GENETIC RESOURCES AND THE PROGRESS REACHED BY WINTER WHEAT BREEDING

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Abstract: *This paper shows the contribution in the development of the winter wheat crop, from the beginning of the breeding activity, through the testing and identification of the most adequate autochthonous and foreign wheat varieties, and later, through creating, introducing and extending in production of eight varieties: Bucovina, Suceava 84, Aniversar, Gaşparom, Magistral, Esenţial, Drobeta and Voroneţ. The cultivars Aniversar, Gaşparom, Magistral and Esenţial were cultivated during period 1996-2005. These cultivars registered an average yield of 6367 kg/ha, reaching a yield rise of 197% in comparison with the average yield registered during the period 1951-1955.*
Thus, during the last 60 years an ascending dynamic progress, materialized through an yearly increasing rate up to 1,4% was registered, in comparison with the average yield obtained at the standard variety Flamura 85, during 1996-2005.
The superiority of the eight varieties created at the Agricultural and Development Research Station of Suceava, from the productivity and yield stability point of view, was statistically demonstrated, through the distribution of the correlations and variability of productions, in comparison with the standard varieties from the above mentioned periods.
An important progress concerning the physiological breeding characteristics such as: winter, foliar diseases and lodging resistances, was registered, too.

Keywords: *average yield, ecological factors, agricultural areas*

Introduction:

The presence of some risk ecological factors with a limitative action not only on the quantity but also on the yields quality has determined the fact that during the 60 years period since the foundation of A.R.D.S. Suceava, a correct strategy of the way of organization and development of the breeding researches for winter wheat should be objectively approached. This affirmation is also sustained through the results that have been registered [1, 2, 3, 6, 7].
The agricultural increasing rate on the more poor lands in the agricultural areas with a wet and cold climate, from the north and north west of Moldova have amplified the necessity to create some new varieties that are superior from both the quality and the quantity point of view to the varieties cultivated in time, as the wheat cultures behave risks because of the biotic and abiotic factors, registering frequently big yield fluctuations [5, 6, 9].
In connection with that, at the A.R.D.S. of Suceava, a research activity sustained in the breeding field, following initial selection and identification of the most appropriate varieties for winter wheat, in our country and abroad, having in mind the introduction of them in the culture and replacing from the cultivated variety the one with poorer production performances, has been carried on, since its foundation in 1946 [1, 4, 7, 12].
The research organized on the basis of a national experimentation system of the

wheat varieties has developed only after 1950, increasing after 1970, when we initiated the special works of breeding in the creation of new varieties and wheat lines more valuable and better adapted to the ecological and cultural conditions in Moldova and in the northern part of the country [1, 2, 6].

Through the development of breeding researches, superior wheat genotypes have been created, this being one of the safest ways and efficient ones to increase productivity, stability and yield quality. Having this in mind, at present the appreciations made by the best researchers in the field are unanimously accepted, as they estimate a continuous genetic progress for the wheat varieties created in our country, dimensioned to a annual rate of up to 1, 4 % and even more for other agronomical characters, with a direct influence on the stability of yield [8, 9, 10, 11, 12].

This work aims at appreciating the contribution brought to wheat culture, initially through the testing and identification of the most appropriated national and foreign wheat varieties and after that through the creation, introduction and extension in the production of the varieties obtained at A.R.D.S. of Suceava in 60 years since its foundation.

Biological Material and Research Method

The breeding working method used so far at the A.R.D.S. of Suceava in the last 60 years has contributed in the first half of the period to the testing and generalization in the culture of the most valorous autochthonous and foreign wheat varieties, and in the second half of the period to creation of the 8 wheat varieties and also to obtaining of a valuable breeding material, well adapted to specific conditions of culture in the north part of the country, that offers the possibility of creating in the future new more performing genotypes.

