2. SELF-ASSESSMENT REPORT

2.1. Administrative structure of the institution

The organizational chart of the National Agricultural Research-Development Institute (NARDI), Fundulea in 2011 is presented in Figure 1.

According to law, the Institute Leadership consists of:
- Administration Board;
- Direction Committee;
- General Director.
- The Scientific Board directs and coordinates the scientific and technical activity of the institute.

The Administration Board consists of nine members (four representatives from NARDI, 4 representatives from the ministries: Ministry of Education, Research, Youth and Sports, Ministry of Public Finance, Ministry of Agriculture and Rural Development, Ministry of Labour, Family and Social Protection and a representative from the Academy of Agricultural and Forestry Sciences) and operates in accordance with the provisions of the Government Decision no. 1882/2005 and with its own Rules of organization and functioning, approved by the Academy of Agricultural and Forestry Sciences *"Gheorghe Ionescu-Şişeşti"*.

The main tasks of the Administration Board: approves the strategy and the specific programs for the institute development; proposes the modification of the organizational and functioning structure of the institute; analyses and approves the draft budget of income and expenses; analyses and approves the annual financial statements; approves the management report regarding the institute activity in previous year; assesses achievement relative to performance criteria, analyses and approves the investments that will be made by the institute, according to law, submits for approval the property increase or decrease, as well as the granting or renting out of some assets that belong to the institute; in compliance with provisions approves the capitalization of own acquired goods, approves the volume of bank loans and establishes their reimbursement; approves the utilization of the disposable funds in foreign currency; approves the mandate for negotiating the collective labour agreement, approves the criteria and competition commissions to occupy job vacancies in the Institute.

Direction Committee – consists of 7 members (the general director and the heads of the main compartments). It ensures the effective leading of the Institute, exercising its duties and being responsible in the limits of competence proposed and approved by the Administration Board.

The Direction Committee establishes the concrete activities necessary for carrying out the objectives resulted from: the strategy of development programs of the institute; annual research-development programs; budgets of income and expenses; investment programs, as well as other legally settled tasks.

The current activity is managed by the general director, whose tasks and responsibilities are mainly the following: he personally represents or by a delegate the interests of the institute towards institutions, organizations and economic agents, as well as persons in the country or abroad; establishes the tasks, competence and the relationships at the level of subunits and departments of the institute, as well as their relationship with third persons approved by the Administration Board; suggests to the Administration Board the modification of the functional and organizing structure of the institute; appoints the heads of the compartments in the organizing structure of the national institute after a competition organized on the basis of the criteria proposed by the Administration Board and revokes them, if necessary with the approval of the Administration Board; employs and dismisses the staff of the institute according to the legal provisions and of the collective labour agreement; ensures the negotiation of the collective labour agreement at the level of the institute or the staff salaries by the Direction Committee and approves the salaries resulted from direct

negotiation; he is responsible for the management of the whole patrimony respecting the provisions of the law; adopts measures and pursues the carrying out of the inland and export-import trade operations through the specialized compartments; analyses monthly the stage of the research results capitalization, including the activity of the marketing office; his tasks are similar to a credit release authority for the money allocated to the institute from the state budget; he can delegate, considering the law, some of his tasks to other persons from the leadership of the institute; he carries out any other tasks allotted by the Administration Board.

The Scientific Board consists of nine members, representatives of the Institute main departments.

The main tasks of the Scientific Board are: participates in the elaboration of the development strategy for the research-development activity and its plans of research and development; analyses, approves and pursues the elaboration of scientific papers, submits for approval to the Administration Board the annual research and development program of the institute, *approves the decisions of the Administration Board* regarding the research policy of the national institute and its branches; proposes measures for professional training and certification of research personnel by professional degrees; organizes and coordinates scientific manifestations, endorses the scientific cooperation actions at internal and international level.

The Research Department

6 research teams organized as specific sub domains are the components of 3 laboratories in the frame of the Department *"Systems of sustainable agriculture"* and 12 teams are the constituents of 5 laboratories from the structure of the Department *"Germplasm improvement"*. The Centre for organic farming functions as a distinct entity subordinated to the leadership of the institute and collaborates with all other components of the research sector.

The high education personnel, directly involved in research activities includes: **33 doctors, 7 PhD students and 8 masters. Four of the Institute employees are members of the Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Sisesti", one of them being also a titular member of the Romanian Academy**.

Regarding the age groups, the personnel consists of: 27,8%- less than 30 years, 13,9%- 31-40 years, 19,8%- 41-50 years, 23,8%- 51-60 years, and 14,7%- over 60 years.

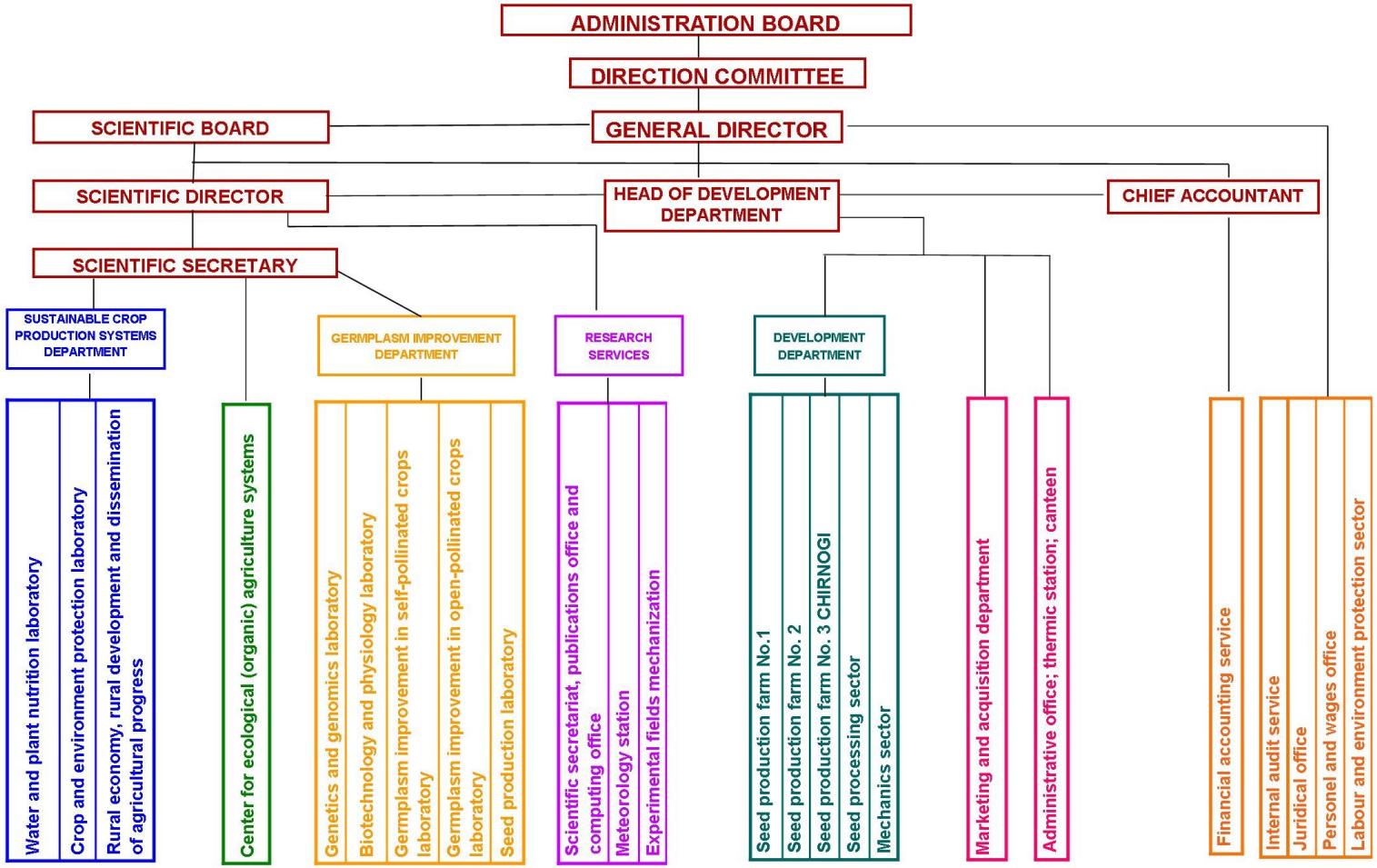
The support activities connected to research are included in the department of *Research services*, which includes Scientific Secretariat and the Office for Publications, the Meteorological Station, and the team for Mechanization of experimental fields.

The Development Department

The development activities are organized in three vegetal farms for producing seeds from superior biological categories, the seeds processing sector and the mechanics sector. Other supporting activities are included in the Marketing and acquisition department, the Administrative office; Thermic Station and Canteen.

The activities of specific interest for all operating structures of the institute, are organized in: Financial and accounting service; Internal financial audit service; Juridical office; Human resources and wages office; Labour and environment protection sector.

Fig. 1 **NARDI FUNDULEA ORGANIGRAMME**
2011



2.2. General activity report of the institution

NARDI was included in the project "MAKIS" (Modernization of Agricultural Knowledge and Information System), financed by the World Bank. In this context, following a detailed analysis performed with the assistance of foreign consultants (from Holland, UK and France) and based on SWOT analyses of many alternative solutions, a Reform Plan was adopted, and approved by representatives of World Bank and Ministry of Agriculture and Rural Development.
NARDI scientific and economic activities, the investments and human resources policies, as well as the technological transfer, dissemination and extension activities, have all been oriented according to this Reform Plan.

2.2.1. The scientific activity

According to the new mandate included in the Reform Plan, NARDI has worked on improving crop management practices and germplasm to help farmers obtain better quality products, as well as higher and more stable economic results, in the context of climate changes. Some fundamental researches related to these objectives have also been approached.

- Regarding **crop management systems**, research has been focused on:
  - Adapting crop management practices to predicted climate changes;
  - Low cost crop management systems with higher input use efficiency**.** A special attention was given to conservative agriculture**,** including identifying cultivars adapted to conservative crop management;
  - Improved integrated, environmental friendly crop management practices to prevent and control weed, disease and pest infestation;
  - Increasing bio-diversity of field crops**,** by diversifying crops and cultivars and optimizing crop rotation, according to environmental conditions, farm types and market requirements.
  - Crop management and plant protection systems to minimize accumulation of toxic or potentially damaging compounds;
  - Crop management practices and cultivars for organic agriculture.

  Among the **main results** obtained in this field since 2007 we can mention:
    - First scientific results demonstrating significant advantages of conservative agriculture in Romania, and specific crop management recommendations to make this system work in Southern Romania;
    - Recommendation of perennial crops mixtures suitable for low input, highly efficient forage production;
    - Technical documentations for the official approval of about 45 new herbicides and pesticides on average every year, based on extensive field studies;
    - Extensive data on end-use quality of organically produced wheat, suggesting ways of improvement;

- For **germplasm improvement**:
  - Germplasm has been largely diversified and significant genetic progress has been achieved in improving quality, increasing adaptation to expected climate changes, especially by improving drought and extreme temperatures resistance, improving tolerance to unfavourable soil conditions etc.;
  - 58 cereals, grain leguminous, industrial and forage crops **new genotypes were submitted for official testing** at the State Institute for Variety Testing and Registration in view of registration;
  - **22 NARDI cultivars were registered** since 2007 (3 wheat cultivars, two triticale, one rice, two soybeans, two alfalfa and two linseed cultivars, as well as two maize

hybrids, three sunflower hybrids and five cultivars belonging to medicinal and aromatic crops);

- Two sunflower hybrids (Dalhia and Robia), bred in cooperation with the French company Caussade were also registered in Romania;
- **20 patents** were obtained for previously released cultivars;
- To ensure the on-farm impact of the achieved genetic progress, NARDI provided annually to farms on average **3100 tons of basic seed** for seed production on **15600 hectares**, as well as parental forms seed for planting **3230 hectares of hybrid seed production plots**.
- As a result of their agricultural value and adaptation, as well as due to ongoing seed multiplication programs**, the share of NARDI cultivars is presently estimated at about 60% in wheat, about 70% in winter feed barley, almost 100% in Triticale, 50% in alfalfa, 17% in maize, 8% in sunflower**, etc.

International cooperation has been intensified, especially with private companies, adding new elements to the already existent contribution of NARDI cultivars to agricultural production worldwide:

- Wheat cultivars Dropia, Boema, Delabrad and Glosa were introduced in Turkey;
- Wheat cultivar Izvor was released in Argentina under the name Lenox;
- Triticale cultivar Stil was released in France;
- Sunflower hybrids Favorit, Venus and Fundulea 225 were released in Ukraine;
- Sunflower hybrids Sellor, Ekllor, Ampil, Oleg, Expllor, Dahlia, Robia, Obraia, Florencia, Almanzor, bred in cooperation with different companies from abroad, were introduced in Spain, France, Italy, Sudan, Russia, Ukraine, etc.

