITY SEED BANKS


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COMMUNITY SEED BANKS AS A GLOBAL MOVEMENT FOR COMMUNITY AGROBIODIVERSITY MANAGEMENT

Collective seed management is a practice which emerged towards the end of the 1970s. It developed in reaction to agricultural modernisation and industrialisation as well as the inter- and intra-national trade and intellectual property right policies which accompanied it and which led to a globally integrated agro-food system. The roots and evolution of Community Seed Banks (CSBs[5]) -as well as the current context in which they function- can be traced along a broader social and geopolitical timeline. A critical understanding of the forces that have shaped CSBs in different contexts identifies these experiences as a global movement contributing to new approaches to seed systems in the framework of Community Agrobiodiversity Management (CAM).

INTEGRATING EXPERIENCES FROM NORTH AND SOUTH IN INNOVATIVE SEED SYSTEMS

DIVERSIFOOD project payed particular attention to understanding the current functions and to shaping an enabling environment for Community Seed Banks, using a global approach. CSBs mainly aim to address the loss of agro-biodiversity and to enhance access to seeds adapted to local conditions, not adequately ensured by the market. CSB activities are also interconnected with participatory plant breeding activites at local level. Even if mainly developed in Global South, in recent years, CSBs have been perceived as an interesting practice for Northern countries. DIVERSIFOOD has focussed on experiences in Europe by looking at the potential role of CSBs in innovative seed systems. Based on the multi-actor approach (see chapter 4), DIVERSIFOOD opened a space for sharing experiences and dialogue on CSB issues in Europe.

5 - For more information on CSBs, see DIVERSIFOOD Innovation Factsheet IF#1 "COMMUNITY SEED BANKS"

SUGGESTED READING

- **Koller B, Bartha B, Bocci R, Carrascosa M, Riviere P and Andersen R, 2017.** Community Seed Banks in Europe - Report from a stakeholder workshop in the framework of the DIVERSIFOOD project held in Rome on 21 September 2017.
- **Riccardo Bocci, Chable V, Vernooy R, Marino M, Leahu R, Koller B, Cadima X, Romeo S A, Song Y, Feyissa R, Sy M, Carrascosa M, Riviere P, Dalmasso C, Fenton C, Andersen R, 2018.** Community Seed Banks: dialogue between CSBs representatives and international Institutions. Report from the workshop held on the 22 of September 2017 in Rome at FAO HQ.

SPECIFICALLY, DIVERSIFOOD:

a. Organised a survey on the European CSBs, mapping 84 initiatives in 20 countries (www.communityseeedbanks.org);

b. Organised a workshop in Rome for those involved in the initiatives who participated in the survey and some selected case studies outside Europe (21 September 2017);

c. Organised a workshop at the FAO in Rome jointly with the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and Bioversity International to raise awareness of the importance of CSBs at global level;

d. Organised a side event on CSBs during the last session of the Governing Body of the ITPGRFA in Kigali, November 2017, to present experiences from Global North and South;

e. Participated in the Informal Dialogue Building Linkages to Strengthen On-Farm Management of Farmer's Varieties/ Landraces: Community Seed Banks, organised by the Commission on Genetic Resources for Food and Agriculture, 24 July, 2018, Rome at the FAO.

DIVERSIFOOD integrated experiences gained in Europe and in the global South with the aim of raising the awareness of international institutions such as FAO, Bioversity International and the International Treaty on Plant Genetic Resources for Food and Agriculture and its Parties, as well as the European Union and its member states. DIVERSIFOOD outcomes pointed out the important role that CSBs can play in conservation and sustainable use of plant genetic resources, facilitating the linkages between public gene banks and farmers, gardeners or citizens.

THE WAY FORWARD

A more comprehensive analysis of the experiences of Community Seed Banks of the North and South could lead to better understand the roles of CSBs in developing innovative seed systems. In order to pave the way to these innovative seed systems, it is paramount to develop appropriate and adapted policies and legal frameworks at national, regional and global level.

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- **Andersen R, Shrestha P, Otieno G, Nishikawa Y, Kasasa P and Mushita A, 2018.** Community Seed Banks: Sharing Experiences from North and South – Report from a Side event held 1 November 217, during the seventh session of the governing body of the International Treaty on Plant Genetic resources for Food and Agriculture in Kigali, Rwanda. www.diversifood.eu/publications-old/booklets-and-reports
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10 DELIVERING A MESSAGE FOR A SOCIO-ECOLOGICAL TRANSITION


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After a century of standardisation of agro-food systems, which has contributed to increase productivity, but with many negative impacts such as biodiversity loss, a transition to a new food culture is urgently required. A shift from uniformity and specialisation to diversity from field to plate is needed. DIVERSIFOOD outcomes provide the proof of concept that transitions to more sustainable food systems cultivating diversity can be supported by multi-actor and transdisciplinary approaches. The project has also developed methodological guidelines on how to involve a wide range of stakeholders – from farmer and research communities to the market – in redefining the food system.

