

# SOLIBAM - Strategies for Organic and Low-input Integrated Breeding and Management

November 2013

## Newsletter 3

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### Collaborative Project (large-scale integrating project)

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## The new EU regulation on plant reproductive material A diversity perspective...

The 28 October 2013 the European Parliament released its amendments to the new regulation on Plant Reproductive Material (PRM) issued by the Commission last May. The position of the Parliament changes the framework proposed by the Commission on the following points:

1. There are not more exceptions for micro-enterprise with regard to the possibility of marketing variety not registered (for the so-called niche market) and the exemptions from fees for registration;
2. The two systems of VCU (satisfactory + sustainable) suggested by the Commission turn again to be only one, that will include also sustainable characteristics;
3. There is a specific article for heterogenous material (HM), the new 15a, and this material is defined as follows:

“Heterogeneous material’ means plant reproductive material that does not belong to a variety as defined in point (1) of this Article, and is not a mixture of varieties.” This material needs to be registered in a national variety register, according to its officially recognised description. The Commission will adopt delegated acts setting out the conditions under which heterogeneous material may be made available on the market:

- (a) The genera or species to which the provisions of this Article may apply;
- (b) Requirements concerning the labelling and packaging of the heterogeneous material concerned;
- (c) Modalities of making available on the market in a manner ensuring that such modalities do not constitute a barrier to the registration and marketing of the heterogeneous material concerned.

At the same time the European union is setting up a temporary experiment to allow limited marketing of populations in order to check the conditions under which heterogenous material will be put on the market. Any Member State may participate in the experiment, but they shall inform the Commission accordingly. In the draft working paper on this experiment, heterogenous material is defined as such:

1. 'Population' means genetically diverse material of plant species bred through half diallel crossing of several identified varieties, lines or other material.
2. 'Composite cross populations (CCPs)' mean populations that are generated by inter-crossing genetically diverse varieties, lines or other material, bulking the F1 or F2 progeny and then exposing the stock to natural selection in successive generations.'
3. Other dynamic populations may be generated by variations on the CCPs model which may include different crossing protocols, or the introduction of individual plant or mass selection among the generations of natural selection.
4. [Populations may also be generated from a mixture of varieties mixed and additionally growing the mixture for at least one year.]

At the moment this experiment will involve only the following crops: wheat, barley, oats and maize.

## Identify traits for organic/low-input systems

Workpackage 1

Veronique Chable (INRA)

The first workpackage of the project has gathered umbrella activities. During all the duration of the project, WP1 has been collecting and analysing information obtained about the scientific concepts of "organic" varieties and the organic professional context (from farmer to the market). The Task 1.1 study provided data where existing published information is scarce. This study, based on surveys, also aims to describe which varieties farmers grow, why, and the organic stakeholders' expectations in plant breeding over a wide range of different agro climatic conditions in Europe, identification of the varieties currently grown by the organic producers; reasons for their variety choice; producers' expectations for organic varieties. This work aimed to identify the key research questions/hypotheses in an European perspective: useful plant traits for organic and Low Input (LI) agriculture may differ considerably from one country to another depending on the agroecological conditions and on the market, e.g. two main market categories have been clearly identified from the French stakeholders' answers. These categories and results fit with the hypothesis that the market is a significant factor influencing the choice of seeds and varieties. Expectations and practices of producers selling on a local market (i.e. direct sale) differ radically from those of producers selling to large retailers. The results had been presented during the last EUCARPIA meeting in September 2013.

WP1 of SOLIBAM has provided some concept definitions. One issue is our vision and definition of "low input agriculture", this precision was frequently asked to the consortium. Recently, an overview about innovation within organic systems has illustrated how SOLIBAM sustains stakeholders'



Farm days 21012 in France. Pierre Rivière (PhD INRA) is presenting French WP6 farmers' results on wheat

initiatives, seven case studies from the project are shortly described taking into account the "diversity hypothesis" at various levels in the entire food system to improve the performance, quality, sustainability and stability of crops adapted to organic and low input systems (deliverable D1.2). The most important issue of the second period has been the list of specific concepts and their first definition corresponding to SOLIBAM strategies. They are collected in a printed booklet for dissemination to a large public: (1) Resilience, (2) Robustness, (3) Functional biodiversity, (4) Yield stability, (5) Adaptability, (6) Intercropping, (7) Sustainability, (8) Evolutionary processes, (9) Organoleptic quality, (10) Participatory research.

Within SOLIBAM trials in WP3-6, we have been testing traits and combination of traits for organic and low-input agriculture based on the experiences of the partners since the beginning of the project. Now, we aim to evaluate the relative effect of crop management/environment and of plant breeding, as well as the benefit of increasing the diversity on crop performance in the framework of many trials performed to test the relevance of the hypothesis of a beneficial effect of diversity to answer to the questions of professionals and farmers. Even if trials have their own logical dealing with the general context of the WP, they will be analysed through an overall/global approach and discussed to feed the concepts elaborated during the last year of the project.



Farm days 21012 in France. Field visit in the ARDEAR Rhone Alpes (Raphael Baltassat)



# Identify and monitor genetic diversity

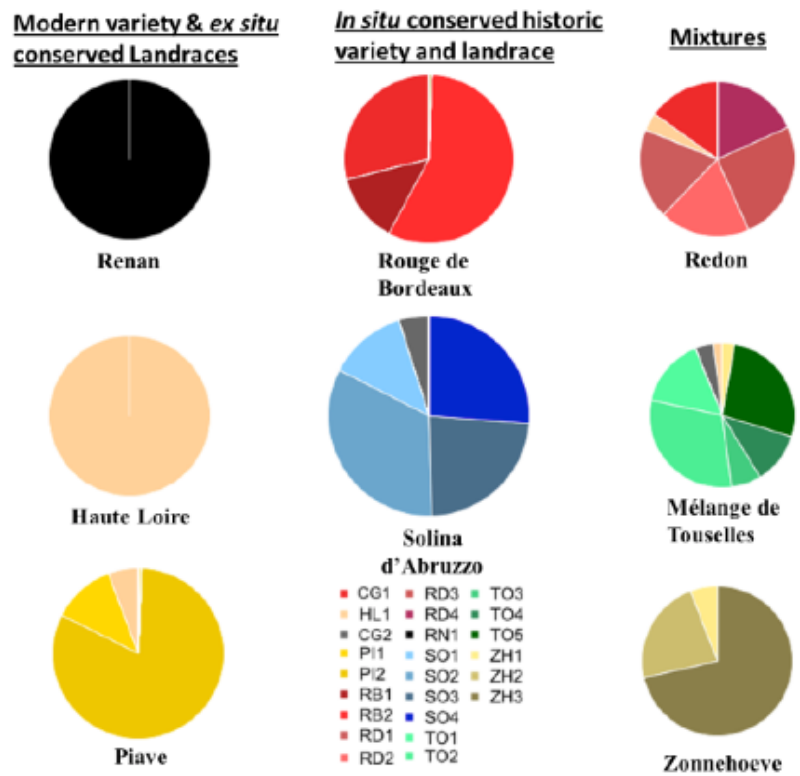
## Workpackage 2

Isabelle Goldringer (INRA)