- **Fundamental research** has been aimed at supporting applied research in crop management and germplasm improvement. Main results obtained since 2007 include:

- Identification of new molecular markers associated with drought resistance and bunt resistance in wheat;
- Calibration of simulation models and assimilation of remote sensing data for the main crops cultivated in Romania;
- Identification of the phenology winter wheat ideotype for high yield and stability under various climatic scenarios for south-eastern Romania, by simulation;
- New genotypes resulting from pre-breeding work for transferring disease resistance from wild relatives to wheat and sunflower;
- Development and application of screening methods for stress resistance in wheat.

2.2.2. Economic status

The last years have been for NARDI a continuous struggle to ensure the funds necessary for continuing the research activities. The main sources that have been available, at various levels, included:

- projects financed from the budget through National Research Programs attributed by competition;
- projects at governmental request financed through "sectorial" programs, by the Ministry of Agriculture and Rural Development;
- projects for "core" financing, through "nucleu" program;
- European projects;
- financing from own revenues.

As seen in Table 2.1, total funds available for research decreased from 12.093.319 lei in 2008 to 8.390.376 in 2010. The decrease was mainly due to a reduction in funds attracted through competition through National Programs, which decreased from 3.449.265 lei (representing 29% from total funds) in 2008 to 413.375 (only 5%) in 2010, because **no new competitions were organized**. This reduction was partially compensated by an increase in core financing through the

"Nucleu" program, which reached over 20% of total financing in 2009 and 2010, being extremely helpful. However, total budgetary funds decreased from 7.357.002 lei in 2008 to 3.990.267 lei in 2010. The continuation of many research programs would not have been possible without financing from own revenues, which covered 52% of total research funds in 2010. We should mention the important contribution of collected royalties, which reached over 20% of total funds.
The uncertainties caused by fluctuation of both budgetary funds and funds from seed multiplication, which are dependent on weather and market conditions, make long term planning of research activities and human resources difficult.

Table 2.1**. Contribution of available financing sources, during 2007-2010**

Source	2007		2008		2009		2010	
	Lei	%	Lei	%	Lei	%	Lei	%
Budget								
National Programs:	(2057050)	(25)	(3449265)	(29)	(959535)	(12)	(413375)	(5)
- CEEX	1517050	19	791500	7	-	-	-	-
- PN II	275000	3	1408000	12	656578	8	413375	5
- CAPACITIES	265000	3	1249765	10	302957	4	-	-
"NUCLEU"	1495290	19	1776000	15	2213909	27	2033979	24
GRANTS	87000	1	547635	5	649586	8	150294	2
SECTORIAL	1371474	17	1584102	12	647185	8	1221613	15
FP 7	-	-	-	-	-	-	171006	2
TOTAL BUDGET	(5010814)	(62)	(7357002)	(61)	(4470215)	(54)	(3990267)	(48)
Own Sources								
R&D contracts with private companies	790289	10	526718	4	988010	12	1240445	14
Royalties	1036065	13	2078071	17	1915221	23	1914805	23
Breeder seed multiplications	1172732	15	2124391	18	928741	11	1187585	14
Other products	8441	0	7137	0	30001	0	57274	1
TOTAL OWN RESOURCES	(3007527)	(38)	(4736317)	(39)	(3861973)	(46)	(4400109)	(52)
TOTAL	**8018341**	**100**	**12093319**	**100**	**8332188**	**100**	**8390376**	**100**

The development sector produced significant revenues, mainly from multiplying, processing and selling seed of NARDI cultivars (Table 2.2).

Table 2.2. **Revenues from the development sector**

	2007	2008	2009	2010
Seed multiplication	10.674.975	6.871.651	6.097.750	6.238.823
Other products and services	1.084.134	709.347	766.741	776.649
Total	**11.759.109**	**7.580.998**	**6.864.491**	**7.015.472**

Despite the encountered difficulties, the over-all economic situation of NARDI during the entire analyzed period was balanced (Table 2.3).

Table 2.3. **NARDI economic status during 2007-2010 (lei)**

	2006	2007	2008	2009	2010
Revenues	20.271.532	21.714.389	20.933.579	18.021.337	19.207.193
Expenses	19.667.673	21.003.152	20.229.198	17.009.936	18.586.846
Difference	+603.859	+771.237	+704.381	+ 1.011.401	+ 620.347

2.2.3. Significant investments

During the period 2007-2010 significant investments were made both in research and development sectors (Table 2.4). The main investments in research included:

- Equipments for molecular genetics studies (Station for DNA isolation and purification, Centrifuges, Thermocycler etc.)
- Controlled climate facilities (Automated greenhouse, growth chambers);
- Equipments for experimental fields (plot combine, sowing machines, etc.);
- Equipments for mycology and toxicology studies (equipment for ELISA analyses, sterilization equipment, etc.).

Table 2.4. **Value of investments, during 2007 - 2010**

Sector	2007		2008		2009		2010		Total	
	Lei x 10^3	**%**	**Lei x 10^3**	**%**	**Lei x 10^3**	**%**	**Lei x 10^3**	**%**	**Lei x 10^3**	**%**
Research	2.619	98,7	2.275	91,8	879	62,1	176	27,1	5.949	82,7
Development	34	1,3	202	8,2	537	37,9	473	72,9	1.246	17,3
Total	**2.653**	**100,0**	**2.477**	**100,0**	**1.416**	**100,0**	**649**	**100,0**	**7.195**	**100,0**

2.2.4. Human resources status

Table 2.5 shows that the total number of employees decreased continually from 568 in 2006 to 359 in 2010. 28 high education specialists were recruited in the research sector, out of which 19 under the age of 30 years. However, this did not compensate the number that retired or left, so that over all there was a reduction of 17.5% in the high education personnel employed in research. There was a larger reduction in the number of auxiliary personnel (41.7%) and in the development sector (43%).

Table 2.5. **Number of employees during 2006 - 2010**

	2006	2007	2008	2009	2010
Total number of employees	568	535	406	381	359
	100%	*94,2%*	*71,5%*	*67,1%*	*63,2%*
- out of which in research	255	238	209	191	181
	100%	*93,3%*	*82,0%*	*74,9%*	*71,0%*
- out of which with high education	63	63	58	54	52
	100%	*100,0%*	*92,1%*	*85,7%*	*82,5%*
Scientific researchers I	15	15	15	14	12
	100%	*100%*	*100%*	*93,3%*	*80,0%*
Scientific researchers II	13	12	10	8	9
	100%	*100%*	*76,9*	*61,5%*	*69,2%*
Scientific researchers III	13	12	10	10	12
	100%	*92,3%*	*76,9%*	*76,9%*	*92,3%*
Scientific researchers	-	-	5	5	3
Research assistants + engineers	22	24	18	17	16
	100%	*109,1%*	*81,8%*	*77,3%*	*72,7%*
Auxiliary personnel	192	173	151	135	112
	100%	*90,1%*	*78,6*	*70,3*	*58,3*

The average age of the scientists is presently 47 years.

Among the measures to improve the qualification level of younger researchers we can mention:

- 16 young researchers have worked for their PhD studies, out of which 10 defended their thesis during the analyzed period;
- intensive courses of English language, for 12 young researchers, organized for 3 years;
- a special five weeks stage of training in conservative agriculture at CIMMYT Mexico for 3 researchers, with the support of MAKIS program;
- 3 short duration trainings at Tuln–Austria, Gatersleben-Germany and Martonvasar-Hungary;

- Participation of 5 young researchers at the EU Agrisafe – European Research Training Programme courses organized by Martonvasar Institute – Hungary;

2.2.5. Technology transfer, dissemination and communication

NARDI has always paid a special attention to the transfer, dissemination and communication of its research results, both to farms and to the scientific and professional communities.

The main measures taken for **the transfer to farms** have been:

- To produce and promote seed of new NARDI bred cultivars. NARDI provided every year on average over 3000 tons basic seed to over 100 farms accredited for seed production;
- To recommend best crop management practices, through leaflets, articles in agricultural extension publications, courses, interventions at radio or TV etc.
- To participate in national and international fairs and exhibitions. Two excellence diplomas were attributed to NARDI at the Annual Research Shows;
- To organize field days for wheat and barley, sunflower and soybeans, as well as for maize and sorghum, where new cultivars and crop management demonstrations are presented every year;
- To organize on-farm demonstration plots and to provide seed of main NARDI cultivars for demonstration plots organized by other institutions.

The **interface with the scientific and professional communities** for joint research, transfer, dissemination and communication included:

- Partnership with 19 agricultural research stations, 3 agricultural universities, 3 national institutes, 3 R-D institutes and one professional association, for research and extension;
- Participation in international testing networks organized by FAO (testing sunflower hybrids), CIMMYT (testing wheat and triticale), etc.;
- Annual sessions of scientific communications, and internal sessions organized one day/week during winter;
- Participation at 60 international meetings (10 congresses, 10 conferences, 11 symposia, 8 seminars, 21 workshops), where NARDI scientists presented 56 communications;
- Contractual bilateral cooperation with 9 research institutes, one Academy of agricultural sciences and 10 private companies, as for example: in wheat and triticale breeding with Martonvasar Agricultural Research Institute of the Hungarian Academy of Sciences, Agricultural Institute Dobrudja „General Toshevo"- Bulgaria, Breeding and Genetics Institute Odessa-Ukraine, Research Institute for Agriculture-Krasnodar, Russia, breeding companies „Donau"- Austria, „Caussade Semences"-France etc.; in maize breeding, with Research Institute for maize Kneja-Bulgaria; in sunflower breeding, with Institute for field crops Novi Sad-Serbia, Agricultural Research Institute Trakia, Edirne-Turkey, Academy of Agricultural Sciences Hebei-China, Caussade Semences, Euralis, Limagrain, Syngenta, RAGT-France, Nidera-Argentine, Dow AgroScience-USA; in breeding linseed and forages, with EuroGrass Breeding GmbH-Germany, etc.
- Publishing the journal "Romanian Agricultural Research" in English, indexed by ISI since 2007, and "Analele INCDA", with English abstracts. During the analyzed period, NARDI scientists published **40 papers in the "Romanian Agricultural Research" and 93 papers in the "Analele INCDA"**. Both publications have been included in international exchanges with 80 and respectively 36 research institutes and universities abroad.
- affiliation to International Sunflower Association-ISA; International Parasitic Plants Society-IPPS; International Association for Plant Tissue Culture; International Triticale Association; Federation of European Societies of Plant Biology – FESPB; Romanian Association for Plant Tissue and Cell Cultures; Romanian Association of Breeders, Dealers and Seed Producers (AMSEM); National Society of Plant Protection;
- NARDI scientists are members of European Aneuploid Co-operative - EWAC; European Society for New Methods in Agricultural Research; International Society of Organic Agriculture Research; Crop Science Society of America, etc.

2.3. Activity reports by teams

2.3.1. *Water and plant nutrition management* team

The research carried out by the team in the period 2007 – 2011 have had as a main objective the establishment of alternative technological variants to the conventional technologies related to soil tillage, crop fertilization and rotation. The aim has been to reduce inputs and increase productivity and economic efficiency, in view of achieving high quantitative and qualitative yield levels of the main field crops, and at the same time improving soil conservation and environment protection.

The Project "Soil tillage systems adapted to local conditions, with the purpose of soil agro-physic state protection, water conservation, and economic optimization of agricultural management", within the 2006 – 2010 "Sectorial" Program of MADR, proposed the promotion of soil tillage systems for soil conservation in different variants adapted to mid – heavy texture soil (30 – 42% clays in arable layer) and the specific crops requirements in the Southern zone of Romania; the end aim being to obtain high yields of corresponding quality, when compared to those obtained when conventional agriculture is applied.

Conservation tillage systems are characterized by reduced soil tillage, or direct seeding (planting) in non worked ground, and maintenance of a large amount of vegetal residue on surface. These systems, largely adopted in other countries, have been claimed to be less suitable for Romanian conditions. The results obtained during the project proved for the first time that **conservation tillage systems are competitive with the conventional technologies by achieving similar wheat, maize and soybean yield levels, or in certain cases even higher, in the conditions of the cambic chernozem of Fundulea**.

The crop technologies within conservation tillage systems offer **important** economic advantages, reducing the inputs without affecting significantly the wheat, maize and soybean yield performances. On average over three crops, a **reduction of around 37% of labour expenditure, of 35% of fuel consumption, and of around 33% of total cost was reported**.

Important net income increases were also recorded, in comparison with conventional technologies, as: 40 – 165 lei per Ha of wheat, and 200 – 636 lei per Ha of maize. These results represent strong economic arguments for extending the new tillage systems into large agriculture practice.

Beside economic advantages, the new tillage systems contribute substantially to soil conservation and the environment protection, as well as to a durable development of agriculture on mid and long terms.

Adopting the conservation tillage systems requires a transition period for correcting soil features, crop rotation organization, and to procure the recommended specific machinery and equipment.

Reduction of the soil work and its protection with vegetal residue were proven to favour the accumulation and conservation of an additional water quantity in cold seasons, especially in dry years.

Soil water accumulation and conservation is determined by the physic characteristics of the respective soil, especially by the its texture and permeability, which are essential in providing water necessity and avoiding water excess; in the end defining its suitability for conservation tillage systems.

