Genetic advance and the present state in plant breeding in Hungary

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Plant breeding has been practised in Hungary for over 150 years. In this time substantial progress has been made in genetics, in keeping with social and economic requirements and market conditions. Thus varieties were replaced by newer ones, which were generally better.

I shall give an overview of the current situation and the way it arose between 1950 and 2000 in the tables and diagrams below, then the situation as it was in 2003 based on the reports by Heszky and OMMI.

Diagram 1 shows the development of varieties and hybrids in the field of the three crops planted over the largest surface area, wheat, maize and sunflower.

The old varieties were restored after World War II, then the Bánkut and F481 wheat were re-examined, then made popular through special seed offers. From the early 1960's, when intensification of wheat cultivation began and mechanised harvesting was introduced, new, intensive varieties were required. First attempts were made to domesticate Italian wheat varieties, but because of their poor quality and low resistance to winter hardiness these were unsuccessful. The Russian Bezostaya 4 and 1, then the Italian Libellula, the Russian Kavkaz and some Yugoslavian varieties (Rana 1, Rana 2, Zlatna, Dolina, Baranjka) became widespread. Thus, in the second half of the 1960's Hungarian wheat varieties were increasingly overlooked (*Diagram 2*).

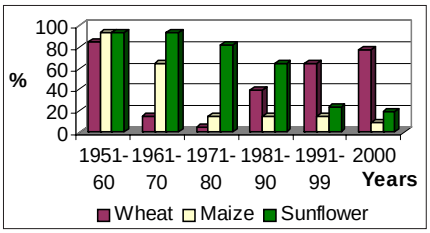

Diagram 1: **Contribution of domestic varieties and hybrids to the area of multiplication 1951-2000 (HESZKY et al.)**

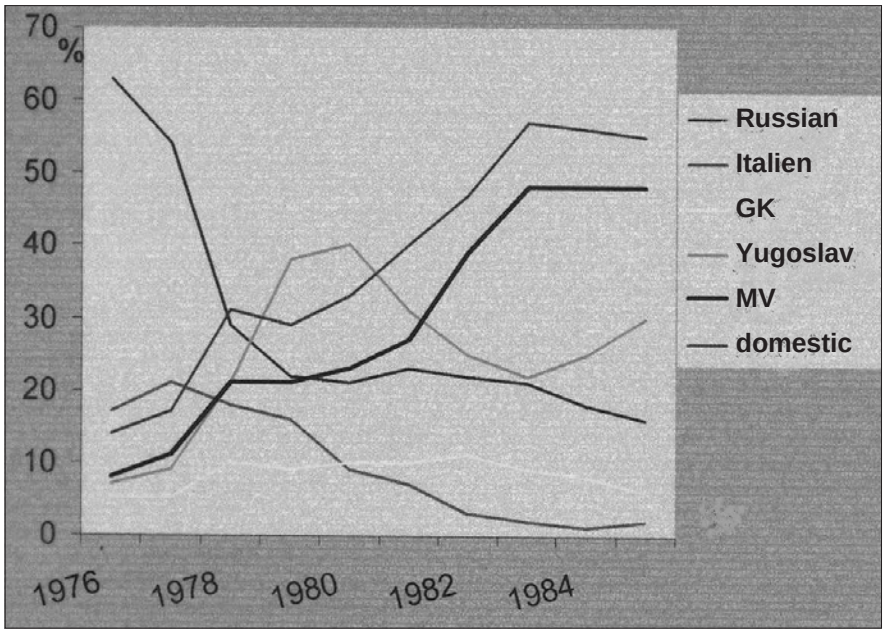

Diagram 2: **Origin and proportionof registered wheat varities in Hungary**

The first new, Hungarian intensive wheat varieties emerged in the 1970's and came to the fore in the early 1980's. These were the Martonvásár varieties (*Diagram 3*), which were joined by the intensive wheat varieties of Szeged from 1985 onwards. In the 1990's Hungarian wheat varieties again accounted for 80-85 per cent of the overall land used to cultivate wheat in the country (BALLA 2000, BALLA 2001, *Diagram 1*).

The cultivation of maize developed differently. Europe's first endogamic hybrid maize was developed by Endre Papp in Mindszentpuszta between 1935 and 1950. The hybrid was certified as soon as 1953 under the Martonvásár 5 name (Endre Papp went over to Martonvásár in 1950).

