

A Scientometric Assessment of Renewable Biomass Research Output in India

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(Received 30 December 2018; Revised 26 January 2019; Accepted 20 February 2019; Available online 25 February 2019)

Abstract - This paper provides a quantitative assessment of the scientific literature for mapping the intellectual structure of Renewable Biomass research in India and its scientific development over 20 years (1999-2018). A total of 691 publications were subjected to examination. The study characterizes top (cited and downloaded) papers, citation patterns, most frequent topic clusters, and keywords, and social mentions by country, discipline, and professional status. The results highlight some areas of improvement in this field of study. This study also reveals a lot of well-established topics which are changing gradually with impact on citations and downloads. Statistical models and analysis give the result that the field is predominantly influenced by fundamental and highly recognized scientists and papers. The analysis was conducted using HistCite software.

Keywords: Scientometric, Bibliometric, Renewable Biomass, India

I. INTRODUCTION

Biomass is an energy source getting by burning wood, crop waste, garbage etc. Biomass is an organic material that comes from plants and animals. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to bio fuel can be achieved by different methods which are broadly classified into thermal, chemical, and biochemical. Biomass power is carbon neutral electricity generated from renewable organic waste that would otherwise be dumped in landfills, openly burned, or left as fodder for forest fires. When burned, the energy in biomass is released as heat. Biomass offers other significant environmental and consumer benefits, including improving forest health, protecting air quality, and offering the most dependable renewable energy source.

II. LITERATURE REVIEW

Previous studies shows that there are related studies are conducted by some researchers. Weishu Liu *et al.*, studied developments in Biomass based bio energy research. They found that biomass publications are distributed in some developed regions and emerging economies. US lead in the quantity of publication and collaboration links.

Kirti Joshi, Avinash Kshitij and K.C. Garg examined the pattern of publication output, geographical distribution and

highly cited papers of about 1 lakh publications of forest mycology from 1987-2008. Anil Sagar, Basavaraj Shivappa, Karanam Bhanumurthy (2013) attempts to highlight the growth and development of dark energy literature and studied the quantitative and qualitative assessment by way of analyzing various features of research output based on WoS, collected 5858 publications and analysed the exponential growth rate, degree of collaboration, key journals etc.

III. OBJECTIVES OF THE STUDY

1. To identify the year wise growth in the field of Renewable biomass research.
2. To identify the Relative Growth Rate of Publication and Doubling time.
3. To identify Authorship pattern and Degree of Collaboration.
4. To identify the Year-wise citation of Records.
5. To identify the Author wise analysis of Publication to find out the most prolific author.
6. To identify the journal wise analysis of records.
7. To identify the language wise and document type wise analysis.
8. To identify the most contributing institution.
9. To identify the most frequently occurred words.

IV. METHODOLOGY

The study was conducted by retrieving data from Web of Science database on Renewable biomass subject for the study period 1992 to 2018 June. The data is analysed using HistCite software tool. Total of 691 records were received and analyzed.

V. DATA ANALYSIS AND INTERPRETATION

A. Year Wise Distribution of Publications

Table I shows the year wise analysis of documents in renewable biomass research in India from 1992 to 2018. Totally 691 records were identified. Among the years 2017 ranked top with 125(18.1%) of records; followed by 2016 with 113(16.4%) of records. Table shows an increasing trend in the growth of publication.

TABLE I YEAR WISE ANALYSIS OF PUBLICATIONS

Publication Year	Records	Percent	Cumulative	LCS	GCS
1992	1	0.1	1	0	26
1993	2	0.3	3	1	268
1994	3	0.4	6	0	20
1995	4	0.6	10	2	13
1996	2	0.3	12	0	17
1997	4	0.6	16	7	339
1998	4	0.6	20	10	222
1999	1	0.1	21	0	5
2000	4	0.6	25	12	254
2001	4	0.6	29	0	150
2002	5	0.7	34	1	438
2003	4	0.6	38	7	159
2004	7	1	45	13	225
2005	1	0.1	46	0	1
2006	4	0.6	50	14	131
2007	14	2	64	27	886
2008	22	3.2	86	63	2508
2009	26	3.8	112	82	1591
2010	31	4.5	143	57	1802
2011	37	5.4	180	45	2422
2012	43	6.2	223	63	2152
2013	54	7.8	277	42	1273
2014	62	9	339	42	1653
2015	97	14	436	70	1336
2016	113	16.4	549	42	710
2017	125	18.1	674	7	170
2018	17	2.5	691	0	1