The value dimensioning of the superiority of the varieties created is presented during three significantly periods of time as follows:

1. Period 1946-1975 highlights the difference in behavior of varieties and the wheat lines verified at Suceava having in consideration the aspect of physiological, quality and production features.
2. Period 1976-1995 presents the productive value of the varieties Bucovina, Suceava 84 and Aniversar, cultivated in this period of time, comparing with the Fundulea 29 used as a standard in the northern areas.
3. Period 1996-2005 highlights the Gaşparom, Magistral, Esenţial, Drobeta and Voroneţ varieties, in comparison with witness variety Fundulea 4 used in this period of time.

For the appreciation of the experimented varieties value, from the point of view of the productive potential, the obtained results have been used, during the experimentation years, in the comparative national crop, comparing it with the witness varieties with the greatest spread in production: Fundulea 29 and Fundulea 4.

The relation between the results of the varieties created in Suceava and those of the standard variety Fundulea 4 in the period 1996-2005 has been described through the calculation of the linear regressions and the establishment of the production has been characterized through the determination of the variances(s^2).The results of the phenological observations made during the vegetation are presented in the work through smaller values, and the interpretation of the production data has been made through statistic methods of variance analyses

The experimentation has been carried out in comparative crops, executed at the beginning after the method of plots position in Latin rectangle (with 5 replications and 10 m^2 the cropped

surfaces of one plot) and then in the balanced grating with reiteration of the basis scheme (6 replications and 7 m^2 cropped plot)

Over the years the experiments have been placed after potato, in the leached chernozem soil, reached in humus and total nitric, middle provided with phosphor and mobile kalium, not being necessary the phase fertilization in autumn, as the potato has received larger quantities of chemical fertilizer. In spring, before the beginning of vegetation period, 60-70 kg N s.a. /ha as ammonium nitrate or nitro-limestone have been administered.

The sowing has been carried out, in the majority of the experimental years, in the optimum epoch for this area being assured 550 germinated grains/ m^2. For the creation of the 8 winter wheat varieties to A.R.D.S. of Suceava, with a genealogy and method obtained being presented in short terms, valuable genetic resources have been used, most of them being adapted to the northern and west northern part of Moldova *(table 1)*.

Table 1

The genealogy and obtaining method of the winter wheat varieties created at the A.R.D.S. of Suceava

Variety	Parental forms	Cross year	Homologation year.	Obtaining method
Bucovina	F.53-67 x F. 117-67	1968	1979	The individual selection (Pedigree method)
Suceava 84	Bezostaia 1 x F.208 – 65	1969	1984	
Aniversar	Lovrin 11 x F.53 – 67	1970	1986	
Magistral	1502W4-1/154I1-1//Aniversar/Roxana	1986	1998	
Gaşparom	Sv. 9710-79 x Fundulea 4	1984	1998	
Esenţial	Sv. 2946 – 86 x Sv. 9710 – 79	1988	2001	
Drobeta	Sv. 9710 – 79 x F. 4141 – W 1	1991	2003	
Voroneţ	Sv. 9710 – 79 x Progres	1994	2004	

Climatic conditions, appreciated from the point of view of the annual precipitation quantity and the way of distribution of these in the course of vegetation, have been favorable in the majority of the experimentation years. Not only in the autumn period but also in the winter period, the climatic conditions have not influenced negatively the vegetation of plants , so that on spring arrival the crops have been closed, having a normal density.

In the majority of the years the regime of the rains has been richer in the intense vegetation period, May – June, being an advantage for the growths and development of plants, exception making the years: 1996, 1999, 2000, 2003 and 2004, when a humidity deficit of 116.3 mm has been registered *(table 2)*.

