DECLARATION

I, Lalrinkimi, hereby declare that the subject matter of this dissertation entitled, **"Bibliometric Study of Research Publications of Faculties in School of Life Sciences, Mizoram University"** is the record of the work done by me, the content of this dissertation did not form the basis of the award of any previous degree to me, or to do the best of my knowledge to anybody else, and that the dissertation has not been submitted by me for any research degree in any other University/ Institutes.
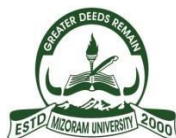
This is being submitted to the Mizoram University for the degree of Master of Philosophy in the Department of Library and Information Science.

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CERTIFICATE

This is to certify that the dissertation entitled **"BIBLIOMETRIC STUDY OF RESEARCH PUBLICATIONS OF FACULTIES IN SCHOOL OF LIFE SCIENCES, MIZORAM UNIVERSITY"** submitted by Lalrinkimi for the award of the degree of Master of Philosophy in Library and Information Science is carried out under my guidance and incorporates the student's bonafide research. This is the candidate's original work and is worthy of examination.

Date: **(Dr. Manoj Kumar Verma)**
                                                                     Supervisor

Place: Aizawl, Mizoram

Acknowledgement

First of all I would like to thank God for giving me with health and strength to accomplish my dissertation work.

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Finally, I would like to convey my gratitude to my family for their endless support and encouragement throughout my studies.

Date: **(LALRINKIMI)**

Place: Aizawl, Mizoram

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1.1 INTRODUCTION

Research plays a crucial role in developing the prosperity of a nation and well-being of its citizens. A university has a great contribution to the growth and development of society and nation through education and research. Progress in field is directly linked with research in that field. Research is endless quest for Knowledge or Unending Search for truth. Research is an Academic Activity and as such the term should be used in a Technical Sense. The Association of African Universities (2000) states that 'without research, universities will lose their capacity to offer first class graduate studies, and to motivate and retain best brains and consequently lose the capacity to train the new generation of research fellows and scientists'.

Universities across the world are considered as producers, entrepreneurial engines and generator of new knowledge through research and the role of academic is not limited to teaching. Research publications enable academics to earn recognition and advancement of individual faculty members largely depend upon the quantity and quality of their research productions. It is an important measurement of the extent of their contributions to developing new knowledge.

The research productivity of academics is communicated in the form of journal articles, books, technical reports and other types of publications. It is often used as an index of departmental and institutional prestige and is strongly associated with individual, organizational and environmental factors. The major outputs of scientific research are the most commonly used vehicles through which new scientific discoveries are known to the rest of the world. The reputation and credibility of an university is based on the quality and quantity of new knowledge produced by it. The academic role in social development is transmitting the accumulated knowledge to next generation and creating knowledge through research activity.

1.2. BIBLIOMETRICS

Bibliometrics is one of the quantitative techniques used by library and information professionals to evaluate written communication. Bibliometric analyses quantitatively the recorded knowledge in the form of books, periodicals, doctoral dissertations etc to know its properties and behavior. It is used to identify the pattern of publication, authorship, citations used for a subject etc, over a period of time.

Alan Pritchard first coined the term 'bibliometrics' in 1969, application of this method dates back to 1917, when Cole and Eales conducted, as bibliometric study. 'Statistical bibliography' was the term used for bibliometric studies in early days. Pritchard defined bibliometrics as 'the application of mathematical and statistical methods to books and other media of communication'. According to Fairthorne "Biblimometric is a quantitative treatment of properties of recorded discourse and behavior appertaining to it". More explicitly, Sengupta defines it as 'Organization, classification and quantitative evaluation of publication patterns of all macro and micro communication along with their authorship by mathematical and statistical calculus'.

The practical approach to bibliometrics in library and information services has been visualized by S.R. Ranganathan in terms of Librametry who conceived the idea at Association of Special Libraries and Information Bureaux (ASLIB) conference at Leamington Spa, United Kingdom in 1948. With the time span many similar term came and became popular like Scientometrics, Informetrics, Webometrics and Cybermetrics.

1.3. TYPE OF BIBLIOMETRICS:

Biblometrics can be categorized in two types on the basis of study (Hertzel, 2010):

1.3.1. Descriptive Bibliometrics: It is a study of number of publications in a given field or productivity of literature in the field like-

    a. Geographic (Countries)
    b. Time periods (Eras)
    c. Disciplines (Subjects)

1.3.2. Evaluative Bibliometrics: In this bibliometrics study, citation counting is employed as an indicator of research output as form of:

    a. Reference
    b. Citation

1.4. SCHOOL OF LIFE SCIENCES, MIZORAM UNIVERSITY

Mizoram University was established by an Act of Parliament in the year 2000 and started functioning in the year 2002. It was accredited 'A Grade' by NAAC in the year 2014. There are 33 functioning academic departments in the main campus, one constituent college and 28 affiliated colleges. There are eight (8) schools in this university.

The School of Life Sciences was established in the year 2005 consisting three departments - Zoology, Botany and Biotechnology Departments, which are assisted by Department of Science and Technology, Ministry of Science and Technology under FIST and Non-SAP UGC programmes. The school is equipped with state of art equipments, Bioinformatics Infrastructure Facility (BIF) and State Biotech Hub for teaching and research. At present there are 21 faculties in school of life sciences as mention in table-1 (**Source**: Mizoram University, Annual Report).

Table-1.1: Teaching Faculty in the Department under the School of Life Sciences, MZU

Name of the Department	Year of Establishment	Professor	Associate Professor	Assistant Professor	Total
Botany	2005	2	1	5	8
Biotechnology	2007	3	1	4	8
Zoology	2005	2	1	5	8
Total		**7**	**3**	**14**	**24**

1.5. SIGNIFICANCE AND SCOPE OF STUDY

Universities play a crucial role in the generation and application of new knowledge. Teaching and research are the most important functions of a university. Teaching is a systematic transfer of the sum total of knowledge a society holds to its growing generation through various well-structured courses of studies and training programmes while research is pursuit of new frontiers of knowledge and wisdom in whatever directions and to whatever extent possible. The achievements in the research fields take a university the glorious positions and give recognition. The research output of the university needs to be effectively disseminated and distributed for its acceptance and timely application for social benefits. The research productivity of a university in different forms like academic publications, patents,

research projects, PhD theses & M.Phil dissertations but research publications are one of the most quantitative measures for the basic research activity in academic community. Research productivity analysis is one of the key components of any research and development activity. One well-known productivity indicator is the number of publications produced by the scientists, institutions and countries. Studies like this will provide some insight into the complex dynamics of research activity and enable the scientists, policy makers and science administrators to provide adequate facilities and proper guidance. Bibliometrics as a technique has extensive applications in identifying the research trends in a subject, discipline, geographical areas in a particular time span.

There are a number of bibliometric studies have been conducted to access the publication trends of various department, subject, institutions, universities in national and international level in different subject areas but no study has been conducted to analyze the publications of School of Life Sciences faculties' of Mizoram University. Therefore, bibliometric study of publications of faculties of School of Life Sciences, Mizoram University is an attempt to fulfill this research gap.

The scope of present study is limited to total 24 faculties of School of Life Sciences, Mizoram University. The scope is further limited to faculty's publications during 2006-2015 (ten years) on the basis of various bibliometric parameters.

1.6. REVIEW OF LITERATURE

Zachos (1991) study compared and evaluated the research performance of two Greek University Departments of Mathematics with the use of bibliometric indicators. The author used elements from the Sussex and the Leiden methodologies in order to perform better comparisons of research performance of the two groups and to be able to test the validity of existed methodologies. The two groups were compared based on their similarities. The result shows that bibliometric indicators if applied properly give interesting information on the research performance and the nature of research carried out in University Departments.

Sangam, S.L. and Nargund, I.N. (1997) analyzed the trend in research publications by Indian Physicists by using bibliometric techniques. The study observed that the Indian physicist during 1993 published their articles mostly in periodicals. Multi authored papers are highest in numbers followed by single authored. The contribution has been made by 127 universities, 39 Indian Universities contributed 10 or more papers each in the subject during

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the year 1993. Out of the total 256 scientific journals, Proceedings of solid state physics symposium, BHU occupied the first ranked of choice of journals for publications.

Hasselback et.al. (2000) conducted a study based on publications in 40 journals were used to measure faculty publication quantity. Journal ratings derived from a compilation of the rankings of five prior studies and co-authorship were used to measure publication quantity choosing benchmarks for an individual faculty requires users data to determine four parameters:- what credit to give a faculty member for co-authored articles, what level of journal quality is appropriate, choosing appropriate level of performance, deciding the emphasis to place on the number of years since the doctoral degree was earned. They discovered the average number of articles per article is significantly correlated with time and growing at a pace of 0.017 authors per article per year.

Gopikuttan, A. (2005) studied the scientometric analysis of the research productivity of university teachers in Kerala University during the year 1980-1999. In this analysis journal articles are the main vehicle of information transfer of faculty members and in the year 1981 recorded the highest number of publication in this form of publication. Two authors contribution make majority in contribution. Their most preferred journal is Proceeding of Indian Academy of Science.

Meho and Spurgin (2005) analyzed the data sources and research methods used in earlier studies to rank the research productivity in the field of library and Information Science faculty and schools. The study also identifies the tools and methods that generate more accurate publications count rankings as well as databases. A list of 2625 items published during 1982 to 2002 by 68 faculty members of 18 American Library Association (ALA) accredited LIS schools, hundreds of databases were searched. The results show that there are only 10 databases that provide significant coverage of the LIS indexed literature and restricting the data sources to one, two, or even three databases leads to inaccurate rankings and erroneous conclusions.

Sarala, K.R. (2005) conducted study of scientific productivity of agricultural scientists in the college of agriculture, Thiruvananthapuram. A database was collected manually from the year 1977-2004. The study described the scientific productivity of faculty members during the time span is 1548 publications and 3795 authors are responsible for contribution. The authors have published mainly on journal articles. The year 1994-95 was found to be the

most productive year and in the authorship pattern two authored papers are the highest in publications.

Sevkan and Sharma (2007) examined research output in plant sciences of the faculties in central universities of India has been analyzed bibliometrically. The study analyses a total of 348 bibliographic records of plant sciences retrieved from ISI Science Citation Index-Extended (SCIE) for a period of 10 years from 1997 to 2006. The output of plant sciences literature has been analysed by year, document type, authorship pattern, and collaboration pattern at different levels i.e, international, national and local. The laws of Bradford and Lotka have also been tested.

Gabriel and Ishaya(2009) analyzed the publication patterns of agricultural research scientists of the Institute for Agricultural Research, Ahmadu Bello University, Zaria. The data were collected from database of the Institute's publications and randomly selected peer reviewed journals, proceedings, seminars, theses, workshops and conferences of the Agricultural Library, Samaru. A total of 438 materials were sampled from the library database, 420 journals, 300 proceedings, 200 seminars, 650 project theses, 100 workshops and 120 conferences and analysed. The result showed a great distinction within and between subjects, status and publication productivity. The study also reveals that grants from government and private bodies remain the major sustaining factor for information publication. It was recommended that grants be maintained to sustain the Institute to facilitate publicity of research results that are beneficial for agricultural development.

Kumar and Naqvi (2010) conducted a study on bibliometric analysis of the research output of the Jamia Millia University, New Delhi during 1971 to 2007. A record in the form of journal articles, conference papers and books were analyzed. Bradford's law and Lotka's law were tested and found applicable to the data. The study shows that authors from the faculty of natural sciences have contributed mainly in the form of journal articles and that the pace of research is slowly developing in the university. The analysis of the study shows that the most productive department is Chemistry followed by Biosciences and Physics. The analysis of the number of publications per faculty member in each department for 2004-2007 shows that Department of Chemistry is the highest followed by Biosciences. They concluded that overall the researchers in the faculty of Sciences showed 77 percent of their publications being produced collaboratively.

Alghanim and Alhamali (2011) identified the prevalence factors and obstacles affecting research productivity among academic staff and health colleges in the kingdom of Saudi Arabia. Questionnaire methods have been used to collect data and were distributed randomly to 500 faculty members. They found out that faculty members who reported involvement in administrative activities were less likely to publish. The faculty members who reported supervising postgraduate students or had attained training on research are most likely to publish. The most obstacles impeding research productivity was due to lack of time, research assistants, and funds for research and busy in teaching load.

Kumar and Murthy (2011) examined various parameters like growth pattern, content coverage, authorship patterns, subject-wise distribution of articles, etc. The journal has a remarkable change after 2006 and the number of papers published increased significantly. The average length of papers was about 6 to 10 pages, which is an ideal length for research articles. Single author paper was the major chunk of total papers published. Out of 3428 references, 1382 were quoted from the journals sourced by the authors. During the period 57 issues including 14 special issues were brought out from eminent LIS professionals; the journal has published thematic issues at an average of 3 every year since 2007. Authors from government research institutes (104), and universities (139) were the main contributors.

Baskaran (2013) investigated the publication pattern, relative growth rate (RGR), doubling time (Dt), Country-wise distribution and subject-wise papers of Cryptography published during 2000-2011. The data has been collected from Web of Science (WOS) through the filter of category Cryptography as a subject research. From the Web of Science, 6610 records were retrieved which were used to assess the academic productivity and distribution of research diversity of Cryptography. The four major countries – China, USA, Taiwan and Japan contribute more papers in cryptography and related field of researches. The highest RGR is 0.44 in 2002 and Dt is 21.656 in 2008 measured during 2000-11. The highest productivity and the most-frequent partners among the collaborative papers at global level was China.

Khaparde (2013) conducted a bibliometric study on research publications of department of Chemistry, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for the period of 1975-2012. He analyzed 774 research publications from 144 journals and examines year-wise distribution of papers, authorship pattern journals in which journals publish productivity of faculty and discipline-wise distribution etc. In this study the numbers of publications was

increased consistently during the year 1975-2012. Majority of publications were from four authors. The faculty who published in large numbers has 259 publications. Majority of papers have been published in Journal of heterocyclic chemistry.

Kumbar and Gupta (2013) provides a comparative assessment of the research contribution in terms of publication output in science and technology, its growth and citation impact during 2001-10 in Mysore University and Karnatak University. It analyses the strong and weak subject areas output of the universities research and their citation impact and the international collaborative output of the universities. It also analyses their collaborating linkages with academic institutions, institutes of national importance, research institutions and industry. The study also shows the contribution and citation impact of top15 most productive authors and journals where the two universities authors have published.

Nongrang and Tariang (2013) conducted a study to analyze research performance of botany faculties in North Eastern Hill University (NEHU), Meghalaya from 2000 to 2010. The data used for the study were retrieved from two citation index database ISI Web of Science (WOS) database and Google Scholar. A total of 1218 articles published in 263 journals were collected from Web of Science (WoS) via Science Citation Index. The analysis of data showed that the nature of growth literature is not consistent as the number of publication varies in nature, however the highest number of publication was in the year 2009 to 2010 which account for 24 (15.58%) out of 154. The study also reveals that the three-authored papers numbering 61 (39.61%) top the list in ten years. The study revealed that the observed percentage of authors varied from the expected percentage of authors as predicted by applying Lotka's equation. In identification of core journals according to Bradford's law of distribution the relationship between the zone is 1 : n : n2 (i.e. 1 : 5: 25). The relationship between the zones in the present study is contradictory which does not fit into Bradford's distribution.

Okiki (2013) assessed the level of research productivity of teaching faculty members in Nigerian Federal Universities. The findings of the study shows that the research productivity of the teaching faculty members in Nigerian federal universities is high in journal publications, technical reports, conference papers, working papers, and occasional papers. The research productivity is higher in Northeast, Southwest and North Central Nigeria. The mean score of information resources availability indicates that the information resources are readily available to teaching faculty members in Nigerian Federal Universities. The barriers

to research productivity by teaching faculty members in the universities include low Internet bandwidth and financial constraint. Besides, the study has shown the strengths and weaknesses of the teaching faculty members in Nigerian universities in terms of their research output.

Okpe et.al. (2013) investigated the pattern of research output publications of faculty in Babcock University, Nigeria. Survey design was used and the population for the study consists of 154 faculties. Data was collected by questionnaire method and analyzed using descriptive statistics, frequency counts and simple percentage and the hypothesis were tested using Product Moment Correlation and chi − square. The hypothesis shows that there is a significant relationship between the status of faculty and pattern of research output publications, there is also a significant relationship between the qualification patterns of publications based on gender. In their conclusion, recommendations has been made for the improvement including mentoring, collaboration with foreign colleagues, male faculty should publish more journal publications and female faculty be encouraged to increases their seminar presentations as well as text books publishing.

Sudhier (2013) analyzed the authorship pattern in physics literature and to examine the validity of Lotka's law of scientific publication productivity. This study compiled a list of journal articles on various aspects of physics research cited in the doctoral theses of university of Kerala, Thiruvananthapuram, South India. A total of 1,665 personal authors were identified by using 'straight count' of authorship, and by using 'complete count' 3,367 authors were identified. K.-S statistical test and Chi-square test were applied to verify the applicability of Lotka's law in the two approaches. The productivity distribution did not fit either set of data for two different authors' communities when Lotka's law was applied in its original form. This confirms that law does not applicable to authors of the physics literature.

Sudhier and Priyalakshmi (2013) analyzed bibliographic details of 1076 research articles obtained from the annual reports of Central Tuber Crops Research Institute (CTCRI). The data was analyzed by normal count procedure using scientometric techniques. During the period under study, the highest number of 169 papers was published in the year 2016 and the average number of publications per year was 97.82. Journal articles are the most preferred form of publications and the scientist prefer mostly foreign journals to publish articles (51.89%). The subject multi author contribution shows a high degree of collaboration in the

science field. The result of the study shows that the applicability of Bradford's Law in the journal pattern of the CTCRI scientists does not fit Bradford's distribution pattern.

Thaker, Oza, Makwana and Patel (2013) analyzed the contribution of faculty members of the university in Gujarat particularly in the areas of Physics and multidisciplinary. The data has been collected from web of science for the period of 1998-2011. Various search strategies were applied to collect the data and scientometric techniques were used to achieve research objectives. The study found cited items, citing articles, h-index of universities and faculties in the subject area. The study further recommended for the establishment of citation database for the publication in Indian languages to provide such platform for scholarly communication in Indian languages to keep a pace with the latest research trends.

Thirumagal (2013) conducted a bibliometric study on the publication of "Turmeric research". The records are collected key word of Curcuma longa or Turmeric from Pubmed database for a period of 2006-2010. Total number of record for this study was 1,076. Single author contributors were only2.78% only and it clearly shows that collaboration of research evident in Turmeric field. The year wise Degree of Collaboration lies between 0.97 to 0.98. The Turmeric research is increasing year by year. The maximum number of contributions and the top most country is the United States followed by England. Result of such studies may be very useful for the research administrators, policy makers and funding agencies.

Aswathy and Gopikuttan (2014) examined the India's contributions in world in the subject area and also analyses year-wise, language-wise, document type-wise distribution and country-wise analysis which provides the percentage of Indian share to this subject. It also includes institution-wise categorization during 1999 to 2012. Authors also analyses degree of collaboration and verifies the fitness of Bradford's Law of Scattering. The data has been collected from Thomson Reuters Web of Knowledge database.

Chaurasia and Chavan (2014) highlighted the various output pattern of Indian Institute of Technology Delhi (IIT Delhi). The study describes the growth, contribution and impact of research carried out by the faculty members and researchers of IIT Delhi. It also attempts to analyze the growth and development of research activity of IIT Delhi in publications output covered by ISI Web of Science during the year 2001 to 2010 with criteria of content of papers published, including the annual average growth rate percent, authorship pattern, author productivity, subject-wise rank distribution of publications, degree of collaboration,

source title in terms of number of publications, most prolific author in terms of productivity count and most prolific department.

Jeyshankar, R and Abu, K.S. (2014) illustrated the bibliographic details of the research articles of CLRI during the period of 14 years (1999-2012). Total numbers of articles published are 1874 and maximum numbers of articles were published in the year 2012. The degrees of collaboration of the scientists are 0.97. The most contributions are made by multi authors and USA is the highest publication in CLRI. This study also examines about relative growth rate, doubling time, co-authorship index and highly preferred by the scientists.

Kar and Monda (2014) conducted a bibliometric study of research publications of UGC-DAE Consortium for Scientific Research, Kolkatta for a period of 2006-2010. The Centre has 265 research publications out of which there are 145 journal publications and the remaining 120 are published in the form of conference, workshop, seminar, symposia. The journal publications are only considered for study due to lack of direct impact factor. The analyses of this study includes distribution of publications by year, by country, in SCI and Non-SCI journals, in journals and proceedings, in different Normalized Impact Factor (NIF) ranges, total NIF, average NIF of each division, collaborative pattern etc.

Kumar and Suresh (2014) analyzed the publication output from Science Citation Index-expanded for 2006 to 2011 in the field of HCI research. The purpose of this study is to test Lotka's law of author productivity using the methodology outlined by Pao (1985) and compare it with the modifications suggested by Nicholls (1987). The values of Lotka's exponent and constant are calculated by both linear least square method and maximum likelihood method. There is not much difference observed in the distribution of publications and the distribution obtained using Pao's procedure and modifications suggested by Nicholls. This study finds that literature in the field of HCI research studies does conform to Lotka's law with reliable results for 18 out of 21 data sets. Lotka's law can be used in HCI research as a standardized means of measuring author publication productivity.

Sweileh, Zyoud, Al-Khalil, Al-jabi and Sawalha (2014) describes the growth, contribution and impact of research carried out by the faculty members, researchers, or students of ANNU in the past 35 years. In this study the data were retrieved from Scopus database. By using Bibliometric analysis they identify the pattern of publication, relative growth rate, authorship pattern, collaborative measures, author's productivity, most prolific authors, and most prolific journals. A total of 791 published documents were retrieved for this study of ANNU.