At the same time the Óvár variety hybrids were certified, but these were not cultivated over a substantial area for long.

Mv hybrids, however (Mv 1, Mv 5, Mv 40) became very widespread in the 1960's and by 1964 accounted for 100 per cent of maize lands (*Table 1*).

Although the number of hybrids increased in the 1970's, the overall surface area where they were cultivated decreased, and stayed that way.

After Endre Papp's leaving (1956), Hungarian maize breeding took a turn for the worse. Since then only the research centre Kiskun Kutató Központ has been able to produce competitive hybrids in recent years. Mv hybrids were squeezed off the market by domesticated hybrids.

It needs to be noted that the first homebred hybrid maize (Mv 5, Mv 1) yielded 20-25 per cent more during the OMMI

Table 1: **The spreading of hybrid maize in Hungary**

Year	%
1957	0
1958	3
1959	28
1960	62
1961	67
1962	80
1963	95
1964	100

Hybrids 100% Hungarian in origin

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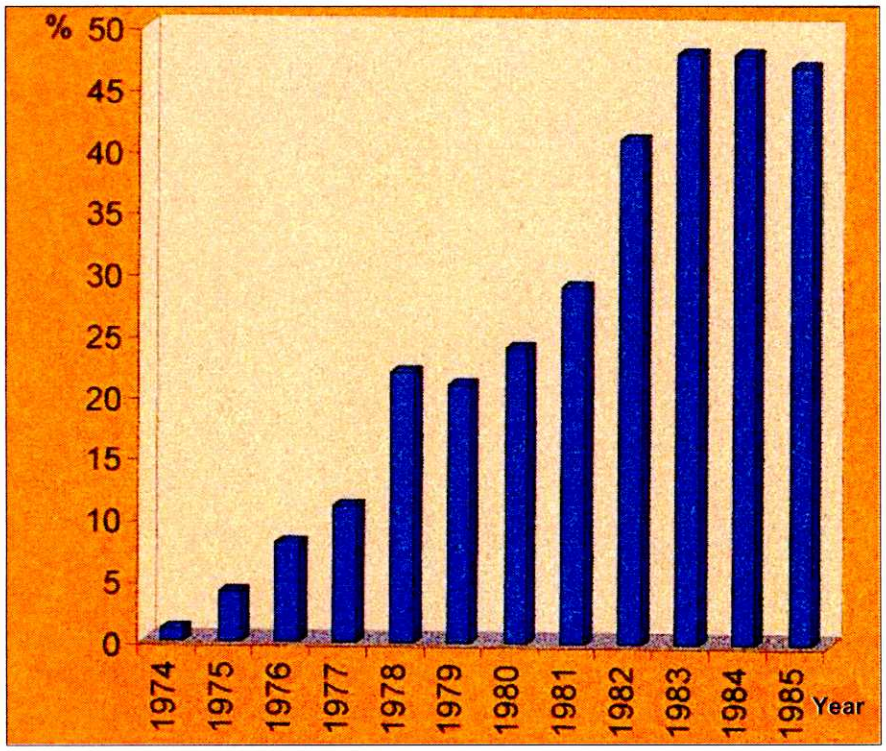

Diagram 3: **Contribution of Martonvásár wheat varieties to the area of production 1974-1985**

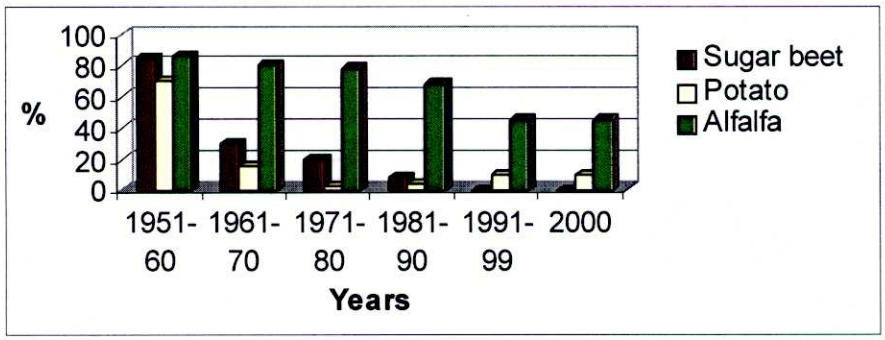

Diagram 4: **Contribution of domestic varieties and hybrids to the area of production 1951-2000 (HESZKY et al.)**

