MAIZE RESEARCH PROGRAM
AT THE INSTITUTE OF AGRICULTURAL SCIENCES FOR SOUTHERN VIETNAM

Maize breeding activities at the Institute of Agricultural Science for Southern Vietnam (IAS) has shifted from population improvement to hybrid development in 1990s. Over past 15 years, there have been much changes in maize production. As maize production in Vietnam changed sharply from utilization of OPV to hybrid seeds, the trend of research activities also turned completely to that tendency. Beginning with very little experiences and knowledge in hybrid research, maize breeders from IAS now already develop some new promising hybrids, which can compare to the best hybrids imported by overseas companies. Maize breeding program had emphasized development of early matured single crosses. Followings are the figures of maize breeding activities and gains at IAS in recent years.

Strategy in selection of breeding materials

At the beginning, any types of germplasm available in the program were considered as source materials for breeding works. We had faced with failure in finding inbreds of good performance and parental seed yield. Efforts then turned to importing inbred lines from many foreign companies and institutions. Once again, we could not develop any hybrid with good yield potential. Selecting breeding materials then concentrated in extracting lines from elite single crosses, which showed their good adaptations and grain yield potential. By this strategy, we began to have some good inbreds, which could give high seed yield and good combining ability. These inbreds had showed very good parental seed yields, good tolerance to inbreeding pressure and very high combining abilities.

Development and combination ability testing of new maize inbreds

Pedigree selection method has been used as the backbone in developing new inbred lines.

Experiment for hybrid development

Origin breeding materials were classified to differentiate inbred lines into genetic groups. From S_1 to S_3, per se performance selection were made among and with in segregating lines, only lines showed good agronomic characters would then be selected. We began to test inbred lines at S_3 generation and only those lines showing promising performances would then be advanced to next selfing generation and be tested further. Elite lines normally fixed at S_8 generation. At the early generations of selfing, top-crossing was used in testing combining ability of inbred lines. Narrow-based genetic testers, normally inbreds, have been used in these early stages. As testers were inbreds, the concerns were not only to general combining abilities but also to specific combining abilities. At late stages of selfing generations, diallel crossing system was used to test the combining abilities of the elite lines. Backcrossing also had been used, although not often, to improve one or more characteristics of the inbreds. By those processes, a number of elite lines were identified such as D_1, D_2, D_8, D_{34} (Table1). These inbred lines possess very high combining abilities in grain yield and desirable agronomic traits.

Numbers of hybrids had been developed

Hybrid development

Coming out from breeding works would be tested on experimental field. This testing would screen the crosses to a much smaller numbers. Those crosses showed undesired aspects, low yield potentials, low resistance to insects and diseases. Only a limited number of crosses with high yield potentials, good agronomic traits, good resistance to insects and diseases would be retained and passed to next steps of testing. The remained crosses then would pass through *multi-location testing*, in which crosses would be tested on different location and ecological environments. After the multi-location testing, only a very small fraction of the crosses coming from breeding program would be used for further *national testing* step, which would be carried out by National Center of Seed Testing and Certification. The process of *national testing* are required as the authorization before official registrations of any new hybrids to release into production.

Hundreds of single, tri-way and double crosses have been developed annually. The crosses had been formed basing on the genetic distances (or heterotic pattern) of inbred lines to avoid lines from same group to be coupled. Agronomic parameters of inbred lines such as date to flowering, silking, plant height, parental seed yield, resistance to pests and diseases were recorded for consideration for seed production later.