Six hundred one (76%) documents were published in journals listed in Web of Knowledge and the total number of citations for documents published at the time of data analysis (November 19,2013) in ANNU was 4553 with an average of 5.8 citations per document. The study identified 384 (25.8%) documents with 59 countries as ANNU-foreign collaborators. Future emphasis on joint research, international collaboration, and publishing in indexed journals is needed.

Choudhari and T.R.Borse (2015) analysed the research productivity of faculty members in School of Mathematical Sciences, NMU Jalgaon. The study observed that 167 publications are contributed by 8 faculty members in the School of Mathematical Sciences. The faculty published their publication only in English language. The male faculty members published more publication than female faculty. 2010 was the most productive year under the study. The study has test the applicability of Bradford law and Lotka's law.

Gupta and Gupta (2015) examined 1206 publications of Indian cloud computing research by using Scopus database during 2004-2013. They found out that the annual growth rate of 25.51% during 2008-2013 and citation impact factor per paper is 11.69. The research output of 21316 publications came from several countries. China, USA, Germany, India, UK, Taiwan, Australia, Italy, Japan etc are the top 10 countries which contribute about 80.57% of the total global output during the study. The main institutional contributions are universities, engineering colleges, institutes of national importance, industrial enterprises and research institutes respectively during the study. India's share 5.66% of the global publication and hold the 4th rank in the global publication during the period under the study. The output in Indian cloud computing comes from several organizations and authors. The top 15 and 10 authors contributed 33.25% and 7.30% respectively.

Gupta and Gupta (2015) analyzed 733 Indian publications in social media research from Scopus database during 2004-13, experiencing an annual average growth rate of 168.31% and citation impact of 1.27. The world social media research output came from several countries, of which the top 15 accounts for 81.95% share of the global output during 2004-13. India's global publication share was 1.97% during 2004-13 and hold 13th rank in global publication output. India's social media research output came from several organizations and authors, of which the top 10 contributed 30.42% and 17.87% share respectively of its total output during 2004-13. India's international collaborative share in social media was 22.10%

during 2004-13. The paper stressed the need for the development of a national social media by Indian government.

Kasa, Ibrahim, and Momoh (n.d.) study is to set out and analyze publication research output patterns of the faculty member of Agriculture and Veterinary complex of Ahmadu Bello University, Zaria from 2002-2012, using selected quantitative bibliometric indicators. The data has been collected from 33 bounded copies of curriculum vitae and publications of professors and associated professors approved by the university central committee responsible for the appointments and promotion of staff. Year wise assessment of research output revealed that year 2006 was the most productive with score distributions of 159 faculty members' research output trends were expressible in research output formats, year-wise distributions and prevalence authorship patterns which show commitment to research activities. The study recommends the maintenance of staff bound curriculum and publications because it is a veritable tool for bibliometric analysis and pointer to progress made by the faculty membership and units of the complex to agricultural development.

Kumar, Nigam and Malik (2015) analyzed research productivity, subject-wise, year-wise, gender-wise productivity, thrust area, new trends and most productive guide in Kumaun University during 2000-10. During 2002-03 and 2009-10, research work 22.41% and 17.24% of theses were awarded respectively. The major research areas that emerge in the research are political process, Politics & Governments, and Public Administration. The study also reveals that male researchers are more interested in doing research on Political Process (20.69%), while 10.34% female are interested in Politics and Government. The most important fact that occurs in this study is that the male scholar's percentage (62.07%) is higher as compared to female researchers

Nagarkar et.al. (2015) conducted a study with the intention to know the research productivity over 15 years (1999-2013), the citations received, collaborations, and authorship patterns. Data were analyzed by using bibliometric techniques and software such as HistCite, Intcoll, and Pajek. Results show that the research productivity of faculty members is increasing, their publications are getting good citations and thereby their journals have better impact factor. The faculty members have collaborated with prominent international researchers and have extended interdisciplinary research. It was based on empirical data exclusively gathered for this research and the medium of Doctoral dissertation is both Hindi and English.

Vanathi, Saravanan and Nagarjan (2015) conducted a scientometric analysis of research publication of faculties in chemistry. The data has been retrieved on the basis of Science citation Index for four universities of Tamil Nadu during 1989-2014. 4033 publications have been contributed during 26 years under the study. In 2014 the highest number of publication was published and Dr. S.R. Ranganathan is the most productive authors with 134 publications. Journal is the most preferred form of publication by faculty with 3898 papers.

Nandan, Naresh & Kaur, Kulvir (2016) analyzed doctoral theses awarded in the faculty of Engineering & Technology, at the Guru Nanak Dev University, Amritsar. The distribution of Ph.D theses are analyzed during the period of 1985-2014. They analyzed guide wise productivity, chronological analysis of theses, gender wise analysis of research scholars and research guides, guide wise productivity. They found out that the time span during these ten years is the most productive years with the awarding of 15(37.5%) doctoral degrees and there is gradual growth of research output in Computer Science & Engineering and Electronics Technology fields. It is also observed that 13 research guides are presently engaged in guiding doctoral students.

1.7. RESEARCH GAP:

The above review of literature shows that there are a number of bibliometric studies have been conducted to access the publication trend of various department, subject, institutions, universities in national and international level in different subject areas but no study has been conducted to analyze the publications of life science faculties of Mizoram University. Therefore, this study is to fulfill this gap of research.

1.8. RESEARCH DESIGN:

1.8.1 Statement of problem:

Bibliometrics is a type of research method used in Library and Information Science. It is a quantitative study of various aspects of literature on a topic and is used to identify the pattern of publication, authorship and secondary journal coverage with the objective of getting an insight into the dynamics of growth of knowledge in the areas under consideration.

Publication productivity is often considered to measure the prestige of an institution and is associated strongly with an individual faculty member's reputation, visibility, and advancement in the academic reward structure, particularly at research institutions and

universities. The relationship between output of research and input measured through the publication productivity. The contribution of the institution and the individual scientists engaged in research are highlighted by the institutional productivity. It also provides some insights into the complex dynamics of research activity and enables policy makers and administrators to provide adequate facilities and gauge the research activities in a proper direction. A well-known research productivity indicator is the number of publications produced by scientists, institutions, or research groups. To evaluate the productivity of research institutions and individual researcher and to map the growth of the research area bibliometric techniques have become tools over the years.

The present study is a bibliometric analysis of publications of faculties in School of Life Sciences, Mizoram University during 2006 to 2015 will analyzes the contribution, growth, authorship patterns, research collaborations, their preferred journals for publications etc. by faculties of School of Life Sciences, Mizoram University. It also analyze the growth and development of research activity of faculties in school of life sciences as reflected in their publications output.

1.8.2 OBJECTIVES OF THE STUDY:

The objectives of the present study are to:

- Analyze the forms of publications of faculties of Life Sciences during time.
- Visualize the year wise growth in publications of faculties and find out most prolific authors of Life Sciences.
- Find out collaboration and authorship pattern in faculties of Life Sciences.
- Identify the preferred journals and country-wise distribution of publications.
- Examine the implementation of Lotka's law of productivity.

1.9. RESEARCH METHODOLOGY:

The present study is a bibliometric analysis of publications of faculties of School of Life Sciences, Mizoram University. The publication data has been collected from *University Annual Report* from the year 2006-2015. Scholar ascertains the publication of faculties from their bio-data available on Mizoram University Website (www.mzu.edu.in*)* by survey and observation methods. There are 428 publications by 24 faculties during the period under cover, which will be total population for this research study.

Under the study, the data collected from the observation and survey method was scrutinized, tabulated and analyzed for inference. Statistical inferences will be drawn by using Microsoft Excel statistical software.

1.10. CHAPTERIZATION:

The study comprises the following chapters as given below:

Chapter 1	:	Introduction
Chapter 2	:	Bibliometric: an overview
Chapter 3	:	Bibliometric Laws
Chapter 4	:	Data analysis and findings
Chapter 5	:	Conclusion and suggestion
		Bibliography

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2.1 INTRODUCTION

Research and exploitation in every field of knowledge is the basic resource for the development and up to date information (Kamalan, 2002). Thus in research assessment, quantitative measures of the productivity have been widely used in the last few decades (Khatri, 2002). Scientific productivity of individual and institution is one of the essential and still open research problems of science studies and it reflects the development and progress in the field of science and technology. The published output of a research and developmental activities are indicator or exposer of the scientific productivity (Preman, P.K., 2002).

Scientific productivity in the form of intellectual contributions communicated in a written is crucial to the scientific community (Sudhier, Pillai K.G., 2013). The research output of the university needs to be effectively dispersed and distributed for the applications and use of social benefits. The research productivity of a university is usually indicated through the research publications that obtain from the various teaching and research departments. Scholarliness is exposed through various ways and academic publication is one of the major indicators to assess the scholarliness. Harold Laski observed that the true epochs in a university life are not marked by its building, its books or even the growth of its numbers they are marked by the great teachers it has possessed. (Gopikuttan, 2005).

Research is a way of finding answers to unknown problems up coming from natural and artificial phenomenon. The individuals or organizations to carry out research across the board are not having the same motivators. The main reasons are to find solutions to challenges or problems affecting humanity that stem from natural and artificial phenomena, confirm or contest or refute theories or hypothesis, develop scientific and professional practices, and to develop creative, analytical and rational thinking for informed decision making. On a more practical basis is that research is done to fulfill learning, domestic and career needs; to satisfy curiosity; egoistic reasons, such as recognition and visibility; for career related regards, such as promotion, securing tenure or permanent appointment; and for self-development or growth, among others (Ocholla et al.,2012).

2.2 BIBLIOMETRICS: ORIGIN AND DEVELOPMENT

Cole's and Eale's in their study "The History of Comparative Anatomy, Pt. 1: A Statistical Analysis" in 1917 was consider as the first bibliometric study due to the expression of "Statistical Analysis" has been used in the literature. Hulme (1923) was the first to use the expression "Statistical Bibliography" and later it is used by many authors in their literature. The term statistical bibliography has been used by Henkle after Hulme in 1938 in his paper "The periodical literature of Biochemistry" (Maheshwarappa, 1997). Gosnell in 1943 used the term 'Statistical Bibliography' in his dissertation and in his article of 1984 (Tiwari, 2006). Later, the term of 'Statistical Bibliography' was used in 1948 and 1949 by Fusilier, in 1962 by Raisig, in 1966 by Baker, in 1969 by Allan Pritchard. The term was considered very clumsy, not so descriptive and can be confused with statistics itself of bibliographies on statistics (Tiwari, 2006).

The word "bibliometrics" first appeared in print in Alan Pritchard article "Statistical bibliography or Bibliometrics?" in the December issue of the Journal of Documentation (Hertzel). Pritchard (1969) suggested the word 'Bibliometrics' instead of 'Statistical Bibliography' and the term has become a very recent origin. Dr. S.R. Ranganathan (1995) coined the term 'Librametry' to connote the use of statistics to evaluate an existing or proposed library services and resources. This wider term which includes in it the concept of bibliometrics and later it was called 'Librametrics' (Gopinath, 1991).

The term 'bibliometrics' is analogous to Ranganathan's 'Librametrics', Russian term "Scientometrics', FID's term 'Informetrics' and also to some other established sub-disciplines such as, 'Econometrics', 'Psychometrics', 'Sociometrics', 'Biometrics', where statistical analysis have been used systematically applied to analyses and solve the problem in the field of library science, history of science, information science, economics, psychology, sociology and biology respectively.(Tiwari,2006)

2.3. BIBLIOMETRICS DEFINITION

Many attempts have been made to define the term bibliometrics and its analogous terms since the use of the term 'statistical bibliography' in 1923 by Hulme. According to Hulme (1923), the purpose of statistical bibliography is to 'shed light on the process of written communication and of the nature and course of development of a discipline, by means of counting and analysis its various facets of written communication. Raising (1962) defined bibliometrics as "The assembling and interpretation of statistics relating to books and periodicals… to demonstrate historical movement, to determine national and universal research, use of books and journals and to ascertain in many local situations the general use of books and journals". It is regarded as one of the classical definitions of bibliometrics.

The term bibliometrics was first coined by Allan Pritchard in 1969 in preference to existing terminology 'statistical bibliography" as he felt there is fair likelihood to misinterpret it as bibliography of statistics (Maheshwarrappa, 1997). Pritchard (1969) defined 'bibliometrics' as "The application of mathematical methods to books and other media of communication". According to Fairthorne (1969), it is the "Quantitative treatment of properties of recorded discourse and behavior pertaining to it". The British Standard Glossary of Documentation of Terms (1976) explained bibliometrics as a study of "the use of documents and patterns of publication in which mathematical and statistical methods have been applied". Hawkins (1977) in his on-line bibliometric study interpreted bibliometrics as "the quantitative analysis of the bibliographic features of a body of literature".

Nicholas and Ritchie (1978) Opined that Bibliometrics provides information about the structure of knowledge, and how it is communicated and they added that bibliometric falls mainly into two broad categories – those describing the characteristics or features of a literature (descriptive) and those examining the relationship formed between components of a literature (behavioral studies).

Potter (1981) recently defined Bibliometrics as "the study of and measurement of the publication patterns of all forms of written communication and their authorship". Schrader (1981) said it even more simply bibliometrics is "the scientific study of recorded discourse". Bonitz (1982) defined it as, "Bibliometrics is a methodological sub-discipline of library science, including the complex of mathematical and statistical methods, used for analysis of scientific and non-scientific documents, library networks, indexing languages, information systems, communication systems, etc".

Broadus (1987) presented a historical overview of various definitions of bibliometrics and proposed an alternative definition of bibliometric and defined as-"bibliometrics is the quantitative study of physical published units or of surrogates of either". Sengupta (1990) defines it as the "Organisation, classification and quantitative evaluation of publication patterns of all macro and micro communications along with their authorships by mathematical and statistical; calculus".

Ravichandra Rao (1988) defined that, "Bibliometrics is understood to cover the study of statistical distribution of the process relating to the activities of library staff and readers". J.M. Britain defines it as, "The study of nature, use and non-use of documents only. It deals only with the document that is the unit of analysis is the document and its characteristics. It does not deal with the user and his needs". Simpson expressed that bibliometrics now include computer databases, databanks and view data systems and also embrace statistical information relating to users (Tiwari,2006).

In simple terms bibliometric analysis may be defined as the application of mathematical and statistical methods to books and other forms of communication. It is a quantitative treatment of the properties of bibliographic unit (B. Mini Devi, 2005).

Narin and Moll define bibliometrics as all the studies seeking to quantify the process of written communication (Pandhi and Garg, 2002). British Standards Institution has defined bibliometrics as "the study of the use of documents and patterns of publication in which mathematical and statistical methods have been applied" (Seetharama, 2004). Egghe describe bibliometrics as "development and application of mathematical models and techniques to all aspects of communication. According to Subramanyam - bibliometric method offers, convenient and non-reactive tool for studying collaboration in research". (Varma, 2008).

Bibliometrics, called a quantitative science, is divided into two areas, descriptive and evaluative. In one of these classes is included the study of the number of publications in a given field, or productivity of literature in the field for the purpose of comparing the amount of research in different countries, the amount produced during different periods, or the amount produced in different subdivisions of the field. This kind of study is made by a count of the papers, books, and other writings in the field, or often by a count of those writings which have been abstracted in a specialized abstracting journal. The other includes the study

of the literature used by research workers in a given field. Such a study is often made by counting the references cited by a large number of research workers in their papers.

The two areas may also be divided as follows:

- ➢ Productivity Count (descriptive)
  - Geographic (Countries)
  - Time periods (Eras)
  - Disciplines (Subjects)
- ➢ Literature usage count (Evaluative)
  - Reference
  - Citation (Hertzel, 2010)

2.4. METRICS IN BIBLIOMETRICS

The main metrics which have been used to measure the impact of research outputs and publications are given below:

2.4.1 **OUTPUT:** The total number of outputs published. It measures productivity rather than impact.

2.4.2 **CITATION COUNTS:** The number of citations received. It measures citations for individual outputs or a set of outputs.

2.4.3 **FIELD-WEIGHTED CITED IMPACT:** The ratio of citations received, relative to the expected world average for the subject field, publication type and publication year.

2.4.4. **OUTPUTS IN TOP PERCENTILE:** The number or percentage of outputs in the topmost-cited publications in the world.

2.4.5. **H-INDEX:** The productivity and impact of a researcher's outputs. It is based on the number of publications as well as the number of citations they have received. An author has an H-index of *n* if they have published n papers, each of which has been cited at least *n* times. For example, to have an H-index of 15, 15 papers must have been cited at least 15 times.

2.4.6. **JOURNAL IMPACT FACTOR:** The importance of a particular journal. It is based on the average number of citations received per paper published in that journal in the preceding two years.

2.4.7. SCIMAGO JOURNAL RANK: The importance of a particular journal. It is alternative to the Journal Impact Factor. The SCImago Journal Rank places higher value/weight to citations from more prestigious journals.

2.4.8. SCOPUS SNIP: The importance of a particular journal The Scopus Snip normalizes for citation rate subject differences. It is a ratio of a journal's citation count per paper and the citation potential in its subject field. (University of Leeds)

2.4.9. EIGENFACTOR^{TM}SCORE: This score measures the journal's total importance to the scientific community. It is calculated based on the number of times that articles from the previous five years from a particular journal have been cited in the current Journal Citation Reports year, but is also weighted towards citations that come from more highly cited articles.

2.4.10. ARTICLE INFLUENCE^{TM} SCORE: The Article Influence^{TM} Score uses the Eigenfactor^{TM} Score to calculate the average influence of the journal's articles over five year period. It is calculated by dividing a journal's Eigenfactor^{TM} Score by the total number of articles published in that journal in the five year period. The mean score is 1.00 and journals that score greater 1.00 can be said to have an average influence in their area.

2.4.11. SOURCE NORMALIZED IMPACT FACTOR PER PAPER: This measures the citation potential of journal articles in a subject field taking into account different citation patterns in a given field. If a typical article in a subject field has dozens of citations, then it will be weighted differently from those in the field where the typical article has fewer than ten citations. This weighting allows for articles in different subject areas to be compared to each other, because of the normalization of the citation counts.(Berger and Baker, 2014)

2.5. BIBLIOMETRIC TOOLS

Some of the bibliometric tools which have been used to gather the data are as follows (University of Leeds, n.d):

2.5.1 SCIVAL: SciVal is a subscription based research performance assessment tool which uses data from Scopus. It allows benchmark for individual researchers, groups of researchers and institutions based on a variety of

bibliometric measures. It holds information for 4600 research institutions and 220 countries.

2.5.2 SCOPUS: Scopus is a subscription based citation based database of peer reviewed literature from more than 21,000 journals, 40,000 books and 24 million patents. The coverage of social sciences is broader than Web of Science. At present, citation data is only available for papers published from 1996 onwards.

2.5.3 WEB OF SCIENCE: Web of Science is a subscription based citation database of more than 12,000 journals and over 160,000 conference proceedings. Coverage includes science, social science and arts and humanities dating back to 1900.

2.5.4 JOURNAL CITATION REPORTS: Journal Citation Reports is a subscription based resource which allows you to evaluate and compare journals using citation data from over 11,000 journals. Coverage includes science, medicine and social sciences dating back to 1998 (University of Leeds, (n.d.)).

2.5.5 GOOGLE SCHOLAR PAGERANKS: Google Scholar has created its own form of article ranking that uses the principles of both the h-index and weighted citation. Articles in a Google Scholar search are ranked based on the following criteria: the previous papers written by that author, the number of citations to that paper, and the importance of those citations.

2.6. BIBLIOMETRIC INDICATORS

Bibliometrics indicators can be classified into three types (Joshi, 2014):

2.6.1 Quantitative Indicators: This indicator is used to measure the productivity of a researcher.

2.6.2. Number of Publications: The simplest way is to count the number of publications by a particular author in a defined time period. It indicates the quantity only

without indicating the quality of the publications. It should be used carefully while comparing the faculty members.

2.6.3. Number of Publications in Top-ranked Journals: The number of articles published in highest quality of journals is considered according to their impact factor. The reference to impact factor is brought in to overcome the short comings of the number count of publications.

2.6.4. Performance indicator: This indicator is used to measure the quality of the journal or the researcher. It can be subdivided into − indicators that measure the quality of the journals (Journal performance indicators) and − indicators that help to quantify the quality of the article published by the researcher as well as its impact on the scientific community (Researcher performance indicator.

2.6.5. Structural indicator: These help to establish a link between publication, authors and research fields.

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3.1. INTRODUCTION

Bibliometrics as a technique has extensive applications in identifying the research trends in a subject, trends in authorship and collaboration in research, core periodicals, obsolescence and dispersion of scientific literature useful in estimating the comprehensiveness of secondary periodicals, studying the author productivity, characteristics of subject literatures including structure of knowledge, historical and sociological aspects of science and helpful in formulation of need based collection development policy, weeding and stacking policy, science policy studies and many others.(Maheshwararappa, 1997)

Bibliometric studies are mostly empirical in nature and are mostly centered on presentation of facts and data. There are very few studies centered on theoretical foundations. The facts are gathered either through surveys or from published bibliographies, indexes and databases. Based on these facts, empirical models and principles have been developed. Source theories are to be evolved from the logical analysis of the empirical models of bibliometrics into certain standards. At present bibliometric studies are constrained by the lack of communication within the scientific community, unsatisfactory impact of bibliometric research outside the bibliometric community and observed incompatibility of bibliometric indicators, produced by different institutions. In these circumstances, the formulation of bibliometric standards is necessary for improving their liability of bibliometric results, guaranteeing the validity of bibliometric results and making bibliometric data compatible as well as applicable (Rao, 1998?)