* (TLCS-Total Local Citation Score, TGCS-Total Global Citation Score)

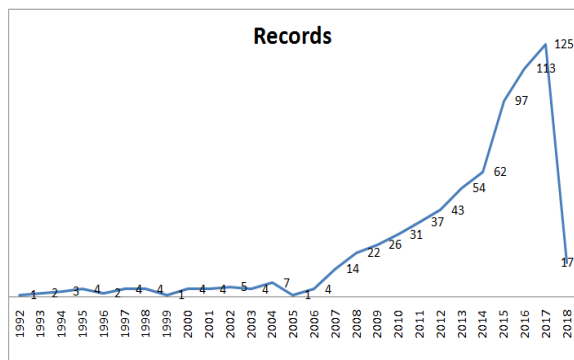


Fig.1 Year wise publication analysis

B. Relative Growth Rate and Doubling Time

Relative Growth Rate is the increase in number of articles or pages per unit of time. The mean RGR over a period of interval can be calculated from the following equation.

$$R(1-2) = \frac{W2-W1}{T2-T1}$$

Where, 1-2 is the mean relative growth rate over the specific period of interval. W1 is the log of initial number of articles; logW2 is the log of final number of articles after a specific period of interval and T2-T1 is the unit difference between the initial time and the final time,

$$\text{Doubling Time (Dt)} = 0.693/R$$

TABLE II RELATIVE GROWTH RATE AND DOUBLING TIME

Publication Year	Number of articles	Cum	W1	W2	RGR	Dt
1992	1	1	0.000	0.000	0.000	0.000
1993	2	3	0.000	1.099	1.099	0.631
1994	3	6	1.099	1.792	0.693	1.000
1995	4	10	1.792	2.303	0.511	1.357
1996	2	12	2.303	2.485	0.182	3.801
1997	4	16	2.485	2.773	0.288	2.409
1998	4	20	2.773	2.996	0.223	3.106
1999	1	21	2.996	3.045	0.049	14.204
2000	4	25	3.045	3.219	0.174	3.975
2001	4	29	3.219	3.367	0.148	4.669
2002	5	34	3.367	3.526	0.159	4.357
2003	4	38	3.526	3.638	0.111	6.231
2004	7	45	3.638	3.807	0.169	4.099
2005	1	46	3.807	3.829	0.022	31.530
2006	4	50	3.829	3.912	0.083	8.311
2007	14	64	3.912	4.159	0.247	2.807
2008	22	86	4.159	4.454	0.295	2.345
2009	26	112	4.454	4.718	0.264	2.623
2010	31	143	4.718	4.963	0.244	2.836
2011	37	180	4.963	5.193	0.230	3.012
2012	43	223	5.193	5.407	0.214	3.235
2013	54	277	5.407	5.624	0.217	3.196
2014	62	339	5.624	5.826	0.202	3.431
2015	97	436	5.826	6.078	0.252	2.754
2016	113	549	6.078	6.308	0.230	3.007
2017	125	674	6.308	6.513	0.205	3.378
2018	17	691	6.513	6.538	0.025	27.820

C. Year-Wise Citation of Renewable Biomass Publication

Table III indicates the block wise research citation of renewable biomass research productivity in India. 18629 citations were received to the 691 records.

Average citation per paper is 26.96. In 2007-2011 total of 130 records were identified and it got 9132 citations (49.02%), average citation per paper is 70.24 and it is the highest. 2012-2016 year got 7026 citation and it comes in second position

TABLE III YEAR WISE (BLOCK WISE) CITATION OF RENEWABLE BIOMASS PUBLICATION

S. No.	No. of years (5years)	Total Records	Citation	Percentage
1	1992-1996	12	344	1.85
2	1997-2001	17	970	5.21
3	2002-2006	21	954	5.12
4	2007-2011	130	9132	49.02
5	2012-2016	369	7060	37.90
6	2017-2018	142	169	0.91
	Total	691	18629	100.00

D. Authorship Pattern and Degree of Collaboration

Table IV describes the authorship pattern in this subject. It clearly shows that multi author research is prominent in this subject and the degree of collaboration is calculated using Subrahmanyam (1983) formula.

