THE BIOLOGICAL BASIS AS RESOURCE IN THE SUSTAINABLE DEVELOPMENT

László Balla, Mária Hornok Fitosné

University of Debrecen CASE RIC Karcag Research Institute H-5300 Karcag Kisújszállási Street 166. e-mail: drballa@t-online.hu hornokmaria@dateki.hu

Abstract

We have studied the yield potential of wheat cultivars grown in the second half of the 20th century and we discussed how much they contributed to the increase of the national average. We learnt that the advance of genetic yield potential was 100% to the extensive types of wheat 40% if we compare to the cultivars of next age and 6-8% compared to the check variety of the last decades. Now there are new varieties which can provide 10 t ha^{-1} or more.

The advance in wheat production can be attributed 50-55% to the development of cultural management and 45-50% to the new cultivars.

The increase of genetic yield potential is a consequence of the raise of the amount of biological yield (50%) and the improvement of harvest index (50%). So the improvement of the biological basis of wheat production is a resource of the sustainable development.

Keywords: wheat production, yield potential, genetic advance, new cultivars,

INTRODUCTION

There is only one thing in the life what is stable, this is the permanent change. Today everything is in the stage of transition around us. This is true for the biological basis of cereal production. Cultivars which were excellent yesterday are out of fashion today, which are regarded excellent today will be out of date tomorrow. That means this is a renewable subject of the development.

The development of new cultivars takes place on an international level in a hard competition. The main point is who will offer the best one tomorrow for production under our diverse soil and climatic conditions.

We have to analyze the question crops by crops because the situation is different in case of crops and years.

MATERIAL AND METHOD

For analysing the wheat production we used the official data published by the KSH (Central Office for Statistics). To measure the yield potential of the cultivars a special trial was set up in Karcag for four years with the most widely used cultivars of different period of time in the second half of the 20th century.

RESULTS AND DISCUSSION

As far as the wheat production is concerned we can see the development in Hungary from *table 1*. The average yield of wheat in the first half of 20th century was 1.2 t ha^{-1} . Very fast development started from early sixties. The average yield in the first half of sixties was 1.86 t ha^{-1} what was a 0.53 t ha^{-1} more compared to the yield of 1960 (Balla 1995, 2001).

That time the scientist disputed whether we can produce more than 2 t ha⁻¹, whether we have precipitation and sunshine enough to produce more. It was generally accepted that no. Nevertheless we reached the 2 t ha⁻¹ in 1965, the first time in the history in the Hungarian wheat production. Then we reached the 3 tonnes in 1971, the 4 tonnes in 1977, the 5.4 tonnes in 1984. The average yield over 5 tonnes remained stable between 1988 and 1991. Then the yield fell behind because of the social and political changes and produced more than 5 t ha⁻¹ again only 2004 and 2008. Not only the yield but the area and the total amount of production fell behind after the changes. We are not going to analyze this because it has nothing to do with the professional questions. The increase in the development of yield production can be contributed to two major factors. One of the developments of cultural management, the other is the evolution of biological basis (Balla 2002, 2004).

In sixties and seventies we determined the optimum level of seeding rate, fertilization and planting time and we were looking for the new cultivars which are suitable for cultivation under intensive conditions (Koltay-Balla 1982).

As it can be seen on the *figure 1*. the sortiment of cultivars changed almost in every fifth year. As we did not have up to date cultivars we started to introduce from abroad. The Russian Bezostaya 1 proved to be one of the best. It replaced the former Hungarian varieties, Bánkúti 1201 and Fertődi 293. Then it was followed by Aurora, Kavkaz, Libellula and Jubilejnaja 50. After that period, late seventies and early eighties some Yugoslav varieties were introduced but only Sava, Baranjka and Rana 2 had some importance. When they were delivered to the mill were refused because of the poor quality so they disappeared soon. Although we had five wheat breeding program in Hungary only the Martonvásár proved to be successful in the seventies. The first Hungarian successful intensive type of wheat varieties were registered from the Martonvásár program was as follows:

- Martonvásár 4 (1974)
- Martonvásár 8 (1978)
- Martonvásár 9 (1979)
- Martonvásár 12 (1980)

They started to spread very fast as it is shown on figure 2 (Balla 2002, 2004a, 2004b).

The situation completely changed in nineties and after 2000. One of the old cultivars survived, this is the Jubilejnaja 50. One cultivar which came out from the Szeged program appeared this is the GK Öthalom was a leading variety in the early ripening group and the Martonvásár varieties became dominant as it can be seen on *figure 1 and 2*. In the meantime a few Szeged varieties also appeared and contributed to the wheat acreages.

The main point is what is the situation today. We set up a trial in Karcag to study the contribution of new varieties to the wheat yield. We included in the trial the leading varieties of the second half of the 20th century and the first decade of 21st century. The result of the trial can be seen on *figure 3 and 4*.

In our trial the extensive type of wheat varieties produced as an average 4.83 t ha⁻¹ (*figure 3*). Varieties which replaced them provided 2 tonnes more than as an average 7.3 t ha⁻¹. Varieties of the next age outyielded the previous ones and produced 8.71-9.53 t ha⁻¹. Then newest ones reached 10.0 t ha⁻¹ under the some agrotechnical conditions. If we take into account the genetic advance we can claim that it is 100% compared to the old Bánkúti 1201, approximately 40% if we compare to the check varieties of the next generations Martonvásár 4 and Jubiljenaja 50 and 6-8% if we compare to the check variety Mv Magdaléna of the recent 10 years.