3.2. LIBRAMETRICS, BIBLIOMETRICS, SCIENTOMETRICS, INFORMETRICS, CYBERMETRICS, WEBOMETRICS

Several synonymous terms have been emerged in representing the quantitative studies in Library and Information Science and they are known as 'Librametrics' in 1940's, 'Bibliometrics' in 1960's, Scientometrics in 1970's and Informetrics in the mid of 1980's, with the advent of information technology two new concepts namely 'cybermetrics' and 'webometrics are emerged in 1990's. (Sangam & Keshava, 2008)

3.2.1. LIBRAMETRICS

Ranganathan was the first who in the year 1948 suggested the term librametry at the ASLIB Conference in Leamington spa. Ranganathan meant the term librametry for the application of quantitative methods in the management and services of the library. Despite his efforts, the field could not develop until the early 1970's, when Ranganathan (1969) in a paper at the Annual Seminar of DRTC, Bangalore, illustrated with some examples the applications statistics to library work and services. The scope of practical applications of librametry was outlined by Neelameghan in another paper presented at the same seminar. The Madras University Librarian practiced various librametric techniques way back in 1925, for solving library problems and activities, service to clientele and also for the betterment of library professional as a whole.

Sengupta (1985) defined Librametrics as "Quantitative analysis of various facets of library activities and library documents by the application of mathematical and statistical calculus to seek solution to library problems". According to Ravichandra Rao (1988), bibliometric and librametrics is nothing but "Information process and information handling in libraries and information centres by quantitatively analyzing the characteristics and behavior of documents library staff and library users".

Ranganathan, intuitively and implicitly, applied the concepts of quantification in a number of areas of library and information management. In some activities he explicitly practiced quantification such as arrangement of books in the stock room by the frequency of their use rather than in Colon Class number sequence. For instance, the books most frequently used were kept on the ground floor near the entrance and the books in low demand were kept on the higher floors. Of course, adequate stacks and bay guides were provided to assist in locating the materials (Padhi and Garg, 2002).

Data collected daily on charged out books and random checks of the materials left on the reading tables after consultation by users, were analysed to estimate the frequency of use of books in different subjects and analysed to assist book selection, acquisition of multiple copies, etc. scatter and seepage studies in different subject areas were carried out at DRTC for selection of periodicals (Padhi & Garg, 2002). Ranganathan applied techniques of librametry in periodical binding, staff deployment, budget allocation of books and periodicals and other aspects of library management (Rao, 1992). Studies using quantitative techniques have been made the world over in the last two decades for almost every aspect of library

operations such as selection of titles, determining multiple copy requirements, selection of journals, and storage of documents and establishment of loan facilities (Garg, 1969).

3.2.2. BIBLIOMETRICS

The word 'bibliometrics' first appeared in print in 1969 in Alan Pritchard's article "Statistical bibliography or Bibliometrics" in the December issue of the Journal of Documentation. In this article, he stated that the term statistical bibliography coined by Hulme in 1923 is clumsy, not very descriptive, and can be confused with statistics itself or bibliographies on statistics. As a result of this, he suggested the word "Bibliometrics". He defined bibliometrics as the "the application of mathematical and statistical methods to books and other media of communication". Narin and Moll (1977) defined bibliometrics as "all the studies seeking to quantify the process of written communication".

Bibliometric studies can be categorized as descriptive and evaluative. Descriptive studies deal with quantification of publications in a given field or productivity of literature in the field for the purpose of comparing the amount of research in different countries, the amount produced in different subdivisions of the field. This kind of study is made by count of the papers, books and other writings in the field, or by count of those writings that have been abstracted in a specialized abstracting journal. Evaluative studies deals with the literature used by research workers in a given field. Such studies are often made by counting references cited by research workers in their papers. All evaluative analyses are descriptive as well. The field has matured from simple publication counts to sophisticated statistical analysis of computerized databases using multivariate techniques.

Within the last decade, the nature and scope of bibliometric studies have evolved considerably, moving away from their initial focus library science to policy-oriented studies in science. The studies have also focused on technology, analyzing patents rather than conventional scientific literature.(Padhi & Garg, 2008)

3.2.3. SCIENTOMETRICS

The term Scientometrics originated as a Russian term for the application of quantitative methods to the history of science. This term was introduced and came into prominence with founding of the journal named 'Scientometrics' by T. Braunin in 1977, originally published in Hungary and currently from Amsterdam. Scientometrics used to mean communication process in science including socio-cultural aspects and appears to be almost synonymous to

science with more stress on quantitative aspects. It also used as a generic term for a system of knowledge, which endeavours to study the scientific (and technological) system using a variety of approaches within the area of science and technology studies. Thus Scientometrics is a part of the sociology of science and has application to science policy making.

Scientometrics is a field which applies quantitative methods to the study of science as an information process. It is a scientific discipline, which performs reproducible measurements of scientific activity and reveals its objective quantitative regularities. Further, scientometric methods include statistical and thesaurus methods, and indicators as to the number of citations, terms, etc.

Scientometrics is a new branch of knowledge which uses bibliometric measurements for the evaluation of scientometric progress, level of scientific development, social relevance and impact of the applications of science and technology. The term scientometrics is derived from the Russian term 'naukometrica' which means the study of the measurement of scientific and technological progress(Egge & Rousseaeu, 1990)

According to Pouris (1989) 'scientometrics is for science what econometrics is for economics'. Therefore it is 'application of quantitative techniques (systems analysis, mathematical and statistical techniques etc.) to scientific communication (science output, science policy, science administration etc.) with the objectives of developing science indicators, measuring the impact of science on society and comparing the output as well as the impact of science at national and international levels. Tague-Sutcliffe defines scientometric as, 'the study of the quantitative aspects of science as a discipline or economic activity. (Sangam and Keshava, 2008)

The principle aim of 'scientometrics' is to determine the state and prospect of a subject and its further development. Several scientometric indicators are used for this purpose and one of the most significant indicators is the number of publications, its changes over time is usually considered as a measure of research topicality in a given field. These indicators are on the way to become standard tools of evaluation and analysis in research management of science policy making. (Amudhavalli, 1997)

In terms of methodology, scientometric techniques can be classified into two categories: one-dimensional (or scalar) and two-dimensional (or rational) techniques. One-dimensional techniques are based on direct counts (or occurrence) and graphical representation of specific

bibliometric entities (e.g., publications and patents) or particular data-elements in these items, such as citations, keywords or addresses. These techniques are used to generate scalar indicators for monitoring the state-of-the-Science &Technology system. These are increasingly being exploited for science policy purposes, both as descriptive and diagnostic tools.

The two-dimensional techniques are based on co-occurrences of specific data elements, such as number of times the keywords, classification codes, citations and addresses are mentioned together. Multidimensional statistical techniques are being used to represent rational (or structural) features of the data in the form of 'maps'. These techniques are particularly useful for strategic decision making (Padhi & Garg, 2008)

3.2.4.INFORMETRICS

According to Brookes (1989), the term 'Informetrics' was first proposed by Otto Nacke of West Germany in 1979.An FID Committee with broadly defined objectives in the provision of research and technical data subsequently given this name. However, the term was not widely adopted until 1987 when B.C. Brookes at the First Conference on Bibliometrics and Theoretical Aspects of Information Retrieval held at Diepenbeek (Belgium) suggested that the term "Informetrics" is the most appropriate term to cover bibliometrics, scientometrics, and other quantitative studies related to Information Science and it should be included in the name of Second International Conference on the subject. Egghe and Rossueau also stated in the proceedings of the conference that the terms 'Informetrics' was favored besides the terms 'Bibliometrics' and 'Scientometrics'. The third International Conference on Informetric, held in Bangalore in 1991. 'Informetrics' was used as a generic term to mean "the study and development of a variety of measures to study and analyse several properties of information in general and documents in particular". Obviously, Informetrics comprises of Bibliometrics and Scientometrics.

Tague-Sutcliffe (n.d.) defined the term as "The study of the quantitative aspects of information in any form, not just records or bibliographies, and in any social group, not just scientists. It can incorporate, utilize, and extend the many studies of the measurement of information that lie outside the boundaries of both 'Bibliometrics' and 'Scientometrics' and she continues to say that "Although in practice the scope of 'informetrics' is very broad, ……two phenomenon that have not in the past, been seen as a part of 'Bibliometrics' and 'Scientometroics'but fit within the scope of 'Informetrics' are definition and measurement of

information and type and characteristics of retrieval performance measures"(Amudhavalli, 1997)

Informetrics involves studies in the growth of literature in subjects; how much literature is contributed by various individuals, groups, organizations, countries; how much exists in various languages; how the literature on a subject is scattered viz., over documentation types, language, periodicals and how quickly the literature on some subject becomes out of date viz., studies of obsolesce. One very important group of informetrics studies with such phenomena as: which authors are most cited, which journals are cited (Sangam and Keshava, 2008)

3.2.5 CYBERMETRICS

Cybermetrics is one of the recently emerged fields in the line of metric studies. It has gained much popularity since the mid-1991 with the advent of Information Technology. As it is mainly concerned with the computer-science-based approaches, it has superseded all other metric studies in this internet era.

Cybermetrics is proposed as a generic term for "The study of the quantitative aspects of the construction and use of information resources, structures and technologies on the whole internet drawing on bibliometric and informetric approaches" (Sangam & Keshava, 2008). It is defined as 'quantitative study of internet-related phenomena'. Cybermetrics thus encompasses statistical studies of discussion groups, mailing lists, and other computer-mediated communication on the Internet including the WWW. Besides covering all computer-mediated communication using Internet applications, this definition of cybermetrics also covers quantitative measures of the internet backbone technology, topology and traffic. The breath of coverage of cybermetrics implies large overlaps with proliferating computer-science-based approaches in analyses of web contents, link structures, web usage and web technologies.

Some activities in cyberspace normally are not recorded, but communicated synchronously like in chat rooms. Cybernetrics studies of such activities still fit in the generic field of Informetrics as the study of the quantitative aspects of information "in any form" and "in any social group" as stated by Tague-Sutcliffe. The inclusion of webometrics expands the field of bibliometrics, as webometrics inevitably will contribute with further methodological developments of web-specific approaches. As ideas rooted in bibliometrics, scientometrics

and informetrics contributed to the emergence of webometrics might contribute to the development of these embracing fields (Sangamand Keshava, 2008).

3.2.6. WEBOMETRICS

Almind Thomas and Ingwersen Peter (n.d.), "Research of all networked based communications using informetric or other quantitative measures is called webometrics". Bjorneborn and Ingwerser used an information science-related definition of webometrics as "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the WWW during on bibliometric and informetric approaches". This definition thus covers quantitative aspects of both the construction side and the usage side of the web embracing the four main areas of present webometric research:

> ➢ Web page content analysis
> ➢ Web link structure analysis
> ➢ Web usage analysis (e.g. exploiting log files of users searching and browsing behavior)
> ➢ Web technology analysis (including search engine performance) (Sangam and Keshava, 2008)

3.3. BIBLIOMETRIC LAWS

The fundamental laws which laid the formation of bibliometric laws are as follows:

> ➢ Lotka's Inverse Square law of Scientific Productivity
> ➢ Bradford's Law of Scattering of Scientific Papers and
> ➢ Zipf's Law of Word Occurrence

Some of the other empirical laws are:

> ➢ Price's Square Root Law of Scientific Productivity
> ➢ Garfield's Law of Concentration
> ➢ Sengupta's Law of Bibliometrics

3.3.1. Lotka's Law of Scientific Productivity

Alfred J. Lotka (1926) proposed his inverse Square Law correlating contributors of scientific papers to their papers number of publications. His law provided fundamental theoretical base for bibliometric studies involving authorships. He was interested in determining "the part

which men of different caliber contribute to the progress of science" (Lotka, 1926). For this, he checked the decennial index of 'Chemical Abstracts' 1907-1916 and counted the number of names against which appeared 1,2,3 etc., entries. He tabulated the data for 6891 names beginning with letter 'A' and 'B'. Similarly the data from the Auerbach's Geschieftftafeln der physic was also collected for the 1325 physicists. Lotka then plotted the graph on a logarithmic scale, the number of authors against the number of contributions made by each author and he found that in each case the points were closely scattered about a straight line, having a slope of approximately two to one. On the basis of these data, Lotka deduced a general equation, for the relation between the frequency 'y' of persons making 'x' contributions as follows:

$$X^n y = constant$$

And for the special case n = 2, the constant is 0.6079. Further he summarised the results as follows:

"in the case examined it is found that the number of persons making 2 contributions is about one-fourth of those making one contribution, the number making 'n' contributions is about $1/n^2$ of those making one and the proportion of all contributions is about 60 per cent" (Lotka, 1926).

3.3.2 BRADFORD"S LAW OF SCATTERING

Samuel Clement Bradford (1934), another pioneer of bibliometrics, should be considered for his classic paper "Sources of Information on Specific Subjects" which is the first paper published on observations on scattering. Bradford examined two bibliographies prepared in the Science Library (Britain) on Applied Geophysics (1928) and Lubrication (1931-32) and he prepared lists of journals arranged by decreasing order of source items contributed by the journals to the bibliographies. He noticed that in each subject there were moderately productive and still a large number of sources of constantly diminishing productivity. The whole range of periodicals was thus seen as " a family of successive generations of diminishing kinship, each generation being greater in number than the preceding, and each constituent of generation producing inversely according to its degree of remoteness" (Bradford, 1934).

In the lists of periodicals ranked by diminishing productivity, Bradford identified three groups of periodicals that produced approximately the same number of articles on the

subject, but the number of periodicals in these three equiproductive zones increased by a constant zones increased by a constant factor. Based on this he stated his law as follows: "If scientific periodicals are arranged in order of decreasing productivity of articles on a given subject that may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the number of periodicals in the nucleus and succeeding zones will be as 1 : n: n^2".(Bradford, 1934).

In other words, it has been stated that 'the aggregate number of articles in a given subject, apart from those produced by the first group of large producers (periodicals) is proportion to the logarithm of the number of producers concerned, when these are arranged in order of decreasing productivity (Maheshwarappa, 1997). This may be stated differently; if periodicals contributing to a subject are ranked and then grouped in such a way that each group contributes the same number of articles, the number of periodicals in each group increase geometrically. The mathematically formulation of this law of Brookes (1968) is the one that is most easily applied in practical situations. It is expressed in two parts:

R (n) = a n^b(1<n<c) ------ (1) for the curved portion and

R (n) = k log n/s (c<n<k) ------ (2) for the linear portion of the citograph.

In cases of distribution of papers on a specified subject among periodical titles, the parameters have the following meanings:

a is the number of articles contributed by the highest ranking periodicals;

b is the rank order of periodicals;

R(n) is the cumulative sum of articles contributed by the most productive n periodicals (i.e. the periodicals of rank 1 to n)

B is the constant, if the publications considered, covers only a short time span. Its value is always less than 1; k is given by the slope of the linear portion of the Bradford-Zipf bibliography;

c   is the value of n at the point where the curve runs smoothly into the straight line portion of the bibliography, periodicals ranked 1-c constitute the core periodicals in the subject;

s   is the value of n at the intersection of the straight portion of the bibliography with the log n axis.

This scattering phenomenon otherwise be represented in the linear portion as:

F (x) = a + b log x

F (x) is the cumulative number of references contained in the first x most productive journals; a and b are constants.

The interpretations of law of scattering depend on the kind of study. Aiyeku ranked the authors according to their contributions to their contributions to a subject and has interpreted differently.

To test the applicability and validity of Bradford's law, two different formulae were used for both the data sets. Brookes (1968) formulation of the complete Bradford-Zipf distribution provides for both the verbal and graphical application of the law. Wilkinson (1972) devised a comparative test for verbal and graphical formulations utilizing the data of the same bibliography for four different subject areas.

3.3.3 ZIPF"S LAW OF WORD OCCURRENCE

Zipf (1949) developed and extended an empirical law, as observed by Estoup, governing a relation between the rank of a word and the frequency of its appearance in a long text. If 'r' is the rank of a word and 'f' is its frequency, then mathematically Zipf's law can be stated as follows:

rf = c, where 'c' is a constant.

His law states that in a long textual matter if words are arranged in their decreasing order of frequency, then the rank of any word of the text will be inversely proportional to the frequency of occurrence of the word. Thus, these three laws are respectively based on

- ➢ Number of authors contributing in a discipline or other field
- ➢ Distribution of articles in asset of journals
- ➢ Ranking word frequency in a particular set of documents (Maheshwarappa, 1997)

This law represents only approximation of the relationship between rank and frequency, which is hyperbolic. Zipf's formulation has been further refined and many generalized forms have been derived earlier. The rationale behind the rank-frequency phenomenon has been stated by Zipf as the 'Principle of least effort'(Jena, 2012). In any language, the words which have a high frequency of occurrence are those that cost less in usage or require less effort in communication. A feature of Zipf's law is that it highlights the phenomenon that once, by chance, a group has achieved a dominant position it retains that position for a long time and indeed is more likely to be promoted than the less fortunate groups (Scarrott, 1974). This feature is also known as 'success-breeds-success' phenomenon i.e. success increases the chances of further success. Zipf came to the conclusion of the 'principle of least effort' from an analysis, which had been made on the frequency of the 26,530 words used by James Joyce in comprising Ulysses. He found that the rank order of the word in the frequency list multiplied by frequency remained relatively static along the entire distribution. The tenth word in the list, for example, was used 2,653 times and the word, which ranked 1,000, was used 26 times. The law represents only an approximation between rank and frequency, which is hyperbolic (Jena, 2012).

A second law proposed by Zipf is for words of very low frequency of occurrence. Because of the abundance of words, which occur infrequently, many words will have equivalent ranks. Zipf devised a technique for ascertaining the number of words having the equivalent rank 'r'. The graphical expression of this law is a straight line. Combination of Bradford's curved initial portion with Zipf's straight-line portion produces a curvilinear graph or a bibliography, which is popularly known as Bradford-Zipf bibliography (Jena, 2012)

3.3.4 PRICE'S SQUARE ROOT LAW OF SCIENTIFIC PRODUCTIVITY

This law states that "half of the scientific papers are contributed by the square root of the total number of scientific authors" (Price, 1971). In other words, $N^{1/2}$ sources yield a fraction ½ of the items. This phenomenon is associated with the occurrence of invisible colleges. This law is sometimes called 'Rousseau's law' since Jean Jacques Rousseau had mentioned the same thing quite clearly in his 'Social Contract' about the size of the elite, i.e. those participating in the government. Egghe and Rousseau (1990) argue that Price's law is not generally valid. This can also be treated as an extension of the success –breeds-success principle originally developed by Simon in 1955 (Vijayakumar, 1997).

Another similar generalization has been observed and is known as 80/20Rule (Burrel, 1985). This rules states that 80 per cent of the total research papers in any subject field are approximately accounted by 250 per cent of the most productive authors. (Gupta, Kumar, Syed and Singh, 1997).

3.3.5. GARFIED'S LAW OF CONCENTRATION

Garfield talked about the number of journals involved in publishing the literature of a single field (Garfield, 1971). He did not say anything about how many journals in one field might overlap with other fields. In fact, there is a significant degree of overlap. Several studies have shown that relatively few journals are involved in the publishing of an overwhelming majority of the material in a subject. A study of the Science Citation Index (SCI) database showed that 500 journals accounted for 70% of the material indexed in SCI in 1969. Almost half of the 3.85 million references published that year were found to emanate from only 250 journals. This type of evidence makes it possible to move from Bradford's law of dispersion to Garfield's law of concentration.

The law states that "a basic concentration of journals is the common core or nucleus of all fields". In other words, the tail of the literature of one discipline consists, in a large part, of the cores of the literature of other disciplines. So large is the overlap among disciplines that the core literature of all scientific disciplines involves a group of not more than 1000 journals (Vijayakumar, 1997).

3.3.6 SENGUPTA'S LAW OF BIBLIOMETRICS

This is basically an extension of the Bradford's law. It states that "during phases of rapid growth of knowledge in a scientific discipline, articles of interest to that discipline appear in increasing number of periodicals distant from that field" (Sengupta, 1973). Mathematically Sengupta' law stands in the following form:

$$f(x+y) = a+b \log(x+y)$$

where $f(x+y)$ is the cumulative number of references as contained in the first $(x+y)$ most productive journals, x indicate number of journals in the same discipline and y stands for number of journals of unrelated disciplines $(y>x)$ and a and b are two constants.(Vijayakumar, 1997).

3.4. APLLICATION OF BIBLIOMETRIC LAWS

3.4.1 BRADFORD's LAW

The statistical reliability pointed out by Bradford's law provides an objective means of determining zones of relative richness or value to a given kind of acquisition process in a library collection. This has implications to the. A library can safely stock the journals which belong to the core or nuclear zone. It is advisable to extend the purchase list to the next zones till the budget limits permit. If at all the budget is elastic, a point will be reached at which it would be desirable to obtain copies of articles in the journals on demand rather than subscribing to the journal. Lancaster (1993) provides an excellent hypothetical example of applying Bradford's law in periodical collection building, while discussing the principle of diminishing returns. Brookes view that if the total expenditure on periodical provision is limited to the fraction 'f' of the sum needed to cover the subject completely, the buying of periodicals may be supplemented by the buying of photocopies of the relatively few relevant papers published in the peripheral periodicals.

While preparing bibliographies we are faced with the problems of coverage, the journals that are to be scanned etc. Bradford's distribution can be fruitfully used to estimate the total size of a bibliography and the periodicals that should necessarily be included in the list of items to be covered.