Table 2

The precipitation regimes at ARDS of Suceava during vegetation periods (1996 – 2005)

Period	Precipitation per years, mm:										Multiyear average
	1995/ 1996	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	
August	51.7	136.0	88.1	21.1	68.2	39.1	73.2	112.3	58.0	52.9	69.7
September-Oct.	95.0	150.6	100.8	186.5	92.0	81.9	191.0	108.3	74.4	65.1	79.2
November	65.5	27.1	21.2	30.5	22.6	10.8	63.5	47.0	10.9	39.5	30.4
Dec. - March	126.5	84.5	104.4	68.3	77.3	89.1	76.6	67.8	90.8	101.4	92.8
April	38.3	52.8	63.0	87.6	50.9	60.5	6.3	10.8	19.0	100.6	45.6
May – June	93.3	153.2	262.9	90.1	54.0	123.9	119.0	46.4	61.6	225.4	163.2
July	53.8	111.9	101.6	65.8	115.0	91.4	238.0	252.5	160.7	45.3	89.3
Total	524.1	716.1	742.0	549.9	480.0	496.7	767.6	645.1	475.4	630.2	570.2

The normal calculation of 61 years
The wet and cold regime in the vegetation period has positively influenced the appearance and development of foliar diseases attack and contributed in the same time to the amplification and sometimes early falling of plants from the most sensitive varieties .
Under the report of thermal regime, in the majority of the experimental years , values relatively close to the multi-annual average have been registered , without inducing negative influences over the plants vegetation.

RESULTS AND DISCUSSION

A valuable contribution in the agricultural progress in Bucovina is brought to the plants breeding research field, beginning with the foundation of the ARDS in 1946 through verifications of different varieties and wheat populations' behavior from the western part of Suceava Plateau area, the research activities being carried out on the basis of a national experimentation system of wheat varieties which have been developed only after 1950 . It can be appreciated that winter wheat , and the other plants taken into consideration in the area has registered an ascending line .
Beginning with the year 1946 and until 2005 , during six decades , a number of 6391 varieties and wheat lines of perspective, have been verified, from the point of view of production and vegetation behavior of which 1750 autochthonous and foreign varieties. The most valuable of these varieties have been introduced and generalized in production , occupying at the level of different periods numerous surfaces.

The yield quality

From the point of view of the physical aspects of production it is easy to see that one thousand kernel weight of the experimented varieties during 1970 -1975, has varied greatly from one variety to another, ranging values from 33,8g to 42,4 g *(table 3).* It has been noticed that from this point of view the Lovrin 10, Aurora and Kaukaz varieties have registered the highest values for one thousand kernel weight (39,9 g –42,4 g)

Table 3

The yield quality of wheat varieties and lines which were experimented during period 1970 -1975 at ARDS of Suceava

Variety or line	One thousand kernel weight -g-	Total protein % from d.s. N x 5,7	Gluten		Pelshenke index	Farinograf note	From 100g flour	
			wet	Dry			Bread volume -cm^3-	Bread weight -g-
Lovrin 10	42.4	15.4	32.9	10.3	59	45	508	152
Aurora	41.0	15.3	31.1	10.4	81	45	518	156
Kaukaz	39.9	16.1	33.6	10.9	75	46	531	154
Brucker 6111	35.5	15.4	31.6	10.4	94	48	530	151
T. 195 - 65	33.8	14.0	27.2	9.6	135	50	514	153
Dacia	36.8	16.1	31.6	10.9	101	49	540	153
Favorit	33.9	16.2	32.9	11.4	107	59	547	154
Bezostaia1-st.	33.8	14.4	29.0	9.8	114	51	496	151

According to protein content, represented through values of 14,0-16,2%, it has been noticed for the Favorit , Dacia and Kaukaz varieties, to have higher content of wet

and dry gluten.
From the point of view of gluten quality, which bread making features depend on ultimately, for the Favorit, Bezostaia 1, Dacia, Brucker 6111 varieties and for inbred line T. 195 – 65, the following aspects have been analyzed: the highest value for Pelshenke index, of 94 – 135, farinograf note, up to 48, the bread volume calculated at 100 g flour between 496 and 547 cm^3, and its weight up to 151 g