TABLE IV AUTHORSHIP PATTERN IN RENEWABLE BIOMASS RESEARCH

S. No.	Author	No. of Records	Authorship	Degree of Collaboration
1	One	191	Single Author 191	0.72
2	Two	196		
3	Three	35	Multi-author 500	
	Four	111		
4	Five	77		
5	Six and above	81		

E. Author-Wise Ranking of Publications

Table V shows the top 20 rank of authors contributed in this subject and the Local Citation Score and Global Citation Score they received. Kumar R contributed 19 articles to this subject area and got a LCS of 18 and GCS of 232. Kumar S came second with 15 articles, and the author got more global citation score (402) than the first author.

TABLE V AUTHOR-WISE PUBLICATIONS IN RENEWABLE BIOMASS

S. No.	Author	Records	% of 691	LCS	GCS
1	Kumar R	19	2.7	18	232
2	Kumar S	15	2.2	9	402
3	Pandey A	14	2	35	1185
4	Saini RP	13	1.9	32	449
5	Singh R	13	1.9	3	174
6	Banapurmath NR	10	1.4	20	187
7	Vaidya PD	9	1.3	8	155
8	Bhaskar T	8	1.2	6	62
9	Chauhan A	8	1.2	19	163
10	Kumar A	8	1.2	15	140
11	Saha B	8	1.2	15	291
12	Singh A	8	1.2	22	661
13	Singh S	8	1.2	4	31
14	Tewari PG	8	1.2	20	185
15	Das D	7	1.01	21	698
16	Iniyan S	7	1.01	3	125
17	Pant KK	7	1.01	9	156
18	Sharma MP	7	1.01	13	243
19	Abbasi SA	6	0.9	13	346
20	Abbasi T	6	0.9	7	290

F. Top 20 Source Output of Renewable Biomass Research

The scientific literature in renewable biomass is spread over 247 different journals. The top 20 most productive journals are visible in Table VI. The highly productive journals are Renewable & sustainable energy reviews with 106(15.3%) publications, Bioresource technology with 29(4.2%) publications and Renewable Energy with 29 (4.2%) publications.

G. Country Wise Distribution of Research Output in Renewable Biomass (Top 20): Table VII displays publication output of the top 20 countries collaborated with India. USA collaborated with India in 44 papers and South Korea in 16 papers.

H. Document wise Research Output: The study reveals that 66% publications are in the form of articles, followed by review (30.7%) and proceedings paper (2.7%).

I. Top 20 Institutions: The topmost prolific institutions involved in renewable biomass research are displayed in table VIII. Indian Institute of Technology tops the list with 67 records. CSIR and Anna University comes second and third positions with 29 and 22 records.

TABLE VI JOURNAL WISE DISTRIBUTION OF DOCUMENTS

S. No.	Journal	Records	Percent
1	Renewable & Sustainable Energy Reviews	106	15.3
2	Bioresource Technology	29	4.2
3	Renewable Energy	29	4.2
4	Biomass & Bioenergy	17	2.5
5	Energy	17	2.5
6	RSC Advances	17	2.5
7	Energy Sources PartA-Recovery Utilization and Environmental Effects	16	2.3
8	Energy Conversion and Management	15	2.2
9	Journal of Renewable and sustainable energy	11	1.6
10	Applied Energy	10	1.4
11	Green Chemisry	9	1.3
12	Energy Policy	8	1.2
13	FUEL	8	1.2
14	Energy for Sustainable Development	7	1
15	Waste and Biomass Valorization	7	1
16	3 Biotech	6	0.9
17	Applied Biochemistry and Biotechnology	6	0.9
18	Applied Thermal Engineering	6	0.9
19	Energy and Fuels	6	0.9
20	Environmental Progress & Sustainable Energy	6	0.9

