A study on the visitor preference for different modules of the National Mango Database

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Abstract

The study was conducted on the visitor preference for different modules of National Mango Database developed by ICAR-Central Institute for Subtropical Horticulture, Lucknow, India. The purpose behind creating the database was to develop a portal for providing information on different aspects related to mango. A number of modules were developed on the portal https://mangifera.res.in. Important modules of the database are on 566 phytochemicals, 294 protein sequences, 540 primers, 30,000 nucleotides, 1690 EST, 66 field gene banks holding >4500 accessions, nurseries, processing units, exporters, species and varieties. A module on online phenology monitoring system and a web tool to compare test variety with reference variety was also developed as per DUS guidelines for suggesting reference variety after comparison with candidate's variety. Agumented knowledge in the database is attracting high number of visitors from all over the world for collecting useful information available in different modules of the portal. The present analysis deals with the popularity of different modules through collated information at the portal. Digital products as an outcome may be developed for the use by farmers, traders, scientists, students and mango lovers. On the basis of analysis made for hits it can be said that mango database becoming popular among people as a unique mango repository and people around the world are showing interest in its different modules.

Key words: Database, mango, *Mangifera indca,* modules, vistiors, phytochemicals, protein sequences, primers, nucleotides

Introduction

In India, R&D activities on mangoes are being carried out for more than a century. Apart from the documented research results, lot of information on traditional knowledge, medicinal value, regional varieties/farmers varieties/land races, patents, phytochemicals, recipes, nurseries, exporters, pack houses and other important aspect has been collated in a database hosted at https://mangifera.res.in. Information of enormous indigenous mango diversity exists in the country (Rajan *et al.*, 2009; Rajan and Hudedamani, 2019) and reportedly there are more than 1000 mango varieties found in the country (Ram and Rajan, 2003; Singh, *et al.*, 2012). The characterization data on mango varieties is essential to provide information on various traits of accessions to assure the maximum utilization of the germplasm. Due to the climatic and varietal diversity, the availability time of mangoes also differ in various states. Apart from all this, online databases compiling important aspects and their up to date information can be accessed from anywhere through internet. Databases are facilities and tools that allow researchers to utilize computers to handle large and/or complex data sets, search such data sets, analyze those sets, and assist in reaching conclusion and hypotheses (Matthews *et al.*, 2009). It is more challenging to create such a system where data are combined and processed into information to the user and where users can retrieve information corresponding to personal requirements and skills (Jensen, 2001). Usages of database information becomes important for further improvement and updation to make it more useful.

Crop based information required by different stakeholders is updated in repository or database. Such online repositories can be visited from anywhere in the world. Due to the presence of valuable and huge information in any database, visitors quickly get connected to it. As a general rule, visitors with a higher visit depth are interacting more with these websites. Useful information or interesting content/utility affects the user engagement, which is one of the distinct design elements of a website (Garett *et al.*, 2016).

Farmers are not the only beneficiary interested to fetch information on mango rather the fruit is becoming popular and important all over world for several industries like pharmaceuticals, cosmetics and food. Exporters are interested to get the information regarding export possibility and e-commerce of mango fruits. Several marketing groups are interested in mangoes, therefore, the portal *i.e.,* National mango database serves people by providing a wide range of required information by various stakeholder groups.

Number of researchers, working on mango from different parts of the world is increasing and due to information explosion, specific topics related with mango are being presented through different modules of this website. The present study was undertaken to assess the popularity of different modules of the database by estimating the number of visitors on different urls.

Materials and methods

The database was developed in MySQL (MySQL, 2007) on a Linux platform. Database interface was developed in PHP (a widely-used general-purpose scripting language, especially suited for web development), HTML and JAVA. PHP were used for searching the dataset by allowing creation of dynamic content that interacts with the database. Server enabled script was used for keyword search for varieties such as accession number, local

name, overall quality, use and period of maturity. The database structure was designed and developed in the continuation of the "Genetic Resources Information System for Mango (http://www.mangifera.org/)" for managing molecular, chemical and phenotypic characterization data on different mango cultivars.

The information on nationwide located mango field gene banks was collected and included in the database along with the characterization of regional varieties, extant and farmer's varieties as per the mango descriptor useful for DUS (Distinctiveness/Uniformity/Stability) testing. Molecular data including ESTs, genes, proteins and chemical profile from NCBI, PubChem and published sources have been included to strengthen the molecular information related component of the database. Information on mango related technologies, traditional knowledge, diseases and pests, nutrition and medicinal values, usage and packages of practices have also been incorporated in the national mango database. Besides, digitization of characterised information from national and other mango gene banks for existing genetic resources available in India, bibliographic sources and on-farm conservation sites have also been included to strengthen the database. The hits on different modules of database were calculated from AWStates in the cPanel of http://mangifera.res.in/.