On the application side of this law, the studies of Goffman and Morris (1970) and Ravichandra Rao are significant. Goffman and Morris found that the pattern of journal usage in the Allen Memorial Library follows a Bradford distribution. Rao, through his analysis of circulation data collected from six Canadian University Libraries, proved that the rank distribution of transactions follows a Bradford distribution. Bradford's law is very much akin to the Pareto's relating to wealth distribution and the 80:20 principle used in warehouse management and the Mandelbrot distribution (Vijayakumar, 1997)

3.4.2 ZIPF'S LAW

Zipf's law can be effectively used in the generation of semi-automatic or automatic indexes useful for an information retrieval system. Its use has increased tremendously with the emergence of natural language indexing of textual matter especially in electronic form. Several studies aimed at finding out the pattern of frequency distribution of descriptors of a thesaurus and the distributions of indexing terms are available. A prominent one among them is that of Fedorowicz (1982).Zipf's law provides a measure of the richness in vocabulary of

an author. This technique can be used for deciding the correct authorship of disputed works. For example, if there is difference of opinion as to the correct author of a work, the word predilections of the attributed authors can be analysed either manually or using a computer. Once the frequencies of occurrence of favourite words are decided, the disputed text can be analysed to see similarity and thereby decide the author conclusively.

The law is also used for identifying words more frequently used in different languages and these words are taught first in the instructional programmes of foreign languages. Emile C. White observes that the super-imposition of the Bradford distribution over the linear Zipf distribution, which demonstrates the emergence of more used and popular items, may yield a technique to describe the pattern of book use by library patrons. She feels that applied to circulation data, these formulations can support such policies as shortened loan periods for heavily used books and the identification of a core collection (Vijaykumar, 1997)

3.4.3 LOTKA'S LAW

Lotka's proposition led to a whole range of studies on scientific productivity. Such productivity studies have gained impetus in the post-second world war period. This in fact, has culminated in the rise of a new discipline called Scientometrics. Scientometrics is defined as the study of the measurement of scientific and technological progress. It provides an understanding of the structure of scientific activity, the disciplines being researched, the organizations involved, the strength and deficiency in the scientific groups and their communication channels at different levels of aggregation. It follows the route of econometrics in the use of quantitative data, concepts and models and extensive use of mathematical and statistical techniques of modeling and data analysis (Vijaykumar, 1997)

Scientific productivity studies have been made from different angles. Impact of social change on scientific productivity, relationship of publication output on scientific productivity, identification of elites in different disciplines, occurrence of discoveries in different cultures etc are some of the approaches made in this line.

Price, who had traced the development of science since Babylon and plotted the growth of big science from little science had observed that Lotka's law applied equally well to the productivity of scientists in the 17th as well as in the 20th century. This meant that majority of publications emanated from a handful of people. The conclusion of an extensive review of early studies of scientific productivity made by Narin was that scientific talent was highly concentrated in a limited number of individuals (Narin, 1976).

3.5. LIMITATIONS IN APPLICATION

3.5.1 BIBLIOMETRIC LAWS

Most of the study tends to support the Bradford distribution; some other researchers could not get satisfactory results. Groos found that the scatter of research papers among physics journals deviated from that predicted by Bradford's law (Groos, 1967). Chonez (1974) tested a large number of different areas and found that the law applied in a very small proportion of them. Out of fifty bibliographies studied by him, only six followed the law. Therefore, he calls the law pseudo-scientific. However, much of the deviation is attributed to the problems of initial data collection (Vijaykumar, 1997).

In the case of Lotka's law, it was found to fit in most cases and the value of the index 'n' was found to be different for different group of scientists. Another problem with Lotka's law is that it totally ignores the potential authors who have not produced any publication so far. Because of these limitations, the empiric natures of these laws are questioned.

3.5.2 CITATION STUDIES

The logic of depending on citations which are given according to the whims and fancies of authors has been questioned by many researchers. They believe that any result that is obtained through such a study of citation leads to erroneous conclusions. Maurice B. Line is a strong votary of this point of view.

The common arguments leveled against citation analysis are the following:

> - Negative citation i.e. citing a paper just to repudiate it. The result is that controversial papers will get more citations than really worthwhile papers.
> - Too much of self-citation and in-house citations.
> - Practice or citing only to get the favours of the powerful or to appease others
> - Citation given just to dress up the paper
> - Variation of citation rate during life time of paper
> - Variation of citation rate with type of paper and speciality (Vijaykumar, 1997).

It is a fact that there are extraneous considerations in giving citations. But that does not totally undermine the value of them. As Sengupta (1974) argues, "the numbers of scientists who are capable of doing such malpractices are not significantly high to make citation studies unworkable or misleading". Further, it is too much to question the honesty and integrity of the majority of scientists.

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4.1 INTRODUCTION

The contribution study is helpful to understand research and development in subject concern at national and international level. Its relevance can be traced out so far the contribution of a group of universities located in the specific geographic area to the larger counterpart in the specific domain (Thaker et.al., 2013). Research is the primary function of universities. The qualitative research provides a pedestal to any university because research in a university speaks of the fertile minds and an environment of intellectual interactions in the university. Scientific literature is expanding very fast. It is estimated that it doubles every five years. The research productivity of universities may vary depending on their nature and involvement in research activities (Vanathi, B…. et al., 2015).

Bibliometric is an emerging thrust area of research in different branches of human knowledge since its inception. It has now become well established part of information research and a quantitative approach to the description of documents (Chaurasia, 2008) and examination of services is gaining ground both in research and practice.(Singh and Chander, 2014)

Bibliometrics has emerged as handy tool to study collection evaluation and building, ranking of journals, identification of core literature, to know the structure of literature, to know the prolific authors to observe the obsolence of literature, to study user behavior and forecast their future needs (Satija, 2004). It has become a generic term for range of approaches directed to quantify output levels, collaboration patterns and impact characteristics of scientific research. The advantage of Bibliometric data on research document is that they have great informative value and systematic comparison of scientific institutions, countries and regions across, range as scientific fields (Singh and Chander, 2014).

The evaluation of an individual or body of published work, and its impact on a field or discipline, can be time-consuming and expensive. As a result, the quantitative analysis of books, articles, or other publications, has gained ground in academia, governments, and research institutions. It appeal as a data-driven measure of productivity, influence, trends, and other factors also lies in mitigating some of the subjectivity and bias surrounding these analysis. The persistence and growth over the past two decades of tools for harnessing institution, author, journal and article level statistics; increasing scientific research output, and the explosion of online publishing, will determine whether or not some of these measures remain relevant in the future.(Berger and Baker, 2014)

Bibliometric are a series of measures used by universities, funders, ranking organizations and others to assess research output. Bibliometrics present both opportunities and challenges for accurate assessment. The process of understanding bibliometric analysis and measures can be significant given the time and expense it takes to collect, analyse, and report on this analysis. In organizations where resources are limited, staff and researcher time funds spent on research metrics has both real and opportunity costs. (Van Raan, 2007) (White paper).

All evaluations are dependent on the availability of adequate and reliable data relating to the outcome of the activities under scrutiny. Literature-based or bibliometric indicators which quantify the production and use of bibliographic material, have been used extensively in the assessment of research performance. Their use is based on the assumption that the immediate purpose of research isto produce new knowledge and that publication is the primary form of output. Publication counts serve as an indicator of the amount of new scientific knowledge produced by researchers. The impact of this new knowledge can be measured by the number of times publications have been cited by other scientists in subsequent work. A particular form of estimating the potential quality of scientific papers is to relate this to the prestige and impact levels of the journals in which these are published (Russsel and Rousseau, n.d.).

4.2. ANALYSIS AND FINDINGS

The analysis revealed a number of fruitful findings in the area of research productivity of faculty members of School of Life Sciences, Mizoram University. The major findings of the study evolved out of the analysis and interpretation of the data has been described below.

4.2.1. Number of Faculty in School of Life Sciences, Mizoram University

Table 4.1 describe the number of faculty members in School of Life Sciences, Mizoram University and the study resolved that there are total numbers of 24 faculty members during 2006-2015 and their publications were taken for the study. The faculty members have been arranged in department wise. The Department of Botany and Zoology has been established on 2005 while Department of Biotechnology was established in 2007. The Department of Botany and Zoology has two Professors and five Assistant professors and Department of Biotechnology has three Professors and four Assistant Professors during the period under the study. The three departments have one Associate Professor each in School of Life Sciences, Mizoram University. After analysis it resolved that there are total 14 (58.33%) Assistant

Professors which are highest in numbers followed by 7 (29.17%) Professors and 3(12.5%) Associate Professor in School of Life Sciences, Mizoram University, during 2006-20015.

Table-4.1: Department-wise Teaching Faculty under School of Life Sciences, Mizoram University during the study (2006-2015)

Name of the Department	Year of Establishment	Professor	Associate Professor	Assistant Professor	Total
Botany	2005	2	1	5	8(33.33%)
Biotechnology	2007	3	1	4	8(33.33%)
Zoology	2005	2	1	5	8(33.33%)
Total		7(29.17%)	3(12.5%)	14(58.33%)	24(100%)
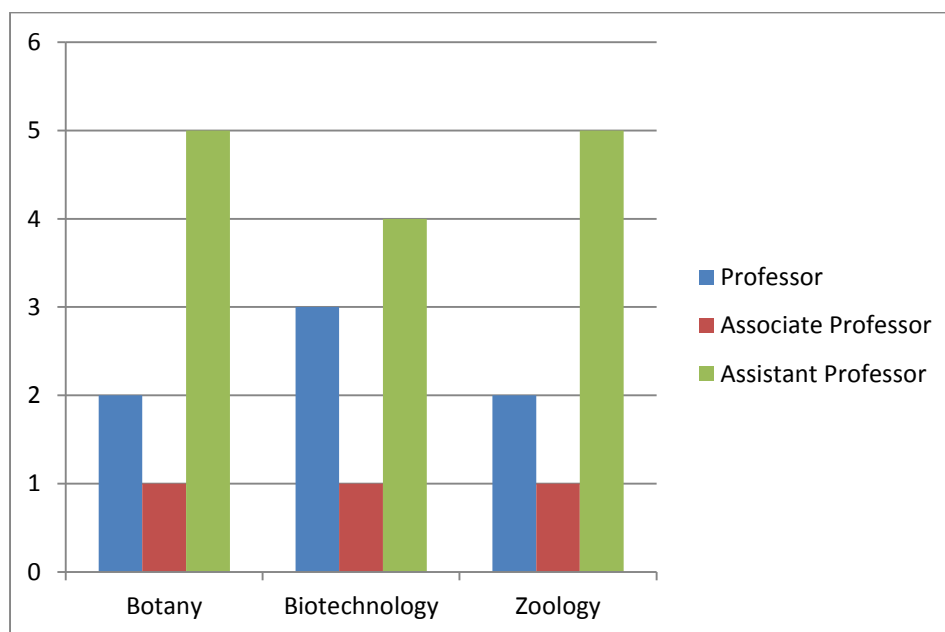
Figure-1: Teaching Faculty in School of Life Sciences, Mizoram University

4.2.2 Gender and Age wise Distribution of Respondents

Table 4.2: Gender and Age of Faculty

Gender of the Faculty		Age of the Faculties(Age Group)				Total	Percentage
		<30	31-40	41-50	>51		
	Male	0	10	6	5	21	87.5%
	Female	1	2	0	0	3	12.5%
Total		1	12	6	5	24	100%
Percentage		4.17%	50%	25%	20.83%		
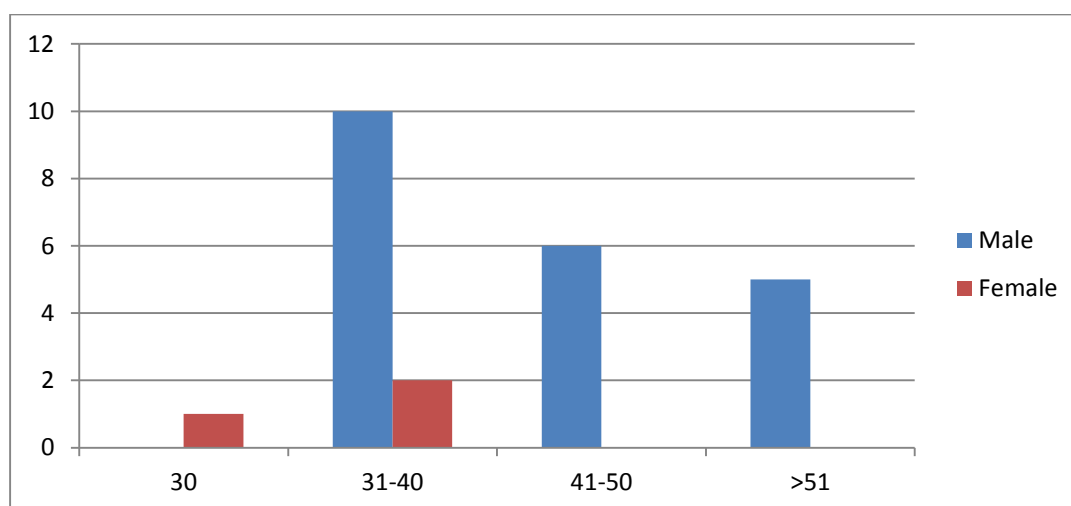
Figure-2: Gender and Age of Faculty

Personal details of the faculty have been taken from Mizoram University website (www.mzu.edu.in). Table 4.2 & Figure 2 describe gender and age of faculty and the study resolved that there are 87.5% male and 12.5% female faculties in School of Life Sciences, Mizoram University. The age of the faculty members has been divided into 4 groups i.e. less than 30, 31-40, 41-50 and more than 51. The faculty members belonging to 31-40 age are 50%, and this group is the highest in the gender age of faculty. The lowest gender age of the faculties is in group of less than 30 years i.e. 4.17%. Majority of the faculty members of School of Life Sciences, Mizoram University are younger (below than 40 years) in both the gender- male and female.

4.2.3. Academic Position and Age of Faculties

Table-4.3: Academic Position and Age of Faculties

Academic Position & Age of Faculties	Age of Faculties				Total	Percentage
	<30	31-40	41-50	>50		
Assistant Professor	1	12	1	0	14	58.33
Associate Professor	0	0	2	1	3	12.5
Professor	0	0	3	4	7	29.17
Total	1	12	6	5	24	100%
Percentage	4.17%	50%	25%	20.83%	100%	
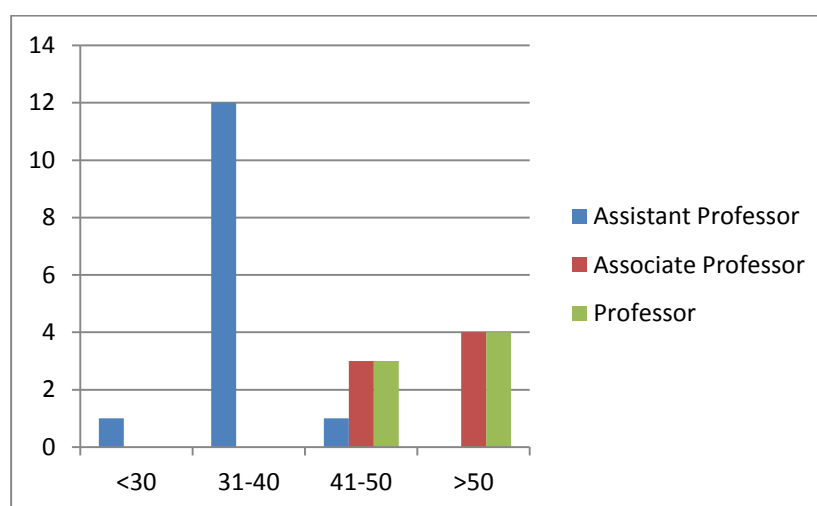
Figure-3: Academic Position and Age of Faculty

Table 4.3 & Figure 3 describe academic position and age of faculty members in School of Life Sciences, Mizoram University and it resolved that 58.33% faculty members belong to Assistant Professor followed by 29.17% Professors while Associate Professors were 12.5%. Further 4.17% belong to age group less than 30, 50% belong to 31-40, 25% belong to 41-50 age groups which included 4.16 assistant professor, 8.32% associate professor and 12.48% professor, while 20.83% belong to more than 50 age group which included 4.16% associate professor and 16.66% professors. Based on analysis it was found that up to 40 years of age group Assistant professors were more and as age increased associate professors and professors were more. Thus we can say that age is the significant factor to reaching higher academic position.

4.2.4 Academic Position vis-à-vis Academic Qualification

Table-4.4: Academic Position versus Academic Qualification

Academic Position & Age of Faculties	Academic qualifications				Total	Percentage
	Ph. D	M.Phil	Master Degrees	Others		
Assistant Professor	13	0	1	0	14	58.33
Associate Professor	3	0	0	0	3	12.5
Professor	7	0	0	0	7	29.17
Total	23	0	1	0	24	100%
Percentage	95.83%	0%	4.17%	Nil		
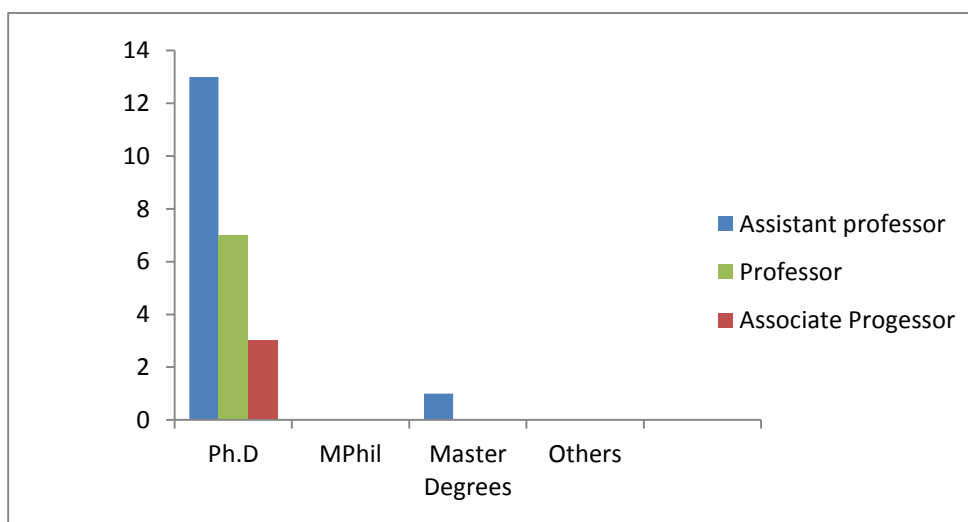
Figure -4: Academic Position versus Qualification

Table 4.4 & Figure 4 describe academic position versus qualification of faculty members in School of Life Sciences, Mizoram University and the study resolved that 58.33% belong to Assistant Professors followed by 29.17% Professors while Associate Professors 12.5% . Further 95.83% faculty members had Ph.D. degree as their highest academic qualification while 4.17% were Master Degree only. There is no M.Phil. and others qualification among the faculty members of School of Life Sciences Mizoram University. Among the Ph.D. degree holders, 56.52% belong to Assistant Professor and 30.43% belong to Professor and 13.04% belong to Associate Professors. The Master Degree holder belongs to only Assistant Professors category. In the category of Assistant Professor, 92.86% had Ph.D. degree, 7.14%

had Master Degree, while in the category of Associate Professor and Professor all had only Ph.D. degree.

4.2.5 Academic Position versus Teaching Experience

Table-4.5: Academic Position versus Teaching Experience

Academic Position	Teaching Experience (in years)							Total	%
	1-5	6-10	11-15	16-20	21-25	26-30	>31		
Assistant Professor	7	5	1	1	0	0	0	14	58.33
Associate Professor	0	2	1	0	0	0	0	3	12.5
Professor	0	1	3	1	0	1	1	7	29.17
Total	7	8	5	2	0	1	1	24	100
%	29.17%	33.33%	20.83%	8.33%	Nil	4.17%	4.17%		

Figure -5: Academic Position versus Teaching Experience

Table 4.5 & Figure 5 describe academic position versus teaching experience of faculty members in School of Life Sciences, Mizoram University and the study resolved that 58.33% faculty members belong to Assistant Professor Category followed by 29.17% Professors while Associate Professors were only 12.5%. There were 29.17% faculties had experience of 1-5 years experience in their career while 33.33% faculties belong to Assistant Professor Category had the experience of 6-10 years. 20.83% faculties had experience of 11-15 years

out of which 20%% were Assistant Professor, 20% were Associate Professor and 60%% were Professor. 8.33% had experience of 16-20 years. There is no faculty member teaching experience between 21-25 years. In the experienced group of 26-30 years and more than 31 years there were 4.17% faculty belong to only Professor Category.

