



Design And Development of Bamboo Information System

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Abstract

Bamboo has immense potential in providing livelihood, ecological and food securities to the mankind. Presently, a number of international and national agencies support bamboo research and development. For the success of such programmes, information is a vital input. The availability of the right type of information at right time can trigger new directions in research, development and managerial action. But data on prior research, information on genera and species, etc., are now widely scattered in different systems, formats and languages. The coordination and integration of information sources and systems have become a priority for bamboo research and development. The present study attempts to evaluate the present status and to prepare a plan for developing an international bamboo information system which can integrate research and development in the sector. A prototype of web based bamboo information system developed and tested is also discussed.

Keywords: Bamboo Information Management System; Information Management System

Introduction

Bamboo with more than 1575 species growing in a wide variety of soil and climatic conditions in the world plays an important role in providing livelihood, and ecological and food securities to mankind. The fastest-growing capacity of bamboo makes it a valuable sink for carbon storage. It prevents soil erosion and creates an effective watershed by binding soil along fragile riverbanks, deforested areas and in places prone to landslides. Recognizing the immense potential of bamboo and its socio-economic values, a number of international agencies such as Asia Pacific Centre for Transfer of Technology (APCTT), Food and Agricultural

Organization (FAO), International Development Research Centre (IDRC), International Network for Bamboo and Rattan (INBAR), International Plant Genetic Resource Institute (IPGRI), International Tropical Timber Organization (ITTO), United Nations Development Program (UNDP), United Nations Industrial Development Organization (UNIDO) and World Bank have come forward to support bamboo research and development. In India, to promote the sector, the Prime Minister launched an Integrated Bamboo Development Programme on the World Environment day of the year 1999 ie 05 Jun 1999. Subsequently the Planning Commission, Government of India

prepared an action plan to give maximum emphasis for promotion and development of bamboo during the 10th Five-year plan period. Since then, there has been tremendous progress in India in the bamboo sector especially in the Research and Development field. Two bamboo missions established by Government of India viz., National Mission on Bamboo Applications (NMBA) under the Ministry of Science and Technology and the National Bamboo Mission (NBM) under the Ministry of Agriculture & Co-operation are to focus on the integrated development of the sector.

Information is a vital input for the success of any research and development programme. The right type of information in the right time can trigger new directions in research, development and managerial action. Presently, research data and information on different aspects of bamboo are scattered in different formats such as journal articles, reports, books, theses, conference proceedings, etc., and therefore right information in the right time in right way remains beyond the capacity of institutions and information centres. An integrated information system can address these problems and can meet the information requirements in bamboo research on environment, conservation and livelihood activities. The present study evaluates the existing scenario on bamboo information and puts forward a plan for developing an information management system which can help research and development in bamboo.

Literature Review

Kamalavijayan and Thampan (1984) produced a bibliographic information system for coconut plants. Johnson (1986) in the thesis *Design and development of National Information System for Marine Fisheries in India* proposed a basic expansion of library services into an information system. Akoijam (1995) has made a similar attempt on development of information system for agricultural

university. In the thesis on *Design and Development of Information System on Ayurveda*, George (2001) studied the information needs and design criteria, rather than a working system. These studies have attempted designing network of libraries based on the functioning of individual libraries in the same system or sub-systems.

A study on agriculture and farm information systems (Raman, 2004) evaluated the systems and services in agriculture and bio sciences with a state of India as sample and found that the sector fails to effectively bank on abundantly available information resources due to the lack of effective information management and evolved a plan for an integrated system for resource sharing and smooth flow of results of research down to the grassroots level to achieve maximum productivity. The thesis *Study of design and development of an integrated university Library and information system in India* (Cholin, 2002) with reference to recent advances in information technology discuss the design of information networks by combining existing features of libraries and by making a cross linked collection. In one of the relevant studies on developing information systems Mangala opined that in the present information age, developing and strengthening a country's knowledge base should receive high priority in the programmes of national development (Mangala, 2003). Satija, 2003 in his study asserted that despite the new technologies being increasingly adopted by libraries throughout the world, their fundamental mission to acquire and build a knowledge base, preserve documents of value, and provide value added information services in anticipation and on demand remains unchanged. He observed that digital technology could dramatically affect the nature of the information services (Satija, 2003). Mahapatra, (2012) surveyed efforts on digital catalogue creation with linked documents in agricultural universities.

