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Decision Support System for Yield of Crop Varieties

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Abstract—*Information is one of the important components of today's life. There are fairly large amount of observed evidences that intuitive judgment of human being and capacity of decision making is far from the desired and best decision, and it further become worse even with complexity and stress. To improve quality of decision, disciplines such as economics, statistics and operations research developed various methods for making intellectual choices. Within the past few years, techniques from information science and artificial intelligence have been implemented in the form of computer programs. "Decision Support System for Yield of Crop Accessions" is an information system which aims to filter data according to the choice made by user. Hence it helps users to make different choice to get the desired results. At Present this system consists data of four crops viz: Barley, Maize, Chilli and Tomato. Barley consists of 5 accessions (ID128510, ID290302,ID252507,ID252995, ID138393), Maize consists of 6 accessions (ID279331, ID281550,ID356353, ID290213, ID535348, ID281554), Chilli consists of 6 accessions (ID251778, ID268982, ID269476, ID269056, ID327697, ID327918), Tomato consists of 6 accessions (ID022494, ID245551, ID299061, ID490867,ID74060, ID139590). These crops are grown in different parts of India from year 2004-2009. The data set consists of following fields viz: Name of crop, Location, Year of cultivation, Name of accessions, Yield. The objective is based on the thought to collect data from all locations and develop a web based retrieval system which can help user to evaluate the accessions grown at various locations, year-wise. It helps to know which accession is suitable for which type of location and giving more yield.*

Keywords*: accessions, decision support system, query, software, yield.*

1. INTRODUCTION

Information is one of the important components of today's life. There is fairly large amount of observed evidences that intuitive judgment of human being and capacity of decision making is far from the desired and best decision, and it further become worse even with complexity and stress. To improve quality of decision, disciplines such as economics, statistics and operations research developed various methods for making intellectual choices. Within the past few years, techniques from information science and artificial intelligence have been implemented in the form of computer programs. In this project a decision support system is developed to get filtered data on the base of query of user. The query is based on crop, location, year etc. This type of system helps the user to know more about the crop grown in particular region and its yield, which further helps in deciding strategies for further cropping strategies.

There are number of information system available in Internet for crop evaluation. Over the last few years, it has become increasingly difficult to maintain the information system crop models, partly due to fact that there were different sets of computer code for different crops with little attention to software design at the level of crop models themselves. Some of them are highlighted are: The DSSAT cropping system model, World Agro Meteorological Information Service (WAMIS), EasyGrapher: Software for Data Visualization and Statistical Evaluation of DSSAT Cropping System Model and the CANB Model.

2. METHODOLOGY

The objective of this system is based on the thought to collect data from different locations and develop a web based retrieval system which can help user to evaluate the accessions grown at various locations, year-wise. It helps to know which accession is suitable for which type of location and giving more yield.

1. System Requirement Specification(SRS)
   Hardware:
   Processor : Pentium 2.4 GHz or above
   Memory : 256 MB RAM or above
   Cache Memory : 128 KB or above
   Hard Disk : 3 GB or above [at least 3 MB free space required]

   Software:
   Operating System : Windows 10, Win NT, Win 2000.
   Font-End Tool: Visual Basic 2008
   Back End Tool : SQL Server

2. Data Flow Diagram (DFD)

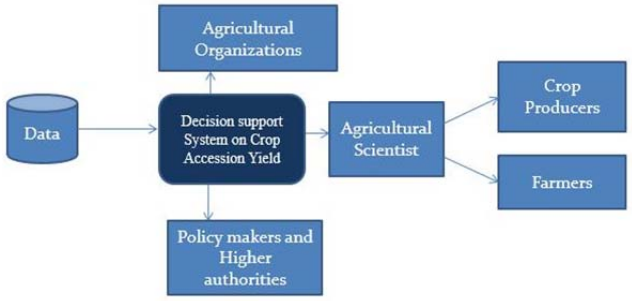


Fig. 1: Data Flow Diagram

3. Data Dictionary

There are Four tables in database of Barley, Maize, Chilli and Tomato and the data dictionary for all of them is as follows:

Field	Type
Sno	float
Crop	nvarchar(255)
Aspect	nvarchar(255)
CharacterData	nvarchar(255)
Location	nvarchar(255)
Cultivation_Year	nvarchar(255)
Accessions	nvarchar(255)
Yield	float

4. Decision Tables

A decision table is a good way to deal with combinations of things (e.g. inputs). This technique is sometimes also referred to as a 'cause-effect' table. The reason for this is that there is an associated logic diagramming technique called 'cause-effect graphing' which was sometimes used to help derive the decision table (Myers describes this as a combinatorial logic network [Myers, 1979]). However, most people find it more useful just to use the table described in [Copeland, 2003]

Conditions	Rule 1	Rule2	Rule3	Rule4	Rule5	Rule6	Rule7	Rule8
Location is selected	True	False	False	True	False	True	True	False
Accession is selected	False	True	False	True	True	False	True	False
Year is selected	False	False	True	False	True	True	True	False
Actions								
Output	Filter data based on the selected location	Filter data based on the selected accession	Filter data based on the selected Year	Filter data based on the selected location and accession	Filter data based on the selected accession and year	Filter data based on the selected location and year	Filter data based on the selected location, accession and year	Error

3. SYSTEM DESIGN

There are three Modules in this System:

1. QueryPage Module: This module is intended to get user's choice and return the filtered result in report web form.
2. QueryPageReport Module: This module displays the result of query.
3. Data Upload Module: It is intended to upload data into the Sql Server Database.

This information System consists of 4 datasets of crop Barley, Maize, tomato and Chilli. All of the dataset are independent dataset.

Types of integrity constraints applied on datasets: (1) Entity integrity (2) Referential integrity.

- Entity integrity concerns the concept of a primary key. Entity integrity is an integrity rule which states that every table must have a primary key and that the column or columns chosen to be the primary key should be unique and not null. All the tables are having S.No. as primary key of the table.
- Referential integrity concerns the concept of a foreign key. The referential integrity rule states that any foreign-key value can only be in one of two states. The usual state of affairs is that the foreign-key value refers to a primary key value of some table in the database. Occasionally, and this will depend on the rules of the data owner, a foreign-key value can be null. In this case we are explicitly saying that either there is no relationship between the objects represented in the database or that this relationship is unknown. In all the tables of this system there is no relationship between the objects represented in the database.

4. PROCEDURAL DESIGN

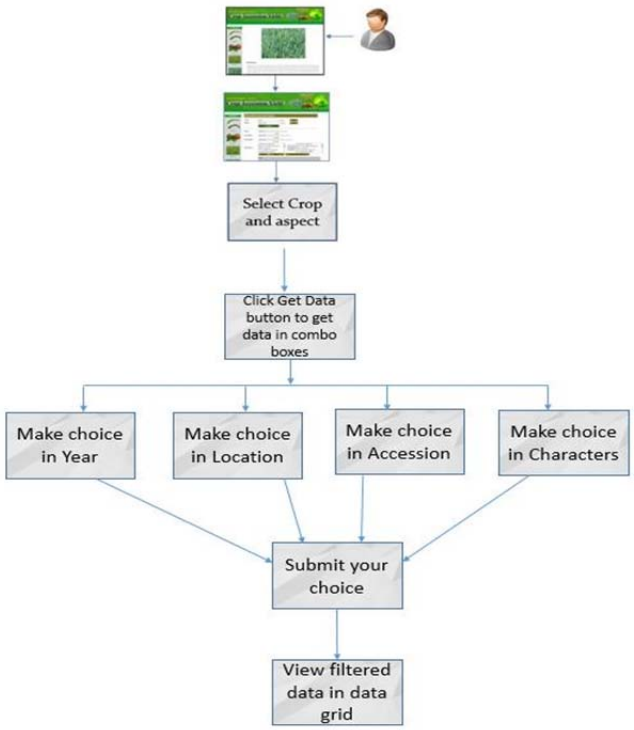


Fig. 2: Procedural Design

5. APPLICATION

There are 4 web forms in Decision Support System of Crop Accession Yield website.