4.2.6 Academic Position versus Publications (2006-2015)

Table-4.6: Academic Position versus Publications (2006-2015)

Academic Position & Age of Faculties	Publications in Numbers					Total	Percentage
	None	1-10	11-20	21-30	>30		
Assistant Professor	1	5	7	0	1	14	58.33
Associate Professor	0	2	0	0	1	3	12.5
Professor	2	0	2	0	3	7	29.17
Total	3	7	9	0	5	24	100%
Percentage	12.5%	29.17%	37.5%	0	20.83%	100%	
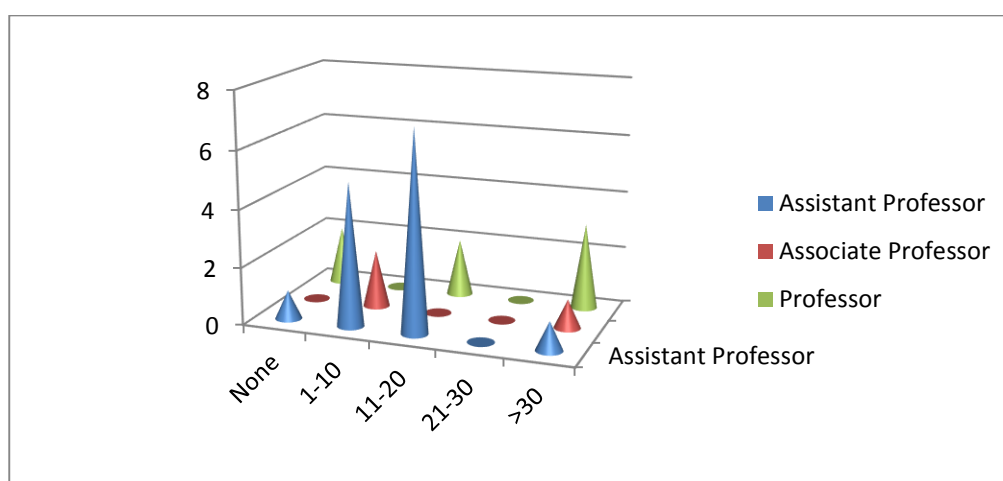
Figure-6: Academic Position versus Publications (2006-2015)

Table 4.6 & figure 6 describe the academic position versus publications of faculty members in School of Life Sciences, Mizoram University and the study resolved that 58.33% faculty members belong to Assistant Professor Category followed by 29.17% Professors while Associate Professors were only 12.5%. Designation and experience had direct relationship with the academic growth of faculty and in this regard, the study had been conducted and found that 12.5% faculties had no publication during 10years of range taken for study. There were 29.17% had total publications range from 1-10 in last ten academic years i.e 2006-2015,

out of which 71.43% belong to Assistant Professor and the rest of them belong to Associate Professor only. 37.5% faculties had publication range from 11-20, out of which 77.78% were Assistant Professor, 22.22% were Professor and Associate Professor has no publication in this category. There is no publication of faculty members in the range of 21-30. 20.83% faculties had publication range more than 30 belong to each category. Further, 66.67% faculties had publications range from 1-20 in last 10 academic years and most of them belong to Assistant Professor Category. Out of total Assistant Professor Category, 50% had publication range from 11-20 in last 10 academic years.

4.2.7 Teaching Experience versus Publications

Table-4.7: Teaching Experience versus Publications

Teaching Experience (in Years)	Publications (During 2006-2015)					Total	Percentage
	None	**1-10**	**11-20**	**21-30**	**>30**		
1-5	1	5	1	0	0	7	29.17%
6-10	1	2	5	0	2	10	41.67%
11-15	1	0	1	0	1	3	12.5%
16-20	0	0	0	0	1	1	4.17%
21-25	0	0	0	0	0	0	Nil
26-30	1	0	0	0	1	2	8.33%
>30	0	0	1	0	0	1	4.17%
Total	4	7	8	0	5	24	100%
Percentage	16.67%	29.17%	33.33%	Nil	20.83%		

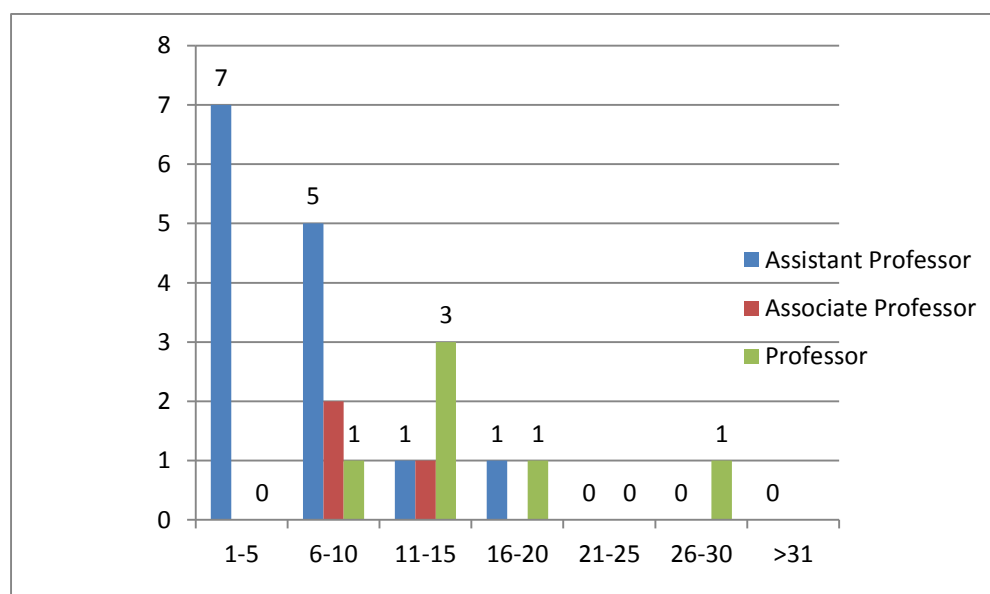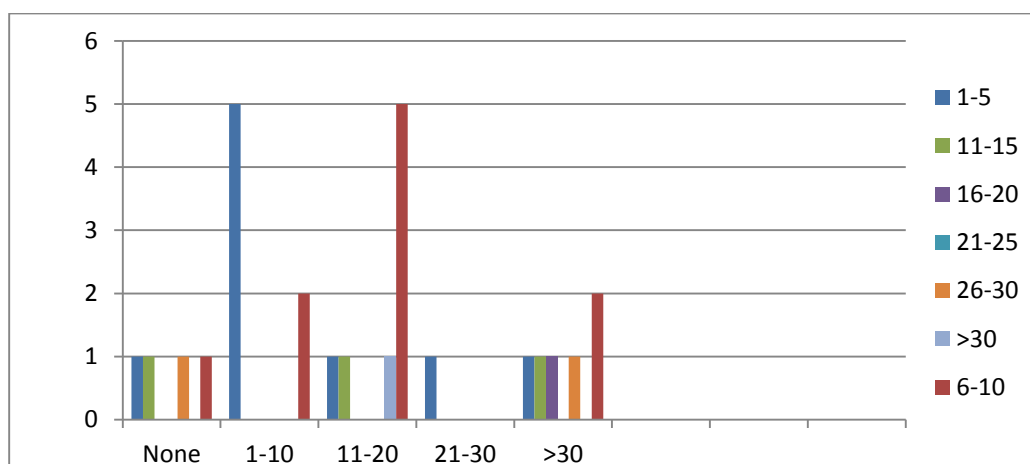**Figure-7: Teaching Experience versus Publications**

Table 4.7 & figure7 describes teaching experience versus publications of faculty members in School of Life Sciences, Mizoram University and the study resolved that out of the 24 faculty members 29.17% had 1-5 years of teaching experience, 41.67% had 6-10 years of teaching experience, 12.5% had 11-15 years of teaching experience, 4.17% had 16-20 years of teaching experience, no faculties in the category of 21-25 years of teaching experience, 8.33% had 26-30 years of teaching experience, 4.17% had more than 30 years of teaching experience. Further, on the upright analysis of table 4.7 it has been observed that 16.67 % had no any publications during 5 years of time while majority of the faculty members 29.17%had 1-10 publications during last 10 academic years. There was 33.33% faculty members had 11-20 publication during the above said period whereas no publications under 21-30 publications in said period. More than 30 publications during the last 10 academic years had been reported by only 20.83% faculty members having experience of 16-25 years. On the cross analysis of the table 4.6, it has been founded as experience increases number of productive faculty members decreases, thus reduction in total number of publications also.

4.2.8 Year wise Growth Distribution of Publications.

Table-4.8: Year wise Growth Distribution of Publications

Year of Publication	Number of Publications	Percentage	Average Growth Rate in %
2006	32	7.48	
2007	40	9.35	25
2008	48	11.21	20
2009	44	10.28	-8.33
2010	20	4.67	-54.55
2011	43	10.05	115
2012	31	7.24	-27.91
2013	48	11.21	54.84
2014	60	14.02	35.42
2015	62	14.48	3.33
TOTAL	428	100	
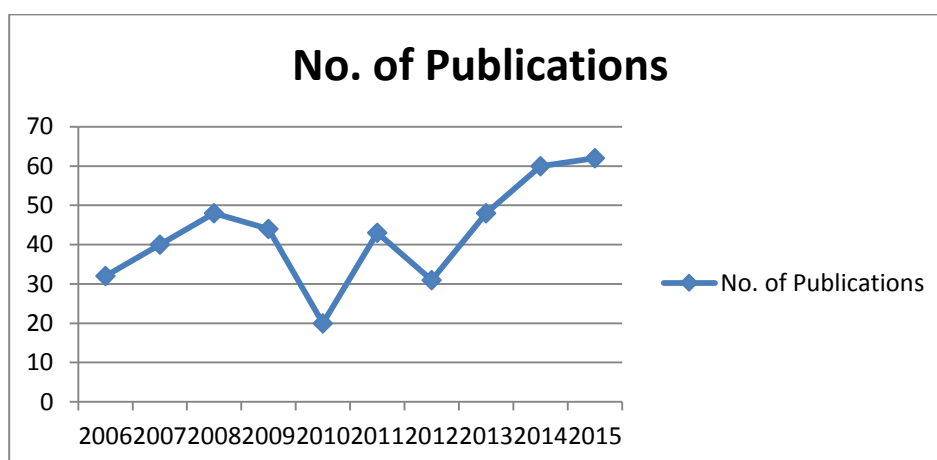
Figure-8: Year wise growth Distribution of Publications

Table 4.8 & figure 8 describe year wise distribution of publications in School of Life Sciences, Mizoram University and the study resolved that out of total 428 publications maximum number of 62 (14.48%) papers are published in 2015, followed by 2014 (14.02%), 2008 and 2013 have same number of publications (11.21%), 2009 (10.28%), 2011 (10.05%) and 2006, 2007, 2010, 2012 have less than 10%. An average article published per year is 42.8 with annual growth rate of 18.09%.The Department of Zoology had the highest average

publications (63.19%) output per faculty member during the period, while the Department of Botany had the lowest i.e. 11.90% per faculty member.

4.2.9 Form of Publication

The productivity of faculties of School of Life Sciences in Mizoram University are spread over a variety of publications like journal articles, books, books chapters, conference proceedings, and other publications. The distribution of items by document type is illustrated in Table 4.9and gives a clear picture of the different bibliographic forms of literature. A total number of 428 items are identified under five categories of forms of publication produced by faculty members.

Table-4.9: Distribution of Items by Type of Documents

Sl. No	Year	Publication			Total
		Papers in Journal	Papers in Conference/Seminar/ Proceedings	Papers in Books/Edited Books	
1	2006	22(7.00%)	5(8.20%)	5(9.26%)	32(7.48%)
2	2007	37(11.78%)	Nil	3(5.55%)	40(9.34)
3	2008	41(13.06%)	2(3.28%)	5(9.26%)	48(11.21%)
4	2009	29(9.23%)	10(16.39%)	5(9.26%)	44(10.28%)
5	2010	12(3.82%)	6(9.84%)	2(3.70%)	20(4.67%)
6	2011	28(8.92%)	13(21.31%)	2(3.70%)	43(10.05)
7	2012	26(8.28%)	3(4.92%)	2(3.70%)	31(7.24%)
8	2013	24(7.64%)	10(16.39%)	14(25.92%)	48(11.21%)
9	2014	40(1.27%)	12(19.67%)	8(14.81%)	60(14.02)
10	2015	55(17.52%)	Nil	7(12.96%)	62(14.48%)
	Total	314	61	54	428
	Percentage	73%	14%	13%	100%
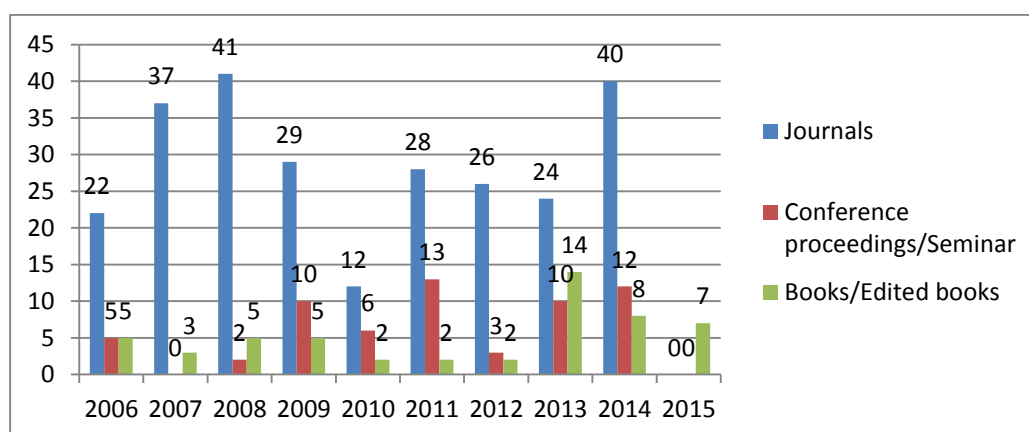
Figure-9: Distribution of Items by Type of Documents

63

Table 4.9& figure 9 describes distribution of items by type of document of faculty members in School of Life Sciences, Mizoram University and it resolved that papers in Journals are the main vehicle of information transfer of faculty members, which accounts 73%, followed by conference/seminar and proceedings 14%. Books and Papers in Edited Books are in the third position with 13% items. In the year 2015 the publication of faculty in papers in journals is the highest of 17.52%, while conference proceedings and seminar papers are highest produced in the year 2011 with 21.31% publication in number. Books or edited books highest published in the year 2013 with25.92% publications.

4.2.10 Department wise Growth of Publications

Table 4.10 &figure 10 describe department wise growth in publication during 2006-2015 of faculty members in School of Life Sciences, Mizoram University and the study resolved that the annual publications output of faculty members from 2006-2015 inclusive by the department. In this analysis literature published by faculty members before joining Mizoram University has not been taken into consideration.

Table-4.10: Department wise Growth in Publications during 2006-2015

(Note: Some authors have collaboration with another department faculty that why total no has increased)

Sl no	Year	Biotechnology	Botany	Zoology	Total
1	2006	Nil*	10(15.38%)	22(6.38%)	32
2	2007	7(5.15%)	7(10.77%)	27(7.83%)	41
3	2008	5(3.68%)	13(20%)	34(9.85%)	52
4	2009	12(8.82%)	5(7.69%)	37(10.73%)	54
5	2010	4(2.94%)	2(3.08%)	17(4.93%)	23
6	2011	24(17.65%)	4(6.15%)	38(11.01%)	66
7	2012	13(9.56%)	6(9.23%)	24(6.96%)	43
8	2013	18(13.23%)	12(18.46%)	33(9.56%)	63
9	2014	25(18.38%)	1(1.54%)	59(17.10%)	85
10	2015	28(20.59%)	5(7.69%)	54(15.65%)	87
	TOTAL	136	65	345	546*
	%	25	12	63	100

(*Department of Biotechnology has started in 2007)
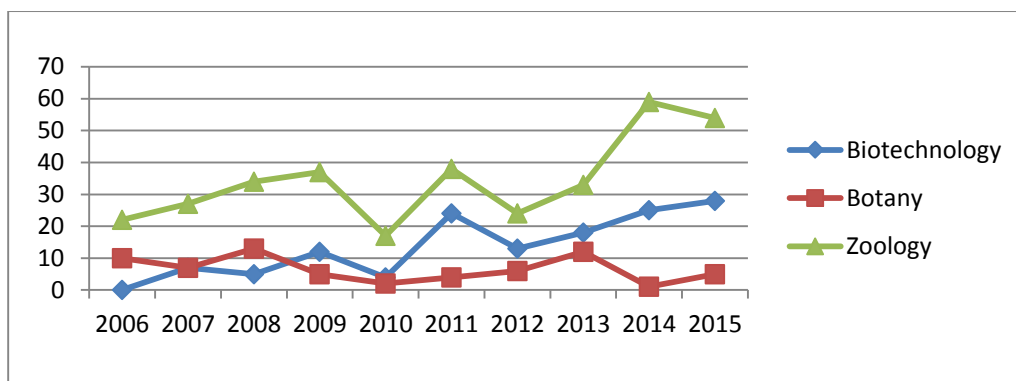
Figure-10: Department wise Growth in Publications

Faculty members of the Department of Zoology recorded the highest number of publications, which accounted for 63% of the total publications. Faculty members from the Department of Biotechnology published 25% and faculty members from the Department of Botany published 12% of the total publications. The department of Biotechnology has no publication in the year 2006 because it was established only on 2007. In 2015 the department of Biotechnology produced the highest publication as compared to the previous year. The growth rate of publication of Biotechnology department is increasing year wise from 2011 except in 2012. In Botany Department, publication is highest in the year 2013 having 18.46%. The growth rate of this department is insufficient in comparison to zoology and biotechnology departments. On the observation of table, Zoology department has got the highest publication in the year 2014 with 17.10%, but the growth rate of this department is also inadequate in comparison to Biotechnology.

4.2.11 Department wise Publications output per Faculty Members

Table-4.11: Publications output per Faculty Members

Sl No	Department	No. of Publications (N=546*)	Number of Faculty members	Publication per Faculty member
1	Biotechnology	136	8	24.90%
2	Botany	65	8	11.90%
3	Zoology	345	8	63.19%
	Total	546*	24	100%

(*Note: Total publication is increased due to joint authorship among faculties)

Table 4.11 describe publications output of each department in relation to the numbers of faculty members in School of Life Sciences during years 2006-2015and the study resolved that the Department of Zoology had the highest average publications output per faculty i.e.

63.19% during this period, followed by Biotechnology 24.90% per faculty publication while the Department of Botany had the lowest per faculty publication with 11.90%.

4.2.12 Faculty wise Publications in School of Life Science during 2006-2015

Table-4.12: Faculty wise Publications during 2006-2015

Sl no	Name of the Faculty	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
A	**Department of Biotechnology**											
1	N. Senthil Kumar	-	4	5	9	3	19	9	8	17	22	96
2	J. Bhattacharya	-	1	0	2	0	0	0	0	0	0	3
3	Th. Robert Singh	-	0	0	1	0	3	4	6	4	0	18
4	B.P. Singh	-	2	0	0	1	2	0	4	4	3	16
5	H. Lalhruaitluanga	-	0	0	0	0	0	0	0	0	1	1
6	Esther Lalnunmawii	-	0	0	0	0	0	0	0	0	2	2
7	D.N. Tiwari	-	0	0	0	0	0	0	0	0	0	0
8	Satpal Singh Bisth	-	0	0	0	0	0	0	0	0	0	0
B	**Department of Botany**											
1	S.K. Mehta	1	3	5	0	0	0	0	3	0	0	12
2	R.C. Laha	2	0	2	0	0	3	0	2	0	2	11
3	F. Lalnunmawia	0	0	0	0	0	0	3	4	0	2	9
4	R. Lalfakzuala	5	1	2	0	0	0	0	1	1	1	11
5	J. Lalbiaknunga	0	0	0	0	0	0	0	0	0	0	0
6	Yengkhom Tunginba Singh	0	0	0	0	0	1	1	1	0	0	3
7	Khomdram Sandhyarani Devi	0	0	0	0	0	0	2	1	0	0	3
8	A.K. Srivastava	2	3	4	5	2	0	0	0	0	0	16
C	**Zoology**											
1	G.C. Jagetia	14	7	6	1	1	2	4	3	12	18	68
2	G.S. Solanki	1	3	5	3	2	6	4	9	11	7	51
3	G. Gurusubramanian	7	11	20	29	12	22	9	8	18	14	150
4	H.T. Lalremsanga	0	5	2	4	2	3	1	6	4	4	31
5	Esther Lalhmingliani	0	1	0	0	0	2	3	2	3	1	12
6	Vikas Kumar Roy	0	0	1	0	0	3	2	3	4	2	15
7	Zothansiama	0	0	0	0	0	0	1	2	3	4	10
8	Amit Kumar Trivedi	0	0	0	0	0	0	0	0	4	4	8
	Total	**32**	**41**	**52**	**54**	**23**	**66**	**43**	**63**	**85**	**87**	**546***

(*Note: Total publication is increased due to joint authorship among faculties)

Table 4.12.describe the faculty wise publication 2006-2015 in School of Life Sciences, Mizoram University and the study resolved that the publication of faculty during the study is increasing year wise. In department of Biotechnology S. Senthil Kumar has highest publications (96) followed by Th. Robert Singh (18), B.P. Singh (16) while other faculties have very less publications during time frame of study. In Department of Botany A.K. Srivastava has highest publications (16) followed by S.K. Mehta (12), R.C. Laha(11), R. Lalfakzuala (11) and F. Lalnunmawia (9). Other faculties have very less publications. In

Department of Zoology G. Gurusubramanian has highest publications (150) followed by G.C.Jagetia (68), G.S. Solanki (51), H. T. Lalremsanga (31) and Vikas Rai (15). S.Senthil Kumar has published highest publication (22) in 2015 while AK Srivastava has highest publications (5) in 2009 and G. Gurusubramaniam has also highest publications (29) in 2009.

4.2.13. Most Prolific Authors

Table 4.13 describe the most prolific authors of faculty members in School of Life Sciences, Mizoram University, it gives the list of prolific authors in terms of productivity count during 2006-2015 and their Department affiliations thereof. The list is ranked in the order of decreasing productivity.

