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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

CREATION AND USE OF CHARACTERISATION DATABASES OF GRAIN CEREALS AND LEGUMINOUS PLANTS ON NATIONAL GENETIC RESOURCES

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Field science: Biology

Applicant: **Ilhama Mirzaliyeva Akif**

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The work has performed at the "International Relations, Information and Coordination Department"of the Genetic Resources Institute of Azerbaijan National Academy of Sciences

Supervisor: doctor of Agricultural Sciences, professor, Corresponding member of ANAS
Zeynal Iba Akparov

Official opponents: doctor of biological sciences, Corresponding member of ANAS
Ilham Eyyub Shahmuradov

doctor of biological sciences, dosent
Adila Novruz Alasgarova

doctor of philosophy in biology
Aziza Elkhan Huseynova

Dissertation council of ED 1.26 Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Institute of Botany of ANAS

Chairman of the Dissertation council: doctor of biological sciences, professor, active member of ANAS
Valida Movsum Ali-zadeh

Scientific secretary of the Dissertation council: doctor of philosophy in biology, dosent
Arzu Yusif Huseynova

Chairman of the scientific seminar: doctor of biological sciences
Latafat Ahad Mustafayeva

INTRODUCTION

Relevance of the subject: At present one of the most important scientific problems are the creation of information systems that provide comprehensive research data on gene pool accessions for effective management, reliable conservation, and efficient use of agrobiodiversity. Thysen, 2000[1]; Guarino et al, 2002[2]; Əliyev və b., 2008[3]. In the Law of the Republic of Azerbaijan on the "Protection and Efficient Use of the Genetic Resources of Cultural Plants" (2011)[4] has taken a special place of creation, development and extensive use of information systems on these resources.

Using specific descriptors for national plant collections Germier, Frese, 2001[5]; Descriptors-BI, 1982-2019[6]; FAO/BI Multi-Crop Passport Descriptors list, 2015[7]; Akparov et al., 2013[8] which is designed and developed by FAO and the International Biodiversity

[1] Thysen Agriculture in the information society. J. Agric. Eng. Res.,76z 2000, 297-303.

[2] Guarino L, Jarvis A, Hijmans RJ, Maxted N. Geographic information systems (GIS) and the conservation and use of plant genetic resources. In: Engels JMM, Ramantha Rao V, Brown AHD, Jackson MT, editors. Managing Plant Genetic Diversity. CABI Publishing, Wallingford, UK, 2002, p. 387–404.

[3] Əliyev C.Ə., Əkpərov Z.İ., Məmmədov A.T. Bioloji Müxtəliflik. Bakı: "Elm", s.232,2008.

[4] Mədəni bitkilərin genetik ehtiyatlarının mühafizəsi və səmərəli istifadəsi haqqında" Azərbaycan Respublikasının Qanunu, – Bakı: – 13 dekabr, – 2011. URL: http://president.az/articles/4301

[5] Germier Ch.U., Frese L. A data model for the evaluation and characterization of plant genetic resources. "Broad Variation and Precise Characterization -Limitation for the Future". Poznan. Poland, pp.174-177, 2001.

[6] Databases Germplasm ECPGR, 1982-2019, URL:http://www.ecpgr.cgiar. org/resources/germplasm-databases of Genetics: Applied Research, – 2013. Issue 1, – Vol. 3, – p.26-29, URL:http://link.springer.com/article/10.1134%2FS2079059713010024

[7] FAO/BI Multi-Crop Passport Descriptors list, 2015 https://www.bioversityinternational.org/e-library/publications/detail/faobioversity-multi-crop-passport-descriptors-v21-mcpd-v21/

[8] Akparov, Z.I., Mobilization and conservation of the seed pool of plant genetic resources in Azerbaijan / Mammadova, S.A., Mammadov, A.T. // Russian Journal

Institute are constantly being studied the genetic diversity, morphobiological, agronomic, biogeographical and other traits and evaluations are carrying out using various, including molecular markers. It is important of development of databases for the digitalization of these studies results and collection, conservation and use of them at the standard forms at the unique virtual space.

