

## Academic output in smart agriculture with conservation of natural resources : Indian vs. global scenario

NK Prasanna Kumari<sup>1</sup>, RS Jayasomu<sup>1</sup>, M Verma<sup>2</sup>

<sup>1</sup>Academy of Scientific and Innovative Research, New Delhi

<sup>2</sup>Central Sanskrit University, Puri, Odisha, India

\*Corresponding author : prasanna@niscair.res.in

### Abstract

Agriculture is the source of GDP for any country. Effort is being made to analyze the trend of contributors at India and global with identification of major/top research areas, publishing journals, fund sources, organizations, researchers; group authors and cited papers in the index databases of Clarivate Analytics from 2014-2019. India is leading globally in the area of smart agricultural, more paper published in the stream of computer science and engineering. After exploration of this area it is observed that India maintains its growth at global level from last six years. Pure research work performed mainly in environmental science, S & T and biodiversity conservation. National agencies are funding more at national and International level. French National Centre for Scientific Research (CNRS) and Indian Council of Agricultural Research (ICAR) are doing much effort to promote smart agriculture at abroad and home respectively. IEEE (Institute of Electrical and Electronics Engineers) and IOP (Institute of Physics) are top group authors. Our study reveals that Indian papers did not get much citation.

**Key words:** Smart agriculture, Mitigation, Biotic Stress, Abiotic stress, Conservation, Natural resources, Biodiversity

### Introduction

Agriculture plays a crucial role in the economy of developing countries, and provides

the main source of food, income and employment to their rural populations. According to FAO (2000), it has been established that the share of the agricultural population in the total populace is 67% that agriculture accounts for 39.4% of the GDP and that 43% of all exports consist of agricultural goods<sup>1</sup>. So, world is making serious efforts to make agriculture as a progressive industry by addressing the following challenges: (i) the shortage of agricultural labors; (ii) shortage of agricultural produce; (iii) reduce harvest and post harvest loses; and (iv) monitoring the real time agricultural environment. Such efforts essentially mean complete utilization of resources and the potential of rural areas through technological innovation. The state-of-art robot technology, information and communication technology (ICT), cloud-enabled CLAY-MIST measurement (CMM) index, wireless sensor network, optical sensors, use of Internet of Things (IoT), Message Queuing Telemetry Tracking (MQTT), and other cutting-edge technologies are used to promote smart agricultural practices. Such smart practices help in achieving economic progress and establishing sustainable agro-ecosystems. In this context, in alignment with the theme of "Smart Agriculture", we have made an attempt to assess the academic output in this subject area. Indexed publications that emerge from research works serve as an Advanced Package Tool (APT) to measure academic output in any given area.

### Objectives

- To find the academic output of India in field of smart agriculture only;
- To explore the area of smart agriculture in the border term;
- To analyze the Indian output Vs Globally;
- To identify the top research areas, funding agencies, journals, leading organization authors and joint authors of India and at global level;
- To identify the top and hot papers on the basis of citations at national and International Level.

### Methodology

We choose the topic of “smart agriculture” as well as focus on some important agricultural areas i.e. “Mitigation of abiotic/biotic stresses”, “Conservation of natural resources with biodiversity” for our data search<sup>2</sup>. We looked for records under the “Topics” for six year period from 2014 to 2019 in the Web of Science (Wos) Core Collection, an authentic source of research publications and widely used index database of Clarivate Analytics. We used Smart Agricult\*, Mitigation with Abiotic/Biotic stress, Conservation with natural resource\* and Conservation with biodiversity as the main keywords for the search in Citation Indices - Science Citation Index (SCI), Social Science Citation Index (SSCI), Conference Proceedings Citation Index of Science (CPCI-S) and Social Sciences and Humanities (CPCI-SSH), from WoS. The data has been downloaded on September 22, 2020 from the databases. We restricted the further search on the basis of documents viz., Articles, Reviews, Proceeding Papers, Editorial Materials, Meeting Abstracts, Early Access and Data Paper. We used intermediary excel sheets or files for the depth analysis of data and for the expected outcomes.

