Bibliometrics is composed of two distinct words i.e. biblio and metrics from the Greek. The prefix biblio means ‘books’ and ‘metrickos’ means measurement. So Bibliometrics connotes the science of measurement pertaining to books or documents. It is a quantitative study of various aspects of literature on topics and is used to identify the patterns of publication, authorship, citations or secondary journal coverage with the objective of getting an insight into the dynamics of the growth of knowledge in the areas under consideration. Bibliometrics is relatively a subject of recent origin. It is being vigorously persuaded and with the result, it has been found that now-a-day’s many articles are published in Library and Information Science periodicals on Bibliometric and its related topics. The basic units of Bibliometric are all facets of written communications, such as primary and secondary sources, articles and abstracts, bibliographies, books, monographs and other media of communications such as web etc. It is a quantitative measurement without any qualitative evaluation.

1.1 Genesis of Bibliometrics

Historically, Bibliometrics is developed mainly in the West. It arose from statistical studies of bibliographies. Before the term bibliometrics was proposed by Pritchard (1969), the term 'statistical bibliography' was in use. According to Pritchard it was Hulme (1922) who initiated the term statistical bibliography. Hulme used the term to describe the process of illuminating the history of science and technology by counting documents.

Schmidmaier (1984) discussed the history of bibliometrics and demonstrated its relation to the concept of science which is traced to the lecture given by Carl Christian Friedrich Krause in 1829. In the former USSR it was G.M. Dobrov’s investigation of the science of science.

Investigations by Grass (1927) and Henkle (1938) on biochemical literature together with later works by Ranganathan (1969) and De Solla Price (1976) belong to the fundamental literature of bibliometrics. Ranganathan (1949) proposed the term Librametrics in 1948. In European information science journals, bibliometric investigations began to be popular in the 1970s and 1980s. Hungary, Eastern Germany and Switzerland which have early started research in Bibliometric.
1.2 Applications / Importance of Bibliometrics

The Bibliometric techniques are now being consistently used to get factual and accurate data for information handling and transfer. According to Narin & Moll \(^9\) (1977) “The most active area of modern Bibliometric is concerned with citation”. Broadues \(^10\) (1977) has applied citation analysis to collection building. Since then a number of works have been undertaken for different purposes. Brown \(^11\) (1956) has studied the list of serials most frequently cited in eight major scientific fields and suggested to increase library co-operation to satisfy the scientist’s needs. Brookes \(^12\) (1970) has used to estimate the size and composition of scientific periodicals. Lawani \(^13\) (1972) has prepared a ranked list of 681 journals according to their productivity, and this has been as guide for the acquisition of title on Tropical and subtropical agricultural libraries. Lal and Ray \(^14\) (1991) have used the Bibliometric techniques to measure the relative scientific activity of the nations of the world in the field of horticulture.

According to Surendra kumar \(^15\) (2009) ‘Bibliometrics studies have the following applications’

1. It can improve the bibliographical control because Bibliometric analysis, the size and character of literature in different fields. The volume and growth of primary literature has a direct effect on structure of secondary literature. Therefore, computed rates and direction of change may be of considerable assistance to editors of secondary services in determining their future approach and coverage.

2. The statistics relating to the country of origin, form, language distribution provide useful information in determining the scope of work, and can suggest weakness in coverage or areas of possible improvement of secondary services.

3. Bibliometric study derives the subject relationship which suggests desirable general patterns of secondary service coverage. Such studies can also help to establish the framework for a service in a particular subject area.

4. The Citation data analysis and volume of publication year wise can be used in planning retrospective bibliographies which will provide some indication of both the age of material used in a discipline and to the extent to which more recent publications supersede the older one, if at all.
5. The Bibliometric analysis in comparative assessment of the secondary services, particularly, overall figures on size of literature and to subject links. This may help the publishers in getting an idea of the achievements and competition and could be useful for marketing purposes.

6. The bibliometrics data also helps in taking some management decisions as selection of primary and secondary – journals and helps in planning future staff, building needs and in improving library services.

7. The citation data also determines the list of highly cited Journals or books, which can be used in taking decision while discarding the stock of the library.