Plant water consumption can be well influenced by soil tillage systems and temporary protection in first vegetation stages, without affecting the total consumption and capitalization of water from precipitations.

Reduction of the soil work and its protection with vegetal residue determined temporary modifications of the main soil physic indicators, in variation limits which did not influence significantly the plat growth and development, or yield levels.

The light increase of soil apparent density, along with total porosity reduction and aeration degree facilitated the water retention process and reduced the organic matter mineralization.

In mid and long terms, important total carbon and total nitrogen increases were estimated, which contributed to the maintenance and restoration of soil physic features and biological activity within it.

Soil mineral nitrogen quantities had a large variability at the beginning of crops vegetation, influenced by the evolution of climatic conditions, the previous crop, and partially by the soil work; so the soil parameters analyses were needed for correcting the fertilizer doses.

Self financed research of the National Agricultural Research Institute - Fundulea, addressed studies on crop rotation efficiency on soil quality amelioration, fertilizer reduction, and the influence of minimum tillage and fertilization in long term experiments.

Crop diversification and rotation contributed to the reduction of needed nitrogen fertilization by 60 – 100 kg N / ha. They also contributed to a reduction of weeds infestation and to soil quality amelioration.

The long term soil fertilization experiments have outlined the possibility to reduce phosphorus fertilizer need, after a long period of its application to maize and sunflower, showing as very efficient moderate doses for winter wheat, and also the good use of its residual effect on the following crops.

In 2010, a new research was initiated regarding the development of the concept "Research and production extension network based on conservative agriculture (CA)", which includes a long term, multi-disciplinary research platform at the level of the research institute, and an adaptive research along with demonstrative modules at farm levels, to verify, demonstrate and launch the new conservative agriculture technologies.

The research platform consists of a long term base trial, aimed to determine the effect of vegetal residue retention on soil surface on: the increase of water use efficiency, soil physic, and chemical and biological properties improvement. This platform includes also associated experiments on technological components of direct seeding (planting), with vegetal residue retention on soil surface, to: (i) compare different fertilization and weed control strategies; (ii) evaluate varieties and hybrids (genotypes) in different soil tillage conditions; (iii) elaborate and test equipment prototypes for conservative agriculture systems; (iv) deliver parameters to interested associated disciplines; (v) instruct research and technical staff and farmers.

In the analyzed period, the team participated in 3 research projects:

- Sectorial Project 2.3.1. / 2006: *Elaboration of integrated and advanced technologies in using of natural resources to increase the efficiency of input in the conditions of soil conservation and environmental protection, for major field crops ;*
- Sectorial Project 2.3.2. / 2006: *Soil tillage systems adapted to local conditions, oriented to agro-physical soil protection, water conservation, and economic optimization of agriculture management;*
- Project PN II 21-038 / 2007: *Technology for promoting in Romania the plant Miscanthus as regenerative energy source with the aim of energy competitiveness and security of this country;*
- Project PN II 51-041 / 2007: *Establishment of technologies and corresponding products for durable development, applied to maize in ripening stage with the aim of food and feeding security and sanitary and veterinary protection*;
- Project 42N/2007: *Elaboration of integrated technologies water and nutrients management and cultural methods for obtaining healthy agricultural products and high nutritional value from fields plants;*
- Project PN 09/25.03.01/2009: *Elaboration of new technological sequences specific to sustainable agriculture.*

The scientific results of all the above mentioned research were disseminated through published papers and communications within national symposiums. During 2007 – 2011, members of the team have published, individually or in co-operation with other research teams, 4 scientific

papers in ISI indexed journals, 3 papers in other publications, and made 2 conference presentations and presented 4 posters in three national symposia.

2.3.2. *Plant protection and weed control* team

The main objective of the team during 2007 – 2011 period, has been to up-to-date and diversify the technologies of the field crops protection against the main pests and diseases, as well as for controlling the weeds.

In the diseases and pests control, the research has focused on:

- study of the pathogens and insects dynamics, for the cereals (wheat, rye, triticale, feed and malting barley, oats, maize), legumes (peas, beans, soybeans), oil crops (sunflower, raps, mustard) and forage crops (alfalfa), in order to establish forecast and warning criteria;
- establishing the races of different pathogens and identification of their virulence using differentials (lines, hybrids or varieties) of the host plants;
- establishing the influence of the fungicides used in the seed treatment on the seeds germination, as well as the biological action of these substances, taking into consideration the time of the seed storage after treatment;
- establishing the influence of the newly registered fungicides on the complex of wheat and barley foliar diseases, as well as their influence on the yield quality;
- establishing the role of some crop management factors in the appearance and evolution of the main field crops pathogens;
- the specific response of the crops genotypes (lines, hybrids, varieties) to the seed chemical treatment or of the treatment made during vegetation period;
- establishing the influence of the insecticides used in the field crops pest control on the useful fauna;
- improvement of the methods of pest control in winter cereals, maize or sunflower by including some chemical substances in the low toxicity products, to reduce the environmental impact.

Research has been initiated on the ecological factors which determine the appearance of pests or pest groups, including some new pests which are not specific for the field crops; first preliminary results have been obtained on the time evolution of the populations of the main pests, according with the crops structure and the crops rotation.

Monitoring of the western corn root worm (*Diabrotica virgifera virgifera*), using feromon traps and research regarding pests multiplication in artificially controlled conditions have been continued.

Based on the research regarding the biological efficiency of some new fungicides and new insecticides, in the experimental conditions, new sequences of insecticides and fungicides combination for the chemical protection were promoted in winter cereals and in oil and industrial crops technology, as the seed treatment, for a simultaneous pest and diseases control.

New fungicides to be used in the vegetation period treatment, in cereals, legumes, oil and industrial crops and forage crops technology have been promoted , to prevent the attack of pathogens on leaves, as well as new insecticides, for application in vegetation stage, to prevent and control different pests attacks.

For weed control, during 2007-2011 research has focused on the improvement of technology for annual and perennial weeds control in field crops, by using the new strategies based on new substances without residual impact on the next crops.

The main results are:

- management measures for wheat and maize crops, which include improved sequences, based on using new combined products, which can increase the technical and economic efficiency and improve environment protection;
- use of imidazolinone and sulfonylurea herbicides, on new sunflower lines and experimental hybrids, including genotypes produced by the NARDI sunflower breeding program;
- registration of a new product which can be used in elaborating new technology for weed control in the soybean and alfalfa crops.

During the analyzed period, besides of the R&D contracts with private companies, members of the team participated to 5 research projects in the frame of national, sectorial and nucleus programs, namely:

- □ Project CEEX 133/2006: Integrative system for management of emerging phytosanitary risks in agriculture of Romania;
- □ Project CEEX 136/2006: Identification of biodiversity indexes from the major agro-biocenoses as a mean to appreciate the modifications induced by introduction of new technologies to control diseases, weeds and pests;
- □ Sectorial Project 2.3.1/2007: Elaboration of integrated and advanced technologies in using of natural resources to increase the efficiency of inputs in conditions of soil conservation and environmental protection, for major field crops;
- □ Nucleus Project 07-42/2007: Restrictive elements elaboration for field plant protection technologies to ensure the quality of yields according to EU standards;
- □ Nucleus Project 09-25.04.01/2009: Introduction of new sequences in seed treatment technologies to protect the main field crops against diseases and insect pests;
- □ Sectorial Project 1.2.1/2011: Identification of cereals, oleaginous and fodder plants genotypes and development of innovative cropping systems adapted to the impact of climatic changes

The main scientific results obtained were disseminated through publications and communications at national and international meetings. In the period 2007-2011 members of the team published, themselves or in cooperation, 38 articles, from which 2 in ISI indexed journals.

2.3.3. *Dissemination and consultancy* team

The main mission of the team consists in carrying out specific activities for research results dissemination to professional communities, namely:

- organization and valorization of demo plots, including about 65 genotypes/year (varieties and hybrids recently registered or submitted to ISTIS for registration) placed on the Institute territory along the National Road 3;
- technical assistance in organizing of representative demo plots for the Institute in the frame of AGRIPLANTA international demonstrations;
- technical assistance in organizing of demo plots with the most representative cultivars of the Institute in ten counties from southern part of Romania (Buzău, Brăila, Călăraşi, Constanța, Galați, Giurgiu, Ialomița, Ilfov, Prahova, Ialomița) and their valorization trough visits, annually organized, including around 20-25 farmers/locality/year;
- participating to the organization of the annually open field days presenting the main applying scientific results concerning wheat, barley, maize, sunflower and soybean, including a large number of participants, mainly private producers (farmers and processors);
- organization of training courses (addressed to 30 farmers) for knowledge transfer, concerning the main field crops management, through providing adequate support components, including lecture rooms, experimental fields, demo plots and scientific personnel;
- participation at national and local exhibitions, including those organized by ANCS (For its participations at the last two editions of *The Research Show,* NARDI Fundulea was rewarded with *Diplomas of Excellence*);

- updating our own permanent exhibition with the most relevant scientific results obtained over the time;

- involvement in the leaflets and brochures publication and dissemination.

2.3.4. *Organic agriculture systems* team

In the last four years, the organic farming research team activity has been focused on:

- establishing of the agro-ecological characteristics and solutions for organic cultivation of cereals (winter wheat and maize), legumes (soybean), industrial (sunflower) and forage (alfalfa) crops;
- identification of cereals (barley, winter wheat, triticale and maize), legumes (peas, vetch, lentils, lupine and soybean) and industrial (camelina, linseed coriander and sunflower) crops varieties suitable for organic farming;
- design of integrated and multifunctional ecological technologies for field crops;
- taking part in national and international research, development and innovation programs;
- education and training of students, farmers and agro-ecological entrepreneurs.

Activity of the organic farming research team was carried on in the framework of 5 projects financed by national and international programs:

- *Qualitative interactions because of transformations of nutritive substance on the food chain „forage – animal – human" for establishing of the impact index on human health* – project carried on 2005 – 2008 period and financed by the Education and Research Ministry in framework of „Excellency Research";
- *Conservation of the Mountain Agro-ecosystem Biodiversity* – project carried on 2005 – 2008 period and financed by the Agriculture and Rural Development Ministry in framework of „Sectorial Programme";
- *Identification and cultivation in organic farming system of winter wheat varieties for baking* – project carried on 2005 – 2011 period and financed by the World Bank and Agriculture and Rural Development Ministry in framework of „MAKIS - SCG Programme";
- *Development of the technological prototype for cultivation in organic farming of fields with cereals, annual an perennial legumes, industrial crops and vegetables* - project started in 2010 and financed by the National Authority for Scientifically Research in framework of „Sectorial Programme";
- *Legume-Future – Legume supported cropping systems for Europe*: financed by European Union in framework of FP 7 programme since 2010.

In 2008, the organic farming research team submitted to the State Institute for Varieties Testing and Registration (ISTIS) the first Romanian new line (Camelia) of camelina, an industrial crop with many environmental benefits.

The organic farming research team has a mutually partnership with farming associations: Romanian Associations for Sustainable Agriculture (ARAD), National Federation of Ecological Agriculture, BIOTERRA Association.

The activity of organic farming research team and its results were disseminated in various occasions and ways:

- Publication of 5scientific papers and 3 booklets;
- Taking part with scientific papers in national and international events: Annual NARDI scientific conference and weakly sessions, OVIDIUS University conference 2007, Tbilisi/Georgia – Organic conference 2009, Chisinau/Moldova Republic – Organic conference 2009,

- Teaching lectures for students of the Management faculty of Bucharest Agriculture University and Nature Sciences and Agriculture Sciences faculty of Constanta OVIDIUS University;
- Experimental field visits by the farmers, farming consultants, representatives of farmer associations, policy makers and rural entrepreneurs during NARDI Fundulea field days – barley and winter wheat day, sunflower and soybean day, maize and sorghum day;
- Documentation visits by the students and staff of Bucharest Agriculture faculty and Ecological University;
- Taking part in various radio and TV broadcasts.

The experimental field and crop products are certified as organic by the ECOINSPECT, one of the main Romanian certification bodies.

2.3.5. *Molecular Genetics and Cytogenetics* team

Wheat cytogenetics researches have been directed to face new problems, in both fundamental and applied genetics, of a great interest worldwide:

- The precise genetic stocks previously created at NARDI-Fundulea (i.e. monosomics, intervarietal substitution lines, single chromosome recombinant lines etc.) were used in genetic analyses to identify new genes, chromosomal location and to make evident their functions.
- By wide hybridization it was possible to enrich the wheat gene pool with alien variability transferred from related species.
- Development of doubled haploids (DH) lines using "Zea" system for wheat breeding program and for genetic analysis (by creating mapping populations) represents important tools to sped up selection procedures, and increase precision of molecular marker analysis and genetic analysis.
- The new wheat mutagenesis program developed at NARDI based on specific and original protocol including two wheat modern genotypes, two irradiation cycles application and DH (doubled haploids) technology represents a valuable alternative to classical mutagenesis for recovering completely homozygous mutated genotypes in a faster way and to improve and accelerate selection procedures.