### Analysis and Findings

**India's Academic Output in Smart Agriculture:** Initially, we focused on smart agriculture in respect of India so limited our search around our choose topic “smart agriculture” with restricted document types, then we received 605 records globally and

found India position is first with 119 records. When we explore these records more and refined then we received 82 pure Indian papers, we observed that most of research work published in the form of Articles and proceedings papers i.e. pure research work performed in the zone of Computer Science, Engineering and Telecommunication and the main funding agency is Department of Science (DST). The leading national Journal is Indian Journal of Agricultural Sciences. Jat ML and Kumar A are main Indian contributors. The IEEE (Institute of Electrical and Electronics Engineers) is the main professional association.

### Comparison- India's Academic Output at Global Level

: Our study revealed interesting rather encouraging facts (Table 1). In “smart agriculture” there are 605 papers published during this period globally, and India leads with 119 papers. Similarly, in the focal themes, “Mitigation of abiotic/biotic stresses” India leads in total number of publications and hold first rank at globally. We noticed good number of publications on conservation aspects. In conservation of natural resources there were 3188 records and India ranks is 7th with 171 records. We received 25136 records globally in the area of “Biodiversity” in which India holds 17th rank with 713 publications.

Further, we included all the search keywords and made single search with the help of advance search module of WoS, to find out the combined result (Table -2). In our finding, we received 28045 documents through WoS and India's Rank is 14th with 995 documents. We observed that in 2014, India position is 16th with 110 documents (3592 is global output) and in 2019, India position is 12th with 217 documents (5775 is global output). It is observed the percentage growth is maintained by India at International Level. The upward chart of academic output of (India Vs Globally) illustrated in Figure 1 & 2, which exhibit the demand and interest of researcher towards innovation in form smart agriculture. The H index of Indian paper is 37 and average citations per item are 8.76, citing articles are 7589, sum of times cited is 8723 and

**Table-1.** Smart Agriculture: publications trend in last six years (2014-2019).

CSASCPILS - 2020 Topics	2014		2019		Total		% Contribution of India at Global Level	India's Rank
	Global	India	Global	India	Global	India		
Smart Agriculture	18	02	222	35	605	119	19.669	1
Mitigation of Abiotic stress	6	3	25	12	81	30	37.037	1
Mitigation of Biotic stress	0	0	7	2	14	8	57.143	1
Conservation of Natural Resources	410	22	603	39	3188	171	5.364	7
Conservation of Biodiversity	3290	91	5107	139	25136	713	2.837	17

**Table-2.** India at International Level (Year 2014-2019).

S. No.	Publication Year	National (Number of Papers)	International (Number of Papers)	Percentage of Indian Global Papers at Level
1	2014	110	3592	3.062
2	2015	127	4122	3.081
3	2016	148	4317	3.428
4	2017	163	4795	3.399
5	2018	230	5447	4.223
6	2019	217	5775	3.757

without self-citation citing 7321 and sum of times cited is 8243.

We examine further more data and filtered records on the basis of document type and observed that the academic output produced mainly in the form of Articles, Review papers and Proceeding papers i.e. pure research performed in the stream of smart agriculture (Figure 3).

For knowing the top research areas we again filtered the data and analyzed that Environmental Sciences Ecology, Science Technology and Biodiversity Conservation are the main areas in which more research works performed at national and International Level (Figure 4).

We also curious about to know that the leading research and peer viewed journal in India and Global Level, so we continuing the filtering

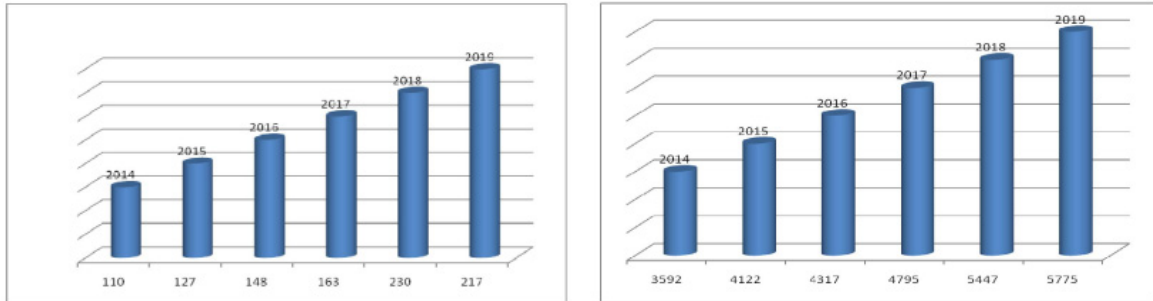


Fig. 1. Shows academic and research growth of India Vs Global; (a) India & (b) Global.