TABLE VII PUBLICATION OUTPUT BY TOP 20 COUNTRIES

Country	No. of Records	Percentage	LCS	GCS
India	682	98.7	588	18313
USA	44	6.4	37	2039
South Korea	16	2.3	2	523
Japan	15	2.2	7	567
UK	15	2.2	8	178
Canada	13	1.9	15	567
Australia	9	1.3	1	187
Peoples R China	9	1.3	2	103
South Africa	9	1.3	7	275
Malaysia	7	1	2	297
France	6	0.9	2	59
Spain	6	0.9	4	110
Sweden	6	0.9	5	290
Thailand	5	0.7	1	66
Unknown	5	0.7	3	49
Brazil	4	0.6	0	56
Denmark	4	0.6	2	175
Singapore	4	0.6	9	112
Belgium	3	0.4	6	222

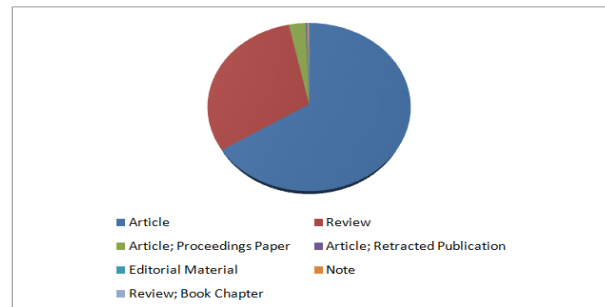


Fig. 2 Document wise distribution of publication

TABLE VIII DOCUMENT WISE RESEARCH OUTPUT

Document Type	No. of Records	Percentage	LCS	GCS
Article	456	66	318	7583
Review	212	30.7	268	10801
Article; Proceedings Paper	19	2.7	21	330
Article; Retracted Publication	1	0.1	0	8
Editorial Material	1	0.1	0	0
Note	1	0.1	0	0
Review; Book Chapter	1	0.1	0	50

TABLE IX RESEARCH OUTPUT BY TOP 20 INSTITUTIONS

S. No.	Institution	Number of records	Percent	LCS	GCS
1	Indian Institute of Technology	67	9.7	92	2394
2	CSIR	29	4.2	32	990
3	Anna University	22	3.2	9	424
4	National Institute of Technology	21	3	33	848
5	Indian Institute of Technology Delhi	18	2.6	17	912
6	Institute of Chemical Technology	17	2.5	10	278
7	Indian Institute of Petroleum	16	2.3	28	803
8	Indian Institute of Science	16	2.3	22	462
9	Indian Inst Chemical Technology	15	2.2	10	283
10	Banaras Hindu University	14	2	15	343
11	University of Delhi	14	2	16	353
12	Indian Institute Technology Roorkee	13	1.9	18	235
13	National Chemical Laboratory	13	1.9	14	747
14	Indian Institute of Technology Guwahati	10	1.4	14	231
15	Birla Institute Technology & Science	9	1.3	10	129
16	BVB College of Engineering & Technology	9	1.3	20	166
17	Tamil Nadu Agricultural University	9	1.3	8	211
18	Indian Agriculture Research Institute	8	1.2	27	639
19	Tezpur University	8	1.2	11	138
20	Jadavpur Univ	7	1	2	32

J. Top 10 Frequently Occurred words

Among the 1967 words the word ‘Production’ is the frequently occurred word from the sample data followed by the words ‘Biomass’, ‘Energy’ and ‘Renewable’.

TABLE X TOP 10 WORDS

S. No.	Word	Records	LCS	GCS
1	Production	177	129	5854
2	Biomass	155	155	3933
3	Energy	148	159	3565
4	Renewable	128	157	4694
5	india	82	78	5075
6	India	73	147	1740
7	Using	58	41	837
8	Based	48	37	842
9	Potential	44	77	2088
10	System	42	47	537

VI. CONCLUSION

The scientometric study of renewable biomass in India shows that the research in this subject is progressing. 691 records were identified and studied. The output is increasing by every year. But Relative Growth Rate shows a

decreasing trend. 18629 citations were received to the 691 records and Multi authored papers dominated in research. The dominating source is journal articles compared to the other sources. The highly productive journals are Renewable & sustainable energy reviews with 106(15.3%) publications, Indian Institute of Technology and CSIR tops in the institution wise production of publication in renewable biomass research. USA and South Korea collaborated with India in most papers. Kumar R produced 19 records and identified as the most prolific author. All the records are published in English language. As energy is a key issue for the future development of the world the research in this area requires more focus.

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