

SOLIBAM

Strategies for Organic and Low Input Breeding and Management



Breeding innovation

As worldwide food demand increases, concern over how to meet it grows. **Dr Riccardo Bocci** tells us about a research programme investigating strategies for organic and low-input breeding and management aimed at enhancing sustainability and crop performance in Europe and Africa

Firstly, could you provide an overview of the context from which the project was developed?

Low-input and organic farming systems require crop varieties that are specifically adapted to these environments. The particular conditions of these systems should therefore be considered during breeding activities, not only from an agronomic and biological point of view, but also a social and economic perspective. For example, organic farmers in most cases have developed different selling methods from those of conventional producers, relying more on local or direct sales. This means they have the responsibility to sell quality produce, usually having to diversify to include a number of species and varieties in order to meet consumer needs.

All these requirements should be considered in crop breeding programmes, not only to increase production but also to address the breeding per management interaction, as is the case with the SOLIBAM project aimed at enhancing sustainability and crop performance.

Climate change is also an emerging issue that agricultural systems are battling and which will become a weighty burden in the future. Increasing the diversity of agroecosystems will produce more resilient agriculture, better adapted to climate change. Breeding programmes should take into account this issue, working more on population than homogenous varieties. Low-input and organic systems constitute the perfect environment for diverse varieties or population crops to grow.

However, these changes all need a new research paradigm and SOLIBAM will support this shift. This will be seen from market-driven agricultural research – increasingly in the hands of private companies – to decentralised and participatory research where public institutions can again find their place and play a pivotal

role. In this way, technical innovations and knowledge of organic farmers will be shared and enhanced through breeding methods.

The general aim of SOLIBAM is to pursue diversity, trying to answer the following questions: How can we increase the diversity of our farming systems and how is this diversity related to cultural practices? What is the relation between cultural practices and varieties, and how can cultural practices (eg. green manure, intercropping, weed management) impact the adaptability of genotypes to different environments? Moreover, how could diversity be included in our seed laws that at the moment only protect, promote and allow the commercialisation of uniform varieties? And finally how is diversity related to environmental, social and economic sustainability of farming systems?

Can you outline some of the research activities that are carried out in order to achieve the aims of the project?

SOLIBAM will conduct field trials on the following species: wheat, maize, barley, tomato, cabbage, broccoli, faba beans; common beans and some African species. These trials will be conducted using organic conditions and farmers' fields, rather than solely in a research laboratory or station. In fact, our aim is to develop a breeding method for organic agriculture and low-input agriculture that includes farmers in its process and exploits genotype-environment interactions. The population of these crops will therefore be analysed in different agroecosystems using diverse technical practices with the objective of testing an assortment of breeding methods in organic and low-input conditions. To this end, innovative tools such as molecular markers will be utilised to assess and monitor the diversity in varieties and population. The SOLIBAM farms will also



be evaluated to assess their socio-economical-environmental impacts.

Specific attention will be paid to dissemination and training activities, which will be targeted to different audiences: farmers, scientists, extension services; policy makers and consumers.

Could you explain the use of 'farm days' within your dissemination strategy? How are these events conducted and how do they help the project to fulfil its objectives?

Farm days will act as the main tool for the dissemination of project outcomes among farmer communities. They will be held separately in each country twice per year, to enable breeders, farmers, extension services and researchers involved in the work packages to share the skills, information, and knowledge generated with neighbouring, non-participating farmers. These days will also be used to distribute project booklets and other material from the stakeholder congresses, and as a space for discussion of both the project results as well as other related topics with farmers.

Digging for diversity

SOLIBAM is seeking to enhance the potential genetic diversity at crop and farm level to stabilise organic and low-input farming systems and enable adaptation to environmental changes

FIERCE DEBATE SURROUNDS the promotion of organic farming at present and huge pressure is being put on scientists to refine organic production to support forecasts for future population growth. Sustainability is synonymous with efficiency and energy-consciousness but at times can prove less cost-effective and more complicated to pursue than conventional approaches. However, at our current rate of population increase and with today's toxic pesticides, these careless farming methods cannot continue. Embracing organic agriculture seems the most viable option to ensure food enough across the world, not only now, but for the future.

SOLIBAM (Strategies for Organic and Low Input Breeding and Management), is an EU programme for enhancing diversity in European and African agriculture that started last year and is finishing in 2014. Led by Dr Véronique Chable, and in line with the recent report, 'International Assessment of Agricultural Knowledge, Science and Technology for Development', the programme is generating tools to analyse the sustainability of different food supply systems developed as a result of innovative breeding and management strategies. This will be considered in terms of the bio-physical flow of energy and matter; resilience to external factors such as climate change and instability in the global economy, as well as the relation to local and regional communities and their economies and needs. SOLIBAM will study a number of cases in

organic and low-input farming and food supply systems in the involved countries and show how future farming systems can be shaped to meet the needs of our society.

OVERCOMING CHALLENGES

The major exciting challenge facing SOLIBAM is showing that organic and low-input systems can be improved by local selection of new varieties and populations of crops used in local production methods, integrating farmers' innovations and experience. The project also aims to promote local consumption, ensuring that communities are sustained by the foods they produce, contributing to high quality food and better health. Local consumption would in turn save energy and money on transportation and export costs as well as creating jobs and wealth in these rural areas.

