Conference report

European Commission Programme Conference organised by EPSO

Crop genetic improvement technologies for a sustainable and productive agriculture addressing food and nutritional security, climate change and human health

CNR lecture theatre, Milano, 14.07.2015

Plant breeding is key to address food and nutrional security, environmental footprint, climate change and human health. EU researchers and breeders therefore need access to all current breeding tools to strengthen the link between fundamental research, applied research and innovation, and to ensure global competitiveness of the EU agriculture. During the European Commission – EPSO conference on Crop Genetic Improvement Technologies at the World EXPO Milano 2015, expert speakers and an audience of 120 people discussed the potential of the modern plant breeding toolbox to tackle some of the major societal challenges.

Agriculture is a business of profound importance in the EU. With 12 million farms and covering almost 50 percent of EU's land area, the primary production sector provides 25 million people with their livelihoods. At the heart of agriculture is **plant breeding**. This 12,000-year-old enterprise has gone through a revolution in pace and potential during the last century, and particularly the last few decades, with new scientific methods providing us with a previously unimaginable toolbox for crop improvement. The European Commission (EC) asked the European Plant Science Organisation (EPSO) to organize an **EC conference** on Crop genetic improvement technologies in Milano, Italy, on 14 July 2015. The event, part of the official EC programme at Milano EXPO 2015 "Feeding the planet, energy for life" and chaired by ***Aldo Ceriotti*** (CNR, Milano) and ***Chiara Tonelli*** (University of Milano), brought together scientists and representatives of industry, farmers, policy and civil society from all across Europe.

The combination of population growth, global climate changes and demands in food diversification by developing countries imposes **serious global pressure** to agriculture. Due to limited availability of new land for cultivation and a need to preserve wild areas, the most important challenge is to increase production without claiming more land. This means the gap between potential and actual crop yield must be closed, emphasized by ***Ulrich Schurr*** (Chair, Plants for the Future ETP) at the opening of the conference as well as later by ***Ruth Bastow*** (Director, Global Plant Council). What will breeders and farmers in the EU need to address these challenges while being globally competitive? This question by ***Thor Kofoed*** (Chairman, Copa-Cogeca Seeds WG) was answered from slightly different perspectives by the stakeholders at the conference. The Director of the European Seed Association (ESA), ***Garlich von Essen***, claimed that **"genes and brains drive growth"**, as indicated by the 3,500 novel products released each year from the seed sector. A major challenge is therefore to avoid Europe losing too many of them. Globalisation creates higher competition for

innovation, and regulations therefore have to shift from prohibitory to enabling policies. A first suggested step is the introduction of the Familiarity principle in the regulation.

New Plant Breeding Technologies (NPBTs), presented by ***Bernd Müller-Röber*** (Potsdam University) at the opening, make plant breeding faster and more precise and are therefore of commercial and societal interest. Disproportionate regulation of NPBTs may lead to trade barriers, brain and technology drain and competitive disadvantage for European breeders and farmers. Above all, legal certainty is needed, particularly as ***Wayne Powell*** (CSO, CGIAR consortium) later pointed out that a larger fraction of agricultural products will move through global trade in the future. ***Caroline Mahr*** (European Landowners' Organization, ELO) agreed to the potential of NPBTs while adding that we need a sensible attitude to the Precautionary Principle; a science-based policy allowing the link between plant research and innovation must be a priority.

A major issue is the relationship between **fundamental and applied research**. ***Annette Scheegans*** (EC DG Agriculture and Rural Development) called for a stronger link between the two, with the latter one being in the "driving seat" in the challenge-based call topics of H2020. However, basic collaborative research needs stronger support in this programme in the future to achieve a well-balanced research and innovation cycle, ***Karin Metzlaff*** (Director, EPSO) emphasized in the discussion. Translational plant research, transferring fundamental knowledge from model species to trait modification in crop plants, can foster the link between the two.

Since "genes and brains drive growth", we will now take a look at some examples of the potential of contemporary plant research and breeding. Traditional plant breeding has certain limitations that an expanded toolbox with NPBTs can overcome.

