Findings Conclusion and Suggestions

5.1. Introduction
The present study “Bibliometric Analysis of Rice Research Institutes of Indian Council of Agricultural Research” has been undertaken to find out the characteristics of Indian rice literature productivity of the two rice research institutes of ICAR. The data collected from the two rice research institutes is analysed to get an overall view of productivity of the Research institutes of ICAR in India.

5.2. Major findings of the study
Based on the analysis undertaken, the present study reveals the following findings:

5.3. Year wise distribution of contributions and communication channels of NRRI and IIRR
1. It is observed that the highest number of Journal articles i.e., 281 have been contributed by the NRRI scientists in the year 2014.
2. The highest number of Journal articles i.e., 259 was contributed in the year 2014 by the IIRR scientists.
3. On an average 80 Journals articles per year wise contributed by NRRI scientists whereas, 60 papers per year wise contributed by IIRR Scientists.
4. The NRRI and IIRR scientists have used various channels of communication for their contributions. The study shows that contribution in Journals and conferences are the most preferred communication channels used by the scientists.

5.2.2. Relative Growth Rate and Doubling Time of Various publications
- The relative growth rate and doubling time of the two rice research institutes of ICAR has been calculated for various publications during the period 1949-2014.
- The whole study period records the mean relative growth rate of NRRI which is 0.22 and Doubling time for publications at the aggregate level has been computed as 3.15 during the study period. Whereas mean relative growth rate of IIRR is 0.06 and the doubling time for publication at the aggregate level is 1.16.

5.2.3 Growth and Development of Rice Literature in NRRI and IIRR
- Publications productivity of rice research institutes of ICAR gradually increasing year by year
- In NRRI, the highest number of papers published is in Agronomy (789) which constitute to 14.71 % of the total output, followed by Plant Breeding (691) and Plant Pathology (647) and followed by other subject.
• In IIRR, the highest number of papers published are in *Plant Breeding* (719) which constitute to 27.32% of the total output, followed by Entomology (499) and *Agronomy* (336) and followed by other subject.

5.3 **Language wise distribution of contributions**

Most of the scientists preferred English language for sharing or communicating their knowledge or research output. The NRRI and IIRR scientists contributed 97.34% articles in English. Therefore, English occupies the predominant medium for publishing the research articles.

5.4 **Authorship Pattern and Degree of Collaboration**

It is found that authorship pattern of contributions, majority of the articles are contributed by multiple authors. Especially ‘two authors’ contributions are the highest among the collaborative productivity of NRRI scientists. Whereas, in IIRR, ‘three authors’ contributions is the highest among the collaboration productivity. It indicates that single authored work is less than that of the multiple authored contributions. The research output of NRRI scientists for ‘single author’ contribution is 1557. The result of degree of collaboration C=0.70 i.e. 70 percent of collaboration author’s articles were published during the study period. It is found from the study that multi-authors (IIRR scientists) contribution is 88% and rest of 12% contributions by single author papers.

5.5. **ProlificAuthors in NRRI**

The following are the most prolific authors in NRRI out of 1770 authors:

• S.K.Mohanty produced 286 papers, followed by T.K.Adhya 210 papers ; K.S. Murthy 170 papers ; P.K.Singh 166 papers and S.Y. Padmanabhan 146 papers.

5.5.1. **ProlificAuthors in IIRR**

The following are the most prolific authors in IIRR out of 1718 authors:

• B.C. Viraktamath contributed 410 papers followed by N.Shoha Rani 307 papers ; R.M.Sundaram 269 papers ; L.V. Subba Rao 248 papers and I.C.Pasalu 235 papers.

5.5.2. **First Author and Dominance Factor**
The highest Dominance Factor value more than 1.00 of NRRI and IIRR scientists is presented in the table 4.8 (A) and (B). The below mentioned NRRI and IIRR scientists have the highest Dominance factor value:

<table>
<thead>
<tr>
<th>NRRI</th>
<th>Dominance factor</th>
<th>NRRI</th>
<th>Dominance factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.sasmal</td>
<td>1.25</td>
<td>B.Venkateswarlu</td>
<td>1.19</td>
</tr>
<tr>
<td>D.P. Sinha</td>
<td>1.00</td>
<td>M.S.V.Sastry</td>
<td>1.18</td>
</tr>
<tr>
<td>A.R.Sharma</td>
<td>1.10</td>
<td>S.P.Rao</td>
<td>1.00</td>
</tr>
<tr>
<td>S.Govinda Swamy</td>
<td>1.00</td>
<td>V.T.John</td>
<td>1.22</td>
</tr>
<tr>
<td>B.N.Singh</td>
<td>1.25</td>
<td>P.Isreal</td>
<td>1.52</td>
</tr>
<tr>
<td>S.B.Pradhan</td>
<td>1.00</td>
<td>P.Nayak</td>
<td>1.29</td>
</tr>
<tr>
<td>S.Sampth</td>
<td>1.16</td>
<td></td>
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</tbody>
</table>

5.6 Lotka’s Law and Bradford’s Laws

Out of the total 3488 authors subjected to these analyses in the subject of Rice computing, single authored contribution is 22.85 %. It means that collaborative authors are very high. It is observed that “Lotka’s inverse Square law” was not applicable in any extent.

According to Bradford’s formula the relationship between the zone is 1: n: n² contrastingly the relationship in each of the present study is 7:40:250 which does not fit into Bradford’s distribution.