Databases should also include characterization and evaluation data that describes the gene pool, as well as the results of molecular-genetic research. By developing the search opportunities in the information media (in terms of theoretical problems and also software and interface) software packages which provide import of data, from the most different sources, as wel as genetic passportization and identification of data, results of the statistical and bioinformatic analyses, and provide automated analysis of the collected data by means of different as well as mathematical-statistical methods, international practice must be taken into consideration throughout the whole process Guarino et al., 2002[9]; Winfried, 2006[10], Agrawal, 2007[11]; Əkpərov, 2009[12]

If such databases have a comprehensive and rich information, they can make the real support to breeding programs as well as food security, also will save the time and funds by eliminating the need for reinvestigation.

The characterization, evaluation, and other specific features of the available databases in Azerbaijan and in the internet resources are few or unavailable, and also access to them is limited.

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[9] Guarino L, Jarvis A, Hijmans RJ, Maxted N. Geographic information systems (GIS) and the conservation and use of plant genetic resources. In: Engels JMM, Ramantha Rao V, Brown AHD, Jackson MT, editors. Managing Plant Genetic Diversity. CABI Publishing, Wallingford, UK, 2002, p. 387–404.

[10] Winfried S. GIS, geostatistics, metadata banking, and tree-based models for data analysis and mapping in environmental monitoring and epidemiology. International Journal of Medical Microbiology, V.296, S1, 2006, p. 23-36.

[11] Agrawal, R., Genebank Information Management System (GBIMS) / Drona, B. and Sanjeev, S. // Computers and Electronics in Agriculture, – Volume 59, – November 2007. Issues 1-2, – p.90-96.

[12] Əkpərov Z.İ. Bitki genetik ehtiyatlarının mühafizəsinin elmi əsasları. Bakı: "Təknur", 2009, s.123.

Taking into account the above mentioned the characterization and evaluation databases will substantially improve the information security of plant genetic resources (PGR) management and expand real-world access. These databases are great importance as the beginning of a qualitative new approach in terms of more effective use cultural plants and their wild relatives in scientific-based selection works by means of biotechnological methods and the conformation of the true value of the genome.

The purpose and objectives: The main purpose of the work is the creation of databases of grain cereals and leguminous plant collections in the National Genebank, standardization, collection, analyses of the results of complex researches and development of the basis of information support for the comprehensive study and efficient use of the gene pool.

The following tasks have been set for this purpose:

1. Determination of the basic principles for the creation of characterization and evaluation databases of plant collections.
2. Creation and use of software structures for the characterization and evaluation of national grain cereals and leguminous plant collections, using international standards for data collection, processing, use and transmission.
3. Design and transfer of spreadsheets to created databases, which allow collecting and standardization of characterization and evaluation data based on international descriptors.
4. Identifying the sources of characterization and evaluation data of plant samples registered and stored in the National Genebank on PGR, collecting, standardizing, and digitalizing them by establishing interactive relationships with relevant researchers and breeders.
5. Design and establishment a system that allows to reach (including *on-line*) characterization and evaluation data for database users to enrich databases with their feedbacks.
6. Creation of trait collections covering the gene pool of grain cereals and leguminous plant species.

Scientific novelty of the research: It have been created characterization and evaluation databases of national plant

collections for the first time in Azerbaijan and have been developed *on-line* access on the scientific bases.

Based on this, has been created also the software and structure content of grain cereals and leguminous databases using the global standards, modern information technologies and their adaptation for data collection, processing, use and transmission.

The collected characterization data were standardized and digitalizing on the basis of existing international descriptors, and was carried out their transfer and integration into the created databases.

For the first time it was created the trait collections of these plants based on grain cereals and leguminous characterization databases to facilitate breeders' access to information.

The models for similar databases of other plants or plant groups have been developed based on the created characterization databases on grain cereals and leguminous plants.

By analysis of the data obtained from complex studies in future selection and other plant studies has been provided the basis on information support for their efficient use.

Practical significant of work. Systematization of characterization data of the national collections of grain cereals and leguminous plants created in new types of databases, as well as the addition of efficient sampling tools to these databases with the aim of finding and revealing valuable varieties (genes) and will provide significant support to plant researchers and breeders in expanding their use. It will be possible to analyze collected, standardized and processed characterization data integrated into the database and make recommendations for breeders using modern information technologies. It will be possible to access to the database through the internet and to order materials and also obtain information. The characterization databases will help to increase the focus and enhance the level of scientific research by implementing the functions of knowledge and expert systems. Collecting data on plant samples conducted so far research results in a unit space, ensuring efficient organization, and easy access to them will save time, manpower, and resources, eliminating the need for further study.