Challenge: Plant health: The late blight disease is a major problem in potato cultivation, forcing farmers to spray up to 15 times per season. Grapevine is heavily affected by fungal diseases and requires 65 percent of total fungicide use in the EU, though only accounting for 3 percent of EU agriculture. A fifteen year-long breeding project has successfully introduced fungal resistance into cultivated grape varieties. However, the problem with grapevine breeding is that this species is highly heterozygous: the new varieties are inevitably different from the originals in spite of the multiple backcrosses. Considering the century-long traditions of wine making from preserved cultivars, ***Michele Morgante*** (University of Udine, Italy) pointed out that direct cisgenic gene transfer generates resistant traditional varieties: gene technology is needed for "innovation to preserve tradition". Using cisgenic techniques, ***Richard Visser*** (Wageningen University, NL) has stacked several resistance genes from wild potato relatives to achieve a potato with more durable resistance to late blight. Prof. Visser pointed out that "*as a breeder, I would like to be allowed to use the entire toolkit provided by contemporary biology*". ***Carole Caranta*** (INRA, France) demonstrated the significance of translational research, when genes enabling resistance to plum pox virus were first identified in the model plant *Arabidopsis* and then modified in apricot through gene silencing, induced mutations and screening for natural variation. Resistant apricots have now been obtained.

Challenge: Sustainable fish farming and human nutrition and health: The toolbox also gives us plenty of opportunities to develop alternative end products. The approach of ***Johnathan Napier*** (Rothamsted Research, UK) to the challenge of decreasing sustainability of aquaculture is to produce healthy "fish oil" in plants, to replace wild fish as feed in fish farms. Fish is for us the dietary source of particular long-chain omega-3 fatty acids. Now Prof. Napier has engineered the oilseed plant *Camelina* to produce 13 percent "fish oil" in the seeds. This would not have been possible without years of fundamental research or without gene technology.

Challenge: Crops to sustainably produce raw materials: As further expansion of rubber tree plantations would be unsustainable, we need alternative rubber sources. ***Joachim Schiemann*** (Julius Kuehn Institute, Germany) reported about such an alternative in the Russian dandelion having 10 percent rubber in its roots. The amount needs to be increased for economic viability and several research teams worldwide are searching for key genes in the process. A pilot rubber facility has been established and a company has successfully been testing car tires made of dandelion rubber. This example was listed among the 50 best inventions in 2009 by Time Magazine.

Challenge: Reducing environmental footprint of agriculture: Even more revolutionary is the potential to develop perennial grain crops, with increased water and nutrient retention, longer season and higher biomass growth, and less negative impact on the soil through less sowing and tilling. ***George Coupland*** (Max Planck Institute for Plant Breeding Research, Cologne) is identifying genes controlling the timing of flowering, senescence and root structure, which may help to maintain reproductive growth over several seasons in otherwise annual and high-yielding plants.

Challenge: Food security – yield stability and improvement: ***Dani Zamir*** (Hebrew University of Jerusalem, Israel) and ***Cristobal Uauy*** (John Innes Centre, UK) provided examples on how genome-wide techniques can improve plant breeding. Trait stability is as important as yield and quality, and Prof. Zamir has introduced chromosome fragments from a wild tomato relative into cultivated tomato as a source of stability genes, whereas Dr. Uauy is tackling the huge genome of bread wheat by sequencing only the protein-coding parts of the genome, which, together with high throughput induced mutations, help finding agronomically useful mutations in wheat.

All of the tools employed in these examples enhance the capacity of plant researchers and breeders. A facilitated access in the EU is needed to strengthen the links between fundamental research, applied research and innovation, and ultimately to address the societal challenges while being globally competitive. Karin Metzlaff from EPSO mentioned in the discussion that scientists are concerned about the H2020 Work Programme 2016/17 Societal Challenges 2 as about 95 percent of the topics in the calls 'Sustainable Food Security' and 'Rural renaissance' are restricted to approaches that benefit organic agriculture, thus indirectly excluding many technologies for plant breeding. The EC should add a clarifying statement in the future to avoid technology discrimination. A supportive environment for all crop genetic improvement technologies was emphasized in the discussion, but also that these technologies need to be combined with other factors, such as management practices, to achieve the goals of a sustainable and productive agriculture.

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Useful links: Conference presentations: http://www.epsoweb.org/epso-expo-conference-plant-breeding-techniques-cnr-headquarter-milano-italy-14-july-2015?1345810649=1

About EPSO: EPSO, the European Plant Science Organisation, is an independent academic organisation that represents more than 220 research institutes, departments and universities from 31 countries. EPSO's mission is to improve the impact and visibility of plant science in Europe.