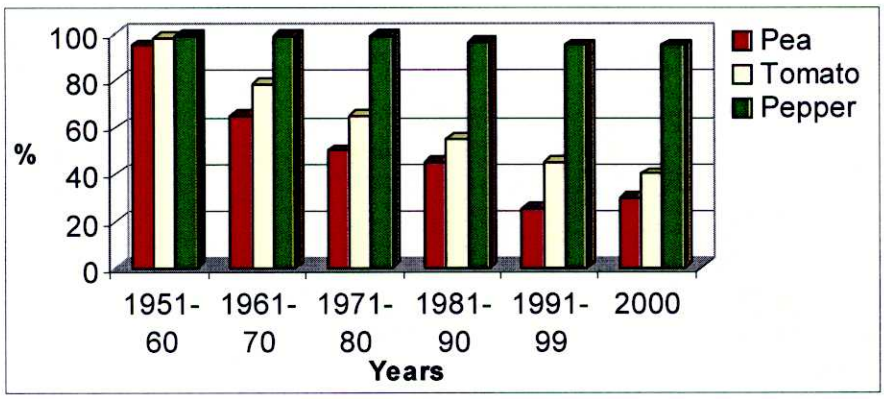

Diagram 5: **Contribution of domestic varieties and hybrids to the area of production 1951-2000 (HESZKY et al.)**

experiments in 1952 than the best varieties, and 8-15 per cent more than the variety hybrids. Therefore, at the sowing seed conference held by the Hungarian Academy of Sciences (MTA) in 1954, Kurt SEDLMAYER initiated the approval of the hybrid programme, which led to the construction of 11 seed plants between 1957 and 1961. The first such facility was completed in MTA's Agricultural Research Institute's Experimental Farm in 1959, which became the flagship of domestic sowing seed production for a quarter century.

The development of the biological basis of sunflower is comparable to that of hybrid maize. With the appearance of hybrid sunflower, foreign varieties increasingly squeezed out the Hungarian ones, and today it is an achievement if a hybrid is produced in cooperation, that is, that one of the partners is Hungarian.

Of the group of crops in *Diagram 4*, of sugar beets, potatoes and alfalfa, the first to disappear completely from large-scale cultivation were sugar beets hybrids and varieties in the 1970's. Today there is no Hungarian breeding programme either. Attempts to resurrect the programme have been unsuccessful since the departure of Mr. SEDLMAYER (1956). Potato met a similar fate, although it is still being bred in Hungary. However, it proved impossible to attempt to compete with the Dutch breeding and sowing tuber production.

Alfalfa breeding is competitive however, and Hungarian alfalfa is still used exclusively in domestic production. Foreign varieties were not competitive in Hungary.

The proportion of the areas of cultivation of our three important crops, green peas, tomatoes and peppers is represented in *Diagram 5*. The production of both green peppers and red paprika is based on Hungarian varieties. The pea- and the once famous tomato-programme are no longer competitive, even in domestic terms.

During the period here discussed, the national average yields doubled or trebled in Hungary. Progress in genetics is to be credited with 40-45 per cent of the breeding, and technological advances with the remaining 55-60 per cent. In *Diagram 6* I detail changes in the average wheat yield between 1961 and 2000 in five-year averages, as well as the dominant varieties of the different periods. It is known that the drop in average yields after 1991 is not a result of changes in the variety sortiment.