The potential users of the new databases will be research

centers, plant breeders, and plant researchers, seed associations.

The main provisions of the dissertation defense:

• The basic principles have been developed for the creation of characterization and evaluation databases of Gene pool;

• Characterization and evaluation databases of grain cereals and leguminous plants from Azerbaijan national plant collections were designed, their software package was developed and launched.

• It was designed and built a system that allows database users to evaluate and enrich databases with feedback;

•By using the characterization and evaluation databases, the recommendations, and guidelines were developed for conducting theoretical and practical research on trait collections;

• The principles have been developed for providing *on-line* access to characterization and evaluation databases of grain cereals and leguminous plants from Azerbaijan national collections.

Approbation of the work: Results of the study were presented at the I International Conference on Genetic Resources of Biodiversity (2006, Azerbaijan), national workshops on PGR (2006-2012), Final Meeting on Central Asia and South Caucasus Regional Database (2007, Uzbekistan), Proceedings of the III International Scientific and Practical Conference "The Role and Importance of Intellectual Property in the Innovative Development of Economy" (2011, Ukraine), in Scientific Conference "Conservation and Development of Biodiversity"(2007, Uzbekistan), I International Conference "Conservation, study and use of PGR for achieving climate change sustainability" (2011, Azerbaijan), X International Conference "Introduction of non-traditional and rare plants"(2012, Russia), II International Conference on subtropical and mild zone's walnut plants and their wild relatives (2014, Azerbaijan); Modern Technologies in Product Production" (2016, Georgia), Scientific council of the Genetic Resources Institute and scientific seminars of the Institute (2006-2019).

Published works: It was published 19 scientific works on the topic of dissertation which are 11 articles (7 articles in abroad) and 8 theses (7 thesis in abroad). 3 of them were published in journals abstracted and indexed in international databases.

Structure and volume of dissertation work: The dissertation work is published on 179 pages, including introduction, 5 chapters, results, and recommendations, list of references, appendices, and the list of abbreviations. There are 7 tables, 35 pictures, 4 charts, and 3 graphs. 214 sources of references were used. Volume of characters of whole dissertation work is 238,447.

BASIC CONTENT OF WORK

CHAPTER I. LITERATURE REVIEW

This chapter deals with the documentation of plant genetic resources, the role of information systems in the study of grain cereals and leguminous plants, international and national information systems with characterization and evaluation information, and the application of modern information technology in research analysis and management, as well as worldwide research has been extensively analyzed with reference to the literature sources.

CHAPTER II. MATERIALS AND METHODS

As the research material for the creation of the national gene pool characterization databases, it was firstly taken bread and durum wheat (*Triticum aestivum* L., *Triticum durum* Desf.), barley (*Hordeum vulgare* L.), maize (*Zea mays* L.), rye (Secale L.), triticale (x Triticosecale), bean (*Phaseolus* L.), cow pea (*Vigna* Savi), vetch *(Vicia* L.), horse bean (*Vicia* faba), lentil (*Lens culinaris* L.), pea (*Cice*r L.) and grass pea (*Lathyrus* L.) collections conserved at the National Genebank, including passport, environmental, climate, geobotanical, taxonomic, storage, restoration, exchange, introduction and characterization data standardized by appropriate technologies. The field and laboratory journals, breeder's records, catalogues, scientific articles, other related literatures, gene pool study materials, reports, and descriptors lists played an important role as the primary source for the collection of data. Standardization, digitalization, collection, and processing of research results on plant studies were

carried out using the international passport descriptors and evaluation descriptors lists. Characterization and evaluation descriptors provide more detailed information about each plant or plant group individually. Quantitative and qualitative criteria for comparison and characterization, statistical processing packages (MS FoxPro, Excel, Access, Statistics, Oracle, etc.) were used in the analysis of collected information. Open Database Management Systems and Software Packages and Database Servers (MS Excel, Visual FoxPro, dBase, xBase, MS Access, MySQL, SQL Server, Apachi, Oracle, etc.) in creating relevant databases software and Internet resources used SQL programming language for writing internal codes. Сосински, 1997[13]; Каратыгин и др., 2000[14]; Дейт, 2005[15]; Кузнецов, 2007[16]; Germier, Frese, 2001[17]; GENESYS; ECPGR Germplasm Databases, 2013[18].