Breeding for organic and low-input (LI) farming implies working with complex traits controlled by many genes interacting with each other and with complex and variable environments. Molecular markers can help understanding the genetic and epigenetic bases of traits important for adaptation to organic or LI conditions as well as monitoring diversity under selection within the breeding process. Solibam WP2 is an analytical workpackage where markers have been developed or adapted to be used in the species/populations of interest in Solibam (barley, durum wheat, bread wheat, maize, broccoli, bean, tomato). In a second step, the populations derived from the different workpackages WP3, WP4, WP5 and WP6, have been studied with different sets of markers depending on the species. Up-to-date and complementary methods have been used to : (i) detect the genetic structure of the populations, (ii) characterise the spatial and temporal differentiation among populations, (iii) detect markers or genes submitted to selection, (iv) identify polymorphism associated to traits of interest. Many results are already available, a few examples are given below :

RISO-DTU and INRA-Le Moulon used molecular markers to study the evolution over 3 years of six 3-ways barley mixtures grown under organic conditions. Among the six mixtures, three did not change significantly in proportions over time while two had stochastic variations and only one mixture showed a trend for one variety to become dominant. For most of the mixtures, the yield and the mixing effect after two or three generations were slightly lower than those of the first generation. This study opens new perspectives to identify components for mixtures that maintain their beneficial properties over time.

Inra-Le Moulon used 74 SNP markers to analyse the genetic structure of seven wheat farmers varieties (ex situ conserved landraces, on farm conserved landraces and historic varieties, on farm conserved mixtures) and a modern variety, and their spatial and temporal differentiation after three generations of cultivation in Italy, France and the Netherlands under contrasted agroecological conditions. The genetic structure of the resulting 56 sub-populations (1650 individuals) was rather consistent with their history of conservation and management : ex situ conserved varieties were less diverse, had a lower number of genetic group with simpler structure of haplotype while the on farm managed varieties had a higher diversity, with more groups and a more complex network of haplotypes. In the on farm mixtures, new genotypes were detected indicating that



Genetic structure of the 8 bread wheat varieties. Size of the pie chart is proportional to the number of individual studied, Different colours correspond to different genetic groups.

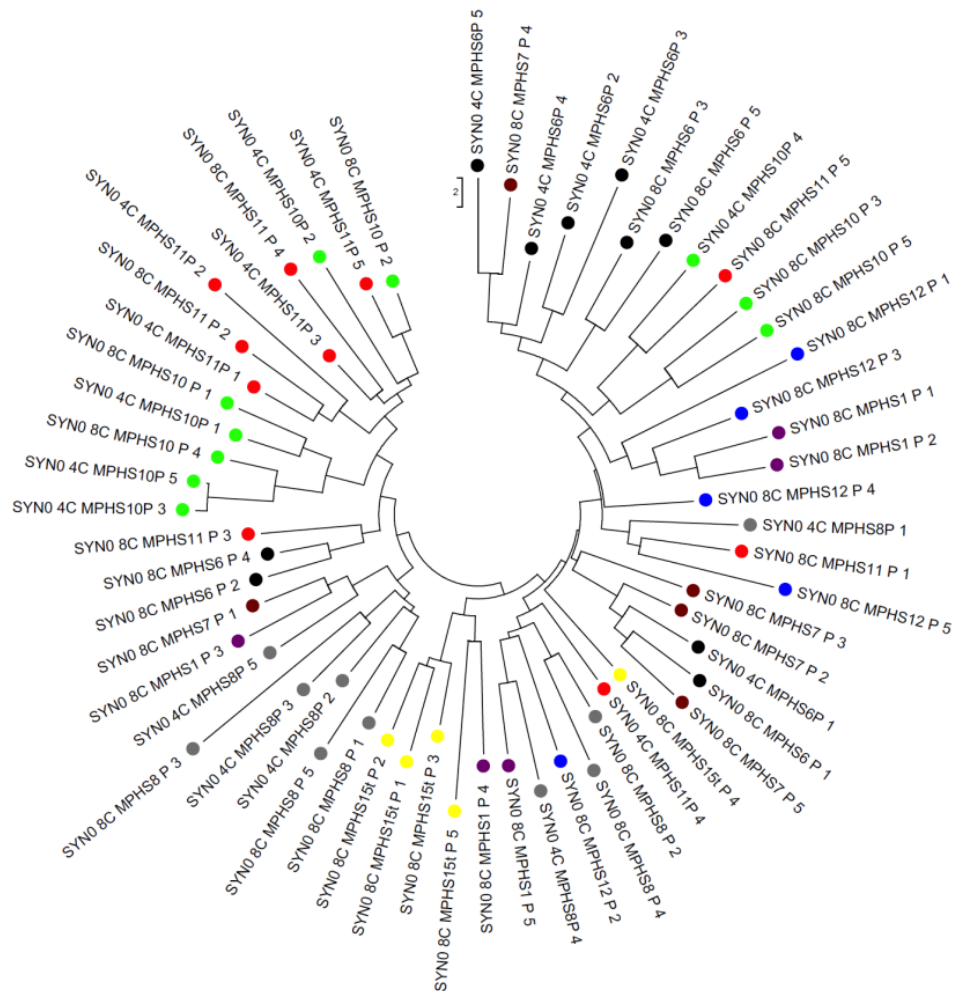
recombination was allowed by the low outcrossing rate. Spatio-temporal differentiation among sub-populations was detected both at the phenotypic and genetic level. The most diverse varieties responded in a larger way and some candidate genes were detected as under selection. Some quasi-monomorphic varieties showed phenotypic evolution ; these will be good candidates to test for epigenetic changes. Further analyses are ongoing.