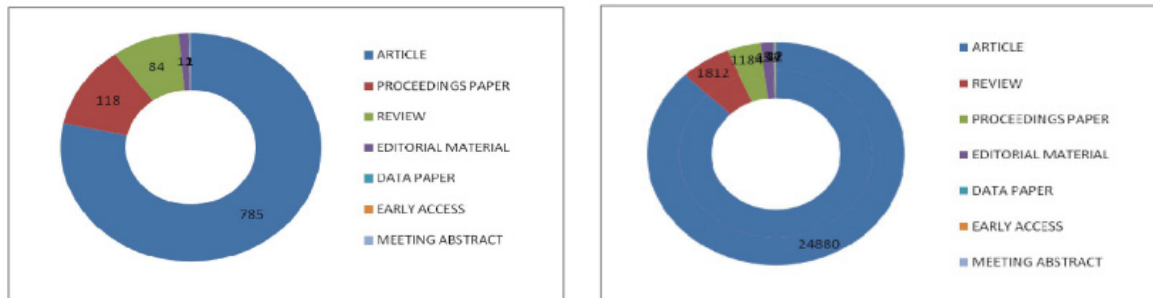


Fig. 3. Illustrated the publication trend of India Vs Global in six years; (a) India & (b) Global.

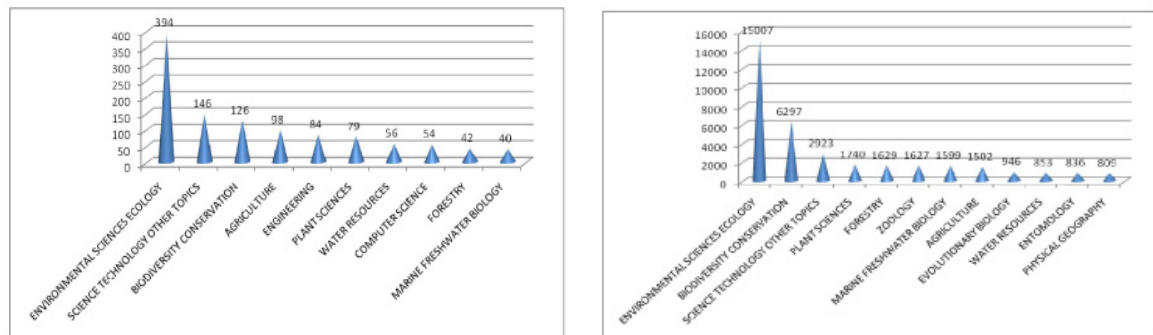


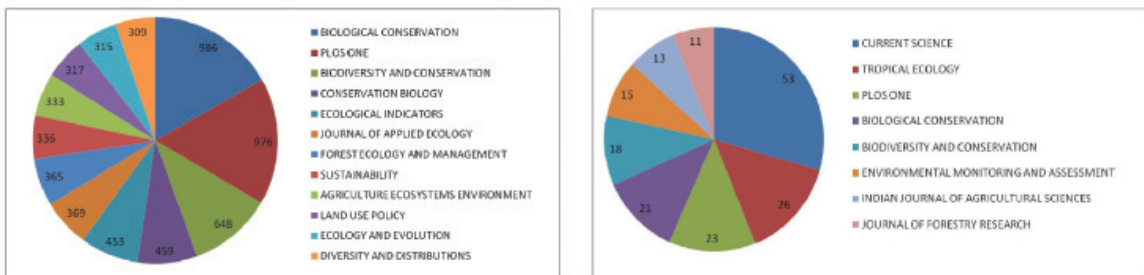
Fig. 4. Details of top ten research areas, in which most of the research performed in India Vs Global; (a) India & (b) Global.

procedure and the illustrated result (Figure 5) display that Plos One, Biological Conservation with Biodiversity and Conservation are the top most journals those were published the number of paper in the field of smart agriculture. In the case of India, Current Science and tropical ecology are the main leading journals.