To clarify of the taxonomic data of the accessions were used the opportunities of The List of High Plant Genus and Families Name and, GRIN-Taxonomy website, Mansfield encyclopedia, and database created by GRIN Taxonomy, 2019[19]; Mansfeld's World Database, 2012[20]. Also, was used FAO Advanced Warning System

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[13] Сосински Б. Разработка приложений в среде Visual FoxPro 5. Пер.с анг. Киев: «Диалектика», 1997, с. 448. 45.

[14] Каратыгин С., Тихинов А., Тихинова Л. Visual FoxPro 6. ЗАО «Издательство БИНОМ», 2000.

[15] Дейт К.Дж. Введение в системы баз данных, Introduction to Database Systems. 8-е изд. М.: Вильямс, с. 13-28, 2005.

[16] Кузнецов, С.Д. Основы баз данных, 2-е изд., Интернет-университет инфор-мацион¬ных технологий; БИНОМ. Лаборатория знаний – Moskва: – 2007. – с.484.

[17] Germier Ch.U., Frese L. A data model for the evaluation and characterization of plant genetic resources. "Broad Variation and Precise Characterization – Limitation for the Future". Poznan. Poland, p.174-177, 2001.

[18] The New Plant Genetic Resource Gateway: GENESYS (that currently compiles the data from EURISCO and GRIN), p.19-22, 2013.

[19] GRIN Taxonomy, 2019 URL: https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch.aspx

[20] Mansfeld's World Database of Agricultural and Horticultural Crops, URL: http://mansfeld.ipk-gatersleben.de/pls/htmldb_pgrc /fp= 185:4:196824468447569, 2012.

(WIEWS), European Internet Search Catalogue for PGR - EURISCO and The European Cooperative Programme for Plant Genetic Resources (ECPGR Germplasm Databases), for database integration and *on-line* operation. In the selection of descriptors, data structuring, and determination of plant strategies were used international reputable systems (www.grin-global.org. and etc.)

CHAPTER III. CHARACTERIZATION DATABASES: CREATION AND MANAGEMENT PRINCIPLES, SOFTWARE

3.1. The main principles for the creation of the characterization databases on grain cereals and leguminous plants

Characterization and evaluation of germplasm helps to better utilization, as they are scientifically based on specific trait descriptors, it requires the creation of an adaptive documentation system and databases that provide access to research results.

There are following principles used for creation of characterization, evaluation, molecular marker, genomics, and etc., databases, literature, analysis of information systems used in appropriate international organizations and advanced foreign scientific centers, as a result of intensive consultation with experts of different fields. Main principles of our research work that based on throughout of this type of work and we are strictly recommend in, are as follows:

1. The software development at the stages of design and development of the characterization and evaluation database:

a) have to study global standards for the collection, processing, utilization, integration of data, controlling of them for their application, must be modified, and adapted if any need.

b) commercial and non-commercial software packages should be investigated, which are available in the world and which are suitable for use;

c) introduction with the information systems used in relevant international organizations, well-known foreign scientific centers,

and identify their advantages and disadvantages;

d) structure of the database and the design of optimal options should be carried out by information technology specialists in consultation with plant researchers in a collaborative environment.

2. At the stage of creation of database content structure and collecting information:

a) results of the studies intended to reflect in databases on target plants, the institutions and laboratories where these studies are conducted, the sources of important information should be identified;

b) collaborations should be conducted between field scientists and information professionals to carry out research in accordance with modern methods, reliable to protocols, collecting and standardizing research results on international and local descriptors.

c) centralized collection of data, protection, processing, utilization, and transfer of data should be organized through reliable methods and programs;

d) data management and monitoring system should be established and automated as much as possible,

e) integration should be provided with decision-making mechanisms.

3. The content of *on-line* characterization databases should not be accessible by public. Because, have been invested a lot of financial means, equipment, manpower and knowledge in conducting relevant research works and obtaining the results. The agreement between which segments are open to which group of users, collection owners, responsible organizations, potential users, and etc. parties may be regulated by joint rules and general decisions.

The importance of the following terms should also be taken into account when the database is launched and used:

a) the perfect interface by functionality and favorable for management and use,

b) optimizing memory usage without injuring functionality;

c) optimization of information traffic at *on-line* system.

It is also important scientifically-based interpretation of interface, user methods, and procedures for characterization databases users.