8. Citation analysis can find out subject relationship which helps in suggesting titles of journals relevant to a given discipline in a particular library.

9. Analysis of the size and growth of literature can identify the developing and declining areas of literature over a time and trend of literature growth.

10. To identify core periodicals in different disciplines;
11. To identify trends in research and knowledge in different discipline of science;
12. To study history of science including scientific policies;
13. To identify authorship and its trends in documents on various subjects;
14. To review past, present and future of scientific publishing trends;
15. To measure usefulness of adhoc and retrospective SDI services;
16. To initiate multilevel network system;
17. To estimate comprehensiveness of secondary periodicals;
18. To regulate inflow of information and communication.

1.3 Definitions

1. Alan Pritchard (1969) defines Bibliometrics is application of mathematics and statistical methods to book and other media of communications”
2. Fairthorne (1969) defines it as “The quantitative treatment of properties of recorded discourse and behavior pertaining to it”.
3. British Standards Institutions (1976) define it as “The use of document’s patterns of publication in which mathematical and statistical methods have been applied”.
4. Hawkins (1977) in his on-line bibliometric study interpreted Bibliometrics as “Quantitative analysis of the bibliographic features of a body of literature”.
5. Nicholas and Ritchie (1978) definition is “Bibliometrics provides information about the structure of knowledge and how it is communicated” They further added
that “Bibliometric studies fall mainly into two broad categories those describing the characteristics or features of a literature (descriptive studies) and those examining the relationship formed between the components of literature (behavioral studies).”

1.4. Some other metrics Now-a-day’s many synonymous words are used for Bibliometrics. Often they are corollary or are used in different context but amounts to almost same sense of counting. They are discussed in the following paragraphs.

1.4.1. Scientometrics

Scientometrics is part of the sociology of science and has application to science policy making. It involves quantitative studies of scientific activities, including, among others, publication and so overlaps bibliometrics to some extent. Scientometrics is branch of ‘Science of science’

This term was introduced and came into prominence with the founding of the journal named ‘Scientometrics’ by T. Braunin in 1977, originally published in Hungary and currently from Amsterdam. The scope of the journal is to publish all those studies of quantitative aspects of science as a discipline or economic activity. The economic aspect of science is to implement the scientific research in daily human life and test the effectiveness of the product against the cost incurred to develop it.

1.4.2. Definition

Nalimov and Mulchenko define this term as “a sub-field which applies quantitative methods to the study of science as an information process”.

Haitun treats’ Scientometrics’ as a scientific discipline which performs reproducible quantitative regularities. According to him, Scientometrics methods include statistical and thesaurus methods and indicators as to the number of citations, terms etc. There are two aspects within science of science.

1.5. Informatics

The most recent metric term ‘informatics’ comes from the German term ‘informatics’ and was first proposed in 1979 to cover that part of information science dealing with the measurement of information phenomena and application of mathematical methods to the discipline’s problem, to bibliometrics and parts of information retrieval theory. It covers the empirical studies of literature and documents as well as theoretical studies of the, mathematical properties of the laws and distributions that have been discovered.
1.5.1. Definition

Tague-Sucicffic defines the term as the study of the quantitative aspects of information in any form, not just record or bibliographies and in any social group, not just scientists. It can incorporate, utilize and extend the many studies of the measurements of information that lie outside the boundaries of both ‘Bibliometrics’ and she continues to say that, although in practice the scope of informatics is very broad to phenomenon that have not, in the past been seen as part of ‘Bibliometrics’ and ‘Scientometrics’. But fit within the scope of ‘informatics are:

- Definition and measurement of information, and
- Types & characteristics of retrieval performance measures.

1.6. Librametrics

The term ‘Librametrics’ was proposed by Dr. S. R. Ranganathan in 1948 as the application of mathematical and statistical techniques to library problems. The Librametry primarily aims at the quantitative analysis of the management of libraries and bibliometrics is limited to recorded knowledge.