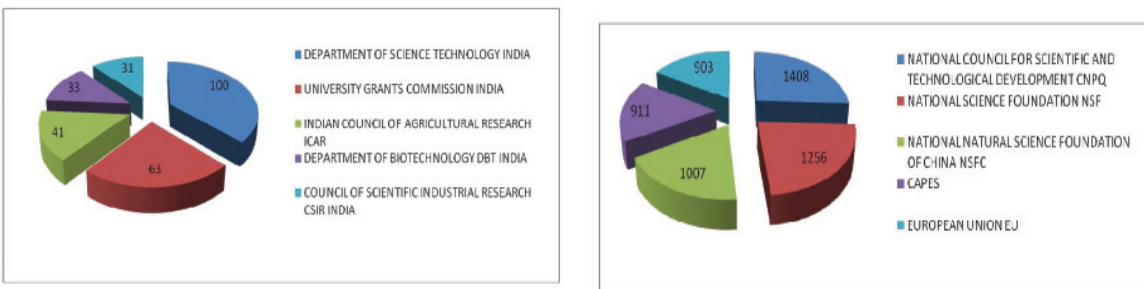
Funding is very important factor for initiative, progress and completion of any kind of research, hence it is very essential to know the funding agencies. For this we filtered and sorted our data after the few cross-checking criteria. The result (Figure 6) demonstrated that Department of Science & Technology (DST), University Grants Commission (UGC) and Indian Council of Agricultural Research (ICAR) are the top three funding agencies, which shows the focus of Indian Government on the smart agriculture (because Indian economic based on agriculture from ancient era) i.e. government interested in advanced and

ICT based smart agriculture. At global level National Council for Scientific and Technological Development (CNPQ), National Science Foundation (NSF) and National Natural Science Foundation of China (NSFC) are top most funding organizations, those are worked to promote smart agriculture at international level i.e. word move towards formal kind of agriculture to smart agriculture which based on hi-tech machinery, technologies and tools.

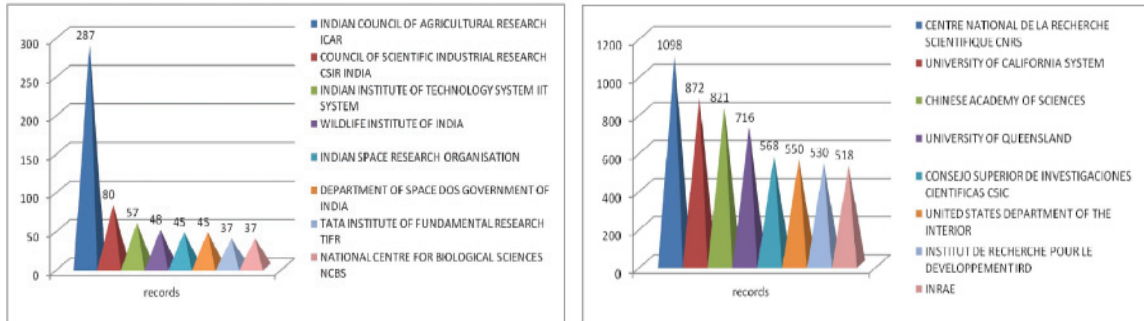
From the above result our approaches moves toward the working organizations and we would like to explore the institutions, those are performed the researches in the zone of smart agriculture; again we filtered and sorted our data. After some validating criteria we received the details of top eight organizations of India and abroad (Figure 7). The Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) and Indian Institute of Technology



**Fig. 5.** Leading research and peer reviewed journals in the field of smart agriculture in India Vs Global; (a) India & (b) Global.



**Fig. 6.** Top five Indian funding agencies contributing more in the field of smart agriculture India Vs Global; (a) India & (b) Global.