3.2. Creation of characterization databases scheme

Upon creation of electronic databases containing specific plant or plant groups in the framework of Central Database (CDB) FoxPro Database Program has already adopted the above-mentioned principles. Some internal programs have been written using software tools and SQL programming language for the creation of characterization database of specific plant which are seed samples stored in National Genebank. For example, the base program for wheat samples are as follows: AZE: wheat, wheat accession in Azerbaijan collection, C: \ AZEDB \ AZE \ cropsel \ wheat \ SELECTIONS; C: \ AZEDB \ AZE \ crop \ wheat \ DB_CROP.dbf C: \ AZEDB \ AZE \ cacsel \ db_user.dbf; SELECT nc FROM accession WHERE taxno2 IN (SELECT tax2 FROM taxon2 WHERE atc ('wheat', tax_name)> 0). Then, from the Edit System Table, enter Register of “crop” tables to enter the relevant information: C: \ AZEDB \ AZE \ CROP \ WHEAT; The WHEATCHAR commands, as well as other plants, have been compiled and created the corresponding tables. Later, the field name was written in the title of the created by us table using the international standards. And then the characterization data which obtained from breeders and plant researchers for each plant samples were included in those tables according to their field titles.

Due to the MS FoxPro software package, structural changes and modifications have been made in the database to provide easy integration to the international systems (Figure 3.2.1). Scientific names of plants are given in Latin.

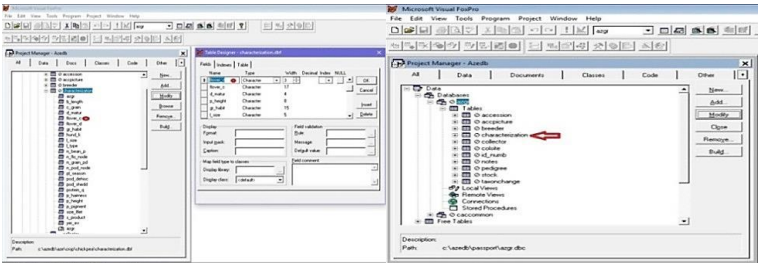


Figure 3.2.1. Creation of table fields that forms a database in MS FoxPro format, characterization table

The characterization databases have been created in the same way for other research plants, and a characterization – "CHARACTERIZATION" table has been added to their structure. As a result, the structure of the CDB is included into the list of other tables that have been created for each plant group and have the same table name for characterization database on each plant groups.

In addition, part of the characterization data, based on the above showed principles, uploaded to the international and national internet-based networks, such as the GENESYS portal (https://www.genesys-pgr.org/ru/geo/AZE), the European Internet Search Catalogue on PGR, the Database Exchange Information Monitoring Facility (hhttp://www. http://www.fao.org/home/search/en/?q=information %20sharing%20mechanizm) downloaded. This information can be viewed by accessing relevant portals or by downloading any segment to the computer, separating from the general context.

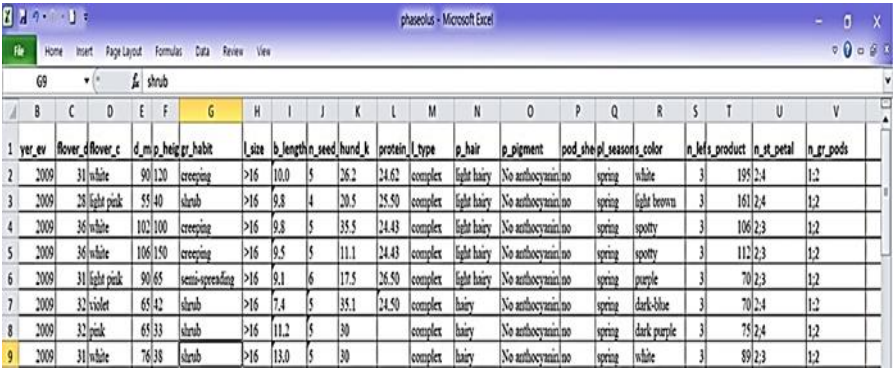
3.3. Characterization databases of grain cereals and leguminous plants: structure and functional blocks

New structural changes have been made in the CDB to place the results of the relevant research (morphological analyses, quality indicators, physiological, biochemical, technological, etc.) by the laboratories investigations of the previous years on grain cereals and leguminous plant collections of National Genebank. Characterization data have firstly been developed in the Excel spreadsheet tables, compiled according to the international standards.