I have examined progress in genetics in wheat breeding at my different work

Table 2: **Genetic advance in wheat breeding Karcag, 2003/2004**

Variety	Year of reg.	Yield (t/ha)	%	%	%
KG Kunhalom	2002	10,09	230,10	142,92	113,95
Glória	fj.	10,04	228,85	142,14	113,33
Buzogány	1998	9,73	221,89	137,82	109,88
GK Cipó	1998	9,64	219,73	136,47	108,81
Róna	1998	9,60	218,81	135,91	108,36
Alex	1999	9,42	214,71	133,36	106,32
Gaspard	1992	9,41	214,48	133,22	106,21
GK Öthalom	1985	9,39	214,03	132,93	105,99
KG Széphalom	fj.	9,06	206,61	128,33	102,32
MV 15	1985	8,93	203,53	126,42	100,79
KG Magor	2002	8,92	203,31	126,27	100,68
Mv Pálma	1994	8,91	203,08	126,13	100,56
Mv Magdaléna	1996	8,86	201,94	125,42	**100,00**
Mv Csárdás	1999	8,76	199,66	124,01	98,87
Hunor	1998	8,70	198,40	123,23	98,25
Fatima 2	1992	8,65	197,15	122,45	97,63
Mv Palotás	2000	8,38	190,99	118,63	94,58
GK Élet	1996	8,34	190,08	118,06	94,13
Boema	fj.	8,05	183,47	113,95	90,85
MV 23	1991	7,94	180,96	112,39	89,61
MV 4	1974	7,21	164,31	102,05	81,37
Mv Magvas	1998	7,16	163,17	101,35	80,80
Jubilejnaja 50	1970	7,14	162,83	101,13	80,63
Bezosztája 1	1960	7,06	161,00	**100,00**	79,73
Tiszavidéki		5,30	120,75	75,00	59,80
Fertõdi 293	1960	5,27	120,07	74,58	59,46
Fleischmann	1924	4,70	107,07	66,50	53,02
Bánkúti új	1929	4,51	102,85	63,88	50,93
Bánkúti 1201	1929	4,39	**100,00**	62,11	49,52
$SD_{5\%}$		**0,75**			

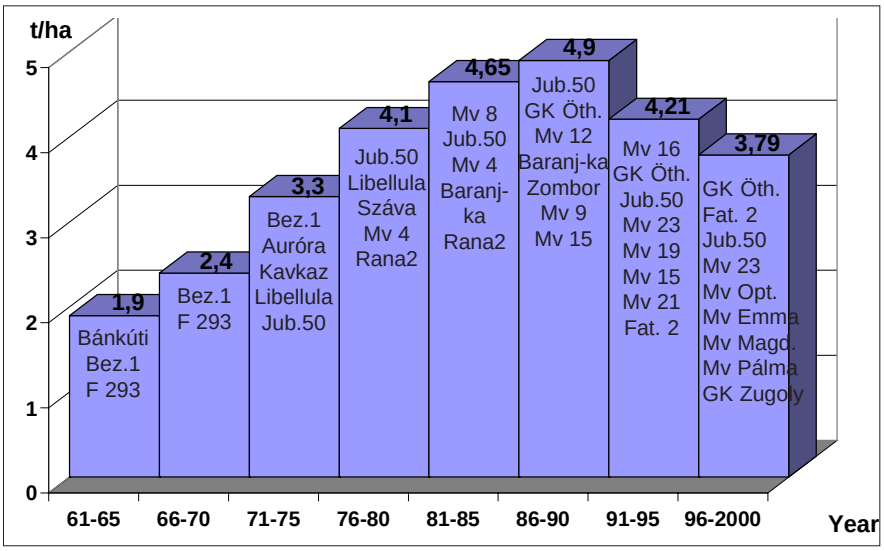

Diagram 6: **Changes of five-year average yield of wheat and the leading varieties in Hungary**

places for a quarter century. The 2003-2004 business crop was particularly suitable for such an examination, because of a lack of biotic and non-biotic stress effects. In spite of yields of 10 tonnes per hectare, there was not even lodging, only in the case of extensive varieties, and only directly before maturation.

In an experiment conducted at Karcag we examined the leading wheat varieties of the 20th century and compared them with the check varieties currently cultivated over the largest surface area. The findings are represented in *Table 2*.

We compared the findings to three known varieties in the table: Bánkúti 1201, Bezostaya 1 and Mv Magdaléna (the original Tiszavidéki wheat from the 1880's is represented in the table). When compared to the Bánkúti 1201 in terms of genetic advance, the best varieties show a 120-130 per cent improvement in yield, when compared to the Bezostaya 1, the improvement is 37-42 per cent, and when compared to the Mv Magdaléna, the improvement is 10-14 per cent. These results were found using the most recent varieties, but the findings are in keeping with the results of experiments conducted in Martonvásár over many years (BALLA et al. 1985, BALLA et al. 1986, BALLA 1987).

Lodging resistance, harvest index improvement and other production safety factors cannot be expressed in kilograms or money.

The results of examining Hungary's place on a global list, based on the biological fundamentals of the past decades, are shown in *Diagram 7*. (PEPÓ, 2003). In the 1970's and 1980's Hungarian average yields exceeded the EU average. The fact that the average yields in EU states have continued increasing since 1992, and the average yields began to decline in Hungary at that time, is not due to biological bazes. This statement is valid when applied to the other species.