Results and discussion

The mango database includes valuable information on various important aspects like crop management, knowledgebase (database of phytochemicals, accessions, proteins, EST etc.), area and productivity, mango diversity fairs, geographical distribution, species, varieties, international industries, uses, nutrients, disease and pest, IPR, phenology monitoring system, online variety comparison tool, agro advisories and mobile apps (Table 1). Information on 38 *Mangifera* sp, over 7000 patent records, 66 field gene banks holding more than 4500 accessions, details of 30000 nucleotides, 1690 EST, 566 phytochemicals, 540 primers, 294 protein sequences and more than 11500 abstracts/reprints are included that make the database a unique repository of its kind. The weekly mango agro advisory covers information like weather forecasts, management of mango diseases and pests, weed control, use of manures and fertilizers, intercropping, etc. Till now, a total of 391 agro advisories on mango have been provided through mango database both in Hindi and English languages are archived.

Initial information was collected on some of these aspects during the first phase of the database project *i.e.* "Mango Resource Information System" (Rajan *et al.*, 2013). Few other databases on horticultural fruit crops are available in various countries but a comprehensive database on mango was lacking. Some database developed previously that provides information on specific or limited areas like Fruit Crop Diseases Database (Chauhan *et al.*, 2014) and MangoDB for mango varieties and landraces (Radha *et al.*, 2018).

There are few databases available on various fruits like AppleMDO (Da *et al.*, 2019), CitGVD (Li *et al.*, 2020) and TRANSNAP (Koshimizu *et al.*, 2019). AppleMDO provides transcriptomic and epigenomic datasets for apple; CitGVD is database of citrus genomic variation and TRANSNAP is a web database providing information on Japanese pear transcriptome.

PlantRGDB (Wang, 2017) integrates 49 plant species and 38,997 retrocopies along with characterization information but lacking the information on mango.

The "National Mango Database" has been developed to retrieve the information available in the "Mango Resource Information System", as well as to include other important information on various aspects on mango and to make it easily available to the public. In the context of database development, the mango database can serve as a model for other tropical and subtropical crop databases.

Due to the immense knowledge contained in the database, people are increasingly getting attracted on its different module. Analysis of the website visitors is one of the important tools to understand the growing demand of the consumers as well as increasing interest in mangoes (Table 2). The number of visits to different links is different, which shows that people belonging to different fields are giving priority to get information related to their area (Table 2). In 2019, researchers are on the top of the list of by exceeding 7 lakhs views on Literature link (7,06,436) and interestingly people are equally interested in getting information on Intellectual Property Rights (7,03,772) on mango. During 2016 to 2019, the literature link was viewed maximum (12,00,106 times) followed by IPR link (11,60,778 times) (Fig. 1). International mango pulp trade is important for Indian processor point of view. Contribution of Indian mango pulp exporters is remarkable. Views numbering more than 28 thousand (2019) shows how traders are gathering information about the pulp export trade of India. Custodian farmers (23,858), recipe (18,494), processing units (12,091) and nursery (10,595) links have also seen remarkably by people during 2019. Website hosts data on more than 400 custodian farmers of India who are known to conserve mango varietal heritage for several decades might be the reason behind its popularity. Visitors interested in cooking can get hundreds of recipes for making different products and more than 18 thousand views in 2019 show growing interest in this direction. Processing units and mango nurseries has also become an important area for the entrepreneurs and it is clear from more than 10,000 visits on both links during 2019 (Table 2). People are still showing their eagerness to know more about mango varieties. This is evidenced by the number of view on variety page from 2016-2019 *i.e.* more than 12000 views. If visitors are only viewing a few pages per visit, it means that they are not engaged, and the effectiveness of the site is low (Booth and Jansen, 2008).

The mango database is being used by many researchers and websites such as Krishi-ICAR (https://krishi.icar.gov.in/), Kisan Samadhan (https://kisansamadhan.com/), Agriculture Biodiversity Weblog (https://agro.biodiver.se/) and The Hebrew University of Jeruslam (http://www.agri.huji.ac.il/mepests/crop/Mango/) for reference purposes.