3.3.1. Addition characterization data to Excel spreadsheets tables

Firstly, characterization data of the bread (*Triticum aestivum* L.) and durum wheat (*T.durum* Desf.) 1033 (characterization trait number 9), barley (*Hordeum* L.) 194 (21), maize (*Zea mays* L.) 177 (10), tritikosecale (*Triticosecale*) 19 (9), rye (*Secale* L.) 135 (9), bean

(*Phaseolus* L.) 93 (20), cow pea (*Vigna* Savi) 25 (19), vetch (*Vicia* L.).) 60 (24), pea (*Cicer* L.) 209 (33), lentil (*Lens culinaris* L.) 85 (33), horse bean (*Vicia* faba L.) 89 (22) and grass pea (*Lathyrus* L.) 67 24) accessions has been added to the Excel spreadsheets. We have developed software modules and MS Excel spreadsheets tables based on a list of the international descriptors for collecting and sampling data for each accession taken from breeders and plant researchers (Figure 3.3.1).



	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	yer_ev	flower_d	flower_c	d_mi	p_heig	gr_habit	l_size	b_length	n_seed	hund_k	protein	l_type	p_hair	p_pigment	pod_she	pl_season	s_color	n_lefs	product	n_st_petal	n_gr_pods
2	2009	31	white	90	120	creeping	>16	10.0	5	26.2	24.62	complex	light hairy	No anthocyanin	no	spring	white	3	195	2:4	1:2
3	2009	28	light pink	55	40	shrub	>16	9.8	4	20.5	25.50	complex	light hairy	No anthocyanin	no	spring	light brown	3	161	2:4	1:2
4	2009	36	white	102	100	creeping	>16	9.8	5	35.5	24.43	complex	light hairy	No anthocyanin	no	spring	spotty	3	106	2:3	1:2
5	2009	36	white	106	150	creeping	>16	9.5	5	11.1	24.43	complex	light hairy	No anthocyanin	no	spring	spotty	3	112	2:3	1:2
6	2009	31	light pink	90	65	semi-spreading	>16	9.1	6	17.5	26.50	complex	light hairy	No anthocyanin	no	spring	purple	3	70	2:3	1:2
7	2009	32	violet	65	42	shrub	>16	7.4	5	35.1	24.50	complex	hairy	No anthocyanin	no	spring	dark-blue	3	70	2:4	1:2
8	2009	32	pink	65	33	shrub	>16	11.2	5	30		complex	hairy	No anthocyanin	no	spring	dark purple	3	75	2:4	1:2
9	2009	31	white	76	38	shrub	>16	13.0	5	30		complex	hairy	No anthocyanin	no	spring	white	3	89	2:3	1:2

Figure 3.3.1. Characterization data of bean accessions in tabular form

3.3.2. Transfer of characterization data to MS FoxPro based database

During the designing of databases for grain cereals and leguminous plant group, the characterization data of the plant samples were grouped according to the traits and systematized into separate fields (columns) for each plant group. The tables form the CDB characterization segment coordinated with each other using unique codes generated by the database (AzGR + sample name, for example, AzGR-11563). Exactly this unique identifier AzGR is a key area to organize and provide communication between all tables in the CDB (Figure 3.3.2).

Central database tables contain more than 300 fields. Each table has a number of required fields that meet international descriptor standards. Based on the structure of the database, it is possible to add new fields (table columns) or delete existing fields

from the database, using the methods proposed by us with the software opportunities. Transferring of completed tables to the database was provided by software tools that we created based on database management systems.