Trying to understand the relationship between genotype and phenotype diversity in plant biology is a key feature of the project. The phenotype is the product of three factors: genotype, environment, and the practices of man – which is what the SOLIBAM team is focusing on. Particular attention will be paid to quantifying the effects and interactions of breeding and management innovations on crop nutrition and taste.

A crop's ability to utilise its environment effectively depends on the interactions of many genes with the environment. By

INTELLIGENCE

SOLIBAM

STRATEGIES FOR ORGANIC AND LOW-INPUT BREEDING AND MANAGEMENT

OBJECTIVES

SOLIBAM's overall objective is develop specific and novel breeding approaches integrated with management practices to improve the performance, quality, sustainability and stability of crops adapted to organic and low-input systems, in their diversity across Europe and taking into account small-scale farms in Africa.

KEY COLLABORATORS

INRA, France • **AIAB**, Italy • **ORC**, UK • **RISO-DTU**, Denmark • **ITAB**, France • **TUM**, Germany • **ITQB**, Portugal • **IAS**, Spain • **ESC**, Portugal • **ARI HAS**, Hungary • **SSSUP**, Italy • **UNIPG**, Italy • **FDEA-ART**, Switzerland • **UCPH**, Denmark • **INRA Transfert**, France • **UNIPI**, Italy • **Donau**, Austria • **Gautier**, France • **Agrovegetal**, Spain • **Arcoiris**, Italy • **ICARDA**, Syria • **CNOP**, Mali • **MU**, Ethiopia

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DR RICCARDO BOCCI is an agronomist born in Rome and lives on an organic farm on the hills around Florence. His primary interest is the sustainable use of agricultural biodiversity and related policies. He is leader of SOLIBAM WP9 on dissemination and training.

DR VÉRONIQUE CHABLE is working on cauliflower breeding, genetic, epigenetic and plant development researches in INRA, especially on Brassica genetic resources. She is now involved in the scientific development of participatory plant breeding with French organic farmer networks, for several species all over the country.



enhancing genetic diversity, SOLIBAM will study improvements in adaptation, how they occur and how they can be better managed.

By studying the genetic and genomic effects of environment that influence plant quality, such as management practices, the project will reveal genetic and epigenetic mechanisms controlling plant plasticity in response to environmental stimuli. It is expected that this will lead to methodologies that improve plant performance and quality in different environments.

Such a study will require in-depth analysis of the mechanisms involved in adaptation: "SOLIBAM will develop new statistical and/or quantitative population genetics methods to apply to breeding populations in order to identify and monitor DNA markers, genomic segments or epigenetic markers associated with phenotypic trait responses in the populations submitted to the selection pressures (eg. agro-climatic conditions, crop management systems and selection practices)," explains one of the researchers.

COMBINING OLD AND NEW

SOLIBAM unites existing techniques with novel genome sequencing and genotyping by high-throughput methods. The aim is to fully exploit methods already in use and to integrate any new approaches with specific breeding methods for organic and low-input (LI) conditions. Dr Riccardo Bocci is keen to emphasise that the project is asking questions that may address new concepts, mainly about the holistic approach to agriculture, but it is also exploring the conventional food chain and our consumption behaviours: "It is not necessary to modify organic techniques, by for example, using pesticides or GMOs, but it is paramount to change the way food is thrown away," he explains. "Each year in Italy 17 million tonnes of food goes to waste. How can we tolerate this system as it stands?"

In SOLIBAM, integrated approaches to crop management will help to exploit crop diversity to enhance crop performance and the quality of the produce in different contexts. Specifically, it is expected that inclusion of legumes in association with arable and vegetable crops and the diversification of cropping systems will increase delivery of agroecological services that have consequences for agronomically important outcomes such as crop yield, yield stability, weed suppression and soil fertility. Specific attention will

be paid to arbuscular mycorrhizal fungal (AMF) communities, which are an important component of soil fertility in organic and low-input systems, facilitating crop nutrition through symbiosis.

THE ROAD TO SUSTAINABILITY

The agricultural sector in Europe and its long-term success could be improved by innovative projects like SOLIBAM that are boldly seeking to understand the role that diversity plays in sustainability, not only within crop varieties, but also favouring crop associations or non-cultivated diversity.

Having partners in different countries will enable SOLIBAM to form policy proposals that will consider the needs of the various stakeholders as well as their role in different farming systems. Organic farming varies substantially across Europe depending on socioeconomic and geographical conditions, and this factor needs to be recognised by the project's mission as the researchers assess and enhance crop diversity. The programme will also analyse and develop breeding and management systems in Africa from field to market, where low-input farming systems would benefit greatly from stabilisation and crops that are adapted to environmental changes, such as those brought about by climate change and/or over-farming, diseases and pests, poor soil and difficult weather conditions.

The blend of traditional approaches and local production methods with novel, scientifically-grounded analyses and cultivation techniques, ensures that cultural and regional values will be complemented rather than substituted, to form a lasting relationship with innovative agricultural research. By involving farmers, the project hopes to reduce costs but increase both crop performance and research efficiency, acting as what Bocci terms 'a promoter of local innovation', mediating between farmers, their associations and research organisations and private seed companies. So far, the project has concentrated on establishing this network since it began in March 2010. To highlight the magnitude of such a task, Bocci explains that it even proved challenging to find a language comprehensible to such diverse partners, let alone easily replicable farming methods. The team has, however, successfully managed to perform both and have organised the sowing of cereals ready for their research to begin.