The current situation

By the time of EU accession, the number of varieties approved by the state increased beyond reason in the case of all plant species. As evidence I present here only the number of wheat varieties in *Table 3*. The number of domestically bred and introduced varieties increased between 1970 and 2002. The approval of more than 130 varieties cannot be justified with professional arguments. The amount of sowing seeds produced and treated covered requirements and allowed a 40-45 per cent rejuvenation rate.

In spite of a failure to create a list of recommended varieties in Hungary, farmers used 12 varieties on 70-80 per cent of the overall area of cultivation in the past years. A further seven varieties accounted for 1-2 per cent of the overall area, with the remaining varieties found in but traces. Their names, origins, the dates of state approval and their proportion of area of cultivation are represented in *Table 4*. These are all Hungarian varieties but two. The Hungarian varieties were developed between 1970 and

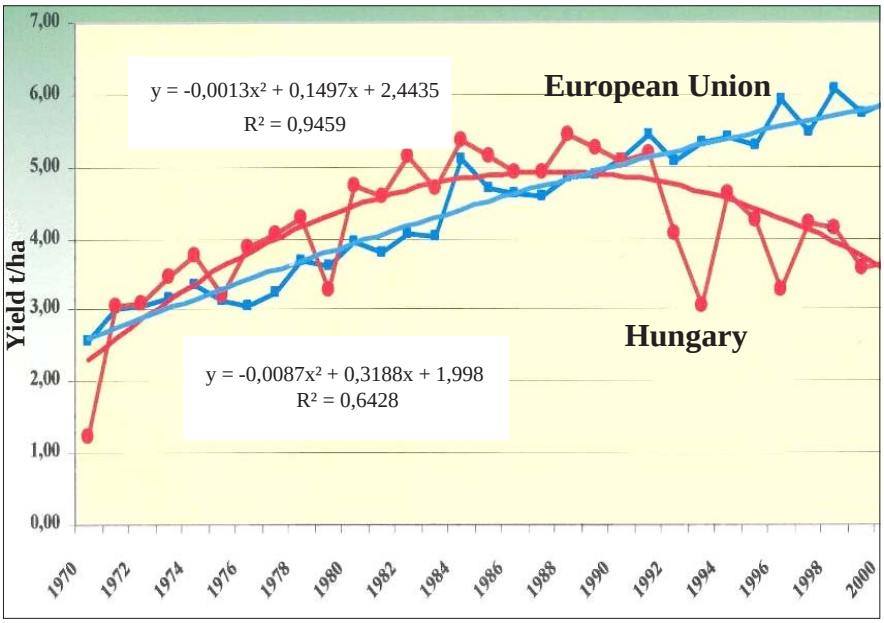

Diagram 7: **Comparison of the average wheat yield in the EU and Hungary 1970-2000**

Table 3: **The origin and member of wheat varieties in different years**

Origin	1970	1980	1990	2000	2001	2002
Total	**14**	**20**	**29**	**88**	**105**	**114**
Hungarian	**4**	**11**	**19**	**62**	**73**	**77**
Joint	-	-	-	2	2	2
Foreign	**10**	**9**	**10**	**24**	**30**	**35**
Yugoslav, Croatian	-	5	6	6	6	6
Rumunian	-	-	-	1	1	1
Austrian	-	-	-	6	8	10
French	2	1	1	4	6	6
Czech, Slovak	-	-	1	3	4	7
German	-	-	-	2	2	2
Soviet, Ukranian	6	2	1	1	2	2
Holland	-	-	1	1	1	1
Italian	2	1	-	-	-	-

Table 4: **Proportion of winter wheat varieties in the multiplication in Hungary 2003 (OMMI data)**

Varieties	Country	Year of reg.	2001%	2002%	2003%
1. Mv Csárdás	HU	1999	7,7	13,3	13,6
2. Mv Magdaléna	HU	1996	11,2	14,3	12,0
3. Mv Magvas	HU	1998	6,9	6,9	7,6
4. Mv Palotás	HU	2000	0,6	3,5	6,7
5. Jubilejnaja 50	UA	1970	7,9	7,6	6,2
6. GK Kalász	HU	1996	5,2	5,2	5,0
7. Lupus	AT	1998	0,8	3,0	3,7
8. GK Élet	HU	1996	6,1	5,0	3,5
9. GK Garaboly	HU	1998	2,1	2,8	3,0
10. Mv Verbunkos	HU	2001	-	0,2	2,4
11. Mv Pálma	HU	1994	2,3	2,1	2,2
12. Mv Emese	HU	2000	0,5	1,4	2,1

2001 as a result of the 1970 OKKFT G-9 programme launched and subsidised by the state. In order to illustrate this I shall describe the process of production of the Mv Magdaléna (MV Csárdás is from the same combination) *Diagram 8*.