Table -4.13: Most prolific Authors in School of Life Sciences

Sl. No.	Name of the Faculty	No. of Publication (n=546*)	Percentage	Ranking	Department
1	G.Gurusubramanian	150	27.47	1	Zoology
2	N. Senthil Kumar	96	17.58	2	Biotechnology
3	G.C Jagetia	68	12.45	3	Zoology
4	G.S. Solanki	51	9.34	4	Zoology
5	H.T. Lalremsanga	31	5.68	5	Zoology
6	TH Robert Singh	18	3.3	6	Biotechnology
7	B.P. Singh	16	2.93	7	Biotechnology
8	A.K.Srivastava	16	2.93	7	Botany
9	Vikas Kumar Roy	15	2.75	8	Zoology
10	Esther Lalhmingliani	12	2.20	9	Zoology
11	S.K. Mehta	12	2.20	9	Botany
12	R.C.Laha	11	2.01	10	Botany
13	R.Lalfakzuala	11	2.01	10	Botany
14	Zothansiama	10	1.83	11	Zoology
15	F. Lalnunmawia	9	1.65	12	Botany
16	Amit Kumar Trivedi	8	1.47	13	Zoology
17	J. Bhattacharya	3	0.55	14	Biotechnology
18	Khomdram SandhyraniDevi	3	0.55	14	Botany
19	Yengkhom Tunginba Singh	3	0.55	14	Botany
20	Esther Lalnunmawii	2	0.37	15	Biotechnology
21	H. Lalhruaitluanga	1	0.18	16	Biotechnology
22	D.N. Tiwari	0	Nil	17	Biotechnology
23	Satpal Singh Bisht	0	Nil	17	Biotechnology
24	J. Lalbiaknunga	0	Nil	17	Botany

(*Note: Total publication is increased due to joint authorship among faculties)

Table-4.13 shows the ranking of most prolific authors in school of life sciences, Mizoram University and after analysis it resolved that among top five most prolific authors, four are belong to zoology department including topmost. G. Gurusubramanian, Department of Zoology got first rank with 27.47% publications, followed by N. Senthil Kumar, Department of Biotechnology occupying the second rank in the list with 17.58% contributions, G.C. Jagetia, Department of Zoology got third rank with 12.45% contributions, G.S. Solanki, Department of Zoology got the fourth position with 9.34% contribution and H.T. Lalremsanga, Department of Zoology got 5th rank with 5.68% publication contribution. Among the faculties, D.N. Tiwari, Satpal Singh Bisht and J. Lalbiaknunga have no publication during the period under the study and among them; first two faculties were available in the department one year only.

4.2.14 Authorship pattern and Degree of Collaboration

4.2.14 A Authorship Pattern

Table 4.14A & figure 11 describe authorship pattern and publications of faculty in School of Life Sciences, Mizoram University and the study resolved that out of 428 publications 32% have been contributed by three authors, followed by two authors 23.83%, four authors 14.72% and five authors 10.98%. It has been observed that only 9.58% publications are single authored and 4.91% publications are authored by seven or more than seven authors while 3.97% publications were authored by six authors. Majority of publications are multi authored shows that school of life sciences faculties prefers collaborative research because it shows that the multiple authorship rates are increasing almost double whereas the single authorship is in the same range.

During the analysis it was found that one article entitled "Understanding Darjeeling tea flavour on a molecular basis" was authored by 14 authors who were published in Journal 'Plant Molecular Biology', 78(6) in April 2012.

TABLE 4.14A: Authorship Pattern and Publications

Sl no.	Year	*Single*	*Two*	*Three*	*Four*	*Five*	*Six*	*>=Seven*	Total	%
1	2006	5	6	6	4	7	2	2	32	7.48%
2	2007	3	7	12	8	5	2	3	40	9.35%
3	2008	3	8	19	7	8	0	3	48	11.21%
4	2009	4	9	24	3	2	0	2	44	10.28%
5	2010	5	1	10	3	0	1	0	20	4.67%

6	2011	3	14	13	8	4	1	0	43	10.05%
7	2012	1	11	12	2	3	0	2	31	7.24%
8	2013	8	17	13	2	4	2	2	48	11.21%
9	2014	6	7	17	15	9	4	2	60	14.02%
10	2015	3	21	11	10	6	5	6	62	14.48%
		41	101	137	62	48	17	22	428	100%
Percentage		9.58	23.60	32.01	14.48	11.21	3.97	5.14		
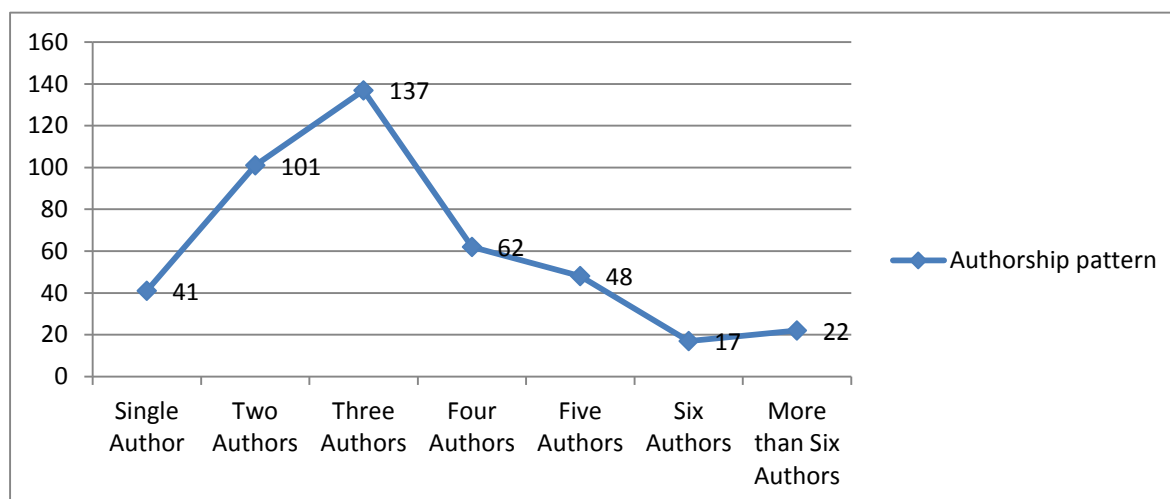
Figure-11: Authorship Pattern

4.2.14B Degree of Collaboration

The Degree of Collaboration is used for describing the prominent area of inquiry in bibliometric studies indicating the trend in patterns of single and joint authorship in the publication. The degree of collaboration among authors is the ratio of the number of collaborative publications to the total number of publications published in a discipline during certain period of time (Jeyshankar and Abu, 2014). A mathematical formula given by K. Subramayam was used to determining the degree of collaboration in publications of faculties in school of life sciences, Mizoram University which is mention below:

$$DC = \frac{N_M}{N_M + N_S}$$

(Where- DC = Degree of Collaboration; N_M = Number of multiple authors and N_S = Number of single authors)

Table-4.14:B.Degree of Collaboration

Sl. No.	Year	Single Authored Publications(Ns)	Multiple Authored Publications (Nm)	Nm+Ns	Degree of Collaboration DC=Nm/(Nm+Ns)
1	2006	5	27	32	0.87
2	2007	3	37	40	0.93
3	2008	3	45	48	0.94

4	2009	4	40	44	0.91
5	2010	5	15	20	0.75
6	2011	3	40	43	0.93
7	2012	1	30	31	0.97
8	2013	8	40	48	0.83
9	2014	6	54	60	0.9
10	2015	3	59	62	0.94
		41	387	428	0.9

Table 4.14.B describe degree of collaboration of faculty members in School of Life Sciences, Mizoram University and after analysis it resolved that the Degree of Collaboration (DC) in publications of faculties in school of life sciences in average is 0.9 (nearly equal to 1)which shows high collaborative research and less single publications attitudes of faculties. The publications published by single author during ten years are only 41 and multiple authors during the same period are 387. The table shows that in 2006, 2010 and 2013 it was slightly decreased from 0.9 but in 2007, 2008, 2009, 2011,2012, 2014 and 2015 found in high degree i.e. 0.9 – 0.97.

4.2.14C Analysis of Research Collaboration

Researchers share and exchange knowledge and techniques through collaboration that bring in a mixture of positive scientific thoughts and decrease cost at the same time (Sevukan etal.2007). Multi authorship necessarily increases productivity and always results in high citation impact.

Table-4.14.C: Year-wise Analysis of Collaboration Trends

Year	IC	%	NC	%	LC	%	Total	%
2006	2	11.11	24	10.39	1	3.35	27	6.98
2007	5	27.8	30	12.99	2	2.79	37	9.56
2008	6	33.33	36	15.58	3	3.35	45	11.63
2009	0	Nil	30	12.99	10	7.82	40	10.33
2010	0	Nil	13	5.63	2	3.91	15	3.87
2011	1	5.55	15	6.49	24	15.08	40	10.33
2012	1	5.55	18	7.79	11	6.70	30	7.75
2013	1	5.55	21	9.09	18	14.52	40	10.33
2014	1	5.55	23	9.96	30	20.11	54	13.95
2015	1	5.55	21	9.09	37	22.35	59	15.24
Total	18	100	231	100	138	100	387	100

	4.21%	53.97%	41.82%	100%	

**(IC–Collaboration at InternationalLevel; NC–Collaboration at National Level and LC –
Collaboration at Local Level)**
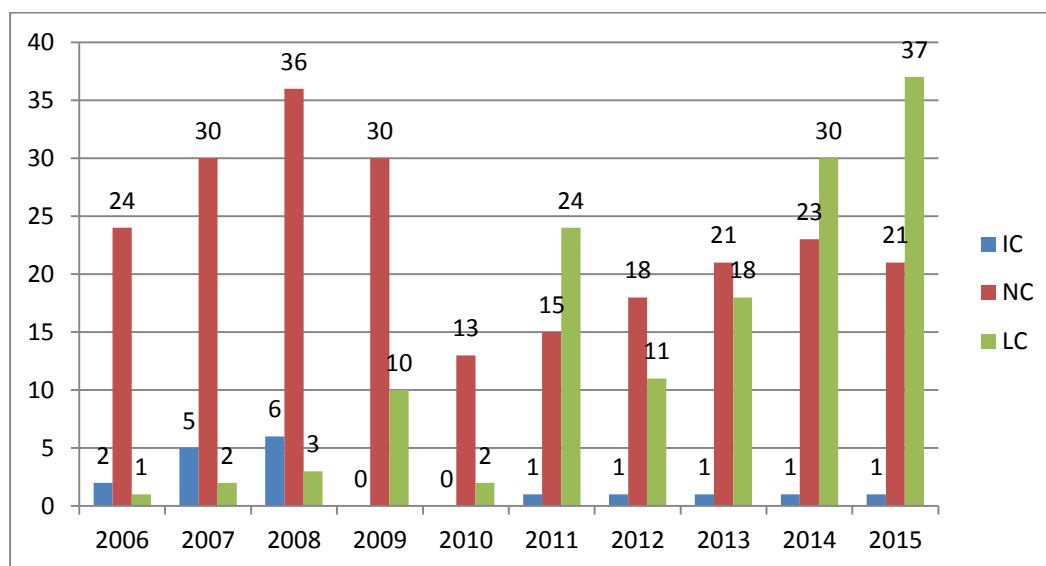
Figure-12: Year wise analysis of collaboration trends

Table 4.14.C& Figure 12 describe year-wise analysis of collaboration trends among the faculties publications of School of Life Sciences, Mizoram University and study resolved that national collaboration is the highest (53.97%) followed by local collaboration (41.82%). In the period of ten years, 2015 was found to be the highest productive when the percentage of international collaboration was 5.55%, national collaboration was 9.09% and local collaboration was 22.35%. International collaboration was again 27.8% and 11.11% in 2007 and 2006 respectively. There was no international collaboration in the year 2009 and 2010. National Collaboration and Local Collaboration is lowest in 2010.

4.2.15 Collaboration Coefficient (CC) of Faculties Publications

Ajiferuke and others stated that the degree of collaboration does not differentiate in level of multiple authorship publications. They shown that proportion of multiple authorship as measure to calculate degree of collaboration in discipline is insufficient and they suggested an alternative measure to calculate degree of collaboration called Collaborative Coefficient

(CC) (Jena, Kamal Lochan, 2012). It indicates the weighed proportion of single and multiple authors and it weighed measure of multiple authorship. When CC is 0, it indicates that the total citations are single-authored. If a paper has a single author, the author has given one credit, if two authors, each receives ½ credit, and in general if we have 'n' authors each receives 1/n credits. Hence, average credit awarded to each author of random paper is E(1/n), a value which lies between zero and one, and if zero it corresponds to single authorship, then the collaborative coefficient is defined as

$$CC = 1 - E(1/n)$$

Its sample estimate is

$$CC = 1 - (f_1 + 1/2f_2 + ---- + (1/K) f_k)/N$$

$$K = [1 - E(1/j) f_j]/N$$

$$j = 1$$

Where, fj= Number of J-authored research papers published in a discipline during a certain period of time

N = Total number of research papers published in a discipline during a certain period of time; and

K = Greatest number of authors per paper.

This type of formulation determines the trends of research in a particular discipline to bring out the type of research whether single or team research prevalent in the fields under the study.

Table-4.15: Collaboration Coefficient of Faculties Publications

Faculty members	Total Number of authorship					Total number of Papers	C.C
	1	2	3	4	>=5		
N. Senthil kumar	1	8	29	20	38	96 (17.52%)	0.99
J Bhattacharya	0	0	2	0	1	3 (0.55%)	1
Th Robert Singh	5	10	1	2	0	18 (3.47%)	0.68
B.P.Singh	3	2	1	4	6	16 (2.92%)	0.81
H Lalhruaitluanga	0	0	0	0	1	1 (0.18%)	1
Esther Lalnunmawii	0	0	0	0	2	2 (0.36%)	1

D.N.Tiwari	0	0	0	0	0	0 (0%)	0
Satpal Singh Bisht	0	0	0	0	0	0 (0%)	0
S.K.Mehta	0	0	6	2	4	12 (2.19%)	1
R.C. Laha	3	8	0	0	0	11 (2.01%)	0.73
F. Lalnunmawia	3	2	3	1	0	9 (1.64%)	0.67
R Lalfakzuala	0	1	5	1	4	11 (2.01%)	1
J Lalbiaknunga	0	0	0	0	0	0 (0%)	0
Y.T.Singh	0	0	1	1	1	3 (0.55%)	1
K.S. Devi	0	2	1	0	0	3 (0.55%)	1
A.K. Srivastava	4	1	0	4	7	16 (2.92%)	0.75
G.C. Jagetia	16	27	11	6	8	68 (12.41%)	0.76
G.S. Solanki	4	17	26	3	1	51 (9.31%)	0.92
G. Gurusubramanian	2	17	66	30	35	150 (27.55%)	0.99
H.T. Lalremsanga	0	4	11	2	14	31 (5.66%)	1
Esther lalhmingliani	0	0	1	2	9	12 (2.19%)	1
V.K. Roy	0	8	6	0	1	15 (2.74%)	1
Zothansiama	0	6	2	0	2	10 (1.82%)	1
A.K.Trivedi	0	1	2	3	2	8 (1.46%)	1
Total	41	114	174	81	136	546 (100%)	
Authorship pattern	82	228	348	162	607	1427	
Percentage	5.75	15.98	24.39	11.35	42.54		

Table 4.15 describe productivity of faculty members in author wise distribution and collaboration coefficient in School of life sciences and analysis resolved that one credit has been assigned to each collaborator 1427 authors (as shown in table 18) have contributed 546 items. The calculation of collaborative coefficient has been done on the basis of earlier study of Choudhari and Borse, 2015. The collaborative index is 2.61. G.C. Jagetia has published the highest publications i.e. 16 publications in first authored publications, followed by Th. Robert Singh while in multi authored publications G. Gurusubramanian and N. Senthil Kumar has 148 and 95 publications respectively with collaborative coefficient of 0.99, and G.C Jagetia has 52 publications with collaborative coefficient of 0.76. Highest more than 5 authored publications have been found in38 publications of N.Senthil Kumar with collaborative coefficient of 0.99 followed by 35 publications of G.Gurusubramanian with collaborative coefficient of 0.99.

4.2.16 Preferred Journals of Publications

The favorite journals in which faculty prefers to publish their research publications are called preferred or productive journals. Each faculty may have their own preferred journal which they publish their research publication. Table 4.16 describe the top five preferred journals in which faculties members of Life Sciences school publish their publication and after analysis it is found that the 'Science Vision' gets the most productive journal in number of publications to be published with 32 (10.19%) titles in its share followed by 'Science and technology journal' with 7(2.23%) titles. The faculties published their works in 192 different journals, the total publications output published in journals were 314 titles out of which 138 titles have been published in different journals. Resistant Pest Management Newsletter got the third rank with 6 (1.91%) titles and Mitochondrial DNA was in 4th rank with 5(1.59%) titles while in 5th ranks there were four journals (Current Science, Genomics Data, International Journal of Ecology and Environmental Science and International Multidisciplinary Research Journal) because all these journal have same publications i.e. 4 (1.27%).

Table-4.16: Most Preferred Journals

Sl. No.	Name of preferred journal	No. of Publications	%	Rank
1	Science vision	32	10.19	**1**
2	Science & Technology Journal	7	2.23	**2**
3	Resistant Pest Management Newsletter	6	1.91	**3**
4	Mitochondrial DNA	5	1.59	**4**
5	Current Science	4	1.27	**5**
6	Genomics Data	4	1.27	**5**
7	International Journal of Ecology and Environmental Science	4	1.27	**5**
8	International Multidisciplinary Research Journal	4	1.27	**5**

4.2.17 Geographical Distribution of Publications

Table -4.17: Geographic Distribution of Publications

Sl. No.	Name of Country	No. of Publications	Percentage
1	India	233	54.44%
2	USA	61	14.25%
3	UK	30	7.00%
4	Netherlands	25	5.84%

5	Germany	23	5.37%
6	Japan	8	1.87%
7	Nigeria	7	1.645
8	Switzerland	5	1.17%
9	Nepal	5	1.17%
10	UAE	4	0.93%
11	Pakistan	3	0.7%
12	China	3	0.7%
13	Czech Republic	2	0.47%
14	France	2	0.47%
15	Korea	2	0.47%
16	New Zealand	2	0.47%
17	Poland	2	0.47%
18	Canada	1	0.23%
19	Bangladesh	1	0.235
20	Bulgaria	1	0.23%
21	Greece	1	0.235%
22	Ireland	1	0.235%
23	Kenya	1	0.235%
24	Mexico	1	0.235%
25	Singapore	1	0.23%
26	Romania	1	0.23%
27	Serbia	1	0.23%
28	Turkey	1	0.23%
Total		**428**	**100**
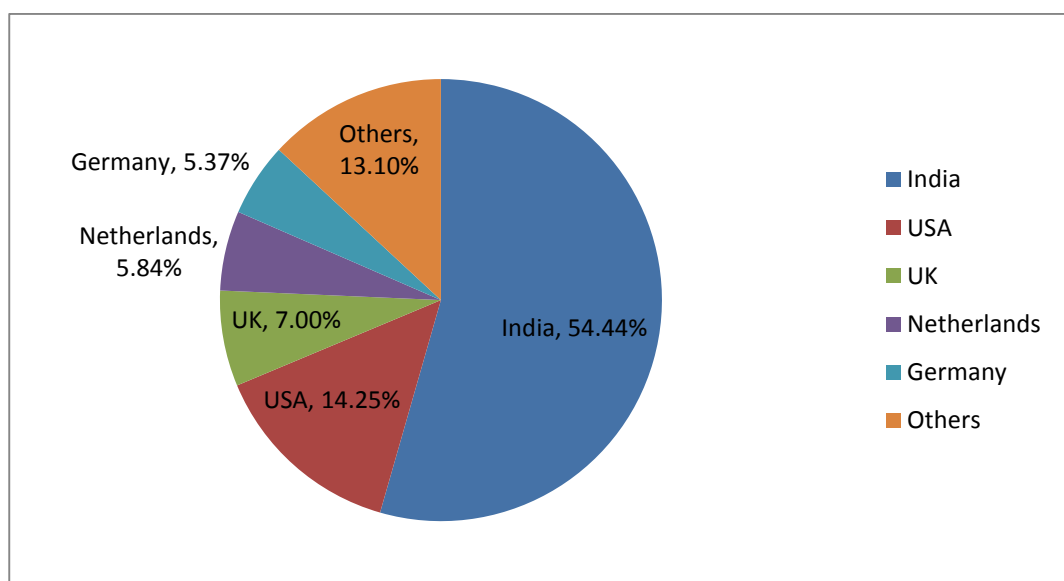
Figure-13: Geographic Distribution of Publications

Table 4.17 & figure 13 described the geographical distribution of publications of faculties of School of Life Sciences, Mizoram University and analysis resolved that the maximum number of publications of faculties published from India constituting 54.44% of total publications followed by USA (14.25%), UK (7%), Netherlands (5.84%) and Germany (5.37%) respectively. The rest 13.10% publications of faculties scattered in many countries in small-small numbers as listed in table. It has been concluded that India, USA and UK which shares the first three ranks countries accounted collectively for 3/4th of the total publications. The rest 1/4th of the periodicals are from 25 countries (28-3 = 25).

4.2.18 Author Productivity

Table 4.18 and figure14describe the author productivity in publication of faculties of School of Life Sciences, Mizoram University and the study resolved that a total of 1427 authors produced 428 with an average of 0.30authors. Number of total unique authors are 361.