The main results obtained durin 2007-2011 include:

- **a novel photoperiod response gene**, **designated *Ppd-B2*,** was mapped to wheat chromosome arm 7BS, by using a set of 46 recombinant lines carrying various segments of 7BS from the early flowering breeding cv.F.26-70 in a background of Favorit variety. The accelerated flowering controlled by Ppd-B2 was positively correlated with increased grain protein content and it was not negatively associated with grain yield.
- For gene pool enhancement by alien gene transfers through wide hybridization, **a new genetic stock of 46 synthetic hexa-amphiploids** was generated by crossing 8 Romanian *Triticum durum* winter wheat genotypes with 46 *Aegilops tauschii* accessions of diverse geographical origins. 23 hexa-amphiploids, already investigated under field conditions in 2008-2010, displayed various growth habits, specific growth rhythms and distinctive morphological characteristics. All synthetics developed long spikes that varied from 8.9 cm. to 14.5 cm. Several synthetics set significantly more grains/spike as compared to the average of experiment. Nine synthetics were noted for their higher 1000-grain weight values. A general relationship between morphological parameters was found. Thus, the number of spikelets/spike was significantly correlated with spike length and the number of grains/spike was directly influenced by the spike length. These correlations denote a high interdependence and at least one of these parameters was used to select the synthetics as donors for specific traits and improvement of ear productivity in developing alien introgression materials.

- By backcrossing synthetics to common wheat the resulted introgression lines (synthetic derived backcross population-SDBP) could recombine genetic variability components of AB durum genome and tauschii D genome from synthetics with homoeologous ABD genome of bread wheat and generate transgresive variation for several traits including a better resistance/tolerance to biotic and abiotic stresses. On the basis of field evaluation results, **18 SDBP were advanced** and now are in different backcross generations and selection phases from F1/Bc2 to F2-F3/Bc1.
- By direct crosses *Triticum aestivum /Aegilops tauschii*- biotypes and subsequent backcrosses, **6 populations (F2/Bc2; F2-F4/Bc1) were obtained** and elite-plants with useful traits (fungal disease resistance/tolerance, wax presence, etc.) were selected for further investigations and / or backcrosses.
- New wide hybridizations aiming alien gene transfers for foliar pathogen resistance/tolerance, protein content etc., were recently realized:
  - **T. durum / T. charlicum-** biotypes (9 combinations);
  - **T. durum / T.diccocoides-** biotypes 5(combinations);
  - **T.aestivum / T. charlicum** (6 combinations).
- The modern **molecular cytogenetic methods (GISH and FISH**) were used to detect and identify the presence of alien chromatin in some valuable introgression lines released in the last years. In the case of the introgression line *T.aestivum /Ae. comosa*, the GISH application with three fluorescence probe made evidence for the presence of a pair of atypical chromosomes compared to normal wheat karyotype. This could be explained as result of a possible intergeneric chromosome substitution. As the GISH analyses did not confirm this assumption, it was presumed that atypical chromosome could have resulted by a translocation involving a small segment of alien chromosome that carries gene(s) for resistance to brown rust. Further analyses are needed.
- **In mutagenesis program,** the starting material was represented by the cultivar Izvor released in 2008 and by advanced breeding line F00628-34, each having valuable but contrasting agronomic traits.The first cycle of irradiation was applied on the seeds of both genotypes and the second one, in different doses, on the hybrid seeds resulted from reciprocal crosses of M1 parental generations. As result of maize cross technique application on the four types of M1`s plants, haploids and doubled haploids were generated. Using this approach it is possible to fix, in one generation, both gene combination resulted by meiotic recombination of parental chromosomes and allelic variants produced by the two mutagenic treatments at any locus in genome. So far **138 mutated DH-lines from parental genotypes and a mapping population 358 mutated/recombinant DH-lines were produced.** This population was developed due to the wide range of trait diversification between the two parents.
- The first field phenotype evaluation of 29 parental mutated DH-lines and on 338 mutated/recombinant DH-lines revealed multiple modifications at several traits as compared to non irradiated parental types. These included changes in plant height, heading date, waxy leaf /stem presence, resistance/tolerance to brown rust and Septoria tritici, leaf length, leaf width, flag leaf position, leaf coloration, ears color at maturity, seedling vigor etc. Leaf probe for DNA extraction and further analysis at molecular level were harvested from all these genetic stocks of putative mutated DH-lines. At the same time, more than 700 M2 population and M3 elites were generated by classical mutagenesis from M1`s of reciprocal crosses.
- During 2007-2010, **1315 DH-lines** were generated for wheat breeding program and **633 DH-lines as mapping populations for genetic analysis at molecular level.**

  From the last category, the **population of 87 DH-lines** derived from the cross of cv. F132 (small grains) and cv.G603 (large grains) was already evaluated for plant height, ear emergence, resistance to same foliar diseases and spike productivity parameters, including grain dimensions**.** Another **population of 151 DH- lines** from the cross Martonvasar 9/

F132- DH-1-30, generated with the aim to pyramid the recessive allele kr1; kr2; kr3; of promoting intergeneric crossability into a modern wheat genetic background with valuable agronomic aspect and a good resistance to same foliar pathogens. After three years evaluation for crossability features (using *Secale cereale* as tester) the selection cycles are now ended and selected DH-lines will be used in wide crosses program.

- 62 DH-lines population developed from the cross between Izvor (high osmotic adjustment) and Jiana (medium osmotic adjustment) was used by Molecular Genetic team to map the position and establish the **association between the osmotic adjustment 'or' gene and several SSR markers** located on chromosome 7A. The markers Xwmc9, Xwmc596, and Xwmc603 proved to be significantly associated to this gene and therefore could be used for marker assisted selection for drought tolerance in wheat breeding. The same markers proved to be associated with a QTL-for membrane stability- located in the same chromosomal region on 7A.
- By molecular assays on other genetic stocks it was found that a gene for bunt resistance is associated with the rye chromatin of chromosome 1RS, transferred to wheat line F00628G34-M, by 1A/1RS translocation. The gene is located on 1RS in the chromosomal region that is homoeologous to the wheat 1A chromosome- Glu-A3 locus- and close to Xgwm(wms)1223 microsatellite locus. This is the first bunt resistance gene reported to be transferred from rye to wheat
- The marker assisted selection procedures were also used to identify the genotypes that carry specific genes for several useful traits in wheat and barley breeding programs (QTL-Fhb-3BS; Bt10 gene; Bdv2/Bdv3 genes; Ryd2 gene).

During the analyzed period the Wheat Cytogenetics and Molecular Genetic team coordinated in the following research projects:

-European Regional project RER/5/013 *–Evaluation of Natural and mutant Genetic Diversity in Cereals by Nuclear and Molecular Techniques*.

-Bilateral project Romania–Hungaria(2008-2009)-*Molecular cytogenetic characterization of wheat-Aegilops introgression and evaluation of the resistance to stress factors*.

-Bilateral project Romania-Bulgaria(2008-209) *–Accelerating genetic progress for drought resistance in wheat, using molecular markers.*

-Capacities project (2007-2009) - *Advancement of wheat and barley genomics studies using molecular cytogenetics methods (GISH, FISH) and DNA markers analysis.*

-Grant-CNCSIS 787- (2006-2008) *– Possibilities of improving drought resistance in winter wheat by genetic studies on osmotic adjustment using pollen grain expression and molecular markers.*

The wheat cytogenetics team also cooperated in 6 research project as "participants".

The wheat cytogenetics and molecular genetic teams have been involved in cooperation projects with:

-IAEA- International Atomic Energy Agency- Regional project RER/5/013.

-Martonvasar Agricultural Research Institute of the Hungarian Academy of Sciences;

-Agrobiotechnology Institute, Sofia, Bulgaria.

The scientific results have been disseminated through publications and communications at national and international meetings.

In 2007-2010 period members of cytogenetics team published, themselves or in cooperation, **17 articles out of which 3 in ISI indexed journals** and the Molecular genetic team **8 articles out of which 6 in ISI journals.**

Some team members attended the 14th International EWAC Conference at Istanbul in 2007 and the International Wheat Conference at Sankt Petersburg in 2010.

2.3.6. *Physiology and Biotechnology* team

Taking into account that the research in the field of plant physiology and biotechnology was mainly focused on supporting breeding programs and crop management research for obtaining high productivity and quality, the following aspects were studied:

1) Physiological responses of plants to different stress factors (cold, freezing, drought, salinity, heat) and screening for genotypes with higher tolerance in winter wheat, barley, triticale, alfalfa and sunflower crops;

2) Influence of different environmental and technological factors on plant growth and development as well as on quality of crop production;

3) Development and application of mathematic models for yield monitoring and evaluation of impact of climatic changes on main crops.

4) Development of the wheat, triticale, alfalfa and sunflower pre-breeding material through somaclonal variation and inter-specific crosses with wild species.

The main **objectives** in the last 5 years have been:

- optimization and application of the methods for assessing the genetic material's resistance to abiotic stress factors. During the analyzed period over 1000 new genotypes per year were tested using new methods and genotypes of winter wheat, durum wheat, triticale and winter barley resistant to negative low temperatures were identified and are thus available as genitors in breeding programs for a better adaptation to severe climate fluctuations;
- development and application of screening methods for rapid identification of genotypes with high stability of pollen at low temperatures in order to evaluate the effect of cold occurring during the meiosis in wheat. The results showed that cool weather reduced pollen fertility, kernel number per ear, weigh of ear and induced spikelets sterility more evident in some genotypes than in others ``;
- development and application of screening method for drought resistance based on a) capacity to adjust osmotic pressure, which in wheat is controlled by alternative alleles at one locus on chromosome 7A and b) based on the significant correlation between water use efficiency, cell membrane stability and yield;
- *in vitro* screening, selection and regeneration (for abiotic and biotic factors) in triticale, alfalfa and sunflower;
- developing an efficient method of *Fusarium sp*.isolates/filtrates culture;
- establishing (in collaboration with colleagues from Valu lui Traian Agricultural Research Station) sunflower cultural practices aimed to diminish the negative effects of drought, heat and broomrape infestation (rotation, soil tillage, fertilization, hybrids, sowing data and density) and assuring suitable, economical and ecological production;
- crop yield monitoring, focused on physiological bases required for forecasting (and "now-casting") of the main crops cultivated in Romania, calibration of the simulation models and assimilation of remote sensing data. The fulfilment of this objective benefited from cooperation with MARS-stat action of Joint Research Institute (EC) from Ispra, Italy (one member of the team had a 5 years working stage there and the scientific cooperation is developing further);
- identification of the phenological winter wheat ideotype for high yield stability under various climatic scenarios for south-eastern Romania, was carried out in cooperation with wheat breeding team and the University of Cluj-Napoca;
- in the frame of FP7 project "Legumes Futures" objectives were: determining of physiological indices, floristic composition, the presence of earthworms in soil and monitoring of micrometeorological conditions within the plots cultivated with cereals and legumes in organic agriculture system.

The progress achieved in plant physiology and biotechnology was based on continuous effort to support breeding programs as well as crop management research. So, the results of these research contributed in both achieving a starting point for plant breeders and improving the

physiological method for testing the newly developed genotypes for resistance to environmental stresses mentioned above. Useful results were obtained for different crop management practices aiming to establish water requirements, mineral nutrition, ways of controlling growth and development process under organic and conventional agriculture system.

A special program for increasing the drought and broomrape resistance by crossing cultivated sunflower with wild species (*Helianthus argophyllus and Helianthus maximiliani* and using embryo-rescue was started and is beginning to show first results.

Special attention has been given to obtaining pre-breeding material (triticale and alfalfa) resistant to *Fusarium graminearum* and *Fusarium oxisporum* and somaclones with higher resistance to this pathogen have already been obtained. At same times wheat and sunflower genotypes suitable from a physiological point of view for organic agricultural system were identified and promoted.

In the year 2010 two courses (involving 150 farmers and students) were organized in order to popularize crop management and Romanian sunflower genotypes suitable for organic agriculture system.

A component for frost kill was included in the WOFOST model used operationally for the DG AGRI of European Commission. Ideas for implementation of the European Crop Growth Monitoring System in Romania were discussed in joint papers published together with JRC's authors in Romanian publications and national conferences.

The team has been participated with two new projects at the National Research Program Competition, 2011 (PN III):

- Means to increase the adaptability to environmental stress of the species *Cynara cardunculus L*. and integrated use of production, for extension of this crop in Romania;
- Sustainable use of Romanian genetic potential of the species *Cannabis sativa* L. for seeds, in order to increase food safety and phyto-remediation of polluted soils.