1. Homepage.aspx

Fig. 3: Homepage

2. Querypage.aspx

Fig. 4: Web form for Query

3. Querypagereport.aspx

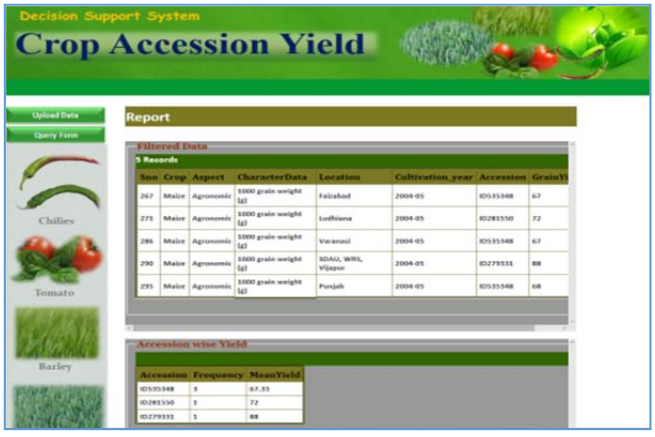


Fig. 5: Web-form for query report

4. Data Upload.aspx

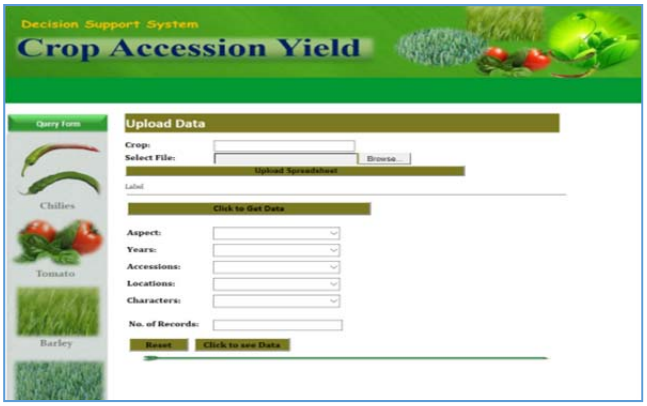
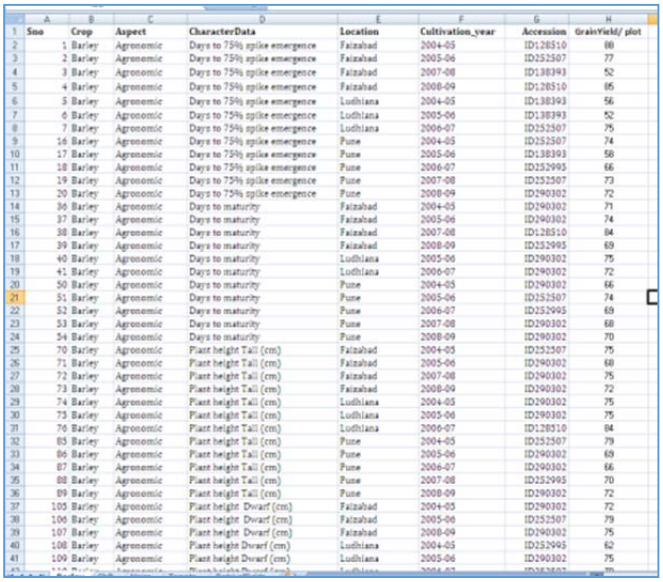


Fig.6. Web-form for Data uploading

Decision Support System of Crop Accession Yield is web based program. Broadly, program is intended to provide selected information on the basis of user choice. This application is developed using Visual Basic IDE (Randolph *et al*. 2008, Evangelos 2008) as front-end-application and SQL Server R2 (Rankins *et al*. 2010) as back-end. At present, data of four crops is entered into the database in following format.