1.6.1. Definition

There may be value in retaining the terms ‘librametrics’ or ‘librarmetry’ for such studies not specially analyzing literature, or at least not specifically directed to the goals of bibliometrics and of information retrieval. These include analyses of book circulation, library collection overlap, library acquisitions, fines, and of shelf allocation, and frequently using optimization techniques from operations research by Willson.

1.7. Need of the Study / Statement of the problem

The assessment of research performances by using Bibliometric techniques with the growth of literature has become a major concern for the scientists, scholars and library professionals as they have to keep themselves abreast with the new advances in their subject. Publication profile is an indicator of the scientific activity of a country.

It was seen from the available literature that very few studies were made in agricultural sciences. Many important observations can be derived by studying scientific publications through their bibliographic features such as the channel of communication, journal titles used for publication, authorship pattern and collaboration.

Thus the present Bibliometric study is a focal point of my research topic and
it is an important area of research in the field of library and information science. Many studies have already been conducted in Bibliometric but Bibliometric studies on Rice Research Institutes of Indian Council of Agricultural Research are not traced as researchers researched through the databases viz. CABI and LISA. The research period was done during January’2013 to December’2015.

1.7. (A): Statement of the Research Title

Bibliometric analysis of Rice Research Institutes of Indian Council of Agricultural Research.

1.7. A (1): Explanation of the concept

1.7.A (2) “Bibliometric” Bibliometric is composed of two distinct words i.e. biblio and metrics from the Greek. The prefix biblio means ‘books’ and ‘metrickos’ means measurement.

1.7. A (3) “Analysis” A systematic examination and evaluation of data or information.

1.7.A (4) “Rice” Rice is the food crop

1.7.A (5) “Research” Careful study and investigation for the purpose of discovering and explaining new knowledge.

1.7 A (6) “Institute” An Organization having a particular purpose.

1.7 A (7) “Indian council of Agricultural Research” Indian Council of Agricultural Research (ICAR) is premier body in the field of agricultural research, education and extension. It was an autonomous organization under the Ministry of Agriculture, Govt. of India, and New Delhi.

1.8. Purpose of the Study

The purpose of the study is to shed light on the contributions of Rice Research Workers / scientists made in various communication channels over the period of their service in the ICAR-National Rice Research Institute, Cuttack and ICAR- Indian Institute of Rice Research, Hyderabad on Rice literature / publications in various communication channels like, Journals, Conferences / Seminars, Newsletters, In-house publications, Popular articles, Book chapters etc.

1.9. Objectives of the study

The present research work on “Bibliometric Analysis of Rice Research Institutes of Indian Council of Agricultural Research” has been carried out with the following objectives:

1. To analyze the research publications produced in various channels in the field
of Rice and related areas by the scientific and research community of the NRRI and IIRR.

2. To find out the growth trends in research publications in rice research institutes of ICAR

3. To find out the thrust areas of the rice research institutes of ICAR during 1949 – 2014.

4. To find out the preferred communication channels of the scientists of NRRI and IIRR

5. To find out the productivity scores of individual authors of NRRI and IIRR

6. To apply Bradford’s Law, Lotka’s Law & Dominance Factor, etc for author and publications productivity of NRRI and IIRR

1.10. Hypotheses

The hypotheses of the research have been formulated on the basis of the study of related literature and the objectives framed above:

1. Journals are the most preferred channels of communication of the scientists of NRRI and IIRR.

2. Collaborative research is increasing in Rice research institute of NRRI and IIRR

3. Most research contributions by the scientists of NRRI and IIRR are in English language.

4. Majority of the Rice Research output is published in Indian Journals.

5. Only a small section of authors are contributing to large number of the articles in journals.

6. The applicability of Bradford’s Law & Lotka’s Law do not conform with Rice research literature produced by NRRI and IIRR scientists.

7. The Growth rate is reduced and the relative growth rate of scientific publications progressive by increased and the doubling time of publications has increased in the institutes. There is an increasing trend in the rice research output in NRRI and IIRR.

1.11. Methodology

The following methodology has been adopted to carry out the study:

- Analytical and Survey methods are used to conduct the study
• Total output of literature produced by the Rice Research institutes of ICAR in different channels during the period 1949-2004 is collected and analysed for the present study.