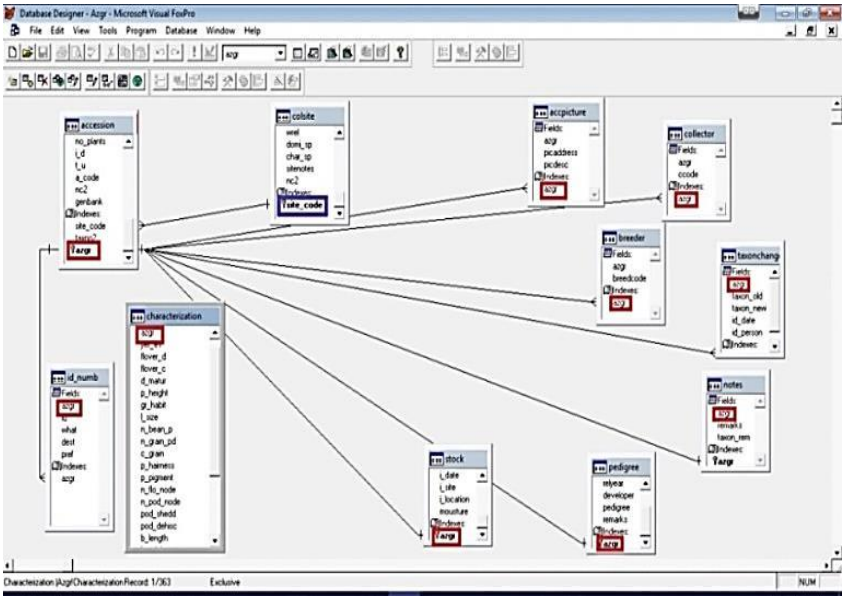


Figure 3.3.2. Coordination of tables in the CDB according to AzGR identifier

3.4. Databases of important global collections, compiled in international Genebanks

It is known that, the grain cereals and leguminous plant collections protected by the National Genebank of Azerbaijan have been selected by international organizations as the major collections of global importance on the basis of characterization database, and by duplicated their reliable protection were considered as a priority. 1521 specimens of these plant accessions were sent to the Global Genebank (Svalbard Global Seed Vault), in the island of Spitsbergen, in Norway, established by the contract, as well as duplicates to other relevant international Genebanks (Table 3.4.1).

Table 3.4.1.

Number of accessions sending to Global Genebank and other organizations

N	Accession	Number of traits	Number of accessions	Other organizations
1.	Durum wheat *Triticum durum* Desf.	9	510	ICARDA
2.	Bread wheat *Triticum aestivum* L.		369	CIAT
3.	Barley *Hordeum* (*distichon, vulgare*) L.	21	194	ICARDA
4.	Maize *Zea mays* L.	10	200	ICRISAT
5.	Bean *Phaseolus vulgaris* L.	20	73	CIMMYT
6.	Grass pea *Lathyrus sativus* L.	24	67	ICARDA
7.	Pea *Cicer arietinum* L.	33	65	IITA
8.	Lentil *Lens culinaris (esculentha, ervoides)* L.	33	40	ICARDA
9.	Cow pea Vigna (*unguiculata, radiata, sinensis*) L.	19	20	ICARDA
10.	Horse bean *Vicia faba* L.	22	14	ICARDA
11.	Sorqo *Sorghum bicolor* (L.)Moench	-	11	ICRISAT
	Total	191	1521	

CHAPTER IV. CONTENT OF THE CHARACTERIZATION DATABASE

4.1. Trait fields of the characterization databases

The characterization tables which created separately for each plant or plant group consist of areas that are arranged in columns, representing the traits of the plant accessions. The names in these fields have been chosen (coded) to provide a convenient database operation, inter-sectoral linkage efficiency, accuracy of searches, and completeness of the information. The explanations of the codes were posted in a form which accessible to users in a specially created area in the database. Characterization databases contains of 233 trait fields (153 of which are unique) according to the optimal number of characterization data.

4.2. Analysis of cereal crops included in the characterization databases on evaluations characters

Characterization databases created on 6 varieties of grain cereals plants have greatly expanded the selection options for breeding and other plant researces. This can be illustrated by the few simple examples.

1033 wheat samples which are stored in the National Genebank (427 durum wheat (28 subspecies) and 606 of bread wheat (30 subspecies)) was structured for the first time as a characterization database. The database is structured to allow comparative data analysis. All of these allow every user to analyze the content of the database without wasting time, and will help to select the accessions which have valuable traits.

There are 4042 samples of grain cereals available in National Genebank; 1558 accessions have characterization data among them, which represent 39% of the stored accessions. 796 of 1033 characterized wheat samples were from Azerbaijan (Aran deni, Gara bughda, Garakilchig, Gizil bughda, Mirvary, Nasimi, Tartar-2, Sharg, Sevinj, Yakut, etc.), 197 from Syria, 13 from Hungary, 9 were from Bulgaria, 3 were from Canada and etc. by origin. The average height of the specimens between 59-189 cm and the fruit stems between 2.3-6.3 cm. 154 of 199 specimens of barley which has characterization data are from Azerbaijan, the others are from Russia (10), France (4), Germany (4), Ukraine (3), Canada (2), and 124 of 135 maize accessions are from Azerbaijan and others from Russia.