ITQB analysed the evolution of the genetic diversity at 20 SSR markers in a maize synthetic population (developed in 2010 in WP6, ESAC) cultivated under different agro-climatic conditions and farmers mass selection. No significant differences were detected among the genetic diversity parameters evaluated between cycles of selection and the AMOVA analysis showed that variation among selection cycles represented only a fraction of the total molecular variance observed, showing that the PPB VASO was effectively conserving genetic diversity within populations.

UNIPG developed 2 synthetic populations derived from one broccoli landrace (WP5). They have been studied using 17 neutral SSR markers and 6 EST based SSR markers (candidate genes for climatic adaptation). In both populations, the inbreeding coefficient was close to zero consistently with the outcrossing mating system of broccoli. High within population

genetic diversity together with a significant family structure was found for both populations indicating a high variability available for breeding. Yet, the two populations were not significantly differentiated among each other.

SSSUP studied 116 accessions of *Triticum turgidum* ssp *dicocoides*, 25 of *T. turgidum* ssp *dicoccum*, 90 Mediterranean and 120 Ethiopian *T. turgidum* ssp *durum* and 93 *T. aestivum* with 46 polymorphic SSR markers and 191 polymorphic and reliable SNP markers obtained from a panel of 384 SNP. The different analyses of genetic structure detected four groups with a clustering of emmer and wild emmer while the origins (Mediterranean and Ethiopian) of *T. turgidum* durum remained distinct.



Neighbor-joining tree of genetic distances among broccoli genotypes from two synthetic populations reveals the presence of several clusters and sub-clusters. Genotypes from the same family are identified with the same colour.

## Exploitation of diversity in breeding

### Workpackage 3

Sally Howlett (ORC)

As outlined in the first Solibam newsletter, the overall aim of WP3 is to increase and utilise diversity in crops in organic and low-input systems to improve performance and quality in the face of increasing environmental variability. In the three years since Solibam started in 2010, partners involved in WP3 have carried out a range of activities, including generating new diversity through selected crosses, evaluation of broccoli and tomato lines for performance and taste as well as numerous field trials comparing different breeding strategies (e.g. landraces, variety mixtures and composite cross populations).

The project has up to one more field season to go depending on the crop, and preliminary analyses are underway. Highlights include interesting results from France concerning genetic versus environmental impacts on the flavour of diverse broccoli populations. Although environment seems to have a stronger effect than genotype on the taste characteristics of broccoli e.g. bitterness and sweetness, nevertheless specific 'regional' flavours can be detected and this is being investigated as a potential selection criterion for broccoli breeders. In the cereal trials, large differences in yields have been observed between sites and management systems, with some early indication that it may be possible to separate winter wheat populations into two groups which are better suited either to organic

or low-input conditions on the basis of yield components. Furthermore, novel assessments of spikelet asymmetry in wheat suggest that this measure might be used as a stress indicator, although future analyses are needed to investigate this further. There are extensive links between WP3 and other WPs within Solibam. This is well-illustrated by the tomato trials in which the main outcome of WP3 has been to generate seeds from tomato populations developed through two rounds of selection. From the end of 2013, these seeds will feed into WP7 to investigate organoleptic qualities, WP5 for further breeding activities and WP6 to undergo participatory breeding.

Some early results have been published by partners as posters at international conferences and the Solibam congress in 2012. Moving forwards, in-depth analyses combining data on given crops from across different countries will provide an integrated picture of the potential to breed crops specifically for organic and low-input agriculture that will perform and deliver stability under highly heterogeneous environments.



Farm days 2012 Italy. Renzo Torricelli (PhD) and Valeria Negri (UNIPG) present their Solibam barley trials in Perugia.



# Diversity in management: unravelling its potential to improve organic and low-input systems

Workpackage 4

Paolo Bàrberi and Gionata Bocci (SSSUP)

WP4 aims to design, develop and test innovative arable and vegetable cropping systems based on a high level of agrobiodiversity: diversification within and between crop species, management and habitat, coupled with use and development of genetically diverse germplasm. Activities are deployed across a range of different pedo-climatic conditions in Europe (Atlantic, Continental, Mediterranean) and Sub-Saharan Africa (Sudano-Sahelian, semi-arid highlands). Novel organic and low-input cropping systems based on optimum use of agrobiodiversity have been designed by taking into account the genotype (G), environment (E) and management (M) components together.

Trials protocols differ among WP4 partners, but common treatments across sites are used wherever possible; it is thus a challenge to drawing general conclusions, but some preliminary trends can already be seen.

annual systems show a generally positive effect of increased species and management diversity, whereas the effect of increased genetic diversity still needs to be elucidated. The only trial on intercropping in perennial systems, only focused



Farm days June 2012. SSSUP wheat trials - Pisa (Italy)

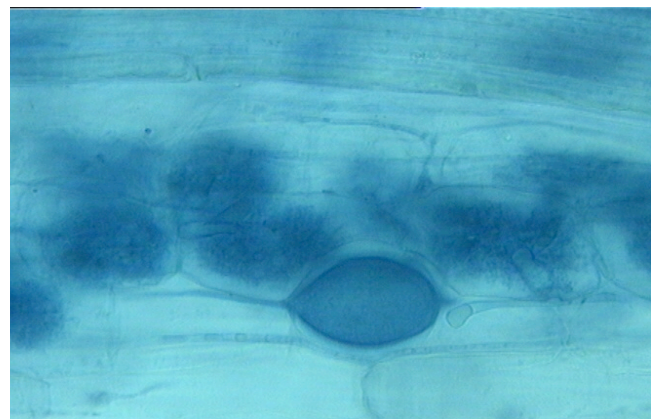


Farm days June 2012. SSSUP wheat trials - Pisa (Italy)

In wheat trials the effect of increased genetic diversity seems generally positive, whereas that of increased species diversity is strongly dependent on the type of practice (positive for preceding green manure crops, negative for legume living mulches). In contrast, in the maize trial increased species diversity (preceding green manure crop) seems to be a more promising approach than increased genetic diversity. A similar trend seems to occur in the tomato trials, where inoculation of arbuscular mycorrhizal fungi showed some promising results, e.g. on fruit quality. The trials on intercropping in

on species and management diversity, showed that some promising solutions exist.