• The data has been collected from Annual reports, Newsletters, and websites of rice research institutes of ICAR namely, National Rice Research Institute and Indian Institute Rice Research under study and also from the CABI abstracts. The annual report of the institutes included research contributions of the scientists of the institutes. The annual reports are considered as the major source for collecting the data.

• The data is fed into the computer using Ms-Excel worksheet and presented in the tabular as well as chart (bar / Pie / Linear) form. Bibliometric laws have been tested with the collected data.

1.12. Scope of the Study
The study is confined to the two rice research institutes of ICAR Viz. National Rice Research Institute, Cuttack and Indian Institute of Rice Research, Hyderabad. The research contribution by the universities and other research institutions are not included in the research due to time and geographical limitations. The study coverage is from the inception of the two institutes and upto 2014. The scope of the study is to find out publication activity of the two rice research institutes of ICAR only.

1.13. Analysis of Data
In the analysis section data collected has been analysed and presented various tables. The summary is as follows:

Table: 1.1. Distribution of Publications

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the Institute</th>
<th>Year of Establishment</th>
<th>Total Publications</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NRRI, Cuttack</td>
<td>1949-2014</td>
<td>5362</td>
<td>64.50</td>
</tr>
<tr>
<td>2.</td>
<td>IIRR, Hyderabad</td>
<td>1965-2014</td>
<td>2951</td>
<td>35.50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>8313</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table: 1.2 Subject Wise Analysis of Publications

<table>
<thead>
<tr>
<th>S.no</th>
<th>Subjects</th>
<th>NRRI</th>
<th>IIRR</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agricultural Chemistry</td>
<td>19</td>
<td>5</td>
<td>24</td>
<td>0.29</td>
</tr>
<tr>
<td>2</td>
<td>Agricultural Economics</td>
<td>62</td>
<td>37</td>
<td>99</td>
<td>1.19</td>
</tr>
<tr>
<td>3</td>
<td>Agricultural Engineering</td>
<td>158</td>
<td>23</td>
<td>181</td>
<td>2.18</td>
</tr>
<tr>
<td>4</td>
<td>Agricultural Extension</td>
<td>165</td>
<td>115</td>
<td>280</td>
<td>3.37</td>
</tr>
<tr>
<td>5</td>
<td>Agricultural Microbiology</td>
<td>44</td>
<td>13</td>
<td>57</td>
<td>0.69</td>
</tr>
<tr>
<td>6</td>
<td>Agronomy</td>
<td>789</td>
<td>336</td>
<td>1125</td>
<td>13.5</td>
</tr>
<tr>
<td>7</td>
<td>Computer Science</td>
<td>29</td>
<td>42</td>
<td>71</td>
<td>0.87</td>
</tr>
<tr>
<td>8</td>
<td>Crop Physiology</td>
<td>539</td>
<td>198</td>
<td>737</td>
<td>8.87</td>
</tr>
<tr>
<td>9</td>
<td>Entomology</td>
<td>566</td>
<td>499</td>
<td>1065</td>
<td>12.8</td>
</tr>
<tr>
<td>10</td>
<td>General</td>
<td>671</td>
<td>171</td>
<td>842</td>
<td>10.1</td>
</tr>
<tr>
<td>11</td>
<td>Nematology</td>
<td>135</td>
<td>80</td>
<td>214</td>
<td>2.57</td>
</tr>
<tr>
<td>12</td>
<td>Biotechnology</td>
<td>54</td>
<td>240</td>
<td>294</td>
<td>3.54</td>
</tr>
<tr>
<td>13</td>
<td>Genetics and Plant Breeding</td>
<td>691</td>
<td>719</td>
<td>1410</td>
<td>16.9</td>
</tr>
<tr>
<td>14</td>
<td>Plant Pathology</td>
<td>647</td>
<td>300</td>
<td>947</td>
<td>11.3</td>
</tr>
<tr>
<td>15</td>
<td>Post Harvest Technology</td>
<td>74</td>
<td>6</td>
<td>80</td>
<td>0.96</td>
</tr>
<tr>
<td>16</td>
<td>Seed Technology</td>
<td>16</td>
<td>16</td>
<td>32</td>
<td>0.38</td>
</tr>
<tr>
<td>17</td>
<td>Soil Science</td>
<td>183</td>
<td>15</td>
<td>198</td>
<td>2.38</td>
</tr>
<tr>
<td>18</td>
<td>Soil Science and Microbiology</td>
<td>502</td>
<td>15</td>
<td>517</td>
<td>6.22</td>
</tr>
<tr>
<td>19</td>
<td>Soil Science and Soil Chemistry</td>
<td>18</td>
<td>121</td>
<td>139</td>
<td>1.67</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>5362</td>
<td>2951</td>
<td>8313</td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