The research projects of the Team have been funded by national and international programs as well as by the Institute own funds. In addition, the laboratory performs physiological and biochemical measurements upon requests (additional contact). During the analyzed period plant physiology and biotechnology team has managed five research projects and has been involved in other ten research projects:

1. Project Copbil C 18873/2006: *Means to improve sustainable agriculture by increasing resistance to salinity of legumes***;**
2. Project SeeEraNet 10237/2007: *Phenotypic and genotypic of cereal genetic resource to improve tolerance to stresses;*
3. Project PN II 51-044/2007: *Integrated strategies for reducing negative effects of drought and broomrape infestation on sunflower;*
4. Project CEEX 74/2006: *Advanced studies on the possibilities of prevention of diseases produced by some toxigenic species of Fusarium sp. the food chain, human-animal fodder;*
5. Project MAKIS 275030/2008: *Identification and promotion of sunflower genotypes with improved resistance to drought and heat, suitable for organic farming systems with low inputs;*
6. Project CEEX 850/2005: *Improvement of forage quality in alfalfa by modifying plant architecture using biotechnological methods;*
7. Project CEEX 23/2005*: Improving feed quality by changing the appearance of alfalfa plant using biotechnological methods;*
8. Project CEEX 2/2005: *Building a new genetic basis for the cereals of the future;*
9. Sectorial Project 2.1.1/2006: *Establishing sets of hybrids and varieties in legumes and forage crops, resistant to stress factors adapted to different growing areas;*
10. Sectorial Project 2.1.3/2006: *Breeding wheat cultivars with superior parameters, high disease resistance and sprouting resistance, adapted to various pedo-climatic regions;*

11. Project PN II 51-073/2007: *Ways to reduce the impact of climate changes on wheat production in Southern Romania;*
12. Project PN II 51-100/2007: *Prospects of genetic progress in breeding wheat and triticale cultivar for organic agriculture system;*
13. Project Makis 299534. *Identification and organic cultivation of wheat genotypes for bakery, pasta and other foods, agricultural and therapeutic uses;*
14. Project "Nucleu" 9/2009. *Creating alfalfa genotypes tolerant to frequent mowing and suitable for different uses;*
15. Project FP 7/2010. *Legumes future*

Additional contract: Contract (with BASF Company): 3143/2009. *Establishing the effect of Cycocel product on winter wheat and barley.*

During 2007-2011, members of the plant physiology and biotechnology team published, themselves and in cooperation with colleagues from other teams, **19 articles in ISI** indexed journals, 12 articles in publications from other databases, 7 articles in proceeding of international conferences and four books in Romanian publishing houses accredited by CNCSIS. Some of the team members participated in the International meetings:

- XVII International Sunflower Conference, Cordoba, Spain, 2008, two oral presentations;
- XVII Eucarpia General Congres, Valencia, Spain, 2008, 1 poster;
- FESPB Congress, Tampere, Finland, 2008, 1 poster;
- FESPB Congress, Valencia, Spain, 2010, 2 posters;
- XII International Symposium on Forage Crop of Republic of Serbia, 1 poster;
- 5th CGMS Expert Meeting, JRC –Ispra, Italy, 2011, oral presentation.

Both research infrastructure and scientific equipment of the Plant Physiology and Biotechnology improved (spectophotometers, chlorphylfluorometter, osmometter, RMN, etc were purchased).

The team of the Department collaborates with other research teams from University (Ovidius Constanța, USAMV Bucharest, Agricultural University from Udine Italy), foreign research institutes (Institute of Field and Vegetable Crops, Novi Sad, Serbia, Agricultural Research Institute of the Hungarian Academy of Science).

PhD and PhD students increased their qualifications by specialization in foreign research centres (Udine, Italy; Martonvasar, Hungary, JRC – Ispra, Italy).

One member of the team is national representative of Federation of European Societies of Plant Biology and two members also have an affiliation to this Federation.

2.3.7. *Wheat and triticale breeding* team

The main mission of the wheat breeding team has been to create better bread-wheat, winter durum and triticale cultivars, by adding to the previously created, adapted genetic basis, more genes useful for superior performance and yield stability to Romanian conditions.

In **bread-wheat** the objective has been to increase the contribution of Fundulea bred cultivars to wheat production in Romania, by consolidating their competitiveness on the seed market, where presently Fundulea cultivars occupy a total of over 62 % of the wheat acreage (out of which 47% are occupied by cultivars released since 2000).

During the analyzed period three new cultivars were officially registered:

- *Izvor*, registered in 2008, proved to be a significant progress in performance under drought, mainly due to a better capacity of osmotic adjustment;
- *Litera*, registered in 2010, is an advance in combining earliness, quality and disease resistance;

- *Miranda*, registered in 2011, proved to be a significant progress in yielding ability over previous cultivars.

Seed of these new cultivars was multiplied in 2011 on over 1500 hectares, in view of their rapid extension.

During 2007-2010, 11 new lines were submitted to the State Institute for Variety Testing and Registration (ISTIS) for official testing in view of registration. On average over the analyzed period, about 700 entries were tested in yield trials and about 7000 in head rows every year. All lines beginning from F4 are tested under artificial inoculation for *Fusarium* head blight and leaf rust resistance, and are analyzed for several quality parameters. Each year, over 500 new hybrid combinations were made and over 30000 elite spikes were selected. Significant genetic progress has been achieved during the reported period in breeding for:

- *Septoria* resistance, mainly by introduction in the breeding material of resistance genes, previously introgressed into wheat from *Aegilops tauschii*, a wild relative of wheat;
- *Fusarium* head blight, both by introduction of resistance genes from a Chinese spring wheat (Sumai 3) into semidwarf winter germplasm, and by cumulating resistance genes from other sources;
- Barley yellow dwarf virus resistance by using genes transferred from *Thinopyrum intermedium* and rye;
- Higher yielding potential, mainly by exploiting the genes from the newest cultivar *Miranda* and from a breeding line (carrying a 1A/1R translocation) that has been one of the highest yielders in the last years

New original parents for breeding, which have been distributed to other breeding programs in the country, have been obtained. They are expected to open possibilities of significant progress in breeding for quality, yield and stress resistance.

Durum wheat production has not been competitive in Romania, as yield level and yield stability of presently available cultivars are not attractive to farmers, as long as pasta-making industry does not pay higher prices for durum wheat. In an attempt to solve this problem, NARDI signed an agreement with a private company AGRICOVER, which assumed the task to create a durum production chain, using two previously released cultivars, from seed production to pasta industry.

Insufficient winter-hardiness and susceptibility to some diseases were identified as the main factors determining fluctuations of durum yields. The durum breeding at NARDI has been focused to solving these problems. On average over the analyzed period, about 60 entries were tested in yield trials and about 500 in head rows every year. Each year, about 50 new hybrid combinations were made and over 4000 elite spikes were selected.

Significant progress has been achieved during the past few years in improving winter-hardiness and plant type of winter durum breeding material, through inter-specific crosses with *Triticum aestivum.* This opens prospects to release more competitive winter durum cultivars in the next few years. New original parents for breeding, which could be useful worldwide in winter durum breeding for stress and disease resistance, have been obtained.

Triticale has become an established new crop in Romanian agriculture, due to the significant genetic progress achieved by the cultivars previously released from the NARDI breeding program. Although official statistics do not include a separate item for triticale, Triticale acreage can be estimated at about 100 000 hectares, with good prospects of extending, especially on acid soils in the hilly region.

During the analyzed period two new triticale cultivars, Cascador F in 2008 and Mezin in 2011 were added to the seven Fundulea triticale cultivars already officially registered. They brought a significant progress in lodging resistance and yielding ability over the existing cultivars.

During 2007-2011, 9 new lines were submitted to the State Institute for Variety Testing and Registration (ISTIS) for official testing in view of registration. On average over the analyzed period, about 300 entries were tested in yield trials and about 6000 in head rows every year. Each

year, over 300 new hybrid combinations were made and over 20000 elite spikes were selected. Significant genetic progress has been achieved during the reported period in breeding for:

- Lodging resistance, mainly by introduction the short straw genes *Rht1* from bread wheat and *Hl* from rye;
- Barley yellow dwarf virus resistance by using the EM1 mutant from rye and triticale germplasm from Poland;
- Earliness, transferred from adapted Romanian bread wheat.

The progress achieved in breeding was based on continuous efforts to widen the genetic variability both through international germplasm exchanges and introgressions from related species obtained by the Wheat Cytogenetics team of the Institute. A special program for parallel gene transfers between wheat and triticale was developed and is beginning to show first results.

Special attention has been given to the use of modern methods and techniques in the breeding program:

- acceleration of reaching homozygosity in wheat through chromosome elimination following wheat x maize crosses. The doubled haploid lines (DH) obtained by this method, in cooperation with the Wheat Cytogenetics team, can be released as cultivars, and used as parents in breeding new cultivars, 3-5 years earlier than it is possible using the classical breeding methodology. Two of the three bread-wheat cultivars registered during the analyzed period, and 4 out of 9 cultivars released during the last 10 years, were obtained using the DH method. The additional wheat production due to earlier introduction of superior cultivars was estimated at over 120 000 tons.
- acceleration of reaching homozygosity in triticale through androgenesis, in cooperation with the Biotechnology team of the Institute.
- marker assisted selection, in cooperation with Molecular genetics team, has been used in breeding for higher osmotic adjustment capacity or *Fusarium* head blight resistance, for identification of rye introgressions etc.
- field and laboratory physiological tests for water and temperature stress resistance have been used for characterization of breeding material.

During the analyzed period the wheat breeding team participated to 8 research projects, namely:

- Project CEEX 2/2005: *Building a new genetic basis for the cereals of the future.*
- Project PN II 5.1-073/2007: *Ways to reduce the impact of climate changes on wheat production in Southern Romania.*
- Project PN II 5.1-100/2007: *Prospects of genetic progress in breeding wheat and triticale cultivars for organic agriculture.*
- COST 860 (SUSVAR). *Sustainable low-input cereal production: required varietal characteristics and crop diversity*-2004-2008
- Sectorial Project 2.1.2*: Identification of small grains cereals (wheat, two and six rows barley, rye, triticale and rice) cultivars, specifically adapted to the main agricultural zones of the country.*
- Sectorial Project 2.1.3/2006: *Breeding wheat cultivars with superior quality parameters, high disease resistance and sprouting resistance, adapted to various pedo-climatic regions.*
- Nucleus Project PN 07-42.01.01*: Breeding competitive, safe and highly nutritious genotypes of cereals, grain leguminous crops, oil and forage crops.*
- Nucleus Project PN 09-25.01.03. *Breeding wheat genotypes with improved mixing properties, corresponding to the requirements of the baking industry and consumers.*
- Project BIOTECH 4545/2004: *Reducing the negative impact of Fusarium graminearum and associated mycotoxins in wheat by molecular markers assisted breeding*

Scientific results usable for increasing the efficiency of the breeding program have been obtained and disseminated through publications and communications at national and international meetings. During 2007-2011, members of the wheat breeding team published, themselves and in cooperation with colleagues from other teams, **19 articles in ISI indexed journals** and 2 articles in publications

from other databases. Some of the team members attended the International Wheat Conference at Sankt Petersburg in 2010, where they presented one oral communication and 3 posters, as well as the 3rd International Symposium on Fusarium Head Blight, Szeged, Hungary 2008 where one oral communication and 1 poster were presented.

The wheat breeding team has been involved in cooperation projects with:

- the International Center for Maize and Wheat Improvement (CIMMYT) - Mexico;
- the International Winter Wheat Improvement Program (IWWIP) – Turkey;
- Oklahoma State University – USA;
- Martonvasar Agricultural Research Institute of the Hungarian Academy of Sciences;
- the Research Institute for Field Crops "Selecția", Bălți. Republic of Moldova;
- SAATZUCHT DONAU GesmbH & Co KG- Austria;
- CAUSSADE SEMENCES- France;
- BIOTRIGO, Brasil;
- European Fusarium Ring test;
- US Wheat and Barley Fusarium Scab Initiative
- several seed companies from Turkey etc.

Through international cooperation, the NARDI wheat breeding team has been able to contribute to wheat production worldwide, by providing superior germplasm for other countries too. For example, the newly released cultivar IZVOR has recently been released in Argentina under the name LENOX.

2.3.8. *Barley and rice breeding* team

The main mission of the team consists in developing of new cultivars with improved agronomic and qualitative performances and with better abilities to face climate changes.

In **winter barley**, both malting and feeding barley with two or six rows, the breeding activities were focused on preserving and increasing respectively the share of NARDI Fundulea cultivars, especially concerning 2-rowed types (70% for 6-rowed forms and 12% for 2-rowed ones being the present status).

During the analyzed period, 9 new breeding lines were submitted to the State Institute for Variety Testing and Registration. From this total number, two lines recently finalized their official testing and are already prepared to be proposed for registration.

On average over the mentioned period, about 190 entries were tested in yield trials and about 3200 in head rows. Annually, about 100 new hybrid combinations were made and over 15000 elite spikes were selected.

Significant genetic progress has been registered in breeding for:

- Barley yellow dwarf virus resistance by using a new gene;
- Combining of high yielding potential and stability with differentiation of large and heavy kernels (TKW more then 50 grams in different climatic conditions). This is needed in order to solve one of the most important requirements of malt and beer industry;
- Drought resistance;
- Genetic uniformity by using the "Bulbosum" method

In **rice** the breeding activities were devoted to obtaining of new cultivars with improved quantitative and qualitative performances in the Romanian specific conditions.

A new rice variety, Impuls, was registered in 2008. Its main characteristics are high yielding capacity (27-30% over the check variety), earliness (112-115 days), and improved resistance to lodging, low temperatures and to specific pathogenic organisms.