4.3. Analysis of leguminous plants by trait evaluation included to the characterization databases

Selection opportunities in breeding and other plant research have been significantly expanded through the characterization databases created for 7 leguminous plants.The average size of 8 beans for shrub species (plant height 50-70 cm), 3 (70-80 cm) for cow peas, 29 (90-95 cm) and 4 (80-90 cm) for grass pea accessions were observed. Failure of opening of beans during the ripening phase is important as breeding indicator and it is a great importance in

reducing crop losses and mechanical harvesting. This index, which is expected to be up to 10%, in the data analyses on database at an average of 22% for vetch, 2% for horse bean, and 44% in grass pea was observed.

Providing high functionality of databases and related software, it is possible to carry out hundreds of such simple and cross-cutting, merging and cross-based selections and searches, which greatly improves the information support for breeding and other plant studies.

CHAPTER V. PRINCIPLES AND PROCEDURES FOR EFFECTIVE USE OF CHARACERIZATION DATABASES

5.1. Principles of purposeful use of characterization databases

The usefulness of information conservation in databases depends on the efficient organization of searching mechanism to obtain any information in those databases. Appropriate tools created in the database to perform the functions of searching and analyzing of different types of data. Characterization databases are adapted to the interface of the Central Database. The searching mechanism created within the database is structured text, numeric, logical, and so on. It has high functionality for manipulating data types. This system can also be used for processing of unstructured, integral, and multi-media data. Specific help desks and pages have been created to make it easier for searching and display any information for needs of database users. Database provides various functions for users such as: “View", "Query", "Selection", "Reports" and etc. One of the services provided to users through the database is the preparation of reports using software tools. The Database “Tools” section also contains a link to importing data into tables in text, dbf, and Excel formats. Thus, all program-based work carried out on the characterization databases are focused on improving its efficient use.

5.2. Characterization databases users and their usefulness

The characterization of PGR determines the high quality of germplasm by identifying high-quality traits, including valuable

genes, as well as high-protein and molecular markers ranging from the morphological and agronomic features. Strengthening the analysis system with the development of customized databases and improvement of searching mechanism will improve the local information space of Azerbaijan *ex situ* collections, makes easy comparative analysis of country collections, identifying suitable parents for segregation, searching for useful traits and examples and etc. processes, saving additional breeding costs. At the same time the created databases allow local and international material transfer, enrichment of the national genepool, as well as ensuring proper policy implementation.

Characterization databases play an important role in managing, operating, and effective activity of the Genebanks.

Users of the database will be able to connect to the server and enter the given password to database and receive any information without any editing. Only the administrator and server administrator are authorized to make changes in the database.

Thus, were created trait collections through creation of characterization databases. These collections create great opportunities for breeders and other plant researchers in the selection of new materials.

RESULTS

1. Accessibility and creation of characterization and evaluation databases of national plant collections have been firstly developed in Azerbaijan on scientific bases.
2. Characterization and evaluation databases of 6 grain cereals and 7 leguminous plants have been designed within the framework of the plant genetic resources information system of Azerbaijan, and their software and content structure has been established.
3. Principles and rules for integration of characterization and evaluation databases into global information systems have been developed.

4. Collection, standardization and digitalization of the research plants' characterization data on the basis of available international descriptors, was carried out their transfer to the created databases and integration into international systems.
5. By analyzing data from complex studies on plant gene pools, interfaces and methods have been developed to facilitate information support for their efficient use in future breeding and other plant research.
6. Trait collections were created on 13 grain cereals and leguminous crop collections on the basis of characterization and evaluation databases of plant genetic resources of Azerbaijan.

RECOMMENDATIONS

1. Purposeful use and reliable conservation of plant genetic diversity can greatly be enhanced by the creation of databases that identify valuable features in national collections and involve them in breeding programs.
2. Additional time and funds can be saved by using the selection options in the databases created for the implementation of targeted selection programs and field experiments
3. The existing characterization databases can be used as models in the creation of characterization and evaluation databases of other plants and plant groups.
4. Access to the database through the Internet, availability to materials and information.
5. Execution of the knowledge and expert system functions of characterization databases will help to increase the level of scientific research and their purposeful conduction

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