Hybrid testing

Testing the performances of a large numbers of crosses is a difficult and expensive work in a breeding program. From a large number of crosses, the test should identify most productive, most adaptive and highest yield potential crosses. In *primary test*, all crosses

Hybrid maize variety V2002

Table 1: Agronomic traits and parameters of some best inbred lines of maize breeding program at IAS (Autumn-Winter 2006, Hung Loc station)

Inbred	Days to flowering (days)	Days to silking (days)	Ear height (cm)	Plant height (cm)	Seed yield (ton/ha)	Potential as
D1	52	54	80	170	3.0	male
D2	50	52	75	165	2.8	female
D8	49	52	80	165	2.5	male
D11	48	51	85	170	3.0	female
D34	49	51	75	165	3.0	both

Hybrid releasing

Hybrid maize variety V98-1

When the most promising cross passed to the legal registration and approved as new hybrid, the hybrid would be demonstrated widely on farmer's fields in many pilot production plots. Farmers could have change to consider and select hybrids that they would prefer to use for their next crop. We already released some high productive single crosses, namely V98-1, V98-2, V2002, V118 and they have been accepted by farmers in Western Plateau and South Eastern provinces. In comparison experiments, these hybrids were tested along with the best hybrids imported from overseas companies, namely G49 from Syngenta, C919 from Monsanto, KD888 from Dekalb. Yields of these hybrids and the best checks in Summer-Autumn 2006 at Hung Loc Station are presented in Table 2. Following are some hybrids and their agronomic aspects:

Single cross V98-1: This early hybrid is now the best in yielding potential. It would mature at 85-95 days after sowing, short plant height, good resistance to lodging, moderate resistance to corn borer and *Rhizoctonia solani*. On intensive farming conditions, V98-1 could yield up to 10 tons per ha.

On farmer's field, V98-1 yielded from 6 to 9 tons per hectare. From 2002 to 2005 this hybrid had been planted to around 6000 hectares annually. It is not recommended to grow this hybrid under low input farming.

Single cross V98-2: This hybrid could mature at 85-92 days after sowing, medium plant and ear heights, tolerant to corn borer and *Rhizoctonia solani*. Its yield potential is among the top productive single crosses (up to 9 tons per hectare in good farming practices). Farmers have noticed an advantage of this hybrid (under unfavorable farming condition, the hybrid still had acceptable yield). In two years 2005 and 2006, this hybrid has been planted to more than 12,000 hectares.

Single cross V2002: This hybrid matures at 88-95 days after planting. Its yield is very high on Western Plateau and Highlands. On farmer's fields it normally gave yield from 7-8 tonnes per hectare. In good farms, it could yield from 8 to 10 tonnes per hectare. Since 2003, each year this hybrid has been grown around 500 hectares.

Hybrid maize variety V118

Single cross V118: Matures at 86-95 days after planting with medium growth duration, very good uniformity in plant height and canopy shape. In rainy season, V118 showed high resistance to *Puccinia polysora* in humid condition. Grain yield of V118 is equal to that of the best imported hybrids, such as G49, C919 and better than that of Bioseed 8960 and DK888.

Table2: Agronomic traits and grain yields of hybrids V98-1, V98-2, V2002, V118 compared to the best checks from Syngenta (G49), Monsanto (C919) Bioseed Genetics (Bioseed 9698) and Dekalb (DK888).

Hybrid	Days to flowering (days)	Days to silking (days)	Plant height (cm)	Shelling (%)	Grain type	Grain yield (ton/ha)
V98-1	48	50	220	76	dent	8-10
V98-2	47	49	225	77	semident	7-9
V2002	48	50	225	76	semident	7-10
V118	48	50	215	76	semident	8-9
G49	49	52	230	75	semident	7-9
C919	49	51	225	76	semident	7-9
Bio 9698	47	50	200	76	semident	6-8
DK888	54	56	240	79	dent	6-8

Breeding special type of maize

Researches to develop waxy maize and sweet maize have also been carried out at IAS. We have developed a single cross of waxy maize and two single crosses of sweet maize. These crosses have shown their advantages to the best of relative types imported from overseas companies. However, their legal registration is not yet to be processed.

Waxy maize Nu-1

Implications

Maize breeding program at IAS has made a big progress since 1990. Breeding activities undertaken at our program continue to make impact on maize production in southern provinces of the country. Hybrids developed at IAS can compete well with best hybrids imported from foreign companies. However, area planted to IAS,s hybrids is still small due to limited seed production. It is appealed to any relevant counterparts to join efforts in producing and supplying seeds to farmers.