The names of the cultivars yielded more than 10 t ha⁻¹ or almost 10 t ha⁻¹ as is shown in the *table 2 and 3*. Actually there is a group of cultivars which were able to yield 10.1 t ha⁻¹ an another group which produced as an average 9.56 t ha⁻¹ the third group 8.61 t ha⁻¹ when

the extensive type of cultivars produced 4.21 t ha⁻¹ under the same conditions in 2007/2008 year as it is shown on *figure 3*. It was interesting to see how they tolerated the unfavorable conditions in 2004/2005. The extensive group produced only 3.82 t ha⁻¹, the next group 4.63, and the group of the cultivars of present 5.55 t ha⁻¹ and the best ones 6.27 t ha⁻¹. Four from the Karcag group tolerated the drought best (*figure 4*).

The four year average can be seen on figure 5.

What is the situation at present? We have 133 cultivars on the National list (Kovács, 2009). 56 of them are foreign in origin and 77 are domestic. 12 of them occupies 51.2%. 7 Mv cultivars occupie 30.3% 3 GKSzeged occupie 12.9% and 8% is occupied by 2 foreign cultivars. This can be seen in table 4. These are quite new cultivars which were registered between 1996 and 2005 as it is shown in table 5. I should like to emphasize that if a cultivar survives 10 years on large scale production or occupies more than 10% of the wheat accreges it is regarded a successful cultivar. Only Mv Magdaléna, GK Kalász, Mv Csárdás can be mentioned from the last ten years. Now the Mv Suba, the GK Békés, KG Kunhalom, KG Kunglória, KG Bendegúz and KG Széphalom are coming up. The Karcag cultivars which are quite competitive are multipled because as they can be seen on *figure 3 and figure 4* have even higher yield potential than the most widely used cultivars today especially in the plain area where the winter is severer and the summer is drier than the average of the country. So the improvement of genetic yield potential is still under way.

The genetic advance can be contributed to the raise of the biological yield and to the improvement of the harvest index (Balla 2003).

The last question is whether we can take the improvement of the biological basis as a resource of sustainable development. The answer is yes. We have to continue breeding. The other side of the coin is that simultaneously we have to take advantage of the genetic yield potential of the present varieties. As you saw on our table we exploit only 45-50% of the yield potential of the present varieties.

We are glad that the Karcag varieties are among the best ones and probable they will provide further possibilities for producing higher yield per hectare. But the breeding is a never ended procedure. We have to continue and to develop more cultivars wich produce more than $10 \text{ t} \text{ ha}^{-1}$ and we have to take into consideration the adaptation to the agroecological conditions. We who live in the Carpathian basin have quite different soil and climatic conditions what is changing from year to year and the wheat has to tolerate it.

In addition we have to take into account the demand of the market regarding the quality. So the high yield potential, adaptability, high quality and the stress tolerance are the goal of wheat breeding today taking into account the sustainable development.

Table 1

years	average yield (t ha ⁻¹)	increasing of yield (t ha ⁻¹)
1960	1,33	
1961-1965	1,86	0,53
1966-1970	2,44	0,58
1971-1975	33,30	0,89
1976-1980	4,04	0,71
1981-1985	4,61	0,57
1986-1990	4,89	0,28
1991-1995	4,21	-0,68
1996-2000	3,79	-0,42
2001-2005	4,04	0,25
2006-2009	4,20	0,16

Data on wheat production in Hungary (1960-2009) (five year average)

Cultivars which yielded more than 10 t ha-1 and year of release

varieties	year of release
KG Kunglória	2005
KG Kunhalom	2002
Hunor	1998
KG Bendegúz	2006
GK Békés	2005
GK Holló	2001

Table 3

Table 4

Table 5

Cultivars which yielded 9.5	5-10.0 t ha ⁻¹ and year of release
varieties	year of release

year of release
1998
2002
2001
1998
2002
1999
1994
1996
1998
2004
1996

Contribution of wheat cultivars to the area of multiplication 2006-2008 (source: MgSzH)

2008.	2007.	2006.	Rank	2006. %	2007. %	2008. %
1.	5.	9.	Mv Suba	3,3	4,9	6,0
2.	1.	1.	Mv Csárdás	7,4	6,7	5,7
3.	2.	3.	Lupus	6,0	6,4	5,7
4.	4.	4.	GK Kalász	5,8	5,1	5,7
5.	3.	2.	Mv Magdaléna	7,1	6,3	5,7
6.	21.	47.	GK Békés	0,3	1,6	4,7
7.	6.	5.	Mv Verbunkos	5,7	4,6	4,5
8.	11.	15.	Mv Marsall	2,7	2,9	3,2
9.	7.	8.	Mv Ködmön	3,5	3,5	2,9
10.	8.	7.	GK Petur	4,3	3,4	2,5
11.	9.	13.	Saturnus	2,8	3,3	2,3
12.	10.	6.	Mv Palotás	4,4	3,3	2,3

7 Mv 30,3%; 3 GK 12,9%; 2 foreign 8,0%;

The year of registration of the most widely used cultivars

Cultivar	Year of reg.		
GK Kalász	1996		
Mv Magdaléna	1996		
Lupus	1998		
GK Petur	1999		
Mv Csárdás	1999		
Mv Palotás	2000		
Mv Verbunkos	2001		
Mv Marsall	2001		
Mv Ködmön	2002		
Saturnus	2002		
Mv Suba	2002		
GK Békés	2005		

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Figure 1: The five year average of wheat yield in Hungary and cultivars which contributed to it (1961-2009)



Figure 2: Contribution of Martonvásár wheat varieties to the area of production (1974-1985)



Figure 3: The yield potential of cultivars (1960-2004) in 2003/2004 (Karcag)



Figure 4: The yield potential of cultivars (1960-2004) in 2004/2005 (Karcag) * check cu check cultivars



Figure 5: Four year average of cultivars of different ages (Karcag) * check cultivars

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