Table 1: Barley dataset



Sno	Crop	Aspect	CharacterData	Location	Cultivation_year	Accession	GrainYield/ plot
1	Barley	Agronomic	Days to 75% spike emergence	Faizabad	2004-05	ID128510	80
2	Barley	Agronomic	Days to 75% spike emergence	Faizabad	2005-06	ID252507	77
3	Barley	Agronomic	Days to 75% spike emergence	Faizabad	2007-08	ID138393	52
4	Barley	Agronomic	Days to 75% spike emergence	Faizabad	2008-09	ID128510	85
5	Barley	Agronomic	Days to 75% spike emergence	Ludhiana	2004-05	ID138393	56
6	Barley	Agronomic	Days to 75% spike emergence	Ludhiana	2005-06	ID138393	52
7	Barley	Agronomic	Days to 75% spike emergence	Ludhiana	2006-07	ID252507	75
16	Barley	Agronomic	Days to 75% spike emergence	Pune	2004-05	ID252507	74
17	Barley	Agronomic	Days to 75% spike emergence	Pune	2005-06	ID138393	58
18	Barley	Agronomic	Days to 75% spike emergence	Pune	2006-07	ID252995	66
19	Barley	Agronomic	Days to 75% spike emergence	Pune	2007-08	ID252507	73
20	Barley	Agronomic	Days to 75% spike emergence	Pune	2008-09	ID290302	72
36	Barley	Agronomic	Days to maturity	Faizabad	2004-05	ID290302	71
37	Barley	Agronomic	Days to maturity	Faizabad	2005-06	ID290302	74
38	Barley	Agronomic	Days to maturity	Faizabad	2007-08	ID128510	84
39	Barley	Agronomic	Days to maturity	Faizabad	2008-09	ID252995	69
40	Barley	Agronomic	Days to maturity	Ludhiana	2005-06	ID290302	75
41	Barley	Agronomic	Days to maturity	Ludhiana	2006-07	ID290302	72
50	Barley	Agronomic	Days to maturity	Pune	2004-05	ID290302	66
51	Barley	Agronomic	Days to maturity	Pune	2005-06	ID252507	74
52	Barley	Agronomic	Days to maturity	Pune	2006-07	ID252995	69
53	Barley	Agronomic	Days to maturity	Pune	2007-08	ID290302	68
54	Barley	Agronomic	Days to maturity	Pune	2008-09	ID290302	70
70	Barley	Agronomic	Plant height Tall (cm)	Faizabad	2004-05	ID252507	75
71	Barley	Agronomic	Plant height Tall (cm)	Faizabad	2005-06	ID290302	68
72	Barley	Agronomic	Plant height Tall (cm)	Faizabad	2007-08	ID290302	75
73	Barley	Agronomic	Plant height Tall (cm)	Faizabad	2008-09	ID290302	72
74	Barley	Agronomic	Plant height Tall (cm)	Ludhiana	2004-05	ID290302	75
75	Barley	Agronomic	Plant height Tall (cm)	Ludhiana	2005-06	ID290302	75
76	Barley	Agronomic	Plant height Tall (cm)	Ludhiana	2006-07	ID128510	84
85	Barley	Agronomic	Plant height Tall (cm)	Pune	2004-05	ID252507	79
86	Barley	Agronomic	Plant height Tall (cm)	Pune	2005-06	ID290302	69
87	Barley	Agronomic	Plant height Tall (cm)	Pune	2006-07	ID290302	66
88	Barley	Agronomic	Plant height Tall (cm)	Pune	2007-08	ID252995	70
89	Barley	Agronomic	Plant height Tall (cm)	Pune	2008-09	ID290302	72
105	Barley	Agronomic	Plant height Dwarf (cm)	Faizabad	2004-05	ID290302	72
106	Barley	Agronomic	Plant height Dwarf (cm)	Faizabad	2005-06	ID252507	79
107	Barley	Agronomic	Plant height Dwarf (cm)	Faizabad	2008-09	ID290302	75
108	Barley	Agronomic	Plant height Dwarf (cm)	Ludhiana	2004-05	ID252995	62
109	Barley	Agronomic	Plant height Dwarf (cm)	Ludhiana	2005-06	ID290302	75