The yield quality

From the point of view of the quality features we can notice that between the experimented varieties in the period 1991-1995 there are no differences that could surprise us, these displaying good qualities of milling and bread making features *(table 4).*
According to the protein content, represented by average values from 12.2 % at Transilvania 1 and Turda 81, up to 13.8 %, in the varieties Aniversar, Fundulea 29, Dropia and Bezostaia 1, the gluten content has registered higher values up to 33.3 % at wet gluten and 10.8 % for the dried one. Taking into consideration this aspect we have noticed that, through the increased gluten content, the varieties Bucovina,
Aniversar, Suceava 84, Apullum, Ariesan, Bezostaia 1 and Dropia have registered values up to 30% at wet gluten and 10.8% dried gluten. From the point of view of the gluten quality, which finally determines the bread making features of flour, we can observe that higher gluten content varieties had also the higher glutenin index, from 54.5 at Bucovina, up to 60.5 at Ariesan.
The bread making features value of the experimented varieties, appreciated through bread volume and weight, from 100g of flour , demonstrates that from this point of view the advanced varieties are mostly varieties with good bread making features qualities, the bread volume registering from 441 cm^3 in the variety Apullum, up to 506 cm^3 at Dropia, and their weight varying between 139 g at variety Turda 81 and 144 g at varieties Dropia, Aniversar and Fundulea 4.

Table 4.

Quality traits of the wheat varieties experimented at ARDS of Suceava (1991-1995)

Current No.	Variety	% protein	% gluten		Glutenic index	Bread from 100 g flour	
			wet	dry		Volume -cm^3	weight –g
1	Fundulea 29	13.8	28.4	9.7	52.8	477	143
2	Fundulea 4	12.4	25.3	8.5	54.4	443	144
3	Flamura 85	13.6	28.1	9.5	54.2	453	142
4	Rapid	13.6	29.0	9.5	58.6	457	143
5	Dropia	13.8	32.1	10.2	59.6	506	144
6	***Bucovina***	13.1	30.9	9.3	54.5	476	142
7	***Suceava 84***	12.8	33.0	9.5	54.7	480	143
8	***Aniversar***	13.8	33.3	10.1	55.3	479	144
9	Moldova 83	12.8	29.4	9.2	53.0	495	140
10	Turda 81	12.2	25.2	8.3	49.6	489	139
11	Apullum	13.4	30.2	9.5	50.2	441	142
12	Arieşan	13.3	30.5	9.4	60.5	437	140
13	Transilvania 1	12.2	26.9	8.6	53.9	502	141
14	F. 308	13.2	28.5	9.6	52.5	495	141
15	Bezostaia 1	13.7	33.3	10.8	57.1	496	141

The yield quality

The physical features of production, at the varieties created at ARDS of Suceava between 1996-2005, are highlighted by bigger and heavy grains, fact that confers them higher values not only for one thousand kernel weight, most often registered between 45-50 g, and the test weight had values between 75-80 kg.
Taking into consideration the bread making features, the Gasparom, Magistral, Esential, Drobeta and Voronet varieties frame themselves among the crops with superior qualities, proving also to be competitive in comparison to the actual requests regarding this matter *(table 5).*
The chemical content of grains frequently registers high values, superior to the Flamura standard, not only for the protein content from 13.8 % to 14.2 %, but also for the wet gluten content (28.4 – 32.4 %) and dried gluten (9.5 – 10.5 %). The gluten indicator between 85.0 and 97.9 ml, superior to the Flamura 85, proves in a special way that the quantity and quality values of the gluten from protein for the newly varieties created at ARDS of Suceava between 1996 and 2005, is obviously due to the lower deformation indicator level (6 – 7 mm as against to 8 mm at standard).

Table 5

The main indicators for bread making features quality for the created and experimented varieties at ARDS of Suceava during period 1996-2005 in comparison with the Flamura 85 variety.