#### 1.14. Author’s ranking of contributions

An attempt has been made to rank the authors by number of contributions and also to indicate scores obtained by equal weightage method. The rank order according to total number of papers contributed and the scores have been prepared for prolific authors with one or more publications. For a single authorship article, 1.0 point has been allotted. Similarly, for two authorship and more authorship articles has been allotted 0.5 for both these authors irrespective of who is the first author. No consideration has been given for type of publication or factor like impact factor of the journal.
1.14.1. Ranking of Journals

In every subject there are some journals which are frequently referred by the researchers because of the close relation between the subjects of the journals and the areas of research of scholar or researchers. Periodicals are serving as the best tool for scientific information in today’s fast growing knowledge. Being the carrier of original research work, journals articles serve as a basis for counting the publication output, in terms of scientific productivity of a nation in a given field, journal articles are now-a-days being used for qualitative performance evaluation of scientists and nations. Total 3878 research articles were published in 695 journals. For understanding the scattering of Literature in journals, the Bradford’s “Law of Scattering” is applied.

1.15. Statistical Applications

The following statistical applications have been used in this study for analysis purpose

- Relative Growth Rate
- Doubling Time for the publications
- Degree of Collaboration
- Collaborative Index
- Dominance Factor
- Lotka’s Law
- Bradford’s Law

1.15.1. Relative Growth Rate (RGR)

Relative Growth Rate is a measure to study the increase in number of articles / pages per unit of articles / pages per unit of time. It is derived originally from the study of the rate and of interest in the financial investment (Blackman, 1919)\textsuperscript{25} and from the study of growth analysis of individual plants effectively applied in the field of Botany (Hunt, 1978)\textsuperscript{26} mean RGR of articles over a specific period of interval as calculated mathematically as

\[ R = \frac{W_2 - W_1}{T_2 - T_1} \]

Where:

- \( R = \) mean relative growth rate over the specific period of intervals;
- \( W_1 = \) Log W1 (natural log of initial number of publication);
- \( W_2 = \) Log W2 (natural log of final number of publication);
- \( T_2 - T_1 = \) the unit difference between time the initial and final time
1.15.2. Doubling Time (DT)

Doubling time is directly related to RGR. It is the time required for articles to become double of the existing amount. Further, if the number of articles in a subject doubles during a given period, then the difference between the number at the beginning and at the end of this period must be the logarithm of the number 2. If the natural logarithm is used, this difference has a value of 0.693.

Thus the corresponding DT is calculated mathematically as:

\[ \text{Doubling time DT} = \frac{0.693}{R} \]

1.15.3. Degree of Collaboration

Collaboration coefficient is the ratio of the number of collaborative research papers during certain period of time. The formula given by Subramanyam (1983)\(^{27}\) is used to determine the degree of collaboration in quantitative terms. According to him, the visibility and productivity of scientist are affected by the collaboration. He defined six types of colleagues such as teachers – pupil collaboration, collaboration among the colloquies supervisor and assistant collaboration, researcher and consultant collaboration, collaboration between organization and international collaboration.