Table 2: Chilli dataset

Sno	Crop	Aspect	CharacterData	Location	Cultivation_ye	Accession	GrainYield/ plot
1	Chilli	Agronomic	Days to 50% flowering	Raipur	2004-05	ID251778	83
2	Chilli	Agronomic	Days to 50% flowering	Raipur	2004-05	ID327697	98
3	Chilli	Agronomic	Days to 50% flowering	Raipur	2005-06	ID268982	62
4	Chilli	Agronomic	Days to 50% flowering	Raipur	2005-06	ID327697	81
5	Chilli	Agronomic	Days to 50% flowering	Raipur	2006-07	ID327697	93
6	Chilli	Agronomic	Days to 50% flowering	Raipur	2006-07	ID251778	89
7	Chilli	Agronomic	Days to 50% flowering	Raipur	2007-08	ID327918	72
8	Chilli	Agronomic	Days to 50% flowering	Raipur	2008-09	ID251778	81
9	Chilli	Agronomic	Days to 50% flowering	Rahuri	2004-05	ID251778	90
10	Chilli	Agronomic	Days to 50% flowering	Rahuri	2004-05	ID327697	83
11	Chilli	Agronomic	Days to 50% flowering	Rahuri	2005-06	ID327697	84
12	Chilli	Agronomic	Days to 50% flowering	Rahuri	2005-06	ID327918	76
13	Chilli	Agronomic	Days to 50% flowering	Rahuri	2006-07	ID268982	55
14	Chilli	Agronomic	Days to 50% flowering	Rahuri	2006-07	ID327918	75
15	Chilli	Agronomic	Days to 50% flowering	Rahuri	2008-09	ID327697	82
16	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2004-05	ID268982	47
17	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2004-05	ID327918	61
18	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2005-06	ID327918	74
19	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2005-06	ID251778	81
20	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2006-07	ID251778	82
21	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2006-07	ID268982	55
22	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2007-08	ID327918	75
23	Chilli	Agronomic	Days to 50% flowering	Ludhiana	2008-09	ID327918	68
24	Chilli	Agronomic	Days to 50% flowering	Hisar	2004-05	ID251778	84
25	Chilli	Agronomic	Days to 50% flowering	Hisar	2004-05	ID327697	100
26	Chilli	Agronomic	Days to 50% flowering	Hisar	2005-06	ID327918	63
27	Chilli	Agronomic	Days to 50% flowering	Hisar	2005-06	ID327918	77
28	Chilli	Agronomic	Days to 50% flowering	Hisar	2006-07	ID327697	93
29	Chilli	Agronomic	Days to 50% flowering	Hisar	2006-07	ID327918	67
30	Chilli	Agronomic	Days to 50% flowering	Bangalore	2004-05	ID327918	58
31	Chilli	Agronomic	Days to 50% flowering	Bangalore	2004-05	ID268982	46
32	Chilli	Agronomic	Days to 50% flowering	Bangalore	2006-07	ID327918	59
33	Chilli	Agronomic	Days to 50% flowering	Bangalore	2006-07	ID327697	84
34	Chilli	Agronomic	Days to 50% flowering	Bangalore	2008-09	ID268982	55
35	Chilli	Agronomic	Days to 50% flowering	Kanpur	2004-05	ID251778	87
36	Chilli	Agronomic	Days to 50% flowering	Kanpur	2004-05	ID327918	67