Thus Hungarian wheat cultivation is based again on Hungarian varieties. It is gratifying that the estimated 5.1 t/ha yield was achieved in 2004, and that semi-dwarf varieties did not lodge, even where the yield was 8-9 t/ha.

I shall give but a brief account of the breeding of other cereals. Outstanding winter barley varieties were developed recently. The better marketing of foreign varieties, however, has resulted in foreign winter barley being cultivated over a greater overall area. Hungarian winter barley is better in terms of resistance to winter conditions, mature earlier and tolerate droughts better. This advantage is not enough, only in a cold winter and a dry summer. The 2003 cultivation area proportions are represented in *Table 5*, but these proportions are changing, because of the cold winter in 2003 and the drought in the summer of that year. Based on figures from the past three years, Kompolti varieties lead the lists of state-trials, both in the „early“ and „medium-early“ groups. Domestic production of winter rye is based again on Hungarian varieties (with the exception of Amilo). Kisvárdai 1, Lovászpatonai, Kisvárdai dwarf and the Polish Amilo account for 75.8 per cent of the land used for autumn rye production. Great expectations were attached to the cultivation of hybrid rye, but such a hybrid was never developed in Hungary, while other countries produce it for target production, but in declining amounts.

I shall now discuss two cereals, which are produced on the basis of purely introduced varieties. One is malting barley, the other is our most extensively produced cereal.

The Martonvásár malting barleys cultivated in the 1950's and 1960's were squeezed off the market, and were replaced by foreign varieties. A Slovakian variety (Jubilant) has been the dominant one for eight years, preceded by five years of another Slovakian variety (Orbit), which accounted for 45pc of production. Two German varieties, Scarlett and Pasadena account for a substantial proportion of production, 20 per cent each, the remaining varieties account for less than 2 per cent. There is not competitive Hungarian variety (*Table 6*).

The other is triticale. Although a very promising triticale programme was launched in Martonvásár in the 1950's, Polish triticale varieties were domesticated for large-scale production in the 1990's (Presto, Tewo, Moniko). Currently three Polish and two German varieties account for 83 per cent of the area of cultivation (*Table 7*).

GK Betadur is the dominant durum wheat variety, and ÖKO-10 is the dominant spelt. These are Hungarian varieties.

Table 5: **Proportion of winter barley varities in the multiplication in Hungary 2003 (OMMI data)**

Varieties	Country	Year of reg.	%
1. Petra	AT	1998	9,0
2. Nelly	DE	1998	8,5
3. Angora	DE	1999	7,9
4. GK Rezi	HU	1998	6,9
5. Rex	HR	1991	6,7
6. Tiffany	DE	2001	6,4
7. Botond	HU	1991	6,4
8. Bogesa	DE	1998	5,1
9. Carola	DE	2000	5,1
10. KH Viktor	HU	1998	5,0
11. Gotic	FR	1996	4,3
12. KH Korsó	HU	1999	4,1

The other main crop of Hungarian agriculture, maize, should be mentioned separately. OMMI reports devote little attention to these, and it is hard to determine the share of the more than 320 hybrids of the overall area of cultivation. Area of propagation is not relevant in the case of maize, because 60-65 per cent of sowing seeds are used abroad. Pertinent details are represented in *Table 8*. The table shows the area of propagation and the number of propagated varieties, details of yield, treatment and exports. It shows that domestic consumption is around 30,000 tonnes.

The number of sowing seed facilities built in the early 1960's increased to 15, and propagated Hungarian hybrids first, then after the decline of Hungarian hybrid maize breeding, they switched to the propagation of domesticated hybrids, much of which was produced for exports or target production. When in the 1990's foreign variety owners began to organise the production of their own hybrids, Hungarian sowing seed facilities, built with state funds, started providing distribution services to the foreign variety owners. Yet the firm Pioneer built the world's largest sowing seed plant in Szarvas, with the first phase of construction works complete in 1996, the second in 2004. The plant produces 24,000 tonnes of treated sowing seeds, of which 60 per cent is exported to 16 countries.