Crt No.	Specification	GASPAROM	MAGISTRAL	ESENTIAL	DROBETA	VORONET	FLAMURA 85
1	Protein content (%)	14.2	13.9	13.8	13.8	14.1	13.6
2	Wet gluten (%)	30.2	32.4	28.5	28.4	29.8	28.1
3	Dried gluten (%)	10.5	9.8	9.8	9.5	9.5	9.5
4	Glutenic index (ml)	85.0	89.6	95.8	97.9	91.8	84.2
5	The deformation index (mm)	7	6	6	7	6	8
FARINOGRAMA							
6	Hydration capacity (%)	66.3	62.8	61.2	62.4	61.8	61.2
7	Developing (min.)	2.1	2.1	2.3	2.5	2.5	2.1
8	Stability (min)	2.3	2.2	2.4	2.6	2.6	2.1
9	Elasticity (uv)	130	128	126	133	131	125
10	Power	56.8	57.7	59	56.6	57.5	50.5
11	Value index	68.4	67.4	70.8	65.2	67.4	61.8
12	Bread volume (cm^3)	510	512	510	505	510	500
13	Bread weight (g)	145	145	145	143	145	142
VALUE GROUP		$A_2 – B_1$	$A_1 – B_1$	$A_2 – B_1$	$A_2 – B_1$	$A_1 – B_1$	$B_1 – B_2$

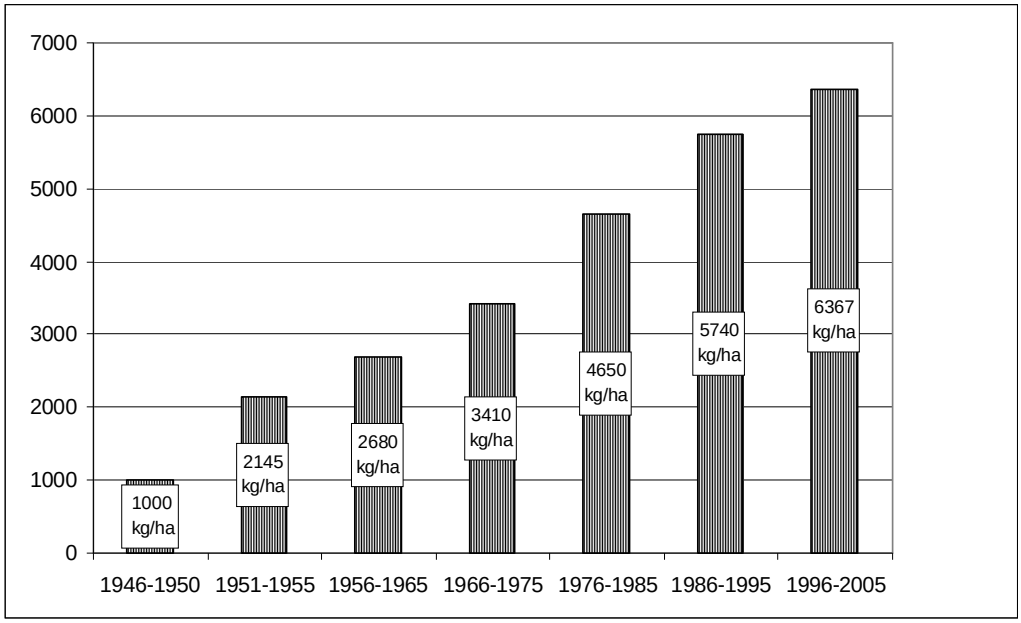

Fig. 1 The genetic progress made by winter wheat, in the period of time 1946-2005, through utilization in the crop of the most valuable varieties, under crop conditions offered by ARDS of Suceava

Analyzing the evolution of the genetic progress registered by wheat through the utilization in the crop production of the most valuable varieties, during the 60 years since the foundation of the ARDS of Suceava, we can notice that there is a continuous increase, quantified by average productions from 2145 kg/ha, during the period 1951 – 1955, to 6367 kg/ha, during the period 1996 – 2005, which in relative values means an increase of 197 % *(fig.1).*

The genetic progress reflects especially the increase of production capacity, registered especially in the last 30 years (1976-2005), when as a consequence of intensification of creating new varieties, wheat productivity has increased a lot, reaching an average level of 4650 kg/ha, during the period 1976-1985, up to 6367 kg/ha during the period 1996 – 2005