Table 3: Tomato dataset

Sno	Crop	Aspect	Accession	CharacterData	Location	Cultivation_year	GrainYield
1	Tomato	Abiotic stresses	ID022494	Cold	VPKS, Almora	2004-05	79
2	Tomato	Abiotic stresses	ID490867	Cold	Ludhiana	2004-05	85
3	Tomato	Abiotic stresses	ID245551	Drought	Durgapura	2004-05	48
4	Tomato	Abiotic stresses	ID490867	Drought	Sehore	2004-05	84
5	Tomato	Agronomic	ID022494	Days to 50% flowering	Raipur	2004-05	61
6	Tomato	Agronomic	ID139590	Days to 50% flowering	Raipur	2004-05	58
7	Tomato	Agronomic	ID139590	Days to 50% flowering	Rahuri	2004-05	59
8	Tomato	Agronomic	ID139590	Days to 50% flowering	Rahuri	2004-05	59
9	Tomato	Agronomic	ID139590	Days to 50% flowering	Ludhiana	2004-05	60
10	Tomato	Agronomic	ID139590	Days to 50% flowering	Ludhiana	2004-05	61
11	Tomato	Agronomic	ID245551	Days to 50% flowering	Hisar	2004-05	31
12	Tomato	Agronomic	ID490867	Days to 50% flowering	Hisar	2004-05	80
13	Tomato	Agronomic	ID299061	Days to 50% flowering	Bangalore	2004-05	40
14	Tomato	Agronomic	ID490867	Days to 50% flowering	Bangalore	2004-05	91
15	Tomato	Agronomic	ID299061	Days to 50% flowering	Kanpur	2004-05	47
16	Tomato	Agronomic	ID139590	Days to 50% flowering	Kanpur	2004-05	78
17	Tomato	Agronomic	ID490867	Days to 50% flowering	Gulbarga	2004-05	89
18	Tomato	Agronomic	ID299061	Days to 50% flowering	Gulbarga	2004-05	41
19	Tomato	Agronomic	ID299061	Days to 50% flowering	Punjab	2004-05	80
20	Tomato	Agronomic	ID490867	Days to 50% flowering	Punjab	2004-05	87
21	Tomato	Agronomic	ID490867	No. of primary branches	Raipur	2004-05	86
22	Tomato	Agronomic	ID139590	No. of primary branches	Raipur	2004-05	78
23	Tomato	Agronomic	ID022494	No. of primary branches	Rahuri	2004-05	62
24	Tomato	Agronomic	ID299061	No. of primary branches	Rahuri	2004-05	87
25	Tomato	Agronomic	ID299061	No. of primary branches	Ranchi	2004-05	88
26	Tomato	Agronomic	ID139590	No. of primary branches	Ranchi	2004-05	61
27	Tomato	Agronomic	ID139590	No. of primary branches	Ludhiana	2004-05	62

All of these dataset consist of following fields: Crop, Aspect, Character Data, Location, cultivation_year and Accession. There are four aspects (agronomic, abiotic, multiple disease, and Quality) in each of the dataset Cultivation year lies between 2004-05 and 2008-09. There are Four Aspects in Datasets viz: Abiotic Stresses, Agronomic, Biotic Stresses , Quality and Multiple Diseases.

The Query web-page of this system is developed to retrieve information. In this web form, user is prompted to make choices on these attributes through dropdown boxes. Click on the submit button displays filtered data according to the choice, into datagrid. Fig. 7 Shows the query web-page.