Intercropping shows clear benefits when the two components are more similar (e.g. wheat-barley intercropping) whereas is more challenging when the two components are different (especially in wheat-legume living mulches). Use of wheat composite cross populations (increased genetic diversity) seems an interesting option, but performance of the same CCP in different environments is highly variable, and sometimes poor. Regarding the two agroecosystem services

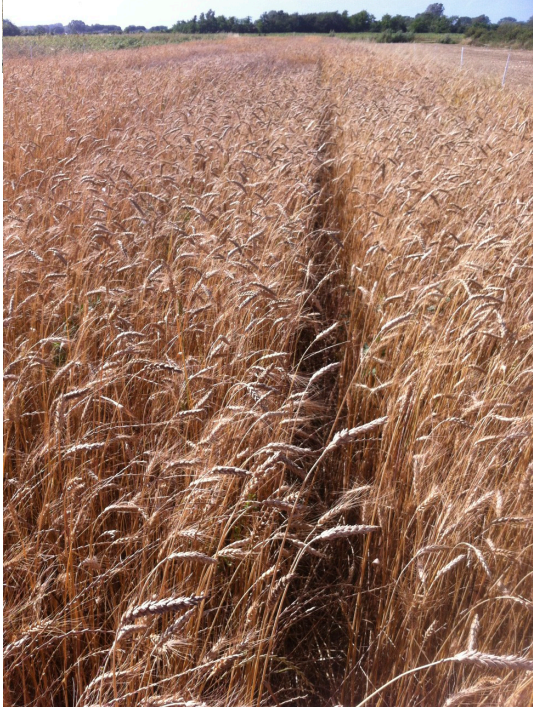


Arbuscular mycorrhizal structures (arbuscules and a vesicle) in a colonized tomato root (Photo: Ezekiel Mugendi Njeru).





On the left: Veronique Chable during a farm day in Rennes (France).  
 Bottom: SSSUP wheat trials- Pisa (Italy)  
 Participants involvement: spike selections within the plots of heterogeneous population



which are more relevant to this WP, namely crop yield and weed suppression, it must be noticed that traits conferring them are not often correlated, therefore reliance just on increased genetic diversity is probably insufficient to meet the goals. As such, careful choice and combination of genetic, species and management components is likely to be the most fruitful approach anywhere, but WP4 trials can only partially provide solutions as to this.

(i.e. choice of the right component) seem more important than increased genetic or species diversity per se. This reinforces the hypothesis that increased functional diversity, i.e. inclusion of the genetic, species and management components possessing the right for a target environment, is more likely to improve crop yield and weed suppression than increased general diversity.

In any case, it is clear that the best solution can only be found locally. In this respect, it is interesting to notice that in many of the WP4 trials genetic or species identity



## Comparison of conventional/organic breeding

Workpackage 5

Peter Miko (HAS)

The overall objective of WP5 is to compare the effectiveness of different breeding strategies under low input and certified organic farming conditions, in order to optimize breeding for varieties that would be suitable for organic and low input farming. The main questions will be answered by the findings of four separate tasks:

Assessment of genetic resources for further breeding activities (Task 5.1):

Hundreds of gene bank accessions and landraces of several autogamous (wheat, barley, durum, einkorn, emmer), allogamous (broccoli, maize) and partially allogamous (faba bean) species had been successfully characterised in field experiments under organic and low input management conditions. This work was completed with Focused Identification of Germplasm Strategy (FIGS) concept carried out by ICARDA. Research works are already finished, and the identification of the useful genetic sources for organic breeding could be successfully served in the future by the findings of this task.

Development of common methodology for early stage selection (Task 5.2):

Results of the selection works could be obtained only in the end of the project. Selection in several crop populations (wheat and synthetic Triticum populations, broccoli, maize, common bean, faba bean, tomato) was succeeded, and selected lines were established for the last season. In case of some species small plot trials have already begun to compare the yielding parameters of lines selected under different management conditions by different selection methods, and these lines will also be analysed in WP7 for quality traits.

Comparison of the already existing selected materials both under low input and organic management systems (Task 5.3):

The same large scale comparative trial (ring test) was established for 3 years at four different countries with the same varieties of durum and bread wheat grown under organic and low input growing conditions. As the ring test has finished in 2013, some preliminary evaluation has already

been carried out, but final results will be obtained only after the quality analyses (in WP7) of the last harvest. Durum trial showed big differences between sites and varieties originated from different breeders, and bread wheat trial revealed the differences between the varieties obtained by 3 different breeding strategies (organic breeding, conventional breeding and breeding for organic agriculture-BFOA). Organically bred wheat varieties differed from the conventional varieties at all sites, which shows the great influence of the site chosen for breeding, but main characteristic traits of them seem to be more disadvantageous (later heading, taller plants, lower yield). Main positive character of organically bred wheat varieties are the higher protein content and yield-stability. Nevertheless, BFOA could be a good alternative to give organic farmers appropriate wheat varieties, because it develops varieties with better agronomic traits than the organic varieties. In addition, Marker Assisted Selection was also carried out on bread wheat lines in Austria in order to select common bunt resistant breeding lines under organic conditions.

Students of the Agronomy School of Sevilla (Spain) in front of Solibam Faba beans' trials (Agrovegetal, Spain).







Farm days in Switzerland in June 2012. Rosalie Aebi (ART) presents SOLIBAM wheat trials

Development of appropriate organic maintenance breeding systems – with post-harvest technology – for true organic seeds for the organic sector (Task 5.4):

Model species of organic maintenance breeding are 2 alternative cereals: einkorn and emmer, while 2 bread wheat Composite Cross Populations are used to test the effects of post-harvest technologies. Organic maintenance breeding and post-harvest approaches are also



Farm days in Switzerland in June 2012. Aerial photo of the experimental site during the field visit in 2012

carried out using vegetable model species, tomato and broccoli in France, where results will be obtained only in last year. In addition, a trial with organic einkorn variety, Mv Alkor is examining the effects of different seed production strategies (certified seed, farm saved

seed, seed produced separately on-farm) under organic growing conditions in the last 2 years of the project.