The study 'Information resources and services in fisheries sector of India: An evaluation study' (Jayapradeep, 2014) observes that India has abundant fisheries information resources but fisheries institutions conducting research in India are not equipped to satisfy the information needs of the stakeholders, especially primary stakeholders consisting of farmers and fishing communities though there are widespread agricultural extension networks under Union and State governments. The study has proposed the establishment of 'Fisheries Information System of India' (FISI) which can provide the stakeholders with equal opportunity for access to fisheries information and for the sustainable development of the fisheries sector. All these studies have stressed that well-organized information system supported by equally efficient information infrastructures only can promote the information transfer more effectively and efficiently for research and development. The survey of literature for the present study revealed that there are few studies on bamboo information management systems.

Sarojam (2003) produced an annotated bibliography on bamboos of the world but a comprehensive listing of information resources on bamboo and works suggesting management of bamboo information are absent in the sector. Also there was no earlier attempt to develop Bamboo Information Management System or a prototype system which can work in all computing environments for integration of information sources on bamboo worldwide. American Bamboo Society (2016) has a web based information system which facilitates species selection based on height, girth, climate and gardening parameters. It does not cover bibliographic, products and taxonomic aspects.

Objectives of the Study

The main objectives of the study are:

- to evaluate the existing Information systems and services on Bamboo.
- to explore the possibilities of developing an integrated system for managing bamboo information.
- to design a prototype of web based Bamboo Information Management System (BIMS).

Significance of the Study

The most consulted information sources on bamboo are Commonwealth Agricultural Bureau International (CABI) abstracting services, Food and Agricultural Organization's (FAO) AGRIS database, National Agricultural Library's AGRICOLA database, Thomson Reuters Biological Abstracts available on the Web of Science platform and Current Contents modules of Agricultural, Biological and Environmental sciences. In addition to these, there are several journals that publish articles on bamboos and locally developed databases and abstracting services. Presently there is no system to manage divergent sources of information on bamboo.

Most of the sources mentioned above provide only bibliographic information. There is need to develop an information system covering all aspects of bamboo such as taxonomy, cultivation, products, utilization, diseases, researchers, artisans, etc. The prototype discussed in the study offers the capability of combined search of different databases. It also offers integrated information system from standalone PCs, local servers, Internet (web based), DVDs, USB media and external hard disks.

The Processes and Methods

India and China are the two major countries where bamboo grows wide and vast and have developed Bamboo Information Centers. The sample entries consisting of bibliographic references, generic, species information, etc were collected from online databases and published bibliographies,

books, journals, proceedings, etc., belonging to these two countries.

Databases

Content analysis was the main method used for data collection. Data was collected from different sources, the main sources consisting of international and national databases and the bibliographies compiled by different agencies such as CABI abstracting services, FAO AGRIS database, NAL's AGRICOLA database, Thomson Reuters Biological Abstracts, literature collected at the Bamboo Information Centre, India, etc was used for this purpose. Reports, Scientific Papers and theses based on the research work carried out in KFRI and collections of KFRI library consisting of books, conference proceedings, monographs and journal articles published on bamboo were also used for this study. Information on bamboo species was mainly collected from monographs and journal articles on bamboo.

Details of bamboo artisans and their products were collected from directories and exhibition sites. Experts in this field were consulted for verification of the details. By contacting them on email, data on the researchers and their projects were collected. Accordingly, a prototype database of bamboo documents, species, researchers, and artisans was created and tested at KFRI. The documentation software CDS/ISIS was used for data compilation. The database development included steps of choosing reference, duplicate checking, formulation of key words, preparing abstract and collection of full text article. The Bamboo Information System suggested consists of three components. The bibliographic database is the first one. The second component is the organization of files into a web page mechanism. The third component is the search engine, which accepts keywords, conduct search and displays results.

