

## **Experiences from organic maize breeding and prospects of coevolutionary breeding**

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### **Objectives of organic maize breeding at KWS**

KWS SAAT AG has the ambition to offer each farmer varieties which are optimized for his very individual purpose and way of farming: for conventional as well as organic farming. For this purpose, KWS has been developing during the past ten years not only maize varieties under conventional cropping conditions, but at the same time as well under the conditions of organic farming. Therefore, KWS started with its own experimental station in the year 2002 at the KWS Kloostergut Wiebrechtshausen, a farm leased from the charitable foundation “Klosterkammer Hannover”.

After ten years of experiences acquired in the development of maize varieties for organic farming, we were able to ascertain that organic breeding not only leads to the development of improved varieties for organic farming, but as well to varieties with a higher yield stability for conventional farming. Moreover, organic breeding aims at developing varieties offering the opportunity to lead the entire agriculture to a more organic approach. This implies for instance maize varieties for dual use, of which stover is still able to be used for silage at grain maturity, as well as maize varieties which are suitable for intercropping with leguminosae, especially with runner beans. Maize varieties for dual use should be able to resolve the famous conflict between the use for bioenergy production and fodder production, and the conflict which is to be found in organic farming and developing countries with less milk performance: the conflict between food and feed („Feed no Food!“). Maize varieties which are suitable for intercropping with leguminosae may offer an opportunity to conventional farming to come closer to ecological goals like agro-biodiversity, nitrogen fixation, and reduction of soybean imports.

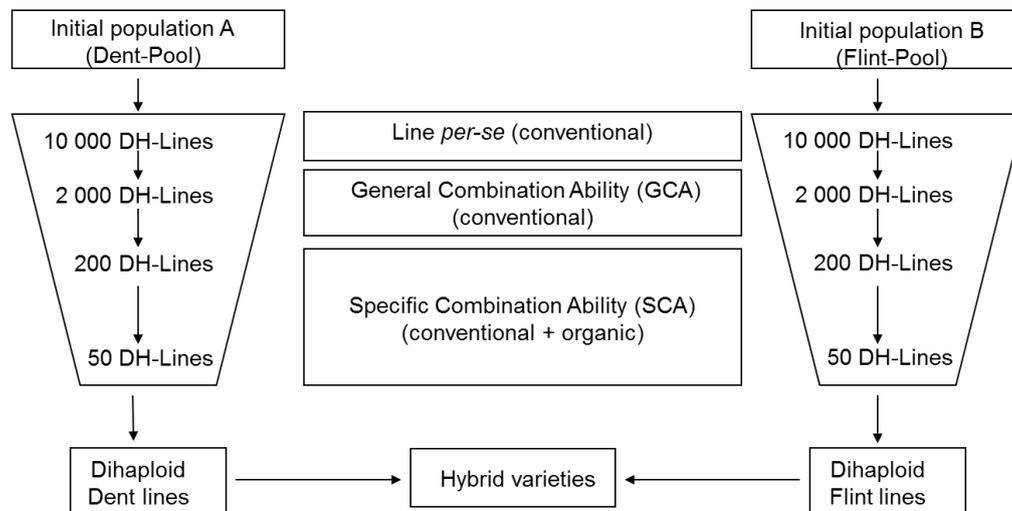
### **Optimizing breeding strategies for the development of organic varieties making a maximum use of selection gains achieved in conventional maize breeding**

During the past years, KWS has been carrying out quite a number of scientific projects in cooperation with the universities of Hohenheim (Prof. Geiger), Göttingen (Prof. Becker, Prof. Rauber), and Wageningen (Prof. Lammerts van Bueren), with the HfWU Nürtingen (Prof. Pekrun), and with the FIBL (Dr. Messmer), to optimize organic breeding.

Within these ten years of projects, the calculations necessary to optimize breeding strategies, and simultaneously the experiences acquired made KWS develop the breeding scheme shown in illustration 1: The organic breeding program picks up lines developed in conventional breeding programs at a moment, where conventional breeding already has done a large part of pre-selection works for organic breeding (lines-*per-se* and GCA-test), while there is still enough variability regarding suitability for organic farming. This is the moment where the lines enter the stage of the SCA-tests.

During this stage, KWS tests the lines under organic conditions at three to four sites in order to identify the ideal lines suitable as well for hybrid development as for reciprocal recurrent selection (RRS). Only the lines with excellent results in both cropping systems are selected and recombined. The conventional test mainly increases the maximum yield potential of the breeding material, while the organic test improves its suitability for organic production, and its yield stability. As a new RRS-cycle is not started before having identified suitability for

organic cropping, such strategy not only improves hybrids regarding their suitability for organic production, but as well the basic populations on which hybrid breeding is based.



III. 1: Combination of conventional and organic varietal development in the German maize breeding program of KWS

However, this strategy has a bottleneck: It is difficult to select for competitiveness against weeds, as on organically farmed trial fields, weeds usually do not appear evenly distributed, but more spot-like. By selecting for competitiveness by means of an underseed of rye, buckwheat, and chicory, we strive for reviving the maize's competitiveness and with this its suitability for intercropping (see poster presentation of STEVER et al. 2013).

### **New breeding approach: Coevolutionary plant breeding to reach ecological goals**

The strong point of maize is its performance potential. As maize breeding has been able to triple grain production and double silage production within the past fifty years, the German cropping surface now reaches 2.5 million hectares. Seen from the ecological point of view, this is increasingly criticized. However, it would not be optimal to renounce to the maize's performance potential in our current crop rotations. Therefore, a most promising solution would be to grow maize the way it has been cropped in the countries where it came from, which is, intercropping together with a different crop. First results have shown that intercropping of maize and climbing beans could be a most attractive cropping system (PEKRUN et al., 2013). At KWS, we have already started improving maize varieties regarding their suitability for intercropping with climbing beans (see poster presentation of HOPPE et al. 2013). The results of the year 2012 showed that this cropping system will enormously benefit, if climbing bean varieties are as well optimized in breeding for their suitability for intercropping. First screening trials proved that variation in runner beans is at least as large as in maize.

Once the best combining maize and climbing bean varieties for intercropping are identified, the next logical step will be to achieve a coevolutionary development of both crops towards each other. If the future would see as well leguminosae growing on a large part of today's 2.5 million hectares of maize cropping surface, this would constitute the most important step conceivable by now, towards more ecology in agriculture.

Hoppe, C., Schmidt, W. & Becker, H.C. (2013). Improving energy maize with specific adaptation to intercropping with climbing beans. *Poster EUCARPIA conference, 24-26 September.*

Pekrun, C., Hubert, S., Schmidt, W. (2010). Mais/Stangenbohnen-Gemenge. Biogassubstrat mit Zukunft? *Mais*, 1/2010: 30-32.

Steuer, M., Schmidt, W., Burger, H. & Becker, H.C. (2013): Development of maize hybrids with high weed tolerance for organic farming systems. *Poster EUCARPIA conference, 24-26 September.*