Three new breeding lines were submitted to the State Institute for Variety Testing and Registration.

Annually, in the special experimental field around 750 entries in germplasm collection, 200 hybrid populations (F_1-F_3), 2800 had rows, 120 lines in trials were tested.

Important genetic progress has been achieved mainly in the following directions:

- Lodging resistance;
- Earliness;
- Low temperatures resistance;
- Quality, including quality diversification.

During the analyzed period, besides of the own thematic plan, members of the team participated to 5 research projects, namely:

□ Project CEEX 2/2005: *Building a new genetic basis for the cereals of the future.*

□ Sectorial Project 2.1.2/2006: *Identification of new sets of small grain cereals: wheat, barley, rye, triticale, rice, with specific adaptability to the main agricultural area of the country*

□ Nucleus Project PN 07-42.01.01/2007: *Obtaining of* genotypes *in cereals, oleaginous and fodder plants, competitive, healthy and with high nutritive value.*

□ Nucleus Project PN 09-25.01.05/2009: *Breeding and selection of winter barley genotypes, competitive in the condition of climatic changes, suitable for different kinds of use*

□ Sectorial Project ADER 1.2.1/2011: *Identification of cereals, oleaginous and fodder plants genotypes and development of innovative cropping systems adapted to the climatic changes impact*

The main scientific results obtained were disseminated trough publications and communication at national and international meetings. In the period 2007-2011 members of barley and rice team published, themselves or in cooperation, 12 articles in NARDI Annals and in other national publications.

2.3.9. *Linseed, legumes, medicinal and aromatic crops breeding* team

Linseed crop acreage in Romania has decreased drastically in the last years, so the internal seed market almost disappeared. In this context, funds allocated to the linseed breeding have been reduced, but the program continued at a limited scale, with the focus on finalizing previous work.
The main results obtained during the analyzed period include:

- official registration in 2010 of two new linseed cultivars:
  - Star FD, with brown seed, characterized by a high yielding potential (10% higher than the control) and improved yield stability, due to better resistance to low temperatures, drought, heat and main diseases;
  - Elan FD, with yellow seed, suitable for special oils extraction, characterized by high oil content, combined with good yields and tolerance to stresses.
- identification of 5 new lines with high yield, high quality and resistance to *Fusarium*, drought and heat;
- maintaining breeder seed stocks of 10 linseed and 5 flax cultivars, previously released by NARDI;
- selection for agronomic performance, disease resistance and quality in the existing breeding material.
- An international cooperation project with the company *Deutsche Saatveredelung Ag/Euro Grass B.V.* continued for identification of new genotypes to be released in Germany, besides the one already released there.

During the analyzed period the team participated in the "Sectorial" project 2.1.1. *Establishing sets of hybrids and varieties in industrial, leguminous and forage crops, adapted to various regions, resistant to stresses.*

Some of the research results obtained in cooperation with scientists from the Polytechnic University – Bucharest were disseminated by one article published in an ISI indexed journal and

communicated at two international conferences. Two communications were presented at the NARDI annual sessions.

Grain legumes acreage has also decreased in Romania in the last years. However, grain legumes are considered essential components of crop rotation, with important potential effects on increasing yield of following crops, while reducing fertilizer inputs. This is why NARDI continued to finance, mainly from own resources, the breeding program in peas and soybeans.

The main results obtained in **field peas** breeding, during the last four years include:

- diversification of the genetic basis by creating 43 to 68 new hybrid combinations every year, and by selection focused on combining the *af* gene (*aphila*) with effects on lodging resistance) and the *def* gene for shattering resistance, with higher biomass;
- one line (F-00-1172) was submitted in 2010 to the State Institute for Cultivar Testing and Registration, in view of official registration. The line combines the *aphila* type with higher biomass, and is very resistant to lodging and shattering, being suitable both for grain and forage production.
- A breeding program was initiated in **winter peas**, based on two, recently identified, gene sources for winter hardiness. This could open new perspectives for a grain legume crop more tolerant to drought and heat.

The main results obtained in **soybeans** breeding during the last years include:

- diversification of the genetic basis of the breeding program, by creating 25 to 67 new hybrid combinations every year, and by selection focused on improving water stress, heat and disease resistance in non-GMO soybeans;
- submitting 6 new lines for testing at the State Institute for Cultivar Testing and Registration in view of official registration;
- registration of two new soybeans cultivars:
    - Oana F, registered in 2009, is an early maturing cultivar with good yields and yield stability, mainly due to an improved tolerance to low atmospheric humidity. In tests performed by processing industry it proved a high protein quality;
    - Crina F, registered in 2011, is a mid-early cultivar, with high yields and very good resistance to lodging and shattering, resistant to the main bacterial and fungal diseases and tolerant to drought.

In **field beans** breeding activities have been limited to maintaining the breeder seed stocks of 6 previously released cultivars.

Medicinal and aromatic crops breeding was recently transferred to NARDI from the former specialized Station. The main results obtained since 2007 include:

- maintaining a large collection of 120 species from 28 botanical families (30 *Compositae*, 22 *Labiatae*, 9 *Leguminosae* etc.). The collection includes:
    - local species, collected from the spontaneous flora,
    - species from other geographical regions, acclimated to Romania, in view of identifying new useful compounds necessary for the processing industry
    - 30 cultivars from 18 species, previously released by the team;
- registration of 5 new cultivars, tested by the State Institute for Cultivar Testing and Registration:
    - CORAL, a *Mentha piperita* cultivar, registered in 2009, with high *herba* yield volatile oil and total menthol content;
    - EMILIA, a *Lavandula angustifolia* cultivar, registered in 2009, with high volatile oil content of high quality;

    - ANDRAS, an *Anethum graveolens* cultivar, registered in 2010, with high yield and volatile oil content;
    - AUTENTIC, an *Anethum graveolens* cultivar, registered in 2010, with high volatile oil content and carvone percentage;
    - SIMFONIA, a *Salvia sclarea* cultivar, registered in 2010, with high volatile oil content of good quality.
- producing basic seed of the main medicinal and aromatic crops, requested by the market: *Matricaria chamomilla* (cultivar Mărgăritar), *Coriandrum sativum* (cultivars Sandra and Omagiu), *Trigonella foenum-graecum* (cultivar Robusta) and *Silybum marianum* (local population De Prahova).

The main activities and results were presented at NARDI annual session in 2011.

2.3.10. *Maize and sorghum breeding* team

The main mission of the Maize and sorghum breeding team is to conserve and exploit the previously collected local germplasm for creating, high yielding maize hybrids of superior quality, adapted to the specific climate and soil conditions of Romania.
NARDI maize hybrids have long been appreciated by the farmers for their drought and heat tolerance. They have been however less competitive in lodging resistance and in the rate of water loss from grains at maturity, in comparison with the hybrids introduced by very strong international breeding companies.
Despite that, NARDI maize hybrids are still preferred by some farmers and, according to official statistics, presently have a 17% share of the seed market. Maintaining and increasing this share, for the benefit of farmers, is a considerable challenge for the team.

The main results obtained by the team during the analyzed period, include:

- diversification of the maize breeding pool, by conserving and using local, adapted populations, along with genetic sources for lodging resistance and high rate of water loss from grains at maturity in creating new synthetics and by self-pollination;
- genetic progress by applying strong selection for lodging resistance and rate of grain water loss;
- testing specific and general combining ability of 50-60 new maize inbred lines every year;
- testing 500-600 new maize hybrid combinations every year in yield trials;
- significant progress in improving non-GMO resistance of maize to *Ostrinia nubilalis* and *Helicoverpa zeae.* The progress was possible due to the cooperation with the Plant protection team;
- progress in improving maize resistance to diseases, especially *Fusarium sp.,* with effects on grain mycotoxin content;
- progress in improving maize resistance to *Ustilago maydis;*
- identification of maize genotypes with improved tolerance to water and temperature stresses, with the cooperation of the Plant physiology team;
- submitting 12 new maize hybrids to the State Institute for Cultivar Testing and Registration, in view of official registration;
- registration in 2010 of 2 new maize hybrids in the official list, namely:
    - Crişana – a high yielding hybrid of the earliness group FAO 400-500, resistant to lodging, drought and heat tolerant, with very good yield stability;
    - Mostiştea – a semi-flint mid-early hybrid of the earliness group FAO 300-400, drought and heat tolerant, with high grain quality.
- producing breeder seed of the inbred lines, parents of the recently registered hybrids, for rapid introduction into farms;

- maintaining the breeder seed stock of the officially registered sorghum hybrids and varieties (grain, broomcorn and sweet sorghum).

To ensure the funds necessary for financing its activities, during the analyzed period the Maize and sorghum breeding team participated to the following projects:

- Project AGRAL 353/2004: *Improving drought resistance of wheat and maize.*
- Project CEEX 84/2005: *Research on production, purification and storage of hydrogen produced by biomass gasification.*
- Project CEEX 28/2005: *Software based on advanced decision methods for sustainable agriculture.*
- Project CEEX 36/2005: *Production and nutriceutic use of bio-active compounds from cereals, leguminous and vineyards byproducts, with applications integrated in rural environment.*
- Project CEEX 236/2006: *Innovative technologies for production and sustainable use of multi-functional carbonic materials through residue recycling, for applications in environment protection.*
- Project P.S. 2.1.1.: *Establishing sets of hybrids and varieties in industrial, leguminous and forage crops, adapted to various regions, resistant to stresses.*
- Project P.S. 6.3.9.: *Projection and promotion of technologies to produce non-conventional energy for farm use.*
- Project PN 09/2002: *Improving convergent selection for increased oil and essential amino acids content in maize inbred lines and hybrids.*
- Project PN 09/2004: *Transferring resistance to aphids (Schizaphis graminum* Rond.) *and low temperatures into grain and sweet sorghum, by using male sterile cytoplasm from broomcorn sorghum.*
- Project PN 62- 068/2008: *Production of phyto-products, pre-biotics and biofuels by complex processing of sweet sorghum*

Some of the research results were disseminated through publication of 5 articles in NARDI Annals, and by communications at international symposia in Novi Sad – Serbia in 2007, Chişinău – Republic of Moldavia in 2009 and Kneja – Bulgaria in 2009.

2.3.11. *Sunflower breeding and seed production* team

The main important direction in sunflower breeding during 2007-2011 was to increase genetic variability in the germplasm collection, by diversifying the sources used as donor for genes for different important characteristics.

Wild sunflower species have been used for obtaining interspecific hybrids, by crossing with cultivated sunflower, in order to release new sources for resistance to dry conditions or to some sunflower diseases and to the parasite *Orobanche cumana* Wallr. (broomrape).

Wild species used included:

- *Helianthus argophyllus* as donor for the genes responsible for resistance to drought;
- *Helianthus maximiliani* as donor for the genes responsible for resistance to broomrape;
- *Helianthus tuberosus* as donor for the genes responsible for resistance to *Plasmopara halstedii.*

The obtained hybrids: (*H. argophyllus* x *H. annuus*; *H. maximiliani* x *H. annuus*; *H. tuberosus* x *H. annuus*) have been used for obtaining populations and lines, sources of genes for interesting characteristics.

By using the source Sint. 15-2-15, for resistance to the pathogen *Plasmopara halstedii,* which produces downy mildew disease, resistant lines having in their genotype the gene *Pl6* were obtained.

For resistance to broomrape (*Orobanche cumana* Wallr.) we transferred in some of our inbred lines with good agronomic traits, genes for resistance to the newest and very virulent populations of the parasite, from the sources identified in our germplasm collection,. We finalized 2 lines.
Using some Russian varieties we have released some populations which will be used for obtaining lines, with high potential in breeding for good agronomic traits and high quality.

Obtaining sunflower hybrids resistant to herbicides (of imidazolinone and sulfonylurea types) has been very important objective in NARDI research program in the last years. For obtaining inbred lines resistant to one of these two herbicides as well as for obtaining commercial hybrids having such resistance, two sources for IMI herbicides and two sources for sulfonylurea herbicides have been used. We used the sources IMISUN 1 and IMISUN 2 for resistance to imidazolinone herbicides and SURES 1 and SURES 2 for resistance to sulfonylurea herbicides. We succeeded to finalize 4 lines with genes IMISUN and 5 lines with genes SURES. In 2011 year we released the first hybrids resistant to one of these two types of herbicides. Presently, 7 lines are in process of transferring the gene for IMI herbicides, for which we are using the new source of resistance, CLHA Plus, which will give the possibility to have a better control of all types of weeds in sunflower crop, by cultivating herbicide resistant hybrids.

Regarding the improvement of the methods used in the breeding work, it is important to mention:

- increasing the efficiency of the methods for the artificial infection with some important pathogens which attack sunflower (*Plasmopara halstedii*, *Sclerotinia sclerotiorum*, *Phomopsis helianth*i) as well as the artificial infestation with the parasite broomrape (*Orobanche cumana* Wallr.);
- using the Protocols SF-31 - PCR method and SF-30 - Invader R, in marker assisted selection (MAS) for the identification of IMISUN and CLHA Plus genes;
- using the tunnels for seed multiplication of the commercial inbred lines, as well as for producing new hybrid combinations between the inbred lines belonging to NARDI institute, crossed with CMS lines belonging to different seed companies in the framework of the collaboration agreements;
- using RAPD and SSR markers (MAS) for resistance to the parasite *Orobanche cumana* Wallr.