There are nearly 1500 species of bamboos, all over the world. American bamboo Society

maintains a database on nearly 500 species. Summary information on many topics can be derived by analyzing this database. The database is down loaded, saved in Html format taken to MS excel as a comma delimited text file. Formatting as pivot table yields information on the habit (runner, clumper), height, diameter and temperature and sun tolerance.

Bibliographic and Taxonomic Data

The prototype of Bamboo Information Management System enables search for any specific information like species of bamboo, their taxonomy, distribution, uses, properties, pest and diseases. Sample searches and their displays are depicted in the findings. The system constructed gives details of bamboos of the world, taxonomy, distribution and status, details of bamboos in India, state wise distribution, pests and diseases of bamboos. Additional fields for country and species are inserted in the bibliographic data to facilitate analysis of species and distribution.

The bibliographic database also provides additional information on growth of research literature over the years, countries of occurrence, taxonomic groups and current research topics. This is achieved by extracting relevant fields from table and performing a pivot table analysis. Table of country wise distribution of genera and genera in Indian states can be made suitable of hierarchical cluster analysis. Similarity matrix is constructed using Jaccard's association Coefficient, $(a/(a+b+c))$, where a is the occurrence of both genera in countries, b and c one genera occurring in countries compared. The resulting dendrograms illustrated grouping that is not readily apparent.

Server

The server mechanism, which can be implemented in local server for individual, institutional users and over web server for internet use, was found to be the available best choice. Information system can be

transferred to standalone DVD or other removable drive from system. In some cases, readymade packages of WAMP such as Servertogo are used in PC or removable media.

The first step done was construction of the server mechanism. The stand alone PC and removable media were used from which content was directly uploaded to the web server. Firstly the folder c:\BIMS was created. Copied files provided by Servertogo package to this folder.

Apache, the public domain web server program is the *de facto* standard. This has to be installed in a web server or local server along with the database such as MySQL and PHP compiler. The server package required customization with respect to the operating system and database. A good solution found was packaging the XAMP server into a preconfigured package like Servertogo (Sourceforge.net, 2016). One can copy this file to a folder or to DVD and supply the program and database from /htdocs subfolder. Thus information management system software can be copied to any folder in any computer. Assembling the information system consists of just copying the whole set of files to website or local server or to a DVD.

The website technology was effectively used in developing the prototype for implementing computerized information system for bamboos. Free and open server technology of APACHE-PHP was used. Local server was used for the development of the system.

Search Engine

A web search engine, a software component designed to search for information on the World Wide Web forms an important part of the proposed system. The search results are generally presented as a mix of text, web pages, images, and other types of files. For BIMS, the search engine had to be developed from scratch as readymade systems were not

available. Search engine developed here is a module into which key words and names of databases can be passed in. This flexible arrangement makes it possible to parse the key words once and pass to any number of databases serially. Search expression is designed to use truncation of keywords. While searching, search engine passes key words and name of database to call it. The records are read serially into string and search conducted inside each string (record). This way the nature of database becomes flexible. It can be comma separated value file, MySQL or other database.

Findings of the Study

Features of the Bamboo Information Management System (BIMS) developed, is illustrated in the following sections. Initially the opening screen, screen shots with search keys and output screens are illustrated. This is followed by a bibliographic analysis of the data compiled and trends in bamboo research it revealed are illustrated. Outputs of other databases such as species, researchers, products and diseases are also illustrated. The last section in this describes in detail the search engine which was specifically created for this information system

Bamboo Information Management System

The entry point of the system is index.php. This displays title and main menu. The menu can be connected to a .PHP or .htm file, which will open a database and display its contents. Search mechanism can also be built in a more complex way by accepting key words and search one or more databases and display relevant information. The present prototype of Bamboo Information System uses this method. When the file BIMS.EXE is run the splash screen would be displayed, followed by the main page (Fig 1 and 2).