Table 4: Maize dataset

Sno	Crop	Aspect	CharacterData	Location	Cultivation_ye	Accession	GrainYield/ plot
1	Maize	Agronomic	Days to 75% spike emergence	Faizabad	2004-05	ID279331	80
2	Maize	Agronomic	Days to 75% spike emergence	Faizabad	2005-06	ID356353	65
3	Maize	Agronomic	Days to 75% spike emergence	Faizabad	2007-08	ID356353	67
4	Maize	Agronomic	Days to 75% spike emergence	Faizabad	2008-09	ID281550	90
5	Maize	Agronomic	Days to 75% spike emergence	Ludhiana	2004-05	ID290213	58
6	Maize	Agronomic	Days to 75% spike emergence	Ludhiana	2005-06	ID290213	55
7	Maize	Agronomic	Days to 75% spike emergence	Ludhiana	2006-07	ID281550	52
8	Maize	Agronomic	Days to 75% spike emergence	Pune	2004-05	ID290213	55
9	Maize	Agronomic	Days to 75% spike emergence	Pune	2005-06	ID281550	53
10	Maize	Agronomic	Days to 75% spike emergence	Pune	2006-07	ID356353	67
11	Maize	Agronomic	Days to 75% spike emergence	Pune	2007-08	ID290213	58
12	Maize	Agronomic	Days to 75% spike emergence	Pune	2008-09	ID535348	70
13	Maize	Agronomic	Days to maturity	Faizabad	2004-05	ID290213	57
14	Maize	Agronomic	Days to maturity	Faizabad	2005-06	ID279331	81
15	Maize	Agronomic	Days to maturity	Faizabad	2007-08	ID356353	68
16	Maize	Agronomic	Days to maturity	Faizabad	2008-09	ID281550	55
17	Maize	Agronomic	Days to maturity	Ludhiana	2005-06	ID356353	68
18	Maize	Agronomic	Days to maturity	Ludhiana	2006-07	ID281550	56
19	Maize	Agronomic	Days to maturity	Pune	2004-05	ID356353	68
20	Maize	Agronomic	Days to maturity	Pune	2005-06	ID281550	57
21	Maize	Agronomic	Days to maturity	Pune	2006-07	ID290213	78
22	Maize	Agronomic	Days to maturity	Pune	2007-08	ID535348	70
23	Maize	Agronomic	Days to maturity	Pune	2008-09	ID279331	85
24	Maize	Agronomic	Plant height Tall (cm)	Faizabad	2004-05	ID535348	60
25	Maize	Agronomic	Plant height Tall (cm)	Faizabad	2005-06	ID290213	78
26	Maize	Agronomic	Plant height Tall (cm)	Faizabad	2007-08	ID281550	57
27	Maize	Agronomic	Plant height Tall (cm)	Faizabad	2008-09	ID535348	60
28	Maize	Agronomic	Plant height Tall (cm)	Ludhiana	2004-05	ID279331	87
29	Maize	Agronomic	Plant height Tall (cm)	Ludhiana	2005-06	ID535348	70
30	Maize	Agronomic	Plant height Tall (cm)	Ludhiana	2006-07	ID281550	58
31	Maize	Agronomic	Plant height Tall (cm)	Pune	2004-05	ID535348	70
32	Maize	Agronomic	Plant height Tall (cm)	Pune	2005-06	ID535348	70
33	Maize	Agronomic	Plant height Tall (cm)	Pune	2006-07	ID356353	68
34	Maize	Agronomic	Plant height Tall (cm)	Pune	2007-08	ID281550	58
35	Maize	Agronomic	Plant height Tall (cm)	Pune	2008-09	ID356353	69
36	Maize	Agronomic	Plant height Dwarf (cm)	Faizabad	2004-05	ID535348	70