Among the released new lines with resistance to herbicides, 4 new lines with resistance to the race F of the parasite *Orobanche cumana* Wallr. and other ones, resistant to *Plasmopara halstedii* (race 330) have been obtained. Some of these lines have been used in releasing new hybrids, including some joint hybrids in collaboration.

In this period many about 650 new sunflower hybrids have been tested in yield trials for the seed yield. In these trials we tested NARDI hybrids, as well as some joint hybrids released with CMS lines received from different seed companies or research institutes.
In 2007, 657 hybrids were tested in yield trials, 14 of these being promoted for the advanced trials. In 2008, we tested 945 hybrids, 24 of these being promoted for the next trials. In 2009 we tested 570 hybrids, 15 of these being promoted. In 2010 year we tested 770 hybrids, 21 hybrids being promoted and in 2011, 543 hybrids have been tested, and 12 hybrids were promoted for the next trials.
In the institute national network trials, each year about 25 hybrids are tested in 11 locations, placed in areas with different soil and climatic conditions. Some of them have produced very good seed yield, especially in Braila, Calarasi, Constanta and Teleorman areas. In these areas, seed yield of more than 4000 Kg/ha, were registered for 2-3 hybrids.
Each year, 3-4 new hybrids are submitted for testing in the network of the National Institute for Varieties Testing and Registration.

In 2009, two hybrids (Flormari and Flordani), having good resistance to the parasite *Orobanche cumana* Wall. were registered in the National official list of varieties. In 2010, the hybrid Fundulea 708, a mid-late hybrid having a high resistance to drought and some other good characteristics (plant height-150 cm; head diameter-24 cm; TKW-70g) was registered This hybrid has a good resistance to the pathogen *Plasmopara halstedii* (resistant to race 330), good resistance to the pathogen *Phomopsis helianthi* and resistance to *Sclerotinia sclerotiorum* (stem attack). In very dry conditions, this hybrid could produce a seed yield of 2800 – 3400 Kg/ha.
In 2011, a new hybrid, Fundulea 912, which produced a good seed yield, with high oil content (53%), good resistance to drought and resistant to the pathogen *Plasamopara halstedii*, race 330 was proposed for registration in the National official list.
As result of the collaboration with different seed companies, in obtaining joint sunflower hybrids, during 2007 – 2011, many joint hybrids were registered and commercialized on the European seed market (Sellor, Ekllor, Ampil, Oleg, Expllor, Dahlia, Robia, Obraia, Florencia, Almanzor) . Many of these hybrids are resistant to broomrape, as well as to downy mildew. They are very well sold in the areas infested with the parasite *Orobanche cumana* Wallr., in eastern European countries, as well as in Spain.

Regarding the scientific activity, in 2007 – 2011 period, many papers were presented as oral or poster presentations to conferences, symposia or congresses, organized in different countries (Congress for Parasitic Plants – Virginia, USA; Symposium for Sunflower in Developing countries – Entebbe, Uganda; The International Sunflower Conference – Cordoba, Spain; Symposium for Biotechnology in Sunflower – Antalya, Turkey – as **member of the Organizing Committee**; Congress EUCARPIA – Valencia, Spain; Congress in Parasitic Plants – Kusadasi, Turkey; Symposium in Sunflower diseases – Krasnodar, Russia; Two symposiums on Orobanche in Sunflower: Antalya, Turkey, 2008 – as **member of the Scientific Committee** and Chisinau, Moldova, 2011 – as **member of the Organizing and of Scientific Committee**; Symposium on Genetic Resources in Sunflower – Kusadasi, Turkey). In all proceedings published at these scientific meetings there are full papers or abstracts having as authors, members of our team. Other scientific papers were presented to the national symposiums. In total, 14 scientific papers to the international scientific meetings and 8 papers to the national scientific meetings were presented.
Some papers were published in scientific journals, such as: Romanian Agricultural Research, NARDI Annals, Helia, Maydica, David Journal of Agricultural Science and Technology. In total, 3 articles in ISI indexed journals and 7 articles in publications from other databases were published.
A person from our team is member of the Editorial Board of HELIA Journal published by the Academy of Sciences and Art of Serbia and member of the Editorial Board of Field and Vegetable Crops Research Journal, published by Institute of Field and Vegetable Crops, Novi Sad, Serbia.

During this period (2007 – 2011) the sunflower breeding team participated to 5 projects, namely:

- Project CEEX BIOCOMB 2/2005: *"The complex utilization of renewable resources for the biofuels obtaining"*;
- Sectorial Project 2. 1. 4/2006: *"Breeding sunflower cultivars with superior parameters and high diseases resistance, adapted to various pedo-climatic regions"*;
- PNII 51-044/ 2007: *"Integrated strategies for reducing negative effect of drought heat and broomrape in sunflower"*;
- COPBIL Project 30-06/2007: *"Introduction and application of control methods against the oil sunflower diseases and parasite weed";*
- COPBIL Project 323/2009: *"Introduction of Romanian high oleic sunflower hybrids, in China"*.

The sunflower breeding team has been involved in cooperation with:

- INRA- France;
- The Institute for Agricultural Research, Edirne-Turkey;

- The Institute of Field and Vegetable Crops, Novi Sad- Serbia;
- Fargo, ND University –USA;
- The Research Institute in Sustainable Agriculture, Cordoba – Spain;
- The University of the Academy of Sciences, Chisinau – Moldova Republic;
- Euralis Semences seed company – France;
- Nidera seed company – Argentina;
- RAGT (2Rn) seed company – France;
- Caussade Semences – France;
- Maisadour seed company – France;
- DOW AgroSciences – USA;
- BASF – USA;
- MAY seed company - Turkey

2.3.12. *Forage crops breeding, seed production and cropping* team

In the last 5 years, the research activity of the "Forage breeding, seed production and technology team" has included alfalfa and orchard grass breeding, seed production in 8 species (2 legume: alfalfa -*Medicago sativa* L. and Alexandrinum clover - *Trifolium alexandrinum* L.) and 6 grasses (italian ryegrass - *Lolium multiflorum* Lam., hybrid ryegrass - *Lolium x boucheanum* Kunth., orchard grass - *Dactylis glomerata* L., Sudan grass - *Sorghum sudanense* Piper. Stapf., tall fescue - *Festuca arundinaceea* Schreber, and millet - *Panicum miliaceum* L.) and also research concerning forage mixtures for dry and irrigated land.

The alfalfa is the most important forage crop in Romania, occupying an important place into the forage structure. From a total of 1.2 million ha cultivated with forage crops, the area cultivated with alfalfa was, during last 5 years, about 350.000 ha (30%). Alfalfa breeding is developed in our country only at NARDI Fundulea. For these reasons developing alfalfa cultivars has been the most important part of the activity in this team.

The main objectives in alfalfa breeding are high forage yield, high quality and a good adaptability to biotic and abiotic environmental conditions. The priority in the last 5 years in forage crops has been improving the quality, including the nutritive value. The objective is fodder quality improvement, maintaining at the same time an high fodder and seed yield potential and a good resistance to diseases, low temperatures and drought, including a good crop persistence (4-6 years). Research developed at NARDI Fundulea has been focused to accumulation of useful genes for traits involved in fodder quality and yield potential, especially in multi-foliole leaf. The approach used to obtain new high quality, high yielding alfalfa cultivars with good adaptability has been:

- using genetically diverse sources (species, local populations, cultivars, lines) in creating new hybrids;
- improving the variability for the characteristics which are involved in nutritive value (leaves/stem ratio of green matter, multi-foliole leaves, empty stem, number of internodes), by using in hybrids the genotypes which have this characteristics in high genetic dosage;
- increasing selection pressure by selecting in various conditions (natural and artificial, in laboratories, greenhouse, field), during a long period years (from 2-3 years of vegetation for yielding and quality to 4-6 years for persistency, winter-hardiness and drought resistance).

The results consist in a valuable breeding material with a large genetic and phenotypic variability regarding the characteristics proposed to be improved. About 2500-3000 plants/year have been selected based on more 11.500 analyses, from more then 6.500 variants They include multifoliated leaf elite progenies, with rapid growth rate after emergence, high tillering ability and well-developed root system,. By self-pollination, the homozygosity level of leaf and high fructification ability traits in elite progenies has been increased. In order to accumulate useful genes involved in fodder quality, every year it 5-12 hybrids were obtained between C_1- C_2 multifoliated leaf inbreeds lines. The frequency of the multifoliated leaf trait and the ratio leaves/stem was

investigated in tested elite progenies, including mapping populations. Around 350 elite progenies with high level of diseases resistance, especially to *Fusarium oxysporum*, were selected .

- The main results of the team during the analyzed period, 2007-2011, are:
  - five new alfalfa synthetic cultivars were submitted to the State Institute for Variety Testing and

Registration for official testing in view of registration;

- two new alfalfa cultivars, Roxana and Mihaela were added to the eight alfalfa cultivars officially registered in the last ten years;
- seven forage plant cultivars were patented: five alfalfa cultivars (Daniela and Alina – 2006,

Roxana, 2010 and Catinca and Adin - 2011), one cultivar of hybrid ryegrass (Cătălin – 2007) and one millet cultivar (Marius – 2010);

- two new crop management technologies for forage mixtures: 1- mixture between alfalfa + Alexandrinum clover + orchard grass and 2- mixture between smooth brome (*Bromus inermis,* Leyss.) and sainfoin (*Onobrychis viciifolia,* Scop.);

- seed multiplication (breeder seed and prebasic seed) of the new cultivars on 8-10 hectares/year, in view of their rapid extension;

- the introduction of alfalfa cultivars (Madalina in 2010 and Sandra and Roxana in 2011) in seed production system in different countries of Europe (Netherlands, France, Hungary) in view of their rapid extension in Europe and Russian Federation, due to the cooperation with Eurograss Breeding GmbH&Co.KG.

All new alfalfa cultivars registered in the last years including Mihaela and Roxana, have demonstrated a good quality, a good stability of yield due by the high level of resistance to diseases and winter hardiness and represent a genetic progress achieved in the alfalfa breeding programme of NARDI Fundulea.

The research team, although decreased in number during the last period, has had the target to increase the performance level of the research. This was possible by developing cooperation with colleagues from plant physiology, chemistry and quality laboratories from NARDI Fundulea and from other institutes and universities: National Research & Development Institute for Biology and Animal Nutrition Balotesti, Institute of Biology Bucharest**,** Banat University of Agricultural Sciences and Veterinary Medicine Timisoara, Craiova University (ARDS Caracal), University of Agricultural Sciences and Veterinary Medicine Iasi.

The National Research & Development Institute for Biology and Animal Nutrition Balotesti evaluated the nutritive quality of the forages produced by alfalfa genotypes.

At Banat University of Agricultural Sciences and Veterinary Medicine Timisoara, the main goal of the researches was to develop a genetic linkage map for a tetraploid *Medicago sativa* population by transferring the molecular markers from *Medicago truncatula*'s and diploid *Medicago sativa*'s genetic maps which were already established and to identify the linkage status of the gene sequence that confer the multifoliated trait. At the Institute of Biology from Bucharest, molecular techniques in Romanian tetraploid *Medicago sativa* germplasm were applied. In a first stage, data on polymorphic molecular markers for *Medicago* genus were summarized.

The research projects of the team were funded by different national programs and partially from own funds of the Institute. During the analyzed period the forage breeding team has managed 7 research projects and was involved in other 2 research projects:

1. Project CEEX 23/2005 : *Improvement of the alfalfa forage quality by changing the architecture of the plant, using the biotechnological methods;*
2. Sectorial Project 2.1.1/2006: *Breeding of industrial crops, leguminous and forage hybrids and cultivars, with superior quality parameters, high disease resistance and sprouting resistance, adapted to various soil and climatic regions;*
3. Sectorial Project 2.3.1/2006: *Development of integrated and advanced technology to use natural resources, increase of input efficiency, soil conservation and environmental protection for the main field crops;*

4. Nucleus Project 07-42.01.01: *Development of new genotypes of cereals, industrial and forage crops with high nutritive value;*
5. Nucleus Project 09-25.01.01: *Breeding alfalfa cultivars with high tolerance to frequent cutting, suitable for different usefulness;*
6. Project PN II 52-103/2008: *Assessment, preservation of grasses and leguminous germoplasm and breeding a new cultivars adapted to various pedo-climatic regions;*
7. Sectorial Project 1.2.1/2011: *Identification of new genotypes of cereal, industrial and forage crops and development of innovative technologies, adapted to impact of climatic changes.*
8. Project Copbil C 18873/2006: *Means to improve sustainable agriculture by increasing resistance to salinity of legumes;*
9. Project CEEX 74/2006: *Advanced studies on the possibilities of prevention of diseases produced by some toxigenic species of Fusarium sp. the food chain, human-animal fodder;*

Scientific results were disseminated through publications and communications at national and international meetings. During 2007-2011, members of the forage plants team published, themselves and cooperation with colleagues from other teams, 9 **articles in ISI indexed journals** and 16 articles in publications from other databases. The members of the team attended at 8 national meetings and two international meetings: the 18th EUCARPIA Congress (Modern variety breeding for present and future needs), at Valencia-Spain, in 2008 and the XII International Symposium on Forage Crops of Republic of Serbia, (Forage Crops Basis of the Sustainable Animal Husbandry Development) in 2010 in Kruševac-Serbia where they presented 4 posters.