This states that:

\[ C = \frac{NM}{NM+NS} \]

Where

- \( C \) = Degree of Collaboration
- \( NM \) = Number of multi authored papers
- \( NS \) = Number of single authored papers

1.15.4. Collaborative Index

Collaborative index (CI) is the mean number of authors per joint authored publications. The mathematical representation of CI is as follows:

\[ CI = \frac{\text{Number of authors of total joint publications}}{\text{Total joint publications}} \]

1.15.5. Dominance Factor

Dominance Factor formula has been developed by Sudhir Kumar (2008)\(^{28}\). D.F. is proportion of number of multi authored papers of an author as first author (Nmf) to total number of multi authored papers of the author (Nmt). Single authored papers have been omitted due it constant value “one” of single authored papers. Mathematically it is represented as:
\[ DF = \frac{Nmf}{Nmt} \]

High DF value shows more dominance of author as first author while low DF value shows low dominance of author as first author.

1.15.6. Lotka’s Law

Lotka’s law (1926)\(^\text{29}\) is one of the three major laws of bibliometrics that mainly explain the literature distribution of various authors’ productivity in a given field. It finds that most articles are being contributed by a few researchers, with a large proportion of researchers contributing just one publication. Therefore, Lotka’s summarizes the logarithmic relation between researchers and publication quantities. It is also called “The Frequency Distribution of Scientific productivity”. It is a key law in the field of bibliometrics which describes and predicts the productivity of publishing by scientific researchers. Lotka’s Law describes the frequency of publication by authors in a given field and states that the number of authors making \( n \) contributions is about \( 1 / n^2 \) of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent. This means that out of all the authors in a given field, 60 percent will have just one publication and 15 percent will have two publications (\( 1 / 2^2 \) times .60) 7 percent of authors will have three publications (\( 1 / 3^2 \) times .60) and so on.

The general formula is \( XY = C \),

Where \( X \) is the number of publication, \( Y \) is the relative frequency of authors with \( X \) publications, and \( n \) and \( C \) is constants, depending on the specific field. In brief, the author who publishes two articles accounts, on average, for \( 1/4 \) of the total number of publications. The authors who publish three articles account for about \( 1/9 \) of the total number of publications and so on. Therefore, authors who publish one article account for 60 % of all the publications. This is to say, authors who publish ‘\( N \)’ publications will be \( 1 / n^2 \) of the proportion of total publications. This formula is also called the Inverse Square Law.

1.15.7. Bradford’s Law

Bradford (S C) (1934)\(^\text{30}\) first formulated his law in 1934 while searching for article in two journals ‘Applied Geophysics and Lubrication’. He noticed that the scatter of scientific journal papers follow a common pattern. He described productivity of papers relevant to a subject field, and then they may be divided into 3 zones so that each zone produces \( 1 / 3 \) of the total relevant papers. In other words, Bradford’s law
of scattering says that “If the scientific periodicals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nuclear of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as nucleus when the number of periodicals in the nucleus and succeeding zone will be as $1: n: n^2$ in zone”. The first nucleus zone contains a small number of highly productive journals say $n_1$, the second zone contains a large number of moderately productive journals, say $n_2$, and the third zone containing a still large number of journals of low productivity say $n_3$. He enunciated his law as $= 1: n: n^2$

1.16 . Organization of the Thesis
The thesis is divided into five chapters:
Chapter One deals with the introduction, the origin, meaning, types and utility of Bibliometrics, the need of the study, objectives hypotheses, methodology, data collection scope of the study and analysis of data.
Chapter Two presents the review of literature pertaining to the topic of the research.
Chapter Three provides Profiles of Rice Research Institutes under the Indian Council of Agricultural Research and also establishment of Rice Research institutes namely, National Rice Research Institute (NRRI) Cuttack, Indian Institute of Rice Research (IIRR), Hyderabad. It also deals with the established organization, activities, achievements, linkages and thrust areas of research of two rice research institutes in India.
Chapter Four discusses the analysis and interpretation of the data collected from two rice research institutes namely ICAR –NRRI and ICAR –IIRR.
Chapter Five - the findings of the study, conclusion and suggestions for further research are given in this chapter
References

31. CRRI Annual Reports from 1949 to 2014.

32. DRR Annual Reports from 1966 to 2014.

33. CABI abstracts on Agriculture -CD 1949-2014.