Table 6: **Proportion of spring barley varities in the multiplication in Hungary 2001-2003 (OMMI data)**

Varieties	Country	Year of reg.	2001 %	2002 %	2003 %
1. Jubilant	SK	1993	42,0	45,0	45,1
2. Scarlett	DE	1999	16,2	16,8	20,7
3. Pasadena	DE	1999	10,7	20,0	20,2
4. Maresi	DE	1989	9,2	4,2	2,0
5. Annabell	DE	2000	2,0	3,0	2,0
6. Madonna	DE	2000	2,1	2,0	1,6
7. Imperial	BE	1994	3,8	0,6	1,2
8. Tactic	FR	2000	0,6	0,1	1,2
9. Prudentia	fj.	-	-	-	1,0
10. Elison	NL	-	-	-	0,8
11. Mandolina	NL	1999	0,8	1,0	0,7
12. Michka	FR	1993	1,9	1,2	0,5

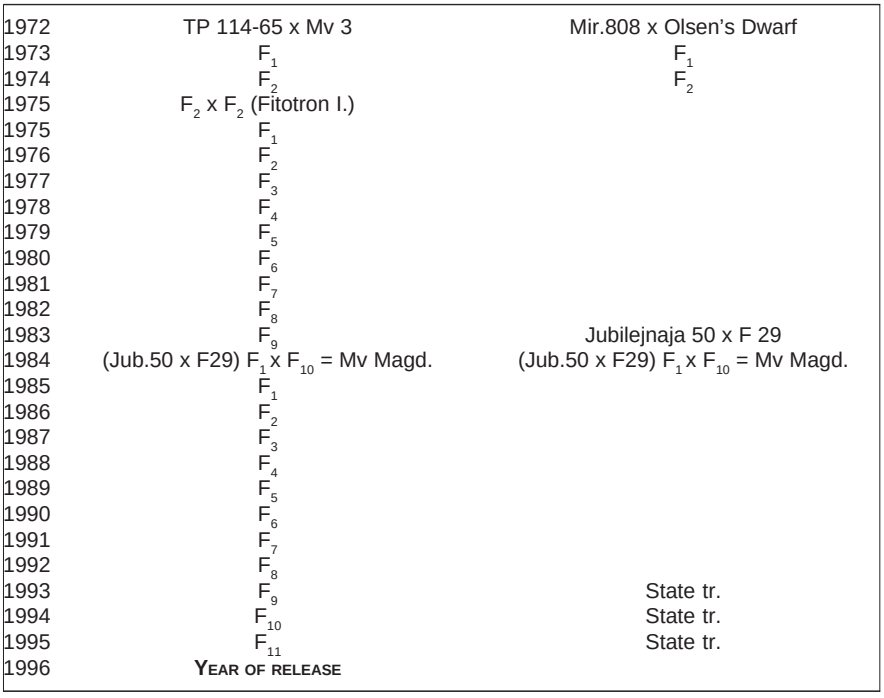

Diagram 8: **The development of Mv Magdaléna and Mv Csárdás**

Table 7: **Proportion of triticale varities in the multiplication in Hungary 2003 (OMMI data).**

Varieties	Country	Year of reg.	%
1. GK Bogo	PL	1998	24,8
2. Kitaro	PL	1998	21,6
3. Disco	PL	2001	18,0
4. Filius	DE	2000	12,8
5. Lupus	DE	2000	6,4

It can be noted that Pioneer recognised Hungary's comparative advantages in the production of hybrid maize and attempts to profit from these advantages. The company launches a HUF 1.5bn (HUF 300,000/ha) irrigation-development programme in order to ensure safe and successful production in the long term. Charge-free propagator's sowing seed was sowed on 90 per cent irrigated lands and Pioneer provides machinery for harvesting. Pioneer is also developing its breeding and testing programmes in Hungary. State-owned Hungarian hybrid maize breeding cannot catch up anymore.

The Hungarian crop produced on the third largest area, sunflower, has also been forced into a position of disadvantage compared to the outstanding American hybrids. In 2003 41 hybrids were produced, but hybrids represented in *Table 9*. Accounted for 48 per cent of the cultivation area. In the US such genetic progress has been made in sunflower breeding, that no country can compete with it. France is still competing, but no one knows for how long.