According to preliminary results, there is a need for organic maintenance breeding, because some species (einkorn) showed susceptibility to herbicides. To get more evidence, a trial was also established for the last year to compare in details the certified seeds of the same einkorn and emmer varieties originated from 2 different maintenance conditions (several generations grown on organic or on low input field). In case of preliminary findings of post-harvest technologies, new breeding techniques could be suggested to be applied in organic breeding of Composite Cross Populations using seed cleaners with appropriate sieves as tools for mass selection. According to the preliminary results of different seed production strategies, the certified organic seed, produced by official breeders has the highest purity and germination rate, while seed produced on farm seems to be more valuable than farm saved seed, because it has higher clarity in terms of weeds, impurities and foreign varieties than the farm saved seeds. Moreover, farm saved seeds has lower germination rate than seed produced on-farm. Further results will be obtained in the end of SOLIBAM.

## Participatory plant breeding and management

Workpackage 6

Salvatore Ceccarelli and Adnan Al Yassin (ICARDA)

The trials on hanfets were evaluated for a second season in the same three locations as in 2012, namely in Habes, Korem and Hawzien, under low and high input conditions for a total of 6 location x management combinations. The experimental material includes three pure barley (Burguda, Embaye and Fetina), three pure wheat (Mekelle 1, Mekelle 2 and Kubsa), and the 9 possible barley-wheat combinations each with two seed ratios between barley and wheat, namely 60:40 and 25:75 for a total of 24 entries. The three local hanfets used by farmers in the three locations were added as checks. Compared with 2012, plot size is increased this season to facilitate the note taking on disease incidence and severity.

The partially replicated design was used, where each local hanfets was replicated 10 times, while the remaining entries were replicated once. For each of the 6 location x management combinations, independent randomization was conducted using PRDiGger software to optimize the randomization by distributing the replicated treatments in a balanced way across the design. Because of the combined use of partial replication and optimized randomization these trials contribute to both task 3.2.2 and task 6.2.

The second stage PPB trials. After conducting stage 1 at 12 location x management combinations in 2012, the selected entries for grain yield and farmers' score from each combination were used in these trials. Selection was conducted independently in each location x management combinations. Same entries were included, as in stage 1 trials, there include; 30 F<sub>3</sub> bulks provided earlier by ICARDA, eight entries selected from a multi location trial initiated before the beginning of SOLIBAM and eight checks (four landraces and four improved varieties, including the two recent releases, Fetina and Hiriti). Excluding checks, there are 32 selected lines under high input, 24 under low input and 13 under both management conditions. However, only 5 lines were never selected.

It was decided to lump selected entries all together in one same trial, because of the small number of selected lines, irrespective if these entries were selected under low or high input or both. Therefore, the trial specific for that location

will be planted under both low and high input. All the trials will have the same eight check varieties which will allow continuing to monitor the repeatability across years of Genotype x Location interaction. Except Habes location, which has the lowest number of entries selected, the trial will have only 40 plots in 2013, while at the other five locations the trial will have 60 plots.

New first stage 1 PPB trials. These trials include a second group of the early bulks derived from targeted crosses in which one or both parents are local germplasm. In 2013 there will be 32 new bulks tested in the same 12 location x management combinations described for the Stage 2 trials. The trials include the same eight checks (four landraces and four improved varieties, including the two recent releases, Fetina and Hiriti) included in stage 2 trials.

Also in the case of PPB trials stage 1, the experimental design used is the partially replicated design described earlier, using PRDiGger to generate optimized randomizations.

In the case of the PPB trials stage 1, there will be 60 plots in each location x management combination with a total of 28 plots allocated to the checks (four checks repeated three times and four checks repeated 4 times).

Task 6.3: Impact of participatory plant breeding on the creation and the management of diversity (ICARDA will contribute germplasm for barley trials in Africa; collect data to characterize the effects of farmer's selection on traits and diversity; and contribute to methodology development and data assessment.



Preparation and harvest of the field trial in Tuscany (Italy).





Let's Cultivate Diversity 2, organised in June 2013 in the organic farm of Floriddia family (Pisa, Italy).  
On the left: Visit of field trial with Salvatore Ceccarelli

Bottom: One of the bread workshops



Evolutionary population. This evolutionary population was assembled at ICARDA in 2011 by mixing the seeds of 798 F<sub>2</sub> including crosses in which one or both parents are local landraces. The population was multiplied in Mekelle in the 2012 off season, and in June 2012 was planted in five different locations: Habes, Hageresalam, Mugulat, Mekelle and Ayba. We expect relatively large amount of seeds this year. Seed sample (4 kg) of each generation will be stored under safe conditions. Therefore, at the time of 2013 planting we should have:

1. A sample of the remnant seed of the original population (the seed received from ICARDA);
2. 5 samples of about 4 kg of the seed harvested in 2012

Seed to be planted in same locations in which it was harvested, namely the seed harvested in Habes will be replanted in Habes, the seed harvested in Ayba will be replanted in Ayba and so on. Farmers in the neighborhood requested seeds from the evolutionary population in 2012. These requests should be accommodated as much as the seed availability permits. However, MU staff should keep track of the spreading of the evolutionary population.

In 2012 a proposed scheme of barley germplasm flow was developed at MU in the hypothesis that ICARDA will not be in the position to supply barley breeding material based on adapted germplasm. Likewise, to ease the use of the evolutionary population as source of breeding material for the future PPB trials, single spike selection started in 2013. For this purpose the evolutionary population is better planted in strips about three meters wide and of variable length depending on the shape and size of land available. It is also important that at heading a meeting with farmers is organized in each location, at the same time of scoring the PPB trials, to discuss the management of the evolutionary populations. Seed of selected spikes will be increased in the 2014 off-season on the MU campus with irrigation, and, if the seed produced is not sufficient to establish the PPB stage 1 trials in 2014 season, again in the normal 2014 season. Therefore, the first PPB stage 1 trials with material derived from the selected spikes from the evolutionary populations, will be established in 2015. Then issues to be addressed this October with MU include; the number of spikes to select in each location and input level and whether to have one set of PPB stage 1 trials or location-specific PPB trials.





Participatory quality testing of bread in France. The test was organised by INRA, ITAB with the support of Triptoleme.  
**On the left:** the breads to be tested: 3 varieties x 3 environments and 5 bakers  
**Below:** Samples of bread prepared for organoleptic evaluation with "napping" method



## Breeding/management effects on crop quality

Workpackage 7

Marianna Rakszegi (HAS)

Organoleptic, nutritional and end-use properties of the breeding lines and populations developed under WP3-6 were studied in the frame of WP7 taking into consideration the global and local needs and expectations of the consumers. Properties were studied on plants grown at different agro-climatic conditions using different breeding techniques and crop management systems.