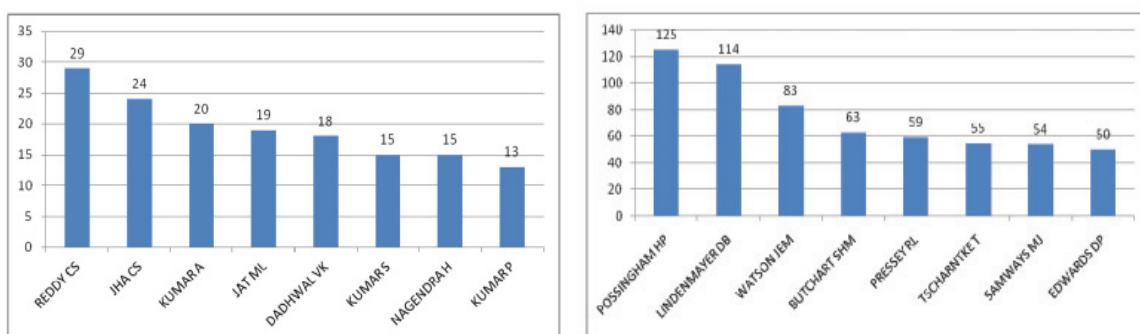
**Fig. 7** Top eight organizations performed and published good research work India Vs Global; (a) India & (b) Global.

(IIT System) are the main organizations; those are produced smart agriculture based innovative researches. In global scenario the Centre National De La Recherche Scientifique (CNRS), University of California System and Chinese Academy of Sciences are produced most significant works for encouragement of smart agriculture globally.

papers and two authors Possingham HP and Lindenmayer DB contributed in more than 100 research papers globally. In the case of group authors, IEEE (Institute of Electrical and Electronics Engineers), ACM (Association for Computing Machinery) and IOP (Institute of Physics) are the top most group author at the International level.

We were last filtered the data, to identify the top most researcher or authors of India and aboard (Figure 8) as well as we to identify the top most group authors and individual researchers of India (Figure 9). We looked that there are three Indian authors - Reddy CS, JHA CS and Kumar A those contributed in more or equal to 20 research

Our last sorting is used to analyze the citation of papers because citation is used to know the utility of any kind of research. Therefore, we sorted our result on the ground of received citation in respect of India and Globally. The Indian papers received less citation in comparison to global level



**Fig. 8.** Top eight authors exploring the research work in the field of smart agriculture India Vs Global; (a) India & (b) Global.

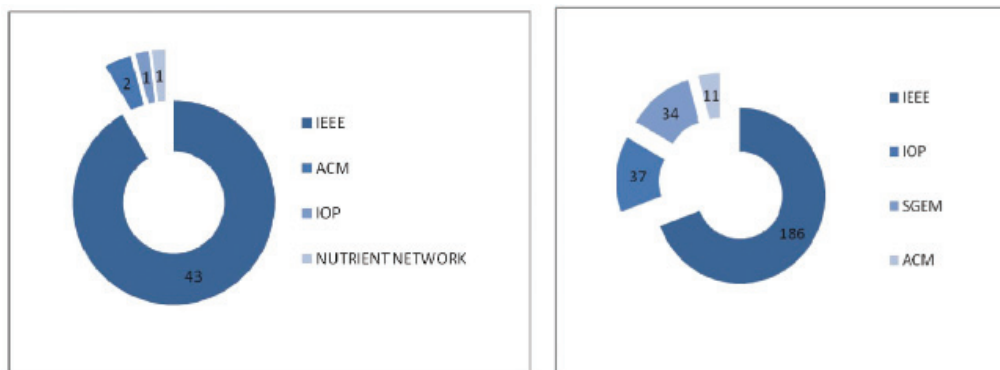
Table-3. List of highly cited papers (green colour denoted the Indian papers and blue for global).