The forage team has been involved in cooperation projects with foreign institutes and companies, the most important being with Eurograss Breeding GmbH&Co.KG, for variety representations in terms of seed-production, promotion, marketing and sales of alfalfa cultivars.

2.3.13. *Breeder seed and pre-basic seed production* team

The main components of the team mission consist in:

- rapid and direct valorisation of the genetic progress included in the new varieties and hybrids registered by the Institute, by producing breeder seed and pre-basic seed to be provided to companies specialized in seed multiplication and marketing;
- developing of the existing associative system with different seed producers in order to supply farmers with performing cultivars, competitive on seed market.

Based on its own research activities, carried out in the experimental fields and laboratory and by permanent collaborations with breeding teams, important results were obtained from which the following are to be mentioned:

- continuous improvements of seed producing methodologies in order to met EU requirements concerning seed quality and to ensure high level of preservation of all initial characteristics of cultivars, especially in self-pollinated species;
- development of a data base, including the main aspects of the produced quantities from high biological categories of seeds belonging to cultivars of interest for national seed market;
- obtaining quantities of seed with high qualitative indexes (as mentioned in table 13.1) from wheat, barley and triticale varieties, used in the successive years for producing basic seeds;

Table 13.1

Crop	Year	Quantities of seeds (tons) (Breeder seed, Pre-basic seed)
Wheat	2007	93
	2008	470
	2009	165

	2010	270
	2011	194
	Total	**1,192**
Barley	2007	50
	2008	55
	2009	19
	2010	10
	2011	12
	Total	**146**
Triticale	2007	25
	2008	65
	Total	**90**

- obtaining of important seed quantities of parental forms of NARDI maize and sunflower hybrids. Based on this, the specialized producers (companies, individual farmers) were able to organize annually around 3,230 ha (out of which 320 ha abroad) for commercial hybrid seed production (Table 13.2).

Table 13.2

Crop	Year	Total acreage for commercial seed producing (F_1) (ha)
Maize	2007	2,600
	2008	3,800
	2009	1,950
	2010	1,850
	2011	1,770
	Total	**11,970**
Sunflower	2007	905
	2008	950
	2009	555
	2010	757
	2011	1,018
	Total	**4,185**

2.3.14. *Basic seed multiplication and seed processing* team

All activities carried out by the team were focused on supplying the companies or farmers specialized and certified in seed multiplication, with basic seed from NARDI cultivars. The main result of these activities consist in producing and processing basic seeds by applying specific field and industrial technologies, a great attention being devoted to ensure a high level of varietal purity and other qualitative requirements..

The quantities of basic seed produced and transferred to farmers during the reported period are mentioned in the table 14.1

Thus, for small grain cereals, the seed multipliers were able to plant annually around 15,600 ha for commercial seed production.

Table 14.1

Crop	Year	Quantity of basic seeds produced and transferred to farmers (tons)
Wheat	2007	3,794
	2008	3,718

	2009	2,547
	2010	2,156
	2011	2,286
	Total	**14,501**
Triticale	2008	66
	2009	57
	2010	15
	2011	-
	Total	**138**
Barley	2007	95
	2008	320
	2009	245
	2010	127
	2011	112
	Total	**899**

2.3.15. Activity report by *R&D service* team

The team includes specialized personnel, with high and medium level of qualification, and its main responsibilities are:

- to carry on all activities concerning field mechanization, including both experimental plots and those for seed multiplication (soil preparing, planting, applying different treatments, harvesting, etc.);
- to supply all other teams with materials needed for their current activities;
- other support activities.

2.4. Major Representative Project: „IMPROVING THE GENETIC BASIS OF WHEAT CROP, THROUGH BREEDING NEW CULTIVARS, SUPERIOR TO THE PRESENT ONES."

Grown in the last years on about 2 million hectares, **wheat is the second field crop as acreage and the first as importance in human consumption in Romania.**

Using a suitable cultivar, adapted to local environment, is one of the most important components of wheat crop management, as this largely determines the efficiency of all other technology inputs. The traits required for a wheat cultivar capable of maximizing wheat crop profitability in Romania are very complex (it should have high yielding potential, winter hardiness, resistance to drought, heat and other abiotic stresses, resistance to the many diseases that attack wheat in Romania, suitability to the management system used in the respective farms, and quality corresponding to various consumer and industry requirements) and continuously evolving (according to climate changes, to changes in management practices and to the evolution of farm economical potential). This is why **breeding suitable wheat cultivars raises many scientific problems of genetics, physiology, phytopathology etc.**

The private sector in plant breeding, both in Romania and worldwide, invested much less in wheat breeding than in breeding other crops that offer prospects of higher profits (such as maize, sunflower or soybeans). This explains why, in many countries, the public sector has been very much involved in wheat breeding. On the other hand, wheat cultivars introduced in Romania from countries with different weather conditions have long proved that, regardless of their performance in their native countries, they generally lack some traits that are essential for adaptation to Romanian conditions (as for example winter hardiness, heat tolerance or adequate earliness). This was the reason why NARDI Fundulea (a public institution with the mission to respond to the requirements of national agriculture), included wheat breeding among the main priorities of its research strategy, regardless of the lower direct profit that might result for the Institute. Therefore, one of NARDI's major representative projects has been for many years **„Improving the genetic basis of wheat crop, through breeding new cultivars, superior to the present ones".**

Taking into account the complexity and the long duration of the wheat breeding process, to ensure the financing of this major strategic project, NARDI has used, along its own resources, funds from projects of the national research programs RELANSIN, AGRAL, CEEX and PN II. These projects have been conceived in a **unitary conception,** aiming at approaching, step by step, at higher levels, some of the major wheat breeding objectives. During the last years, NARDI applied and was awarded by competition the following projects, which are part of this major priority project:

- Project Relansin 49/1999: *Increasing wheat production of high bread-making quality, through introduction of new cultivars superior to the present ones.*
- Project Agral 20/2001*: Genetically modifying grain reserve proteins quantity and characteristics, to improve bread-making quality and market competitiveness of wheat produced in the South of the country.*
- Project Agral 26/2001: *Genetic manipulation of vegetation duration to reduce the effects of drought and heat on wheat yields in regions frequently affected by water stress.*
- Project Agral 353/2004: *Improving drought resistance of wheat and maize.*
- Project CEEX 2/2005: *Building a new genetic basis for the cereals of the future.*
- Sectorial Project 2.1.3/2006: *Breeding wheat cultivars with superior quality parameters, high disease resistance and sprouting resistance, adapted to various pedo-climatic regions.*
- Project PN II 5.1-073/2007: *Ways to reduce the impact of climate changes on wheat production in Southern Romania.*

- Project PN II 5.1-100/2007: *Prospects of genetic progress in breeding wheat and triticale cultivars for organic agriculture system.*
- Nucleus Project PN 09-25.01.03. *Breeding wheat genotypes with improved mixing properties, corresponding to the requirements of the baking industry and consumers*

Each of the contracted research projects contributed to genetic progress in one or more objectives, considered important in breeding new cultivars. This allowed the accumulation in the breeding program of many genes necessary for higher performance of wheat crop in Romania.

Planning the whole strategic project and each component project, was based on **using modern methods**, such as convergent recurrent selection, the biotechnological method of faster reaching homozygosity through chromosome elimination following wheat x maize crosses, marker assisted selection, new physiological methods for characterization and selection of breeding material, etc.

To this purpose, **multidisciplinary teams** were involved in the projects execution, including, besides the wheat breeding (which includes specialists in disease resistance and quality), wheat genetics, molecular genetics and physiology teams from NARDI Fundulea, teams from the Agricultural Universities of Cluj and Timişoara, from National Agency for Meteorology (ANM), teams from the Agricultural Research Stations Şimnic, Dobrogea, Albota, as well as co-financing beneficiaries, such as the development sectors of NARDI and ARS Şimnic, the milling and baking enterprise PAMBAC, etc.

Finalization of the researches carried on in the major project „Improving the genetic basis of wheat crop, through breeding new cultivars, superior to the present ones" has included so far:

- Breeding, official testing at the State Institute for Cultivar Testing and Registration (ISTIS), official registration during 2000-2011 and introduction on large scale farming of **10 wheat cultivars,** out of which **3 cultivars were registered since 2007;**
- **Recommendation of most suitable cultivars** for continuously improving the genetic basis of wheat production in various environment and crop management conditions;
- **Creation of new original parents for breeding,** such as:
    - Parents for improving quality (lines with high grain protein content, carrying the gene *Gpc-1* transferred from *Triticum dicoccoides* in a winter wheat background, more adapted to Romanian conditions, wheat genotypes showing positive deviations from the general relationship high yield-low grain protein, and wheat genotypes with improved rheological characteristics, more favourable for baking;
    - Parents for improving resistance to the main diseases, to which present cultivars are not sufficiently resistant (lines with *Septoria* resistance transferred from *Aegilops squarosa* or *Thinopyrum intermedium* in an adapted genetic background, lines with *Fusarium* head blight resistance genes transferred from the Chinese spring wheat Sumai 3, or with other different genes, in a superior agronomic type, lines with several bunt resistance genes in an improved background, lines with resistance to Barley Yellow Dwarf Virus transferred from *Thinopyrum intermedium* or *Triticale* in a genetic background adapted to Romanian conditions);
    - Parents for improving resistance to water and high temperature stress, with superior performance under drought, due to the presence of the "*or*" allele controlling higher osmotic adjustment, to higher seedling growth rate, to longer coleoptiles or higher albedo.
- **Scientific results usable for increasing the efficiency of the breeding program**, such as:
    - Establishing the methodology for using new molecular markers, and implementing available markers to facilitate the transfer of desired genes;
    - Establishing most suitable mixing parameters for use in breeding wheat for improved baking quality;

- Characterization of "***or***" gene effects on physiological and agronomic traits;
- Identification of potentially new genes of resistance to bunt or Barley Yellow Dwarf Virus in wheat;
- Use of negative asymptotic regressions for describing genotypic effects on the relationship between grain protein concentration and yield;
- Use of climatic change scenarios for Southern Romania, based on global scenarios, to formulate wheat breeding objectives for the future;
- Estimating the effect of changing the genetic vernalization and day-length requirements on wheat yield and yield stability, trough modelling the interaction between climate changes and genetic traits;;
- Establishing the breeding strategy for creating cultivars suitable for organic agriculture.

In the frame of this major project, 5 PhD theses were completed or are in progress. This can be considered an important contribution to training the new generation of researchers.

Extension of results from the major project was achieved through seed multiplication and introduction in many farms of the newly obtained wheat cultivars, on a significant acreage. According to a recent study, these cultivars achieved a genetic progress in yield of 30 – 82 kg/ha/year, similar with the ones reported in most important wheat breeding programs worldwide. Due to this progress and to their superior adaptation to Romanian environment, the wheat cultivars released from the project proved to be competitive, and have been preferred by most farmers, especially in the South of the country, in an open competition with a large number of cultivars imported by many seed companies. According to data, centralized by the Ministry of Agriculture and Rural Development, regarding the wheat seed produced in 2010, the **wheat cultivars released from this major project occupied in 2011 about 47% of the total wheat area in Romania, representing near 1 million hectares.**

The level of performance and competitiveness of the project's results is also illustrated by the **registration and cultivation of some wheat cultivars, bred at Fundulea in the frame of the project, in other countries such as Turkey, Hungary and Argentina.**

Scientific results obtained in the project were disseminated by **11 articles published in ISI indexed journals, 2 articles in publications from other databases and one book**, or were communicated at 2 international conferences and one national scientific meeting. They have been directly used in the wheat breeding program, contributing to a more precise definition of breeding objectives and to faster genetic progress by using modern methods (especially Doubled Haploid production or marker assisted selection).

The economic impact of the project's results can be estimated by the yield increase due to the new cultivars, obtained, without additional expenses, on the area where these cultivars were grown. Because the replacement of older cultivars with the new ones is continuous and gradual, a precise estimation of the total economic impact is difficult, but for example we can take the case of just one of the newly released cultivars, Glosa. In multi-year yield tests, performed in many locations all over the country, the cultivar Glosa outyielded on average the next placed cultivars by 231 kg/ha. Taking into account the fact that the cultivar Glosa was grown in 2010 on about 300 000 hectares, one can estimate an total annual production increase of at least 60 000 tons wheat, worth about 9.4 million dollars at the minimum price of the last 5 years, or 20.8 million dollars at the price on August 26, 2011.