Table-4.18: Author productivity

Year of Publication	Number of Publication	Number of Authors	Average Publication Per Author
2006	32	113	0.28
2007	40	145	0.28
2008	48	167	0.29
2009	44	132	0.33
2010	20	55	0.36
2011	43	128	0.34
2012	31	106	0.29
2013	48	139	0.35
2014	60	217	0.28
2015	62	225	0.27
Total	428	1427	0.30
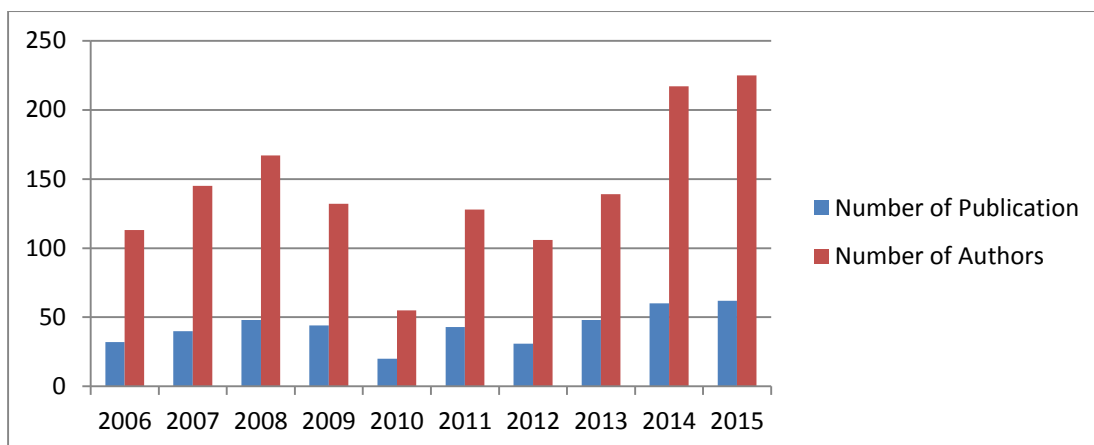
Figure-14: Author Productivity

4.2.19 Lotka's law of Productivity

'Scientific productivity' is frequently measured in terms of published output, mostly because the data on the number of publications by authors can be easily collected and are quite reliable (Kumar and Naqvi). The Lotka's laws have been developed to calculate the frequency and distribution of scientific productivity. Alfred Lotka in 1926 had given Lotka's law to describe the frequency of publication by authors in a given field. Lotka's law states that "the number (of authors) making 'n' contributions is about 1/n2 of those making one; and the proportion of all contributors that make a single contribution is in all the region of 60 percent".

This law implies that among all the authors in a given field, 60 percent will have single publication, 15 percent will have two publications (1/32 times 0.60), and so on. Hence, Lotka's proposed the following inverse square law of scientific productivity.

an = c/nb   (1)

Where   c>0, b>1

c – is a constant

n – 1,2,3,……….n

b – characteristics exponent of the distribution for a set of data and

an – number of authors contributing n number of paper each.

Table-4.19A: Number of articles published by number of authors during 2006-2015

Number of articles published	Number of authors making the stated number of contributions	Percentage of all authors

1	201	55.68%
2	59	16.34%
3	29	8.03%
4	14	3.88%
5	8	2.22%
6	6	1.66%
7	4	1.11%
8	8	2.22%
9	1	0.28%
10	6	1.66%
11	4	1.11%
12	6	1.66%
13	3	0.83%
14	1	0.28%
15	1	0.28%
16	2	0.55%
18	1	0.28%
31	1	0.28%
35	1	0.28%
41	1	0.28%
51	1	0.28%
68	1	0.28%
96	1	0.28%
150	1	0.28%
546	361	100%

Table 4.19A described number of articles published by number of authors making stated numbers of contributions during 2006-2015 in School of Life Sciences, Mizoram University and analysis resolved that 361 authors produced 546 publications. It also provides a basis for testing the application of Lotka's law. When Lotka's equation is applied to the data in table 4.19.A, it is found that:

$$X = Y/n^2 \text{ (here } Y = 201)$$

Table-4.19B: Application of Lotka's Law

Results of Lotka's equation	Observed values from Table 19A
For $n = 1$: $X = 201/^2 = 201$	201

For n = 2: X = 201/2^2 = 201/4 = 50	59
For n = 3: X = 201/3^2 = 201/9 = 22	29
For n = 4: X = 201/4^2 = 201/16 = 13	14
For n = 5: X = 201/5^2 = 201/25 = 8	8
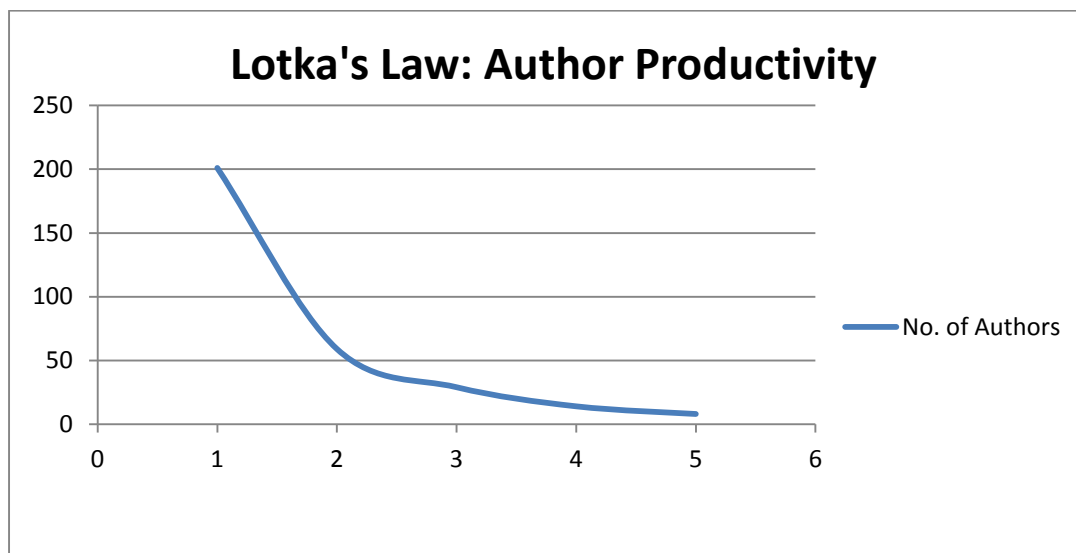
Figure-15: Lotka's Law of Author Productivity

Table.4.19.B and figure 15 describe the Lotaka's law application on publication of faculty members and values derived from the application of Lotka's equation are nearly equal to the observed values (i.e. 201, 59, 29, 14, 8) Therefore, Lotka's Law was applicable in publication of faculty members in School of Life Sciences, Mizoram University.

4.2.20 Price Square Root Law of Scientific Productivity

This law states that "half of the scientific papers are contributed by the square root of the total number of scientific authors" (D. Solla Price). In other words, $N^{1/2}$ sources yield a fraction ½ of the items.

Table-4.20A: Distribution of publications in Life Sciences, MZU

No. of papers	No. of authors	Percentage	Total Contributions	Percentage of Contributions
0	3	12.5%	0	Nil
1	1	4.17%	1	0.18%
2	1	4.17%	2	0.37%

3	3	12.5%	3	0.55%
8	1	4.17%	8	1.46%
9	1	4.17%	9	1.65%
10	1	4.17%	10	1.83%
11	2	8.33%	11	2.01%
12	2	8.33%	12	2.20%
15	1	4.17%	15	2.75%
16	2	8.33%	16	2.93%
18	1	4.17%	18	3.30%
31	1	4.17%	31	5.68%
51	1	4.17%	51	9.34%
68	1	4.17%	68	12.45%
96	1	4.17%	96	17.58%
150	1	4.17%	150	27.47%
Total	24	100%	546	100%

Table 4.20.A analyzed distribution of publications of 24 faculties in School of Life Sciences, Mizoram University in increasing order of productivity. The distribution of authors and their contributions are analyzed and it resolved that three faculties have no publication during the period under the study and another three faculties have three publications each during 2006-2015. Two faculties have 2.01% publications; other two faculties contributed 2.20% publications. Another two faculties have contribution of 2.93% publications. The rest categories of publications have been contributed by only one author each. One faculty having 150 (27.47%) is the highest contributor during the period under the study.

Table-4.20B: Applicability of Price's Square Root Law and 80/20 Rules

Authors	No of	Papers	
	Authors	**No. of Papers**	**Percentage**
Square root of total authors	5	396	72.53%
Ten percent of total authors	2	246	45.05%
Twenty percent of total authors	5	396	72.53%
Thirty percent of total authors	7	430	78.75%

Forty percent of total authors	10	473	86.63%

Table 4.20.Bdescribe the Square root law of total authors in School of Life Sciences, Mizoram University and the study resolved that 4.898% i.e. 5 authors, contribute to 72.53% of the total papers, which is more than 50% as predicted by De Solla Price, which means the data fit in the Price Square Root Law. Similarly, it can be observed that 10%, 20%, 30% and 40% of total authors in School of Life Sciences, Mizoram University contribute 45.10%, 72.46%, 78% and 86.69% respectively of total papers, this is more than 80% as predicted by 80/20 Rules. Thus this study also confirms the Price's Square Root Law and 80/20 rules application in publication of faculty members in School of Life Sciences, Mizoram University.

4.3. MAJOR FINDINGS:

The major findings of the study are:

1. The faculty members of school of Life Sciences, Mizoram University have a contribution of total 438 publications. According to the analysis, the Department of Zoology of publication 345 is the most productive department followed by Department of Biotechnology 136 and Department of Botany respectively. Majority of the faculties are younger in age, which belongs to less than 40.The total female faculties are younger and less in number.

2. Assistant Professor published 58.33% of the total publication which is more than the combination of Associate Professor and Professor (41.67%) publications. Male faculties are more productive than female as the percentage of male faculty members are more.

3. The year wises productivity was increased from 2006-2008, and it has been decreased in 2009-2010, then it was increased in 2011 and then decreased in 2012. It is also found that decreased-increased manner from 2010-2012. The year wise productivity is increased-decreased manner and this means that fluctuation in productivity has been occurred during the period of 2006-2015.

4. Total numbers of 428 items are identified under three categories of forms of publication produced by faculty members. Journal articles are the main vehicle of

information transfer of faculty members, which accounts 314, followed by conference papers 61, chapter in books is the third position with 54 publications.

5. G. Gurusubramanian, Department of Zoology published highest (27.47%)publications and the key author followed by N. Senthil Kumar, Department of Biotechnology (17.58%) publications among 24 faculty members in School of Life sciences, Mizoram University.

6. The study reveals that in collaboration, the Collaborative index is 2.61.

7. G.C. Jagetia has published the highest publications i.e. 16 publications in first authored publications, followed by Th. Robert Singh while in multi authored publications of G. Gurusubramanian and N.Senthil Kumar have the same collaborative coefficient of 0.99, followed by G.C Jagetia with collaborative coefficient of 0.76.

8. The national collaboration trend is the highest (53.97%) among faculty members followed by local collaboration (41.82%) and international collaboration (4.21%) respectively.

9. It was found that faculties published their works in 192 different journals, the total publications output published in journals were 314 titles out of which 138 titles have been published in different journals. The journal 'Science Vision' gets the most productive journal in number of publications to be published with 10.19% titles in its share followed by 'Science and technology journal' with 2.23% titles. Resistant Pest Management Newsletter (1.91%) got the third rank followed by Mitochondrial DNA (1.59%).

10. The geographical scattering of publications shows that in India 54.44% published of the total productivity followed by USA 14.25%, UK 7.00%. These three countries published a total of 75.69% publication leaving behind the rest 20.31% for the remaining 25 countries.

11. The study examines Lotka's Law and the values derived from the application of Lotka's equation are nearly equal to the observed values, that are 201,59,29,14,8 etc. Therefore, Lotka's Law was applicable in this study.

12. The study found that Square root of total authors in Life Sciences, MZU is 4.898% i.e. 5 authors, contribute to 72.53% of the total papers, which is more than 50% as predicted by De Solla Price, which means the data fits in the Price Square Root Law. Similarly, it can be observed that 10%, 20%, 30% and 40% of total authors in School of Life Sciences, Mizoram University contribute 45.10%, 72.46%, 78% and 86.69% respectively of total papers, this is more than 80% as predicted by 80/20 Rules. Thus, study also approved De Solla Price law applicability in this study.

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5.1. CONCLUSION

Bibliometrics is a sub-discipline which includes mathematical and statistical methods used to analyze bibliographical characteristics of documents. Bibliometrical and scientometrical methods are used in parallel to research in the different qualities and aspect of the same phenomena. The interesting features of the bibliometrics/scientometrics/informetrics are the fact that there are three related terms uses to described part or all of this discipline. Each of these terms has a range of definitions that have been applied to them by the authors who are working in this field.

The application of bibliometrics in library and information field is efficient for the satisfaction of the user needs and development of the library. The studies of bibliometrics is mostly analytical than descriptive. It is also necessary to know the situation of the library and to measure the inadequacy of the collection of libraries and the future plan for the library operation. It also related for discovering different models for the experience of library operations.

Scientific productivity of a country reflects its scientific and technological development and progress. The published output of a research and developmental activities are indicators of the scientific productivity. The productivity pattern of scientists varies considerably depending on particular scientific field, which is significant to both averages scientific productivity and relation with the professional once. The scientific productivity of eminent scientist and others is one of the crucial and still open research problems of science studies. The productivity and its quality in the first place, is at the same time the starting point and the basis of studying in the contribution of scientists to the scientific knowledge.

It has been widely recognized that an analysis of the published output of scientists is a good indicator of their research activities, in terms of both volume and quality. Research productivity of publications has been accepted as the most highly valued aspects of their profession by faculty members, especially when university promotion, faculty evaluation and university goals are considered. The analysis has given a clear picture of the total research productivity of faculty members of School of Life Sciences, Mizoram University during the period of ten years (2006-2015). The three departments in School of Life Sciences, Mizoram University, vary considerably in respect to quantity of research and publication pattern.

The study demonstrates that productivity has been correlated to various factors such as age, position, service, gender, Department, form of publication, authorship pattern, collaboration, year wise growth of the publication, most preferred journals, country wise distribution, most prolific authors and examination of Lotka's Law. From the study it has been expected that it would be one of the motivators that encourages the faculty members to publish abundantly. It has been clearly seen that the scientific talent is highly concentrated in a limited number of individuals.

The study reveals that within the ten years period under the study, the Department of Zoology is the most productive followed by Biotechnology and Botany respectively. The female faculties are younger in age and less in number as compared to male faculty members. The Assistant Professors produce highest publications in numbers followed by Associate Professors and Professors respectively. The year wise productivity is increased-decreased manner and this means that fluctuation in productivity has been occurred during the period under the study. Journal articles are the main mode of transfer of information by faculty members.

Among the faculty members, G. Gurusubramanian, Department of Zoology published highest publications and the key author followed by N. Senthil Kumar, Department of Biotechnology. The research papers are highly published in collaborated with national, followed by local and international level respectively. In first authored publications, G.C. Jagetia has published the highest publications followed by Th. Robert Singh, while in multi authored publications, G. Gurusubramanian and N.Senthil Kumar have the same collaborative coefficient. Majority of the research papers have been published in journal of Science Vision which was from Mizoram. The geographical scattering of publications shows that majority of the research papers has been published in India followed by USA and UK respectively. Lotka's Law and Price Square Root Law have examined and it was approved that it was applicable in the study.

5.2. SUGGESTIONS

During the study some points have been observed which need to improve the quantity and quality of publications of faculty members in School of Life Sciences. On the basis of that scholar placed some of valuable suggestions as:

1. The faculties in the university are consumers of information and generators of information. One form of information generation is the publication of articles. At the university level considerable measures should be initiated to motivate publications of the faculty. There is need for the female faculty members to have more publications.

2. The main influence to productivity may be laboratory and library facilities especially in the field of science for research publication. So it is necessary to improve the laboratory and library facilities to enhanced research productivity.

3. It is essential to evaluate and study the research trends from time to time so that it would be quite easy for designing, organizing and managing various information services and products to provide the information needs of researchers effectively, expeditiously and exhaustively. It is also essential to formulate a well research policy at the university level.

4. It is necessary for the faculty members to produce their publication in high quality research papers and publish in the journal with high impact factor which will increase impact factor of the faculty members.

5. The research papers must be written in collaboration with other departments of the university and also with foreign institutes to give their research work world recognition, so it is necessary for the faculties to have more publications collaborated with international level.

6. The faculty members should carry out research activity to utmost extent and write articles in books or chapters in books in the area of their research field.

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LIST OF MOST PREFERRED JOURNALS FOR PUBLICATIONS OF FACULTY MEMBERS OF SCHOOL OF LIFE SCIENCES, MIZORAM UNIVERSITY

Sl. No.	Name of the Journals	No. of Publications	%	Rank
1	Science vision	32	10.19	1
2	Science & Technology Journal	7	2.23	2
3	Resistant Pest Management Newsletter	6	1.91	3
4	Mitochondrial DNA	5	1.59	4
5	Current Science	4	1.27	5
6	Genomics Data	4	1.27	5
7	International Journal of Ecology and Environmental Science	4	1.27	5
8	International Multidisciplinary Research Journal	4	1.27	5
9	African Journal of Biotechnology	3	0.95	6
10	Applied Biochemistry and biotechnology	3	0.95	6
11	International Journal of Acarology	3	0.95	6
12	Japan Bamboo Journal	3	0.95	6
13	Journal of Basic Microbiology	3	0.95	6
14	Journal of Natural History Museum	3	0.95	6
15	Journal of Pest Science	3	0.95	6
16	Journal of Plantation Crops	3	0.95	6
17	Proceedings of the Zoological Society	3	0.95	6
18	Research on Crops	3	0.95	6
19	The Indian Forester	3	0.95	6
20	Acta Histochemica	2	0.95	7
21	Advanced Biotech	2	0.95	7
22	American-Eurasean Journal of Agriculture & Environmental Sciences	2	0.95	7
23	Archives of Phytopathology and Plant Protection	2	0.95	7
24	Asian Journal of Microbiology, Biotechnology and Environmental Science	2	0.95	7
25	Bioinformation	2	0.95	7
26	Current Biotica	2	0.95	7
27	ECOPRIENT	2	0.95	7
28	Experimental Parasitology	2	0.95	7
29	Herpetological Review	2	0.95	7
30	Indian Journal of Experimental Biology	2	0.95	7
31	Insect Biochemistry and Molecular Biologgy	2	0.95	7
32	Integrative Cancer Therapies	2	0.95	7
33	Interdisciplinary Sciences: Computational life Sciences	2	0.95	7
34	International Journal of Primatology	2	0.95	7
35	International Journal of Recent Scientific Research	2	0.95	7
36	International Journal of Tea Science	2	0.95	7
37	International Journal of Tropical Agriculture	2	0.95	7
38	Journal of Biomolecular Techniques	2	0.95	7

39	Journal of Bombay Natural History Society	2	0.95	7
40	Journal of Environmental Biology	2	0.95	7
41	Journal of Experimental Zoology Part A	2	0.95	7
42	Journal of Plant Protection Research	2	0.95	7
43	Journal of Threatened Taxa	2	0.95	7
44	Medicinal and Aromatic Plant Science and Biotechnology	2	0.95	7
45	North Bengal University Journal of Animal Science	2	0.95	7
46	Parasitology Research	2	0.95	7
47	Pedosphere	2	0.95	7
48	Pesticide Research Journal	2	0.95	7
49	Phytotherapy Research	2	0.95	7
50	Trends in Green Chemistry	2	0.95	7
51	Tropical Ecology	2	0.95	7
52	Uttar Pradesh Journal of Zoology	2	0.95	7
53	World Journal of Microbiology And Biotechnology	2	0.95	7
54	Zootaxa	2	0.95	7
55	Academic Journal of Entomology	1	0.32	8
56	Acta Physiologiae Plantarum	1	0.32	8
57	Acta Tropica	1	0.32	8
58	Advances in Biomedicine Pharmacy	1	0.32	8
59	Advances in Experimental Medicine and Biology	1	0.32	8
60	Agricultura Tropica et Subtropica	1	0.32	8
61	Agriculture and Environmental Management	1	0.32	8
62	Agroforestry Systems	1	0.32	8
63	Allelopathy Journal	1	0.32	8
64	Alternative & Integrative Medicine	1	0.32	8
65	Alytes	1	0.32	8
66	American Research Journal of Medicine and Surgery	1	0.32	8
67	Antioxidants	1	0.32	8
68	Antonie Van Leeuwenhoek	1	0.32	8
69	Archives of Biological Sciences	1	0.32	8
70	Austin Journal of Biotechnology and Bioengineering	1	0.32	8
71	Biochemical Genetics	1	0.32	8
72	Biochemistry and Physiology	1	0.32	8
73	Biocontrol	1	0.32	8
74	Biojournal	1	0.32	8
75	Biologia Plantarum	1	0.32	8
76	Biological and Pharmaceutical Bulletin	1	0.32	8
77	Biological Rhythm Research	1	0.32	8
78	Biology and Medicine	1	0.32	8
79	BIOMETALS/International Journal on The Role of Metal Ions in Biology, Biochemistry and Medicine	1	0.32	8
80	Biotechnology	1	0.32	8
81	Botanical Science	1	0.32	8
82	Botanical Studies	1	0.32	8
83	Breast Cancer	1	0.32	8
84	Burns	1	0.32	8