In the prototype, the main files of the first page is index.php, title.php, sidebar.php, search.php. Index.php is a typical .htm file. The <head> tag defines title and keywords



Figure 1: Files in Root Folder and BIMS Splash Screen

for the page. The frameset part defines position and size of windows, and files linked to them. Title.php is called in the top most title box. Sidebar.php is called in the side box and search.php displays box for collecting key words for searching. The program first defines background color, title of information system and horizontal menus. The menu is designed as a table. Each menu item, displays a popup showing its contents. The menu is linked to a file such as general.php for the menu General. Like this other menus, Bibliography, Researchers, Artisans, Products, Species selection and Disease are covered. The link mechanism is through the tag <a href... >. Side menu is linked to the side frame.

Instructions for Searching

The menu is linked to the particular .php program and data. At first, this program

displays a box for entering search key word(s). Search.php is a lengthy program, which contains the entire search engine. The program accepts the search key word input, prepares an array of key words to be fed into the search engine.

Using HTML, it is possible to construct a simple system to show linked files. A more useful feature will be to allow the user to specify key words and the browser should be able to display records having selected key words, somewhat similar to Google. The mechanism developed for the prototype is, read contents of a record as string, and the php search program written will look for the presence of the key words in the string. In php, strstr () does this. Multiple occurrences are checked by looking for presence of all key words specified. The search program is designed in a very flexible way. A local net work would have a server, usually WAMP,



Figure 2: BIMS Main Page

and contents of folder http has to be copied to the folder http in the server. Accessing the local server would cause the web page to open up.

In the case of the stand alone package, user has to run BIMS.EXE. This program is designed to run in Windows 7 and in higher versions, compatibility should be set to Windows 7: For this, right click BIMS.EXE -> Properties -> Compatibility -> Windows 7. In the case of Internet, one has to access the page at <http://kfri.org/bis>. The user can click one of the items in vertical or horizontal menu on opening of the page. The sub menu like Taxonomy is further linked to Distribution, Species in India, etc. displaying documents in detail. On the other hand clicking Bibliography will show a box for specifying key words. The SEARCH button in the side bar is more powerful and can search entire web site and display matching records.

Analysis of Bamboo Literature

Once a database on an aspect is created, many types of analysis can be carried out. For example, database on Bibliography shall analyze and illustrate year wise coverage, author productivity, country status, etc. The prototype of BIMS was tested for analyzing the bamboo literature. The analyses based on the results are discussed in the following sections. A total of 5905 bibliographical

references on bamboo since the year 1832 were recorded from the sources selected for the study. The ten references published prior to 1900 covered mostly the bamboo status and taxonomy by well-known botanists like Gamble, Hooker, Bourdillon, Brandis and Kurz. The increase in the number of publications was very slow during the period between 1900 and 1950. During the next 50 years, between 1950 and 2000, the references on bamboo almost doubled in every 10 years. The trend in research publications on bamboo since 2000 was notable and it became stable (almost same number of publication per decade) as in the case of well established subjects like research on teak.

Publication pattern of authors over the years were also analyzed. The list of the most prolific authors and the period of publication was examined. Ninety-one authors had 10 or more publications as first, second, third or later authors. Out of this, 11 persons were from KFRI (India). Subjects covered were found to be flowering, seeds, propagation, conservation, distribution and status, taxonomy and utilization. The country wise analysis of the contributions revealed that India topped the list with 1140 publications followed by China (454), Japan (133), Taiwan (96), and so on. One reason for reporting reduced number of references from China, in spite of increased area under bamboo cover and largest number of species might