S. No.	Authors	Article Title	Journal Name	Publication Year	Cited Times
1	Pascual U <i>et.al.</i>	Valuing nature's contributions to people: the IPBES approach	Current Opinion in Environmental Sustainability	2017	332
2	Anderson-Teixeira K J <i>et.al.</i>	CTFS-ForestGEO: a worldwide network monitoring forests in an era of global change	Global Change Biology	2015	243
3	Pettorelli N <i>et.al.</i>	Satellite remote sensing for applied ecologists: opportunities and challenges	Journal of Applied Ecology	2014	194
4	Vurukonda S S K P, Vardharajula S, Shrivastava M and SkZ A	Enhancement of drought stress tolerance in crops by plant growth promoting rhizobacteria	Microbiological Research	2016	182
5	Jat R K	Seven years of conservation agriculture in a rice-wheat rotation of Eastern Gangetic Plains of South Asia: Yield trends and economic profitability	Field Crops Research	2014	110
6	Meena K K <i>et.al.</i>	Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants: The Omics Strategies	Frontiers in Plant Science	2017	105
1	Ripple W J <i>et.al.</i>	Status and Ecological Effects of the World's Largest Carnivores	Science	2014	1198
2	Dirzo R <i>et.al.</i>	Defaunation in the Anthropocene	Science	2014	1188
3	Pimm S L <i>et.al.</i>	The biodiversity of species and their rates of extinction, distribution, and protection	Science	2014	1029
4	Haddad N M <i>et.al.</i>	Habitat fragmentation and its lasting impact on Earth's ecosystems	Science Advances	2015	992
5	Ceballos G <i>et.al.</i>	Accelerated modern human-induced species losses: Entering the sixth mass extinction	Science Advances	2015	926
6	Dulvy N K <i>et.al.</i>	Extinction risk and conservation of the world's sharks and rays	Elife	2014	732
7	Edgar G J <i>et.al.</i>	Global conservation outcomes depend on marine protected areas with five key features	Nature	2014	725
8	Chapron G <i>et.al.</i>	Recovery of large carnivores in Europe's modern human-dominated landscapes	Science	2014	651
9	Watson J E M, Dudley N Segan D B and Hockings M	The performance and potential of protected areas	Nature	2014	615

Table 4 — List of hot papers (green colour denoted the Indian papers and blue for global).

S. No.	Authors	Article Title	Journal Name	Publication Year	Cited Times
1	Neutral Network	TRY plant trait database - enhanced coverage and open access	Global Change Biology	2020	38
2	Reid A J <i>et.al.</i>	Emerging threats and persistent conservation challenges for freshwater biodiversity	Biological Reviews	2019	157
3	Bekun F V, Alola A A and Sarkodie S A	Toward a sustainable environment: Nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries	Science of the Total Environment	2019	148
4	Barlow J <i>et.al.</i>	The future of hyperdiverse tropical ecosystems	Nature	2018	86
5	Meyfroid P <i>et.al.</i>	Middle-range theories of land system change	Global Environmental Change-Human and Policy Dimensions	2018	62
6	Brancalion P H S <i>et.al.</i>	Global restoration opportunities in tropical rainforest landscapes	Science Advances	2019	50
7	Chenu C <i>et.al.</i>	Increasing organic stocks in agricultural soils: Knowledge gaps and potential innovations	Soil & Tillage Research	2019	47
8	Diaz S <i>et.al.</i>	Pervasive human-driven decline of life on Earth points to the need for transformative change	Science	2019	44
9	Trevelline B K, Fontaine S S, Hartup B K and Kohl K D	Conservation biology needs a microbial renaissance: a call for the consideration of host-associated microbiota in wildlife management practices	Proceedings of the Royal Society B-Biological Sciences	2019	40





**Fig. 9.** Top group authors worked together India Vs Global; (a) India & (b) Global.

(Table 3 & 4) i.e. there is need of improvement in the research work in the field of smart agriculture in India.

### Conclusion

Though India ranks ahead in total number of publications, it lags behind in highly cited papers. It indicates need for quality work to gather more citations and improve the country's position in quality publishing. Academic stages like this may help in this regard. On growth trend of publications, India performs better with higher growth rate compared to world growth trend in almost all areas of our search here especially in the area of smart agriculture but for "biodiversity", where it has to concentrate and come up with good number of quality publications to stay ahead. These observations are, though authentic, but incomplete without looking into other equally good sources viz., Scopus, Google Scholar.

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