Hedonic tests with large panel of consumers as well as sensory analysis with trained juries were carried out in order to select the preferred organic cereal, legume and vegetable genotypes by consumers. A methodology was developed in order to integrate organoleptic quality criteria in breeding programs of tomatoes, broccoli and bread. This tasting guide recommend four different tests, and explains how to prepare samples and how to analyse the results. This guide provided a useful method for all those partners who are planning to study organoleptic quality of vegetables or bread.

Nutritional properties, such as antioxidants, proteins or starch were also measured to evaluate the health related effects of the organically bred lines.

Tocol contents and phenolic composition of 32 bean accessions were quantified while phenolic compounds present in beans' coat and cotyledons were characterized

Effect of soaking and cooking on phenolic composition of common bean (*Phaseolus vulgaris* L) were studied. Phenolic composition of traditional Portuguese varieties of maize and corresponding "Broa" were explored. Differences in chromatographic profiles were verified between maize flour and corresponding "Broa". How does final phenolic composition in "Broa" is influenced by gastric and intestinal digestion is planned to be answered. Volatile compounds in traditional Portuguese varieties of maize, from flour to bread were determined and new volatile compounds were identified in "Broa", possibly related to processing.

The effect of the breeding strategy and field management (organic, low-input, conventional) on the protein and starch content were determined using 35 wheat varieties, 10 CCPs and 20 variety mixtures.

Dietary fiber content of the CCPs and variety mixtures were measured and significant differences were identified between the lines.





Participatory quality testing of bread in Italy during Let's Cultivate Diversity 2, organised in June 2013 in the organic farm of Floriddia family.



End-use quality (breadmaking, pasta making etc.) of the lines were measured while the expectation of the consumers and the requirements of the processing related to special local products were taken into consideration.

Baking quality of regional maize varieties were assessed through sensory and instrumental evaluations of 'broa' bread. Commercial 'broa' had the lowest mean score for all the attributes evaluated. However, the 'broa' from a special maize genotype showed the highest mean scores, characterized as 'appealing color', 'excellent yellow color', 'great taste', 'good flavor', 'nice texture', 'ideal humidity', and 'most tastily' by sensory analyses.

The effect of the breeding strategy and field management on the end-use properties of wheat

(physical, compositional and breadmaking) were determined using 35 wheat varieties, 10 CCPs and 20 variety mixtures

The effect of the breeding strategy and field management on the end-use properties of durum wheat (physical, compositional, colour, pasta-making) were determined using 15 durum wheat varieties and 2 CCPs.

The effect of the breeding strategy and field management on the end-use properties of barley (physical and compositional) were determined using 7 barley varieties. Results will finally support the breeders, the agronomists, the processing industry and last but not least the consumers.



## Sustainability assessment of innovations

### Workpackage 8

Hanne Østergård (Risø-DTU)

Some of the results obtained in the work package on Environmental, economic and social sustainability assessment has been published. The journal *Sustainability* has recently published the paper "How eco-efficient are low-input cropping systems in Western Europe and what can be done to improve their eco-efficiency". This publication reviews recent evidence from Life Cycle Assessment (LCA) on the relationship between the level of inputs applied to cropping systems and their eco-efficiency, measured as the ratio of its production to environmental impacts. Various cropping systems interventions have been reviewed that can improve this ratio. Authors suggest that optimum input rates for eco-efficiency can be lowered by utilizing positive synergies between crops to minimize nutrient losses. Breeding, increasing diversity, no-tillage or intercropping are some of the strategies that can be effective to achieve this goal. Eco-efficiency can also be improved by utilizing locally produced organic waste; both from within the farm as well as from the surrounding sociotechnical environment. LCA helps to evaluate various improvement scenarios and shows environmental trade-offs resulting from their application. The article and its supplementary material can be fully accessed online at <http://www.mdpi.com/2071-1050/5/9/3722> (no subscription needed).

Also a PhD thesis partly financed by SOLIBAM has been finalized (Markussen MV 2013: Sustainability assessment of food and bioenergy systems in a societal context – in a time of crisis. DTU, Denmark). Here is analysed energy self-sufficiency in farming, energy required to produce food in relation to the nutritional value of the food and resource use in a small-scale, low-input organic vegetable production. The latter relates to SOLIBAM. A case study of a small-scale low-input organic vegetable farm in United Kingdom with high crop diversity and a related box scheme is analyzed based on energy analysis which is an environmental accounting method where flows of energy and materials from nature as well as the society are evaluated based on the direct and indirect use of available energy measured in solar equivalent Joules (seJ). The case is benchmarked against two modeled organic



Wp8 meeting in Zurich, October 2013

systems, which produce the same amount of vegetables as the case farm, however with a much reduced crop diversity and either low or high inputs and crop yields. Further, the modeled systems are embedded in a supermarket distributed food supply system. The results show that the case food supply system uses 13 - 20% less resources (measured in seJ) than the modeled systems and even more when taking direct and indirect labor into account. Further, the food distribution system from the case farm is at least three times as resource efficient as the modeled systems and it is argued that the case system, is in many ways more resilient than the modeled systems due to its high degree of diversity and autonomy.

In another study organic agriculture and sustainable practices have been analysed and a typology of innovative farmers is developed. The factors that influence the choice of organic farmers to innovate for more sustainable practices that go beyond the strict limits imposed by the certification are identified. Using survey data collected from 352 Italian and Portuguese certified organic farmers, a probabilistic model was estimated. The results show that farmers, in particular women, longest engaged in organic farming are more likely to adopt sustainable practices. They also indicate that farm size, landownership, the existence of some types of complementary activities and the sources of information used by farmers affect the adoption of such practices.



## Dissemination activities: farm days in 2012

In 2012 SOLIBAM partners organised 28 farm days in Spain, Italy, France, United Kingdom, Austria and Switzerland involving farmers, scientists, bakers, consumers, policy makers, technicians and processors.