CALL FOR A TRANSITION TO A NEW FOOD CULTURE BASED ON DIVERSITY

Uniformity and specialisation have invaded all levels of modern society, affected the entire food production chain and reduced the links between agriculture and living systems, between soils, plants, animals and people. Many consumers are no longer aware of the realities of farming, of the needs of their own body or of the quality of their food.

Organic farming pioneers, including Sir Albert Howard and Evelyn Balfour (1943), have underlined the close connections between the health of soils, plants, animals and humans, meaning all living beings are interdependent. According to this vision, sustainable food systems should be conceived through a comprehensive and systemic approach (or holistic approach).

DIVERSIFOOD embedded all its actions and studies within this *"life-oriented"* and holistic approach, translating it into boosting diversity at all levels:

SUGGESTED READING

- **Albert Howard (1943).** An Agricultural Testament. Oxford University Press, New York and London.
- **Evelyn Barbara Balfour (1943).** The living soil: Evidence of the Importance to Human Health of Soil Vitality, with Special Reference to Post-War Planning, London, Faber and Faber.

- DIVERSIFOOD engaged in recovering and enriching crop diversity by reintroducing underutilised and forgotten species and by applying decentralised and participatory plant breeding methods.
- DIVERSIFOOD has witnessed experiences of bottom-up initiatives and explored the conditions needed to create innovative markets for biodiverse and ocal food products.
- DIVERSIFOOD outcomes promote farming and food systems based on diversity and on the respect of biological processes and of societal needs.
- DIVERSIFOOD outcomes promote community agrobiodiversity management to empower local farming systems.

In doing so, DIVERSIFOOD outcomes support the call *"From uniformity to diversity: a paradigm shift*[6] *from industrial agriculture to diversified agroecological systems"* as advocated by the International Panel of Experts on Sustainable Food systems (IPES-Food 2016).

A RESEARCH COMMITMENT TO A LIFE-ORIENTED APPROACH

In a perspective that puts *"Life"* first - i.e. all living systems with all their diversity and complexities -, DIVERSIFOOD has promoted participatory and multi-actor research and adopted transdisciplinarity (see Chapter 4). While a great diversity of landraces have been stored as genetic resources in gene banks for decades, DIVERSIFOOD has thrown light on the neglected diversity of several underutilised and forgotten species and has evaluated this diversity in networks of farmers in different agro-ecosystems in Europe (Chapters 1 & 2), which (re)discovered our diversified crop heritage with great enthusiasm. In collaboration with networks of producers, processors and consumers, DIVERSIFOOD has tested new breeding strategies to renew and increase the diversity of cultivated plants and its associated knowledge (see IF #2 and Chapter 5). DIVERSIFOOD has described and created links between European Community Seed Banks (Chapter 9), shedding light on these informal seed systems that collectively manage their seeds based on common objectives rooted in shared values, knowledge and rules (Chapters 6, 7 & 8). DIVERSIFOOD has developed a multidimensional approach analysing marketing strategies for biodiverse food products. Moreover, it has studied consumers' attitudes towards food diversity, as well as new labelling concepts and innovative approaches to develop markets for biodiverse food products (Chapter 3).

Adopting a life-oriented paradigm has also been instrumental in renewing concepts for food diversity[7]. The word *"life"*, with its associated meanings and implications, is the cornerstone of the paradigm shift, just as it is for organic movements.

PROMOTING DIVERSITY TO PROGRESS TOWARDS RESILIENCE AND SUSTAINABILITY

The fact that the choice of seed greatly determines farming practices and all stages of the food supply chain right up to consumers' plate, reinforces the original mission of DIVERSIFOOD: *"to provide an alternative food culture"*. The scientific hypotheses, mainly based on mechanic genetic models for plant breeding, need to be broadened when we breed for resilience and adaptation of socio-ecological systems. In organic farming all living beings are linked and evolve together: plant populations bred and multiplied on the farm allow organic agriculture to progress towards resilience and sustainability. Meanwhile, biodiverse and local food products should stimulate a renewed food culture, which would help citizens to (re) connect their existence and their wellbeing with the health of the planet. DIVERSIFOOD outcomes point to significant potential of renewed, sustainable co-evolution of ecological, social and economic systems.

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6 - A paradigm shift refers to a radical change in beliefs or theory.

7 - See DIVERSIFOOD booklet #0 "9 Key-concepts for food diversity"

- **IPES-Food (2016).** From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agroecological systems. International Panel of Experts on Sustainable Food systems. 96 pages. http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf
- **DIVERSIFOOD Innovation Factsheet IF #2 :** Varieties and populations for on-farm Participatory Plant Breeding www.DIVERSIFOOD.eu/publications-old/innovation-factsheets

This **booklet #6** presents and describes 10 novel ideas and approaches that support innovation embedding diversity in food systems from the field to the plate.

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All DIVERSIFOOD partners contributed to this booklet through workshops and exchanges with the authors.

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