Finally, the alfalfa. Alfalfa is the exceptional plant, which has 35 registered va-

Table 8: **Data on maize multiplication in Hungary 1993-2003**

Year	Area (ha)	Number of hybrids	Yield (kg/ha)	Total (t)	Certification				Number of fields
					Total (t)	Domestic use (t)	Export (t)	Export (%)	
1993	39.153	327	1.980	77.515	95.463	30.189	65.274	68	929
1994	42.030	324	2.160	90.735	81.085	24.800	56.284	69	1002
1995	32.699	289	2.516	82.283	88.553	29.525	59.028	67	849
1996	16.568	245	2.713	44.954	74.518	29.958	44.560	60	514
1997	19.262	238	2.903	54.392	84.379	32.804	51.545	61	511
1998	23.904	288	3.480	81.929	68.075	27.485	40.590	59	626
1999	25.912	309	3.952	96.007	79.262	29.171	50.090	63	731
2000	24.836	306	2.223	54.394	79.503	35.118	44.384	55	718
2001	29.017	369	3.793	108.741	54.820	22.348	32.471	59	842
2002	30.420	418	2.826	83.645	66.547	36.362	30.184	45	947
2003	27.126	384	2.613	70.296	74.822	31.353	43.469	58	915

Table 9: **Proportion of sunflower hybrids in the multiplication in Hungary 2003 (OMMI data).**

Hybrid	Country	Year of reg.	Area (ha)
Aréna PR	CH	1998	350
Alexandra PR	CH	1999	155
Rigasol	FR	1998	130
Pixel	CH	1998	100
Zoltán	YU	1999	99
KWS Helia 06			90

Table 10: **Proportion of alfalfa varities in the multiplication in Hungary 2003 (OMMI data).**

Varieties	Country	Year of reg.	%
1. Anna	HU	1989	15,1
2. Viktória	HU	1994	12,4
3. Szarvasi AS-1	HU	1995	11,1
4. Hunor 40	HU	1989	10,0
5. Tápiószelei 1	HU	1967	9,0
6. Verko	HU-DE	1978	8,5
7. Klaudia	HU	1996	6,1

rieties, of which 34 are Hungarian. Although efforts were made to find alfalfa varieties more suited to the Hungarian ecological conditions, they were not met with success. At the same time Hungary exports substantial amounts of seeds. The proportion in percentage of the extent of cultivation of the seven varieties propagated in 2003, are represented in *Table 10.*

Green pea and tomato production is based almost exclusively on foreign varieties. Green peppers and red paprika production, however, are based on domestic varieties.

It must be noted separately that factories owned by multinational corporations dictate the variety assortment of industrial plants. Produce is only purchased, if it was grown using the varieties approved by the companies. This applies to sugar beets, malting barley, cucumber, sweet corn, and every plant used in the tinning industry.

The Hungarian government retained ownership of the Hungarian plant breeding research establishments. Their state subsidies were initially cut gradually, then drastically over the past 2-3 years. First the state attempted to compensate for the cuts by introducing variety-use fees, then allowed patenting of varieties and charging licence fees.

The state also subsidised breeding, primarily through the OMFB.

These sources of funds gradually dried up. Subsidies to state-owned institutions (more than 30) were cut, arable land was planted to foreign varieties, which led to a drop in variety-use and licence fees and control of the price margin was ceded to foreign companies, a great loss for the country.

There has been no notable change in breeding in Hungary since accession to the EU. Breeding is conducted in more than 30 research institutes. These institutes but three are owned by the state. Their financial support, is cut year on year by the state, meaning that results are fewer year on year.

Research institutes have three primary sources of income:

❶ subsidies from the budget

❷ grant monies

❸ licence or variety-use fees

These are, however, insufficient to ensure competitiveness in an international context. Which is why foreign varieties can spread in Hungary.

After accession Hungarian varieties were entered on the joint EU variety-list and can be freely distributed in the whole of EU. No licence fee is to be paid after them.

Hungary also adopted the European variety-list and these varieties are freely distributed in Hungary, but licence fees must be paid after them, because they are protected varieties.

We hope this situation will change soon and the Hungarian government will ensure that Hungarian plant breeding becomes competitive.

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