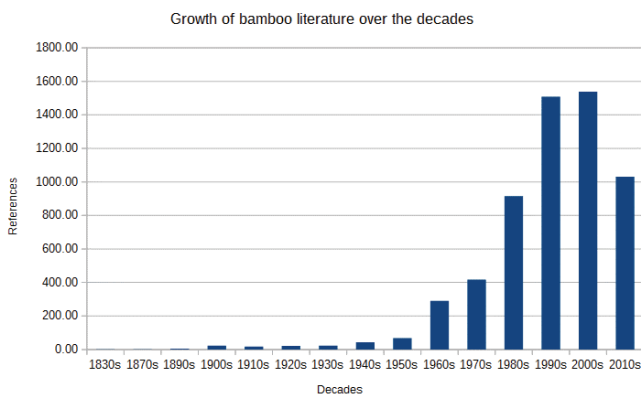


Figure 3: Growth of Bamboo Literature from 1900 to the Present

be that the references were mostly in Chinese language.

Dendrocalamus strictus was found to be the most often referred species (268 times), followed by *Phyllostachys pubescens*, the giant bamboo of China. This is followed by *Bambusa bamboos* (165) and *Bambusa vulgaris* (144) *Bambusa tulda* (71), *Dendrocalamus hamiltonii* (59), *Phyllostachys edulis* (50), *Dendrocalamus latiflorus* (49), *Bambusa balcooa* (47) in a descending order.

Spatial Analysis of Bamboo Genera

Bamboo distribution is analyzed at world, India and Kerala levels. Bamboos of the world are described on the basis of taxonomy, geographic regions and countries. India, when considered as a whole for naturally occurring bamboos, genus, *Sinarundinaria* has the maximum number of species (18/87), followed by *Schizostachyum* (17/87). *Bambusa* comes in the third position with 12/87 species, followed by *Ochlandra* (9/87), *Dendrocalamus* (7/87). There are a total of 41 introduced bamboo species in India, the top two genera being *Bambusa* and *Dendrocalamus*. State wise, there are a total of 128 species, both native and introduced species together. Genus *Dendrocalamus* is reported from 22 states, *Bambusa* from 19 states, *Schizostachyum* from 16 states, *Gigantochloa* and *Sinarundinaria* 11 each, *Melocanna* 9 and others in decreasing order.

A hierarchical cluster analysis (Sokal and Rohlf, 1994) was performed to group the States on the basis of bamboo genera present. Orissa, Bihar and Madhya Pradesh form a highly similar group (similarity 1, 0). *Bambusa*, *Dendrocalamus*, *Gigantochloa* and *Melocanna* are the four genera noticed in these states. Rajasthan, Haryana and Punjab form another tight group having only one genus, *Dendrocalamus*. Gujarat, Andhra Pradesh and Maharashtra form another tight group with similarity 0.58 to 0.75. Karnataka, Kerala, Tamil Nadu, Tripura, Orissa, Bihar, and Madhya Pradesh form a distinct cluster.

Bambusa and *Dendrocalamus* are present in all these states. *Melocanna* is present in Tripura and Karnataka. *Ochlandra* is present in Kerala, Karnataka and Tamil Nadu. *Sinarundaria* is found in Kerala and Tamil Nadu. Nine states form the last notable cluster, but with poor similarity. *Schizostachyum* is present in all eight states (Arunachal Pradesh, West Bengal, Assam, Mizoram, Meghalaya, Nagaland, Manipur, Sikkim). *Bambusa* and *Sinarundinaria* are in seven states, *Dendrocalamus* and *Melocanna* are seen in six states, *Racemobambos* in five states, *Chimonobambusa* and *Phyllostachys* in four states.

In Kerala there are 21 species of bamboo, distributed over five genera (Muktesh Kumar, 2002). There is one species under genus *Bambusa*, one under *Dendrocalamus*, ten species under *Ochlandra*, four species under *Pseudoxytenanthera*, one under *Schizostachyum* and one under *Sinarundinaria*. *Bambusa bamboos* is the common thorny bamboo, found throughout Kerala.

