EU-SOL - High Quality Solanaceous Crops for Consumers, Processors and Producers by Exploration of Natural Biodiversity

Email newsletter no 1, September 2007

- ***Introduction to EU-SOL,*** *interview with project leader Willem Stiekema*
- ***Quality traits perceived by consumers,*** *interview with Mathilde Causse, INRA Avignon*
- ***Key technology in EU SOL,*** *interview with Mark van Haaren, Keygene*

EU-SOL Programme Management Office
Centre for Biosystems Genomics
P.O. Box 98
6700 AB Wageningen
Tel: +31 317 477254
Fax: +31 317 477266
eusol@wur.nl
www.eu-sol.net
Editor: Huib de Vriend. LIS Consult

Introduction to EU-SOL

In November 2006 scientists from several EU member states gathered in Wageningen for a first meeting of the EU-SOL consortium. To get a grasp of what this EU financed project is about, we talked with Willem Stiekema, director of the Centre for Biosystems Genomics in Wageningen and project leader of EU-SOL.

EU-SOL is an international network of plant scientists from universities, research institutes and industry who do research on the development of high quality crops of the Solanacea family: mainly tomato and potato. The consortium brings together expertise across a wide variety of disciplines across the EU and several other countries – from taxonomy to molecular biology to consumer integration.

Why did you pick tomato and potato?

Simply because tomato and potato are the two most important vegetables in Europe. With an annual world-wide production of 125 million tonnes, tomato is an important crop, both in developed and developing countries. A medium tomato (120 g) contains about 23 mg of vitamin C, which covers about 1/3 of the daily need of adults. In addition, tomatoes contain lycopene. It is the one responsible for the red color of tomatoes. Lycopene is a phytochemicals on which many studies have been done. With their actual knowledge, researchers agree that this compound has powerful anticancer properties, especially prostate cancer. Potatoes are the world's most widely grown tuber crop, and the fourth largest food crop in terms of fresh produce — after rice, wheat, and maize. In Europe potato represents some 40% of the seed market and € 4 billion annually.

Is there still a need to improve those crops?

Certainly. Producers are challenged by constraints in plant architecture and development such as fruit set and tuberisation. But we focus on varieties with improved consumer-, processor- and producer-directed traits. Quality and wholesomeness of food and food products are two issues addressed prominently by society. Producers will have to meet with increasing preference of consumers for 'regional' and 'niche' food specialties.

There is also a need to develop more sustainable agricultural production systems and to minimise the use of agrochemicals that are detrimental to the environment. This can only be achieved with combined efforts of farmers and breeders. EU-SOL has the objective to reduce irrigation demands by introduction of abiotic

stress tolerance and to develop marker-assisted breeding strategies which may also be of interest for organic farming practices.

How will EU-SOL contribute to these goals?

Breeding companies are beginning to focus on these trends by the introduction of tastier tomato varieties, but opening up the enormous natural variation present in the Solanaceae by genomics research is needed for true breakthroughs in this field. Genetic variation is the engine that
drives modern plant breeding. EU-SOL will utilize exotic genetic material that was developed over the past 10 years by the Solanaceae community and is already present in gene banks to improve the efficiency of breeding. EU-SOL will participate in the international tomato genome sequencing initiative, so European Solanaceae research and innovation will be tied into the full global activities in this area. We will map, isolate and characterise genes responsible for quality traits and dissect the molecular mechanisms underlying these trait by application of state-of-the-art knowledge and innovative technologies.

Which technologies will be used to achieve this?

I have already mentioned marker-assisted breeding, which has the potential to speed up the breeding process considerably. The state-of-the-art knowledge and innovative technologies includes fully automated DNA sequencing, metabolomics and lots of bioinformatics. We will also use genetic engineering, but we will apply plant genes only.

Can you tell us more about the participants in EU-SOL?