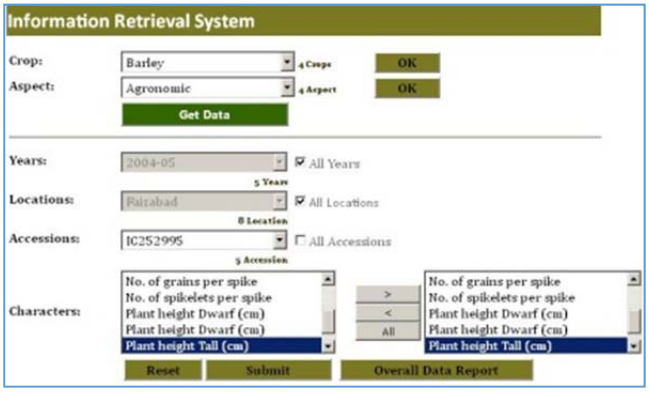


Fig. 7: Web-form of query page

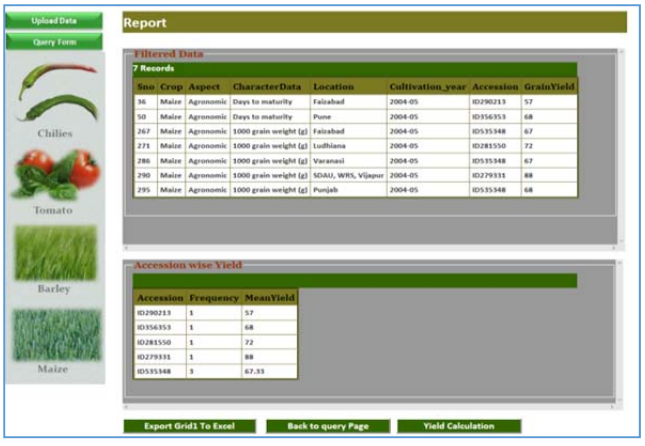
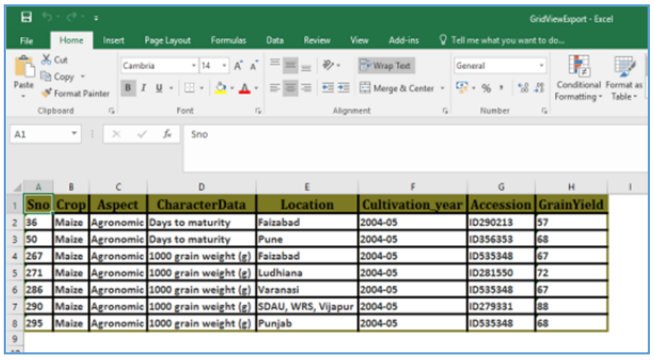


Fig. 8: Web-form displaying report of query of accession grown of Agronomic aspect of Maize crop

In the query web-page, user is prompted to select crop from dropdown box and click button. As soon as user makes his choice, the dropdown boxes of aspects is populated. Again, user is prompted to select an aspect from dropdown box and click "OK" button. It results in populating characters, locations, years and accessions dropdown boxes. Now User can make his choice on all of these options and click submit button to see in datagrid. Fig. 8 Shows filtered data according to choice made by user.

The output window has button to export the data grid in MS Excel. Fig. 9 Shows datagrid exported to MS Excel.



Sno	Crop	Aspect	CharacterData	Location	Cultivation_year	Accession	GrainYield
36	Maize	Agronomic	Days to maturity	Faizabad	2004-05	ID290213	57
50	Maize	Agronomic	Days to maturity	Pune	2004-05	ID356353	68
267	Maize	Agronomic	1000 grain weight (g)	Faizabad	2004-05	ID535348	67
271	Maize	Agronomic	1000 grain weight (g)	Ludhiana	2004-05	ID281550	72
286	Maize	Agronomic	1000 grain weight (g)	Varanasi	2004-05	ID535348	67
290	Maize	Agronomic	1000 grain weight (g)	SDAU, WRS, Vijapur	2004-05	ID279331	88
295	Maize	Agronomic	1000 grain weight (g)	Punjab	2004-05	ID535348	68

Fig. 9: Snapshot of Data Exported to MS Excel

6. LIMITATIONS AND FUTURE APPLICATIONS

The Decision Support system described in this paper will help scientists, researchers and policy planners to do need based selection of accession at a single interface. It is helpful in finding plant species which can be useful for diversification of agriculture. With the help of this system farmers also can be benefited to get information of improved varieties of plants species which can improve their yield. It offers immense opportunity for identification of trait specific germplasm suited to different agro-climatic niches. It can be used to help in analysing characters of different aspects, which can standardize package of practice information. Primary features of this support system are data filtering, retrieval, data displaying, data management, data uploading through MS Excel worksheet. The Information on all these crops will be useful to germplasm curators, breeders, researchers and students to select material for their further use in studies and crop improvement programme and promote utilization of plant genetic resources.

7. CONCLUSION

Various types of accessions are grown in many parts of the country in large areas. Yet, no authentic information is available on the area and distribution. This has become a major constraint in identifying and using these germplasms. This system helps to find out the accessions which are providing major yield in particular location. By doing query search user may know accessions providing high yield, which can be informed to farmers or crop producers companies. At present it consists data of only four types pf crops. It can also be extended for more number of crops.

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