85	Cell Stress and Chaperones	1	0.32	8
86	Chemico-Biological Interactions	1	0.32	8
87	Chemosphere	1	0.32	8
88	Cibtech Journal of Zoology	1	0.32	8
89	Comparative Biochemistry & Physiology: Molecular Biology, Part B	1	0.32	8
90	Comparative Biochemistry and Physiology Part A	1	0.32	8
91	Crop Research	1	0.32	8
92	DNA Barcodes	1	0.32	8
93	Entomological Research	1	0.32	8
94	Environmental and Experimental Botany	1	0.32	8
95	Environmental and Molecular Mutagenesis	1	0.32	8
96	Environmental Engineering Research	1	0.32	8
97	Environmental Science and Pollution Research	1	0.32	8
98	Environmental Science Indian Journal	1	0.32	8
99	European journal of Pharmaceutical and Medical Research	1	0.32	8
100	Evidenced Based Complimentary and Alternative Medicine	1	0.32	8
101	Folia Primatologica	1	0.32	8
102	Frogleg	1	0.32	8
103	Frontiers in Microbiology	1	0.32	8
104	General and Comparative Endocrinology	1	0.32	8
105	Genetic Resources and Crop Evolution	1	0.32	8
106	Genomics and Applied Biology	1	0.32	8
107	Green Farming	1	0.32	8
108	Hamadryad	1	0.32	8
109	Human and Experimental Toxicology	1	0.32	8
110	Immunochemistry & Immunopathology	1	0.32	8
111	Indian Journal of Traditional Knowledge	1	0.32	8
112	Insect Environment	1	0.32	8
113	Insect Molecular Biology	1	0.32	8
114	International Journal for Agro, Veterinary and Medical Sciences	1	0.32	8
115	International Journal of Applied Agricultural Research	1	0.32	8
116	International Journal of Biotechnology and Bioengineering Research	1	0.32	8
117	International Journal of Current Microbiology and Applied Sciences	1	0.32	8
118	International Journal of Entomological Research	1	0.32	8
119	International Journal of Fundamental & Applied Sciences	1	0.32	8
120	International Journal of Genetic and Molecular Biology	1	0.32	8
121	International Journal of Hyperthermia	1	0.32	8
122	International Journal of Innovative Science, engineering & Technology	1	0.32	8
123	International Journal of Pharma and Biosciences	1	0.32	8
124	International Journal of Pharmaceutical Research	1	0.32	8
125	International Journal of Plant, Animal and	1	0.32	8

	Environmental Sciences			
126	International Journal of Radiation Biology	1	0.32	
127	International Journal of Scientific Research	1	0.32	8
128	International Journal of Tropical Insect Science	1	0.32	
129	International Journal on Recent and Innovative Trends in Computing and Communication	1	0.32	8
130	International Wound journal	1	0.32	8
131	Japanese Journal of Hyperthermic Oncology	1	0.32	8
132	Journal of Applied Phycology	1	0.32	7
133	Journal of Applied Toxicology	1	0.32	8
134	Journal of Biodiversity, Bioprospecting and Development	1	0.32	8
135	Journal of Biological Rhythms	1	0.32	8
136	Journal of Biomolecular Structure and Dynamics	1	0.32	8
137	Journal of Biopesticides	1	0.32	8
138	Journal of Bioresources	1	0.32	8
139	Journal of Biotechnology	1	0.32	8
140	Journal of Clinical & Medical Genomics	1	0.32	8
141	Journal of Clinical Biochemistry and Nutrition	1	0.32	8
142	Journal of Clinical Immunology	1	0.32	8
143	Journal of Clinical Laboratory Analysis	1	0.32	8
144	Journal of Contemporary Dental Practice	1	0.32	8
145	Journal of Entomological Research	1	0.32	7
146	Journal of Entomological Research Society	1	0.32	8
147	Journal of Entomology & Nematology	1	0.32	8
148	Journal of Environmental and Social Sciences	1	0.32	8
149	Journal of Environmental Pathology Toxicology and Oncology	1	0.32	8
150	Journal of Environmental Research Development	1	0.32	8
151	Journal of Ethnopharmacology	1	0.32	8
152	Journal of Experimental Biology	1	0.32	8
153	Journal of Hill Research	1	0.32	8
154	Journal of Inorganic Biochemistry	1	0.32	8
155	Journal of Medicinal Plant Research	1	0.32	8
156	Journal of Microbiology and Biotechnology	1	0.32	8
157	Journal of Molecular Biochemistry	1	0.32	8
158	Journal of Nature Conservation	1	0.32	8
159	Journal of Neurorehabilitation	1	0.32	8
160	Journal of Pharma Research	1	0.32	8
161	Journal of Plant Biochemistry & Physiology	1	0.32	8
162	Journal of Plant Breeding and Genetics	1	0.32	8
163	Journal of Primatology	1	0.32	8
164	Journal of Tropical Forestry	1	0.32	8
165	Journal of Plant Physiology	1	0.32	8
166	Medicinal Chemistry Research	1	0.32	8
167	Microbiological Research	1	0.32	8
168	Microbiology/Journal of Microbiology	1	0.32	8
169	Molecular Reproduction and Development	1	0.32	8

170	Multilogic in Science	1	0.32	8
171	Mutagenesis	1	0.32	8
172	Mycopathologia	1	0.32	8
173	National Journal of Life Sciences	1	0.32	8
174	Nutrition Research	1	0.32	8
175	Pharmaceutical Biology	1	0.32	8
176	Pharmacologyonline	1	0.32	8
177	Photochemical and Photobiological Sciences	1	0.32	8
178	Photosynthesis Research	1	0.32	8
179	Physiology and Behavior	1	0.32	8
180	Plant and Cell Physiology	1	0.32	8
181	Plant Cell Report	1	0.32	8
182	Plant Molecular Biology	1	0.32	8
183	Plant Protection Science	1	0.32	8
184	Planta	1	0.32	8
185	PLOS One	1	0.32	8
186	Primate Conservation	1	0.32	8
187	Research in Pharmaceutical Biotechnology	1	0.32	8
188	Romanian Journal of Plant Protection	1	0.32	8
189	SAARC Journal of Agricultural Science	1	0.32	8
190	Saline Systems	1	0.32	8
191	Sericologia	1	0.32	8
192	Society of Indian Foresters	1	0.32	8
193	Strahlenther Onkology	1	0.32	8
194	The FASEB Journal	1	0.32	8
195	The International Journal of Science & Technoledge	1	0.32	8
196	Transcriptomics	1	0.32	8
197	Translational Medicine and Biotechnology	1	0.32	8
198	World journal of Pharmacy and Pharmaceutical Sciences	1	0.32	8
199	World Journal of Zoology	1	0.32	8
	TOTAL	**314**	**100**	

1. Introduction

Research plays a crucial role in developing the prosperity of a nation and well-being of its citizens. A university has a great contribution to the growth and development of society and nation through education and research. Progress in field is directly linked with research in that field. Research is endless quest for Knowledge or Unending Search for truth. Research is an Academic Activity and as such the term should be used in a Technical Sense. The Association of African Universities (2000) states that 'without research, universities will lose their capacity to offer first class graduate studies, and to motivate and retain best brains and consequently lose the capacity to train the new generation of research fellows and scientists'.

Universities across the world are considered as producers, entrepreneurial engines and generator of new knowledge through research and the role of academic is not limited to teaching. Research publications enable academics to earn recognition and advancement of individual faculty members largely depend upon the quantity and quality of their research productions. It is an important measurement of the extent of their contributions to developing new knowledge.

The research productivity of academics is communicated in the form of journal articles, books, technical reports and other types of publications. It is often used as an index of departmental and institutional prestige and is strongly associated with individual, organizational and environmental factors. The major outputs of scientific research are the most commonly used vehicles through which new scientific discoveries are known to the rest of the world. The reputation and credibility of an university is based on the quality and quantity of new knowledge produced by it. The academic role in social development is transmitting the accumulated knowledge to next generation and creating knowledge through research activity.

2. Bibliometrics

Bibliometrics is one of the quantitative techniques used by library and information professionals to evaluate written communication. Bibliometric analyses quantitatively the recorded knowledge in the form of books, periodicals, doctoral dissertations etc to know its properties and behavior. It is used to identify the pattern of publication, authorship, citations used for a subject etc, over a period of time.

Alan Pritchard first coined the term 'bibliometrics' in 1969, application of this method dates back to 1917, when Cole and Eales conducted, as bibliometric study. 'Statistical bibliography' was the term used for bibliometric studies in early days. Pritchard defined bibliometrics as 'the application of mathematical and statistical methods to books and other media of communication'. According to Fairthorne "Biblimometric is a quantitative treatment of properties of recorded discourse and behavior appertaining to it". More explicitly, Sengupta defines it as 'Organization, classification and quantitative evaluation of publication patterns of all macro and micro communication along with their authorship by mathematical and statistical calculus'.

The practical approach to bibliometrics in library and information services has been visualized by S.R. Ranganathan in terms of Librametry who conceived the idea at Association of Special Libraries and Information Bureaux (ASLIB) conference at Leamington Spa, United Kingdom in 1948. With the time span many similar term came and became popular like Scientometrics, Informetrics, Webometrics and Cybermetrics.

3. Type of Bibliometrics:

Biblometrics can be categorized in three types on the basis of study (Hertzel, 2010):

- **DescriptiveBibliometrics**: It is a study of number of publications in a given field or productivity of literature in the field like-
  - a. Geographic (Countries)
  - b. Time periods (Eras)
  - c. Disciplines (Subjects)
- **Evaluative Bibliometrics**: In this bibliometrics study, citation counting is employed as an indicator of research output as form of:
  - a. Reference
  - b. Citation

4. School of Life Sciences, Mizoram University

Mizoram University was established by an Act of Parliament in the year 2000 and started functioning in the year 2002. It was accredited 'A Grade' by NAAC in the year 2014. There are 33 functioning academic departments in the main campus, one constituent college and 28 affiliated colleges. There are eight (8) schools in this university.

The School of Life Sciences was established in the year 2005 consisting three departments - Zoology, Botany and Biotechnology Departments, which are assisted by Department of Science and Technology, Ministry of Science and Technology under FIST and Non-SAP UGC programmes. The school is equipped with state of art equipments, Bioinformatics Infrastructure Facility (BIF) and State Biotech Hub for teaching and research. At present there are 21 faculties in school of life sciences as mention in table-1 (**Source**: Mizoram University, Annual Report).

Table-1.1: Teaching Faculty in the Department under the School of Life Sciences, MZU

Name of the Department	Year of Establishment	Professor	Associate Professor	Assistant Professor	Total
Botany	2005	2	1	5	8
Biotechnology	2007	3	1	4	8
Zoology	2005	2	1	5	8
Total		**7**	**3**	**14**	**24**

5. Significance and Scope of the Study

Universities play a crucial role in the generation and application of new knowledge. Teaching and research are the most important functions of a university. Teaching is a systematic transfer of the sum total of knowledge a society holds to its growing generation through various well-structured courses of studies and training programmes while research is pursuit of new frontiers of knowledge and wisdom in whatever directions and to whatever extent possible. The achievements in the research fields take a university the glorious positions and give recognition. The research output of the university needs to be effectively disseminated and distributed for its acceptance and timely application for social benefits. The research

productivity of a university in different forms like academic publications, patents, research projects, PhD theses &M.Phil dissertations but research publications are one of the most quantitative measures for the basic research activity in academic community. Research productivity analysis is one of the key components of any research and development activity. One well-known productivity indicator is the number of publications produced by the scientists, institutions and countries. Studies like this will provide some insight into the complex dynamics of research activity and enable the scientists, policy makers and science administrators to provide adequate facilities and proper guidance. Bibliometrics as a technique has extensive applications in identifying the research trends in a subject, discipline, geographical areas in a particular time span.

There are a number of bibliometric studies have been conducted to access the publication trends of various department, subject, institutions, universities in national and international level in different subject areas but no study has been conducted to analyze the publications of School of Life Sciences faculties' of Mizoram University. Therefore, bibliometric study of publications of faculties of School of Life Sciences, Mizoram University is an attempt to fulfill this research gap.

The scope of present study is limited to total 24 faculties of School of Life Sciences, Mizoram University. The scope is further limited to faculty's publications during 2006-2015 (ten years) on the basis of various bibliometric parameters.

6. Review of Literature

The scholars reviewed 35 articles from books and journals. The review of literature shows that there are a number of bibliometric studies have been conducted to access the publication trend of various department, subject, institutions, universities in national and international level in different subject areas but no study has been conducted to analyze the publications of life science faculties of Mizoram University. Therefore, this study is to fulfill this gap of research.

7. Statement of the Problem:

Bibliometrics is a type of research method used in Library and Information Science. It is a quantitative study of various aspects of literature on a topic and is used to identify the pattern of publication, authorship and secondary journal coverage with the objective of getting an insight into the dynamics of growth of knowledge in the areas under consideration.

Publication productivity is often considered to measure the prestige of an institution and is associated strongly with an individual faculty member's reputation, visibility, and advancement in the academic reward structure, particularly at research institutions and universities. The relationship between output of research and input measured through the publication productivity. The contribution of the institution and the individual scientists engaged in research are highlighted by the institutional productivity. It also provides some insights into the complex dynamics of research activity and enables policy makers and administrators to provide adequate facilities and gauge the research activities in a proper direction. A well-known research productivity indicator is the number of publications produced by scientists, institutions, or research groups. To evaluate the productivity of research institutions and individual researcher and to map the growth of the research area bibliometric techniques have become tools over the years.

The present study is a bibliometric analysis of publications of faculties in School of Life Sciences, Mizoram University during 2006 to 2015 will analyzes the contribution, growth, authorship patterns, research collaborations, their preferred journals for publications etc. by faculties of School of Life Sciences, Mizoram University. It also analyze the growth and development of research activity of faculties in school of life sciences as reflected in their publications output.

8. Objectives of the Study:

The objectives of the present study are to:

- Analyze the forms of publications of faculties of Life Sciences during time.
- Visualize the year wise growth in publications of faculties and find out most prolific authors of Life Sciences.
- Find out collaboration and authorship pattern in faculties of Life Sciences.
- Identify the preferred journals and country-wise distribution of publications.
- Examine the implementation of Lotka's law of productivity.

9. Research Methodology:

The present study is a bibliometric analysis of publications of faculties of School of Life Sciences, Mizoram University. The publication data has been collected from *University Annual Report* from the year 2006-2015. Scholar ascertains the publication of faculties from

their bio-data available on Mizoram University Website (www.mzu.edu.in) by survey and observation methods. There are 428 publications by 24 faculties during the period under cover, which will be total population for this research study.

Under the study, the data collected from the observation and survey method was scrutinized, tabulated and analyzed for inference. Statistical inferences will be drawn by using Microsoft Excel statistical software.

10. Chapterization:

The present study has been divided into Five Chapters as given below:

Chapter 1 of the study comprises of introduction, bibliometrics and types of bibliometrics, School of Life Sciences, Mizoram University, significance and scope of the study, review of literature, research design reflecting the statement of the problem and objectives of the study, research methodology, etc. Chapter 2 focuses on origin and development of bibliometrics, definition of bibliometrics, metrics in bibliometrics, different types of bibliometrics tools and indicators. Chapter 3 of the study deals with the anonymous terms of bibliometrics, laws of bibliometrics, and it also highlighting the application of bibliometric laws, limitations in applications. Chapter 4 relates to data analysis of research productivity of faculties in School of Life Sciences, Mizoram University obtained through the Annual Report and Website of Mizoram University and Findings. Chapter 5 reflects about Conclusion & Suggestions followed by a list of Bibliography and Appendices.

12. Findings

The major findings of the study are:

- The faculty members of school of Life Sciences, Mizoram University have a contribution of total 438 publications. According to the analysis, the Department of Zoology of publication 345 is the most productive department followed by Department of Biotechnology 136 and Department of Botany respectively. Majority of the faculties are younger in age, which belongs to less than 40.The total female faculties are younger and less in number.

- Assistant Professor published 58.33% of the total publication which is more than the combination of Associate Professor and Professor (41.67%) publications. Male faculties are more productive than female as the percentage of male faculty members are more.

- The year wises productivity was increased from 2006-2008, and it has been decreased in 2009-2010, then it was increased in 2011 and then decreased in 2012. It is also found that decreased-increased manner from 2010-2012. The year wise productivity is increased-decreased manner and this means that fluctuation in productivity has been occurred during the period of 2006-2015.

- Total numbers of 428 items are identified under three categories of forms of publication produced by faculty members. Journal articles are the main vehicle of information transfer of faculty members, which accounts 314, followed by conference papers 61, chapter in books is the third position with 54 publications.

- G. Gurusubramanian, Department of Zoology published highest (27.47%) publications and the key author followed by N. Senthil Kumar, Department of Biotechnology (17.58%) publications among 24 faculty members in School of Life sciences, Mizoram University.

- The study reveals that the Collaborative index is 2.61.

- G.C. Jagetia has published the highest publications i.e. 16 publications in first authored publications, followed by Th. Robert Singh while in multi authored publications of G. Gurusubramanian and N.Senthil Kumar have the same collaborative coefficient of 0.99, followed by G.C Jagetia with collaborative coefficient of 0.76.

- The national collaboration trend is the highest (53.97%) among faculty members followed by local collaboration (41.82%) and international collaboration (4.21%) respectively.

- It was found that faculties published their works in 192 different journals, the total publications output published in journals were 314 titles out of which 138 titles have been published in different journals. The journal 'Science Vision' gets the most productive journal in number of publications to be published with 10.19% titles in its share followed by 'Science and technology journal' with 2.23% titles. Resistant Pest Management Newsletter (1.91%) got the third rank followed by Mitochondrial DNA (1.59%).

- The geographical scattering of publications shows that in India 54.44% published of the total productivity followed by USA 14.25%, UK 7.00%. These three countries published a total of 75.69% publication leaving behind the rest 20.31% for the remaining 25 countries.

- The study examines Lotka's Law and the values derived from the application of Lotka's equation are nearly equal to the observed values, that are 201,59,29,14,8 etc. Therefore, Lotka's Law was applicable in this study.

- The study found that Square root of total authors in Life Sciences, MZU is 4.898% i.e. 5 authors, contribute to 72.53% of the total papers, which is more than 50% as predicted by De Solla Price, which means the data fits in the Price Square Root Law. Similarly, it can be observed that 10%, 20%, 30% and 40% of total authors in School of Life Sciences, Mizoram University contribute 45.10%, 72.46%, 78% and 86.69% respectively of total papers, this is more than 80% as predicted by 80/20 Rules. Thus, study also approved De Solla Price law applicability in this study.

13. Suggestions

During the study some points have been observed which need to improve the quantity and quality of publications of faculty members in School of Life Sciences. On the basis of that scholar placed some of valuable suggestions as:

- The faculties in the university are consumers of information and generators of information. One form of information generation is the publication of articles. At the university level considerable measures should be initiated to motivate publications of the faculty. There is need for the female faculty members to have more publications.

- The main influence to productivity may be laboratory and library facilities especially in the field of science for research publication. So it is necessary to improve the laboratory and library facilities to enhanced research productivity.

- It is essential to evaluate and study the research trends from time to time so that it would be quite easy for designing, organizing and managing various information services and products to cater the information needs of researchers effectively, expeditiously and exhaustively. It is also necessary to formulate a well research policy at the university level.

- It is necessary for the faculty members to produce their publication in high quality research papers and publish in the journal with high impact factor which will increase impact factor of the faculty members.

- The research papers must be written in collaboration with other departments of the university and also with foreign institutes to give their research work world

recognition, so it is necessary for the faculties to have more publications collaborated with international level.

- The faculty members should carry out research activity to utmost extent and write articles in books or chapters in books in the area of their research field.

14. Conclusion

Bibliometrics is a sub-discipline which includes mathematical and statistical methods used to analyze bibliographical characteristics of documents. Bibliometrical and scientometrical methods are used in parallel to research in the different qualities and aspect of the same phenomena. The interesting features of the bibliometrics/scientometrics/informetrics are the fact that there are three related terms uses to described part or all of this discipline. Each of these terms has a range of definitions that have been applied to them by the authors who are working in this field.

The application of bibliometrics in library and information field is efficient for the satisfaction of the user needs and development of the library. The studies of bibliometrics is mostly analytical than descriptive. It is also necessary to know the situation of the library and to measure the inadequacy of the collection of libraries and the future plan for the library operation. It also related for discovering different models for the experience of library operations.

Scientific productivity of a country reflects its scientific and technological development and progress. The published output of a research and developmental activities are indicators of the scientific productivity. The productivity pattern of scientists varies considerably depending on particular scientific field, which is significant to both averages scientific productivity and relation with the professional once. The scientific productivity of eminent scientist and others is one of the crucial and still open research problems of science studies. The productivity and its quality in the first place, is at the same time the starting point and the basis of studying in the contribution of scientists to the scientific knowledge.

It has been widely recognized that an analysis of the published output of scientists is a good indicator of their research activities, in terms of both volume and quality. Research productivity of publications has been accepted as the most highly valued aspects of their profession by faculty members, especially when university promotion, faculty evaluation and university goals are considered. The analysis has given a clear picture of the total research productivity of faculty members of School of Life Sciences, Mizoram University during the

period of ten years (2006-2015). The three departments in School of Life Sciences, Mizoram University, vary considerably in respect to quantity of research and publication pattern.

The study demonstrates that productivity has been correlated to various factors such as age, position, service, gender, Department, form of publication, authorship pattern, collaboration, year wise growth of the publication, most preferred journals, country wise distribution, most prolific authors and examination of Lotka's Law. From the study it has been expected that it would be one of the motivators that encourages the faculty members to publish abundantly. It has been clearly seen that the scientific talent is highly concentrated in a limited number of individuals.

The study reveals that within the ten years period under the study, the Department of Zoology is the most productive followed by Biotechnology and Botany respectively. The female faculties are younger in age and less in number as compared to male faculty members. The Assistant Professors produce highest publications in numbers followed by Associate Professors and Professors respectively. The year wise productivity is increased-decreased manner and this means that fluctuation in productivity has been occurred during the period under the study. Journal articles are the main mode of transfer of information by faculty members.

Among the faculty members, G. Gurusubramanian, Department of Zoology published highest publications and the key author followed by N. Senthil Kumar, Department of Biotechnology. The research papers are highly published in collaborated with national, followed by local and international level respectively. In first authored publications, G.C. Jagetia has published the highest publications followed by Th. Robert Singh, while in multi authored publications, G. Gurusubramanian and N.Senthil Kumar have the same collaborative coefficient. Majority of the research papers have been published in journal of Science Vision which was from Mizoram. The geographical scattering of publications shows that majority of the research papers has been published in India followed by USA and UK respectively. Lotka's Law and Price Square Root Law have examined and it was approved that it was applicable in the study.