What I just described is the fork-to-farm philosophy, which is addressed throughout the EU-SOL project. This philosophy is reflected by the participation of consumer organizations (envisaged), plant breeding companies, academia, governmental research laboratories and industry.
The majority of the participants work for universities and public research institutes from ten EU-member states, Argentina, Brasil, South Africa, Israel and the West Bank. They perform the majority of the research. We have ten seed companies in our consortium: ENZA, Seminis Seeds, Vilmorin, Syngenta, Rijk Zwaan, De Ruiter Seeds, Nunza, Agrico, Averis and HZPC. They play an important global role in breeding of tomato and potato. Then we have several commercial technology suppliers, such as Keygene, GeneLab, BIOPLANT, Genomex and Metapontum Agrobios. Their participation will assure rapid dissemination and transfer of the results to producers and consumers. SAVEOL and Rougeline are important partners because of their tomato marketing activities.
Most people know little about the origin of tomato and potato and the way modern varieties of these vegetables have been bred. Therefore, the Natural History Museum in London develops education materials on genetics, DNA and genomics, and creates a database on the internet that will make popular versions of the latest knowledge available to the public.
INRA and LIS Consult both look at consumer aspects: INRA is characterizing consumer expectations with respect to tomato diversity (taste and other sensory properties) and LIS Consult together with the Centre for Methological Ethics & Technology Assessment in Wageningen is looking at consumer perceptions and will organize input from European consumer organisations on societal issues related to our project.

When will EU-SOL be a success?

Of course, EU-SOL is meant to lead to the development of new varieties of tomato and potato that will be preferred by the producers and their clients because they meet consumer demands, are beneficial to the environment. But EU-SOL has wider ambitions. The project aims for a paradigm shift in breeding for quality, which makes it an interesting model for world-wide scientific collaboration on innovative research in a wide variety of other crop plants. The establishment of a Technology Transfer Platform will ensure transfer of EU-SOL scientific output to society at large.

Quality traits perceived by consumers

An important part of the EU-SOL project is devoted to the analysis of the biological bases of organoleptic quality traits perceived by consumers. Mathilde Causse from the Genetics and Fruits and Vegetables Improvement Department of INRA in Avignon, explains how this analysis will be done.

EU-SOL puts strong emphasis on so-called consumer preferences. But isn't there already sufficient knowledge about consumer preferences?
Indeed, we already have global knowledge about consumer preferences and expectations concerning flavour, aroma and texture of tomatoes. We know that there are differences in relation to the different use of tomatoes in the different parts and cultures throughout the European Union. But the EU SOL target of improvement of the fruit quality and diversification requires more specific data, which can be related to chemical and molecular characteristics. We are conducting a large scale experiment that will allow a better knowledge of consumer expectations at the European level, and that produce insight in the future potentials of preferences of the different tomato types and varieties.

How will consumer preferences be defined?
At this stage of the project, we are presenting trained panels and consumers in three countries with tomatoes of different varieties (cherry tomatoes, large fruit, and traditional varieties) that have grown under different conditions. We have chosen to do this research in three countries with different traditions of tomato usage: The Netherlands where tomato is only grown in greenhouses, Italy where traditional varieties grown in the field are still important, and France which represents an intermediate situation. We are comparing the results from consumer preference tests to sensory analysis by trained panels, fruit composition and other tools to measure fruit quality.
Over time, we will do several tests that will allow us to evaluate the long-term liking of certain tomato varieties, The result will be a "preference map" that reveals the structure of consumer preferences in terms of sugar and acid content, flavour and aroma, fruit texture and colour. This preference map can be used to identify major traits to improve. Next year we will start experiments that enable us to establish the level of acceptability of each quality component in each country. Special attention will be paid to the identification of tomato varieties with an expected increase in liking (long-term liking), which gives us an indication of their future market potential.

All of this still sounds very much like traditional science. What is the novelty?