Searching

The prototype of Bamboo Information Management System enables search for any specific information like species of bamboo, their taxonomy, distribution, uses, properties, pest and diseases. Sample searches and their displays are depicted in Fig.4. The system constructed gives details of bamboos of the world, taxonomy, distribution and status, details of bamboos in India, state wise distribution, pests and diseases of bamboos. The search program is designed in a very flexible way once the key words are parsed and stored, it could be passed on to any number of data sets. This would enable searching one database or all datasets in the web site. When the user enters term such as 'reed', the system hit 75 records from two databases. When 'reed flower' is used as key word, the hit get narrowed to three records. The system uses 'truncation' mechanism and terms are searched accordingly.

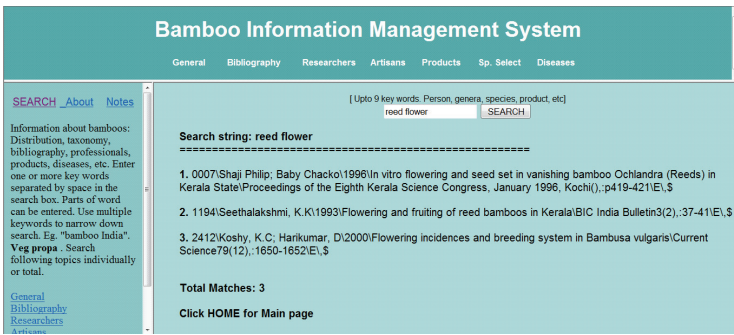


Figure 4: Sample Search and Output

The study and the development of prototype of Bamboo Information Management System revealed that a reliable and comprehensive information system can be compiled using open source technology and novel techniques like new search engines. The system developed was found versatile in the sense that it can be used for analysis and managing the literature on bamboo. It can be hosted in a folder in a hard disk of PC, in local server or internet web site. It could also be hosted in standalone DVDs, pen drives or external disks. Source code of every step is available, it is possible for anybody to review the architecture, or carry out updating of the Bamboo Information System. Updating the information system involves updating the databases.

Search Programme

Using HTML, it is possible to show linked files. A more useful feature will be to allow the user to specify key words and the browser

should be able to display records having selected key words. It is somewhat similar to Google. Code for this was not available and had to be written. The mechanism developed is open database, read contents of a record as string and the php search program written will look for the presence of the key words in the string. In most programming languages there is a function for looking up one string inside another. In php, strstr() does this. The code fragment that did this is given in Figure 5.

Code stands for open database, repeat reading records from beginning to end, store one record into string and compare words in it with stored key words. Co occurrence of key words in the string marks a hit record. The operation turned out to be extremely fast and large site could be looked up in matter of seconds. This is because function supplied by the php program is extremely fast. Multiple occurrences are checked by looking for presence of all key words specified. The code for this is given below:

```
$fp1=fopen($fn,"r") or die("Could not open database: $db");$mm1=0;$nn=0;
while (!feof($fp1)&& ($mm <= $MAXHITS))
{ $s=fgets($fp1,4096); $nn++;$su=$s;$sw=$s;$s=strtoupper($s);$m=0;
for ($i=1; $i <= $n; $i++) { if (strstr($s,$kwd[$i])) $m++; }
if ($m==$n) $mm++; //print("match found");
}
fclose($fp1);
```

Figure 5: Search Part of search.php

for (\$i=1; \$i <= \$n; \$i++) {if (strstr (\$s, \$kwd [\$i])) \$m++; }

Repeat for all words in the string (derived from record), each word matching one of the key word increments a counter. The count equaling the number of key words marks a hit record.

Conclusions

Bamboo Information Management System enables compilation of extensive bibliography for analysis and to bring out several information products on several facets such as species, geographical features, wood properties, publication pattern, experts in this field, etc. in an integrated manner enabling research, education, extension, conservation and development of bamboo.

Bamboo Information Management System (BIMS) need deep knowledge of Webscape and specialized data processing techniques. Traditional library can complement the process by channelizing professional involvement. BIMS can reveal trends, identify gaps and predict future directions in the field of research and development of Bamboo. BIMS enables to save a lot of time in sifting through many separate distributed systems. The prototype of Bamboo Information Management System can be further developed and adopted in bamboo research libraries and information centres for boom results in Bamboo field.

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