The database is a companion for farmers, students, researchers, policymakers and extension workers and many others for getting desired information. The usefulness of such a database depends on how quickly it is being updated with important information and to sustain the importance of this database it is necessary to update it periodically by adding latest information and developing useful products especially for the farmers. One of the important potential benefits of the products from research output will be the connection of the farmers with exporters and to provide scientific

Table 1. Important modules in national mango database

Module	Characteristics of module	Details/numbers of characteristics/module	URL
Crop Management	Farmers friendly materials	Crop management and production technology of mango.	http://mangifera.res.in/farmers_friendly_materials.php
	Package of practices (POP)	POP of mango recommended for different states.	http://mangifera.res.in/pop.php
	Mango processing units	>200 processing units with products.	http://mangifera.res.in/mango_processing_unit.php
	Mango nursery	>850 nurseries	http://mangifera.res.in/nursery.php
	Mango exporters	297 mango exporters	http://mangifera.res.in/mango_exporter.php
	Mango pulp exporters	472 mango pulp exporters	http://mangifera.res.in/mango_pulp_exporter.php
	Mango packhouses	59 mango packhouse	http://mangifera.res.in/mango_pack_house.php
Knowledgebase	Accession at gene bank	>4500 accessions in 66 field gene banks	http://mangifera.res.in/station.php
	Accession base	Details as per accession name and IC list	http://mangifera.res.in/accession.php
	Literature base	>11500 abstracts	http://mangifera.res.in/literature.php
	Chemobase	Details of 566 phytochemicals of *Mangifera* species	http://mangifera.res.in/chemobase.php
	Primer	540 primers	http://mangifera.res.in/primer.php
	EST, Nucleotide, Protein	1690 EST, 30000 nucleotide and 294 protein sequences	http://mangifera.res.in/probase.php
	On-farm conservation	Database on Mango On Farm Conservation	http://mangifera.res.in/onfarm_conservation.php
	Technology	192 latest technologies	http://mangifera.res.in/technologies.php
	Innovation	89 innovations	http://mangifera.res.in/innovation.php
Area and Productivity	National status	Indian status of mango	http://mangifera.res.in/indianstatus.php
	International Status	International status of mango	http://mangifera.res.in/international.php
Custodian Farmers	Farmers maintaining, conserving and promoting mango diversity.	>400 custodian farmers of India	http://mangifera.res.in/custodian_farmer.php
Mango diversity fairs	Diversity fairs organized by different departments of different states	Details of 59 diversity fairs organised in different states	http://mangifera.res.in/mango_festival/
Geographical distribution	Geographical distribution	Regions based climatic suitability for mango	http://mangifera.res.in/geographical.php
Species	*Mangifera* sp suitability maps	38 *Mangifera* species distribution in Southeast Asia	http://mangifera.res.in/species.php
Varieties	Varieties and hybrids	Important mango varieties and hybrids	http://mangifera.res.in/varieties.php
International Industries	Mango industries of Australia and Israel	Mango industries in Australian and Israel are highly innovative and based upon research. information on mango industry of these countries have been added in the database	http://mangifera.res.in/international_mango_industry.php
Uses	Medicinal uses	Leaf, seed kernel, bark, flower, leaf, root and fruit uses	http://mangifera.res.in/medicinal_uses.php
	Fruit recipes	230 mango based recipe	http://mangifera.res.in/recipe.php
District information	District information of mango	393 districts information	http://mangifera.res.in/district_information.php
Nutrients	Nutritive value of mango	Nutritive values of mango fruit, peel, seed and pulp	http://mangifera.res.in/nutrient.php#_
Disease and pest	Disease and pest of mango	Symptoms and management of diseases and pest	http://mangifera.res.in/disease_pest.php
IPR/Patents	Patents on mango	> 7000 patent records	http://mangifera.res.in/ipr.php
Phenology monitoring system	Mango Phenology Monitoring System	The phenological stages of mango according to their extended BBCH-growth stage identification codes.	http://mangifera.res.in/phenology/
Online variety comparison tool		Online tool to compare test varieties with reference varieties (as per DUS guidelines).	
Agro advisories	Weekly mango advisory	391 mango advisories	http://mangifera.res.in/agro_advisory.php
Mobile apps		Mango orchard based poultry farming app	http://mangifera.res.in/index.php
		Mango harvesting advisory app	

Table 2. Number of view by visitors on different modules of national mango database