Since we want to develop varieties that meet both consumer and producer needs, the relationship between quality traits such as sugar and acid content (consumer needs) and fruit size (producer needs) will be investigated. Genes and regions on the genome controlling fruit size and/or composition in sugars, acids, volatiles and fruit texture will be identified. This information will

be used by the private companies involved in EU-SOL to develop prototypes of tomato lines. These prototypes will then be tested again by panels and consumers to evaluate whether they meet with the expectations

What is the role of the participants in this part of the project?
Four institutes will manage the sensory experiments: The National Institute of Agronomic Research (INRA) in Avignon, the Interprofessionnel Technology Centre for Fruits and Vegetables (France), the Institute of Plant Genetics in Portici (Italy) and Agrotechnology and Food Innovation in Wageningen (Netherlands). This part of the project also involves Saveol and Rougeline, two tomato grower cooperatives strongly interested in sensory quality.

Marker Assisted Selection key technology in EU-SOL

Mark van Haaren is manager business development for Keygene. He is responsible for dissemination of knowledge and technology transfer in EU-SOL. We asked Mark van Haaren to explain why the technology provided by his company is so important for the project.

To start with, can you give us a brief description of Keygene and your position in the company?
Keygene develops novel enabling technologies and applications to support companies and institutes that carry out fundamental or applied genetic/genomic research or that seek to enhance the quality of their product through the improvement of the genetic material used in their industrial processes. The company was founded in 1989, employs more than 110 staff, and is number three in Dutch biotech.
My own background is in molecular breeding research. After my PhD in plant breeding in Leiden, with professor Schilperoort, and a postdoc in tomato breeding at Calgene (US). I worked as an assistant professor molecular genetics for seven years at the Free University of Amsterdam. Since almost 10 years I now work for Keygene first in charge of research projects and now as business developer. In my present function as head of external affairs I maintain the contacts with companies and institutes that deal with research and licensing.

Why is Keygene participating in EU-SOL?
Currently, our company has five shareholders: ENZA Seeds, De

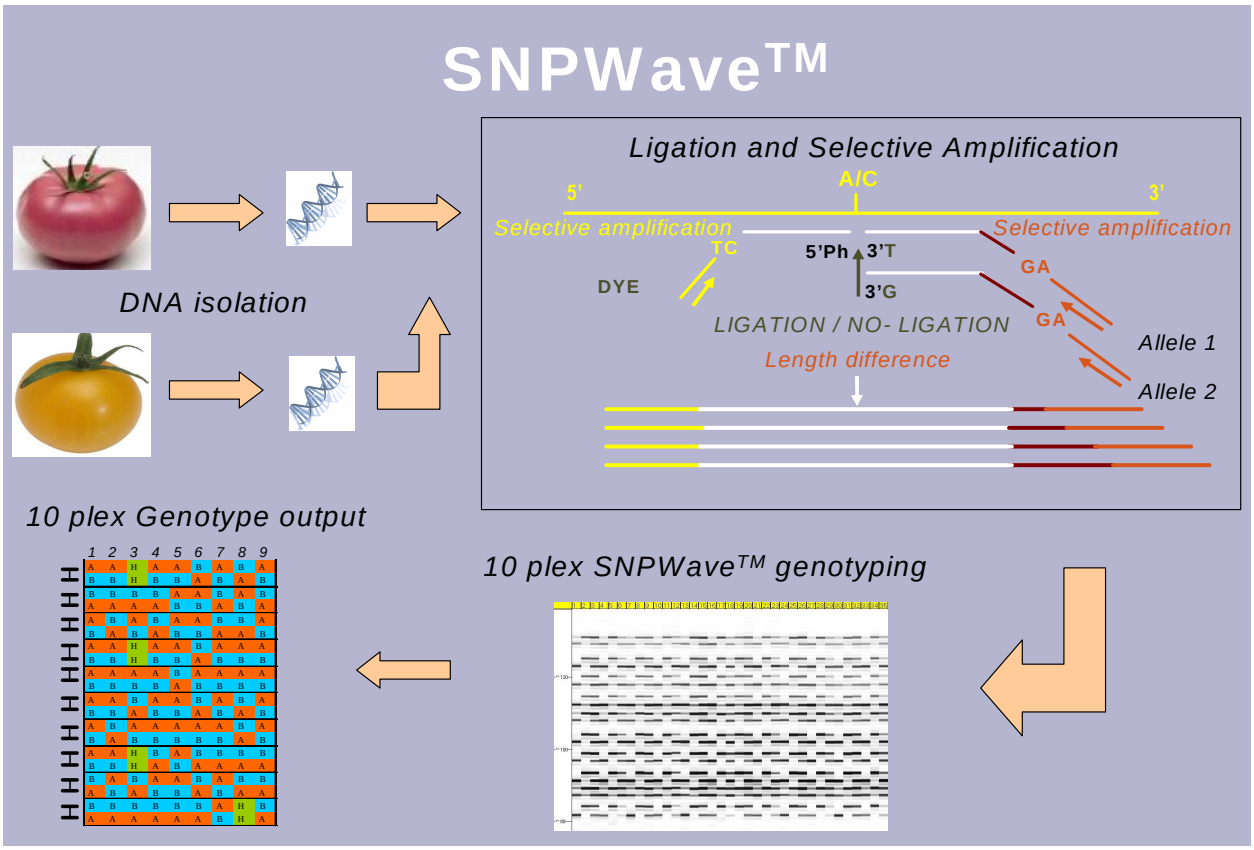
Main players in the vegetable seed industry (Keygene partners in red)