CONCLUSIONS

- The research activities carried out between 1946-2005 at ARDS of Suceava, initially in the direction of identifying varieties and more valuable lines and afterwards creating new varieties and wheat lines more productive and better adapted to crops conditions from the North Moldova , have contributed to the rational zoning of the best varieties, at the introduction and generalization in the crop and through this to progressive increase of production.
- Through the researches carried out over time at ARDS of Suceava, 8 common winter wheat varieties have been created (Bucovina, Suceava 84, Aniversar, Gasparom, Magistral, Esential, Drobeta and Voronet) more productive and better adapted to the specific crop conditions for the wet and cold climatic areas.
- The global analyses of the production performances have proved that, through the creation and utilization in the crop of these genotypes, in time, dynamic increasing progress has been registered, dimensioned through an annual increasing rate of production, in comparison with the annual average yield of the standard variety Flamura 85,

of up to 1.4 % during the period 1996-2005

- Significant progresses concerning the breeding of the physiological features and quality features have been also registered:
  - The winter resistance and resistance to cryptogrammic diseases attack has been increased from average forms to resistant forms;
  - The lodging resistance has been improved, through the shortening of height and the thickening of stem, from low to very good;
  - Concerning the quality features, the progress obtained places the new varieties, created at ARDS of Suceava, among the wheat varieties with superior bread making features (classes A_1-B_1 and A_2-B_1).

The winter wheat varieties that may be found at present in Moldova, especially in the northern and west-northern part of Moldova, are autochthonous varieties with multiple adaptability qualities to the ecological conditions, and until the creation of some more performing varieties , we strongly recommend the following ones: Gasparom, Magistral, Esential, Drobeta and Voronet.

References

1. GAŞPĂR, I., 1968 – Soiuri şi linii de grâu de toamnă de perspectivă pentru cultură în Podişul Sucevei. Probleme agricole, nr. 8;
2. GAŞPĂR, I., 1976 – Soiuri şi linii de grâu şi secară valoroase şi de perspectivă pentru judeţul Suceava. Volum omagial, 1946 – 1976: 47-61;
3. GAŞPĂR,I., 1984 – Soiul de grâu de toamnă Suceava 84. Cercetări Agronomice în Moldova, vol. 3 (67): 39-44;
4. GAŞPĂR, I., 1987 – Caracterizarea bioproductivă a soiului de grâu „Aniversar", creat la Staţiunea Agricolă Suceava. Cercetări Agronomice în Moldova, Anul XX, vol. 4 (80):37-42;
5. GAŞPĂR,I., 1993 – Rezultate experimentale privind comportarea unor soiuri de grâu, secară şi triticale la S.C.A. Suceava. Cercetări Agronomice în Moldova, Anul XXVII, vol. 3-4 (102): 31-38;
6. GAŞPĂR,I., ZAMĂ, E., - 1996 – Rezultate experimentale privind comportarea unor soiuri şi linii de grâu de perspectivă în condiţiile de cultură din Podişul Sucevei. Volum omagial, 1946-1996: 21-36;
7. GAŞPĂR, I.,CRISTEA, M., POPOVICI,D., 1996 – Strategii şi obiective în ameliorarea plantelor la Staţiunea Suceava. Lucrări ştiinţifice- volum omagial, 1946-1996. S.C.Agris-Red. Rev. Agricole S.A.: 11-21;
8. GAŞPĂR, I., ZAMĂ, E., POPESCU, CONSTANŢA, MURARIU, M., 2000 – Gaşparom şi Magistral – soiuri noi de grâu de toamnă, create la Staţiunea Suceava. Analele I.C.C.P.T. Fundulea, vol LXVII: 49-64;
9. GAŞPĂR, I., MURARIU, M., ZAMĂ, E., 2002 – Progresul realizat în ameliorarea grâului de toamnă la S.C.A. Suceava în ultimele trei decenii, Cercetări de genetică vegetală şi animală, vol.VII: 59-69.