2016		2017		2018		2019	
Module	View	Module	View	Module	View	Module	View
Literature	3782	Literature	6840	Literature	483048	Literature	706436
Home	1744	Home	3378	IPR	455705	IPR	703772
Phenology	1122	Species	1937	Mango Pulp Exporter	54216	Mango Pulp Exporter	28228
District	848	Varieties	1582	Recipe	14010	Custodian Farmer	23858
Species	773	Botany	1549	Custodian Fa ner	12139	Recipe	18494
Index	737	IPR	1301	Home	6587	Processing Units	12091
Gene Bank	732	Gene Bank	1269	Mango Exporter	6167	Nursery	10595
Varieties	710	Index	1179	Processing Units	5889	Mango Exporter	8852
Custodian Farmer	696	Disease	999	Variety	5286	Home	8124
Disease	530	Recipe	914	Species	4643	Varieties	4445
Others	7187	Others	13185	Others	56133	Others	57926
Total	18861	Total	34133	Total	1103823	Total	1582821
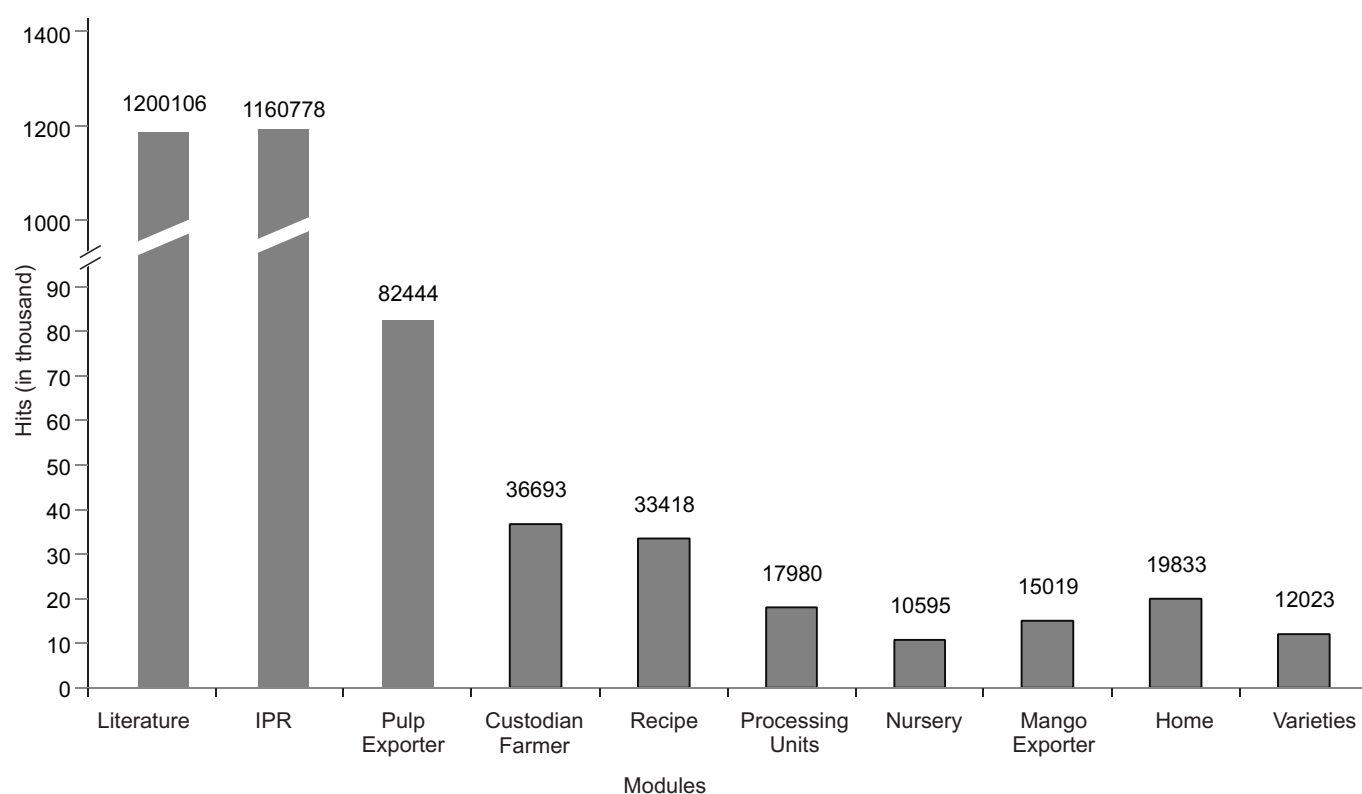
Fig. 1. Hit pattern related to different modules of the National Mango Database (http://mangifera.res.in)during 2016-2019

real-time advisory to the farmers to produce quality fruits.

Many products can be developed from the research output of present database and will be very useful for various stakeholders like "Online Mango Advisor", "Web-Based Mango Phenology Data Analysis Tool", "Custodian Farmers Network", "Mango DUS Test Assistant" and "Mobile Apps". The mango database is serving the requirements of the stakeholders and the products developed from it will be useful in many new ways.

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