Company	Turnover / year (mln Euro)	Share of world market (%)
Monsanto/Seminis (US)	420	14.0
Vilmorin Clause & Cie (Fr)	346	11.5
Syngenta (Sw)	290	9.7
Sakata (Jp)	175	5.8
Takii (Jp)	180	6.0
Nunza (Bayer Crop Science) (Nl)	170	5.7
RijkZwaan (Nl)	120	4.0
ENZA (Nl)	100	3.3
Bejo (Nl)	90	3.0
De Ruiter Seeds (Nl)	85	2.8
Keygene (Nl)	831	27.7

Ruiter Seeds, Rijk Zwaan, Vilmorin Clause & Cie, and Takii. Together these companies control 27 percent of the world vegetable seeds market, including tomato seeds. This is of course why Keygene and the shareholders decided to participate in EU-SOL.

Can you tell us more about these novel enabling technologies you just mentioned?

In the early 1990's Keygene developed the AFLP® technology, followed by the SNPWave™ in 2000. Both technologies are polymerase chain reaction (PCR) based genetic fingerprinting techniques. The AFLP technology generates a digital picture that represents a kind of fingerprint of the genome. Such fingerprints that are build up by random genetic markers allow us to identify genetic markers linked to interesting traits in plants, animals and micro organisms. These markers are stretches of unique DNA that are always



present in combination with the desired trait, but that have not necessarily a direct relation with that trait. Although the trait is defined by only one gene, or a combination of genes on specific locations at the chromosome, we can use those stretches of DNA as markers.

With the SNPWave technology we can detect a specific predetermined set of single nucleotide polymorphisms (SNPs) (sequence variation present in individual samples) in different genomic regions simultaneously. It is also highly sensitive and reproducible.

How is this technology applied in EU-SOL?

We are setting up a core collection of 7,000 lines that will be analyzed with a SNPWave assay that can detect 15 to 20 markers distributed over the tomato genome. On basis of the SNPWave results the core collection will be divided in several segments for further research, for instance on taste or plant architecture. Thus, we can supply researchers with appropriate material and we can identify genes that are involved in the quality and yield performance of the plants.

The results will then be applied in the breeding practice of the companies that participate in EU-SOL, i.e. our shareholders and Seminis and Syngenta. In principle, this can be done by using our tools for Marker Assisted Selection (MAS) or by applying selected genes via genetic engineering. For the time being EU-SOL will only use genetic engineering as a research tool, to test whether a chosen approach would work. But we are well aware that development of commercial genetically engineered vegetables is not a realistic option right now due to high regulatory costs. Therefore, we will focus on improving precision in conventional breeding with MAS, making it faster and cheaper.