5.7 Discussions

The Bibliometric investigation is helpful in understanding research and publications pattern among the Rice Scientists. The single author papers are more in the beginning of the establishment of the institutes. As soon as, the institutes grow, there are more collaborative papers. It has been observed from this study that there are few very productive scientists who are less productive regularly in contributing to knowledge. On the other hand majority of scientists are less productive. In research institutes, the scientists are engaged in research continuously and publish papers in various communication channels. Scientists also contribute their research work in newspapers and popular magazines in local and regional languages. It is also observed that highly productive authors are very collaborative. The study found that the scientists collaborate with fellow scientists to increase their publication productivity. This might result in not only for more research but also for their personal career advancement. The globalization has brought scientists together and hence they can collaborate not only in their institutes but also nationally and internationally. The
government must provide more funds for research to enhance the research and publications productivity.

5.8 Testing of Formulated Hypotheses

**Hypotheses-1: Journals are the most preferred form of communication channel for publications by the scientists**

Journals are regarded as the faster means of scientific communication and important channel of research findings. The present study shows that the highest 46.64 % papers have been contributed in various Indian and International Journals as compared to 38.17 % in conferences / seminars and 3.05 % in popular media. The observed findings prove the hypothesis No.1

**Hypotheses-2: Collaborative research is increasing in rice research**

It is found from the study that multiple authors’ (NRRI Scientists) contribution is 70.96 % and the remaining 29.04 % contribution is by single authors. It is also found that multiple authors’ (IIRR Scientists) contribution is 0.88 % and remaining 0.12 % contribution by single authors. So this hypothesis no.2 is proved.

**Hypotheses-3: Most of the contributions are in English language by the scientists.**

The study reveals that 97.34 % papers are published in English language. Only 2.65 % papers are in Hindi and other languages. So this hypothesis No.3 is proved.

**Hypotheses-4: Majority of the Rice Research output is published in the Indian Journals**

The study reveals that in total there are 695 journals where 3878 articles have been published. Whereas, 2657 articles are published in Indian Journals, and 1221 articles are published in foreign Journals. So the hypothesis no.4 is proved.

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

Prominent authors play important role in creation and dissemination of knowledge. Importance of prominent authors has been identified by ranking method. From this study it is found that 3488 authors have contributed 8313 articles. Out of which 3287 authors (94.23 %) have contributed less than 24 articles. Whereas, 201 authors have contributed more than 25 papers. So the hypothesis is proved.

**Hypothesis-6: The applicability of Bradford’s Law & Lotka’s Law do not confirm with Rice research literature produced by NRRI and IIRR scientists**
Out of the total 3488 authors subjected to these analyses in the subject of Rice computing, Single authored contribution is 22.85 %. It means that collaborative authors is very high. The scientific productivity of authors in Rice Research confirms to Lotka’s (N-value) inverse square law of scientific productivity and hence, hypothesis no. 6 is proved. According to Bradford’s formula the relationship between the zone is $1:n:n^2$. Contrarily, the relationship in each of the present study is $7:40:250$ which does not fit into Bradford’s distribution.

**Hypothesis-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.

Table 4.2.1 (A) & (B) present the growth rate and doubling time of various publications used by scientists of NRRI. This analysis aims to identify the trend and growth prospects in the present research.

In NRRI, for journals, the growth rate decreases from the rate of 1.31 in 1965-74 to 0.22 in 2005-14. The mean relative growth for all blocks showed a growth rate of 0.67. The correspondingly doubling time for all blocks gradually increased from 0.53 in 1st block (1965-74) to 3.15 in last block (2005-14). The mean Doubling time for different blocks percentage is 1.82.

In IIRR, for journals the growth rate $\{R(P)\}$ of journals decrease from the rate of 2.28 in first block (1975-84) to 0.6 in last block 2005-2014. The mean relative growth of all blocks showed a growth rate of 0.965. The corresponding doubling time for all blocks doubling time gradually increased from 0.30 in first block to 1.16 in last block. The mean doubling time for all blocks was only 1.12.

It concludes that growth rate and doubling time of various publications has been on increasing trend in journals, conferences / seminar, popular articles, in-house publications during study period and hence, the hypothesis No.8 is proved.

5.9 Conclusion

The main objective of the study is to shed light on the contributions of scientists in various communication channels over the period of their service in NRRI and IIRR institutes.
This study provides the quantitative analysis of the progress of publications output reported in mainstream national and international journals. The application of Bibliometric study techniques to study the Rice literature and its characterization is found to be very useful in understanding the communication in the field of study. So far as the information professionals and librarians are concerned, the literature growth study, journals ranking, institutional productivity will help to design and develop the information resources in the areas of specialization of the institutes.

1.10 Areas for Further Research

Further studies can be made on the following aspects:

1. Scoring or ranking of contributors on the basis of the impact factor of journals where their articles are published
2. Dominance factor studies by taking into consideration of official positions of the first contributor.
3. Inter-institute collaboration pattern in India: A Bibliometric study.

5.11 Suggestions

1. Collaboration in research activity should be encouraged which can produce more research output in less time.
2. Scientists are advised to use Hindi and other regional languages for their publications to spread their knowledge to the farmers who are the major stakeholders of agriculture in India. This may help in spreading newer technology and instruments among the farmers for helping in their work field and gaining more and more crop production.
3. Publication of articles in popular media like newspapers, magazines should also be encouraged.
4. International collaborative studies should be made and encouraged in a global world
5. There should be an encouragement policy for the Indian scientists to publish their research findings in Open Access Journals.