Farm day 1	
Date	11 May 2012
SOLIBAM Partner involved	INRA
Name	CBD Cultivons la Biodiversité en Poitou-Charentes
Country	France
Village	17510 Fontaine-Chalandray
Species	Wheat – legumes association
People involved	Scientists from INRA, members of CBD (Farmers and extension)
Farm day 2	
Date	May 5 <sup>th</sup> 2012
SOLIBAM Partner involved	INRA - ITAB
Name	Triptolème
Country	France
Village	Peaule (56)
Species	wheat
People involved	scientists, farmers, millers, bakers, extension services and consumers
Farm day 3	
Date	29 – 30 September 2012
SOLIBAM Partner involved	INRA
Name	AgrobioPerigord
Country	France
Village	Le Change
Species	Maize
People involved	scientists, farmers, millers, policy-makers, extension services and consumers
Farm day 4	
Date	1 <sup>st</sup> October 2012
SOLIBAM Partner involved	INRA
Name	CBD
Country	France
Village	Dissay
Species	Wheat - maize
People involved	scientists, farmers, extension services
Farm day 5	
Date	12/06/12
Name	Jean Sébastien Gascuel
Country	France
Village	63360 Gerzat
Species	Bread wheat
People involved	farmers, scientist, citizens, cooperative
Farm day 6	
Date	26/06/12
SOLIBAM Partner involved	INRA
Name	Romain Wittrisch
Country	France
Village	28270 BREZOLLES

Species	Bread wheat
People involved	farmers, scientist, citizens, cooperative
Farm day 7	
Date	30/06/12
SOLIBAM Partner involved	INRA
Name	CETAB (Jean François Berthelot)
Country	France
Village	47130 Port-Sainte-Marie
Species	Bread wheat
People involved	farmers, scientist, citizens, baker, policy maker
Farm day 8	
Date	02/07/12
SOLIBAM Partner involved	INRA
Name	Graines de Noé
Country	France
Village	21220 Épernay-sous-Gevrey
Species	Bread wheat
People involved	farmers, scientist, citizens
Farm day 9	
Date	02/07/12
SOLIBAM Partner involved	INRA - ITAB
Name	Triptolème (Florent Mercier)
Country	France
Village	49080 Bouchemaine
Species	Bread wheat
People involved	farmers, scientist, citizens, bakers
Farm day 10	
Date	06/07/12
SOLIBAM Partner involved	INRA
Name	François Cazeirgues
Country	France
Village	30320 Bezouze
Species	Bread wheat
People involved	farmers, scientist, citizens
Farm day 11	
Date	06/07/12
SOLIBAM Partner involved	INRA
Name	Kerna un sohma
Country	France
Village	67120 Duppigheim
Species	Bread wheat
People involved	farmers, scientist, citizens
Farm day 12	
Date	09/07/12
SOLIBAM Partner involved	INRA - ITAB
Name	ARDEAR Rhone alpes (Christian Dalmasso)

Country	France
Village	38690 Torchefelon
Species	Bread wheat
People involved	farmers, scientist, citizens, bakers
<b>Farm day 13</b>	
Date	10/07/12
SOLIBAM Partner involved	INRA - ITAB
Name	ARDEAR Rhone Alpes (Raphael Baltassat)
Country	France
Village	74380 Bonne
Species	Bread wheat
People involved	farmers, scientist, citizens, bakers
<b>Farm day 14</b>	
Date	12.6.2013
SOLIBAM Partner involved	Saatzucht Donau
Name	Probstdorfer Saatzucht GmbH Farm and Seed production unit
Country	Austria
Village	Probstdorf
Species	Wheat, barley, spelt, triticale, peas, soybean....
People involved	2000 – 2500 people Family Gohn-Mauthner – owner of the farm and company Probstdorfer Saatzucht. Farmers, neighbours, people from the city Policymakers; Maire of the city Großenzersdorf Ernst Zimmerl; Agricultural Attaché in Hungary V. V. Németh Zsolt, State Secretary of Hungary Stefan Pernkopf – member of provincial government = county agricultural governor; Krista Kummer– most prominent “weather forecast lady” of Austrian television ORF.  Associations and Companies dealing with organic cereals in Austria: Bio Austria, Bio Austria Marketing GmbH, Bioland Markt Deutschland, Mauthner Bio, Österreichische Biomühle (organic mill) Hans Hofer; Several representants from organic commodity stock holders.
<b>Farm day 15</b>	
Date	28 <sup>th</sup> June 2012
SOLIBAM Partner involved	ORC
Name	Wakelyns Farm Open Day
Country	UK
Village	Nr. Fressingfield
Species	Wheat, barley, beans, broccoli
People involved	ORC staff, non-ORC scientists (UK-based and overseas), farmers, vegetable growers, National Trust (UK), Organic Arable.
<b>Farm day 16</b>	
Date	9 – 5 - 2012
SOLIBAM Partner involved	AgroVegetal
Name	Jornada Tecnica de FAECA
Country	Spain
Village	Escacena del Campo

CULTIVONS LA BIO-DIVERSITÉ EN POITOU CHARENTES

**SOLIBAM 'Blé Poitou'**  
Echanges et Observation  
essai co-sélection céréales/légumineuses

**Vendredi 11 Mai 2012 – de 10h45 à 16h30**  
– 17510 Fontaine Chalandray –

*Observation d'essai de légumineuses associées aux céréales*

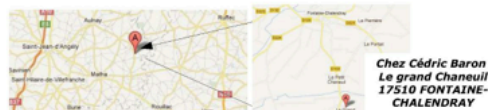
MATIN : 10h45 à 13h

- Observation des essais de Cédric Baron
  - Semis d'une plateforme de multiplication de variétés anciennes
  - Semis de blé associé à un semis de printemps : pois, féverole, luzerne trèfle blanc, violet, Alexandrine.
- Partage des expériences de chacun des participants du programme :
  - Présentation via des photos des expérimentations
  - Exposition des rotations qui ont pu être effectuées

**Pour le repas du midi n'oubliez pas votre pique nique !** APRES-MIDI : 14h à 16h30

- Questionnement autour des essais de légumineuses
  - Quelles sont les objectifs recherchés ? Y a-t-il eu des essais ou non ?
  - Avec quelles légumineuses souhaitez-vous travailler (semences fermières, espèces et variétés...)?
- Se préparer pour la suite de la campagne
  - Quelles nouvelles étapes d'observation cruciales pour évaluer l'association végétale
  - Rappel de l'organisation pour la récolte
- Questions divers

Participation: Estelle SERPOLAY (INRA)



Pour faciliter l'organisation de cette journée merci de confirmer votre participation auprès de : Thibaud: 05 49 48 91 06

Contact: En partenariat avec: Avec le soutien financier:

Species	Faba bean
People involved	Farmers and some experts
<b>Farm day 17</b>	
Date	13 – 4 - 2012
SOLIBAM Partner involved	AgroVegetal
Name	Students of Agronomy School of Cordoba ETSIAM
Country	Spain
Village	Escacena del Campo
Species	Faba bean
People involved	Agricultural engineers students
<b>Farm day 18</b>	
Date	13 – 4 - 2012
SOLIBAM Partner involved	AgroVegetal
Name	Students of Agronomy School of Cordoba ETSIAM
Country	Spain
Village	Escacena del Campo
Species	Faba bean
People involved	Agricultural engineers students
<b>Farm day 19</b>	
Date	17 – 4 - 2012
SOLIBAM Partner involved	AgroVegetal
Name	Students of Agronomy School of Sevilla ETSIA
Country	Spain
Village	Escacena del Campo
Species	Faba bean
People involved	Agricultural engineers students
<b>Farm day 20</b>	
Date	June 14 2012
SOLIBAM Partner involved	ART
Name	1 Bioackerbautag (1 <sup>st</sup> farmday for organic arable farming)
Country	Switzerland
Village	Lindau

Species	Soft winter wheat (presented by R. Aebi and J. Hiltbrunner) but other things were presented by other partners
People involved	Farmers, scientists, extension services, stakeholders, teachers of agricultural schools
<b>Farm day 21</b>	
Date	5 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Stazione Sperimentale di Granicoltura, Giuseppe Li Rosi
Country	Italy
Village	Caltagirone
Species	Wheat, barley
People involved	Policy makers, scientists, farmers, extension services or stakeholders (bakers)
<b>Farm day 22</b>	
Date	8 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Andrea Pitton
Country	Italy
Village	Rivarotta
Species	Wheat, barley
People involved	Policy makers, scientists, farmers, extension services or stakeholders (bakers)
<b>Farm day 23</b>	
Date	12 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Rosario Floriddia
Country	Italy
Village	Peccioli
Species	Wheat, barley
People involved	Policy makers, scientists, farmers, extension services or stakeholders (bakers)
<b>Farm day 24</b>	
Date	12 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name (farmer/s, farm or association)	Scuola Superiore Sant'Anna
Country	Italy
Village	Pisa
Species	Wheat
People involved	Scientists, extension services
<b>Farm day 25</b>	
Date	13 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Oriana Porfiri
Country	Italy
Village	Urbisaglia
Species	Barley
People involved	Extension services
<b>Farm day 26</b>	
Date	14 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Modesto Petacciato
Country	Italy
Village	San Giuliano di Puglia
Species	Durum wheat



People involved	Farmers, extension services
<b>Farm day 27</b>	
Date	14 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Ilaria Ruggiero
Country	Italy
Village	Matrice
Species	Barley
People involved	Farmers, extension services
<b>Farm day 28</b>	
Date	15 <sup>th</sup> June 2012
SOLIBAM Partners	AIAB-ICARDA
Name	Valentino di Benedetto
Country	Italy
Village	Castellaneta
Species	Wheat, barley
People involved	Farmers, extension services



## Dissemination activities: SOLIBAM on the cloud!



<https://vimeo.com/channels/518750>



<http://www.flickr.com/photos/64755801@N05/>



<https://www.facebook.com/Solibam?ref=hl>

## Next meetings and events

**18-19 February 2014 - Munich (DE) - SOLIBAM Annual meeting**

**07-09 July 2014 - Nantes (FR)**

### **SOLIBAM Congress**

**Diversity strategies for organic and low input agricultures and their food systems**

<https://colloque.inra.fr/solibam>

#### **The Congress key concepts are:**

1. Sustainable breeding targets – resilience, robustness and yield stability
2. Functional biodiversity, including intercropping
3. Sustainability
4. Evolutionary processes and adaptation
5. Participatory research and breeding

The key concepts will be covered by six sessions:

#### **Plenary**

Transdisciplinary research for organic and low-input agricultures

#### **Parallel Sessions**

- A. Diversity for robustness, resilience and yield stability
- B. Diversity for functional biodiversity, specific adaptation and evolutionary processes
- C. Diversity for quality in organic systems "soil to fork"
- D. Sustainable food supply systems from diversity

#### **Plenary**

Agriculture for a future society: challenging paradigms

#### **Abstract submission**

You are kindly invited to submit an abstract to present a paper or a poster for the SOLIBAM Congress. The Scientific Committee will select the abstracts received. The list of the papers and posters and their abstracts will be included in the CDrom that will be available for the participants of the Congress.

**Call for oral presentations and posters:** November 2013

**Registration open:** 1st December 2013

**Deadline for submission of abstracts:** 31st March 2013

**Deadline for early registration fee:** 30th April 2014

**Closing registration:** 20th June 2014

**Early-bird registration fee:** 50 € (including VAT)

**Late registration fee:** 70 € (including VAT)

**In Collaboration with COBRA Project**





SOLIBAM  
Snapshots from  
Let's cultivate  
diversity 2013 in  
Italy





# The 23 SOLIBAM Partners

Institut National de la Recherche Agronomique (France)



Associazione Italiana per l'Agricoltura Biologica (Italy)



The Organic Research Centre, Elm Farm (UK)



Technical University of Denmark, DTU (Denmark)



Institut Technique de l'Agriculture Biologique (France)



Technical University of Munich (Germany)



Instituto de Tecnologia Quimica e Biologica (Portugal)



Agencia Estatal Consejo Superior de Investigaciones Cientificas/Instituto de Agricultura Sostenible (Spain)



Escola Superior Agraria de Coimbra (Portugal)



Centre for Agricultural Research, Hungarian Academy of Sciences (Hungary)



Scuola Superiore Sant'Anna, Pisa (Italy)



University of Perugia (Italy)



Agroscope Reckenholz-Taenikon Research Station ART (Switzerland)



Institute of Food and Resource Economics (Denmark)



INRA Transfert (France)



University of Pisa (Italy)



## Crop breeding companies

Saatzucht Donau - cereal breeding (Austria)



Gautier Semence - vegetable breeding (France)



Agrovegetal - legume breeding (Spain)



Arcoiris - vegetable breeding (Italy)



## Institutions from African countries and international organisation

International Center for Agricultural Research in the Dry Areas (International)



Coordination Nationale des Organisations Paysannes du Mali (Mali)



Mekelle University (Ethiopia)



<http://www.solibam.eu>

For information: [r.bocci@aiab.it](mailto:r.bocci@aiab.it)