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Scientometrics of Indian crop science research as reflected by the coverage in Scopus, CABI and ISA databases during 2008-2010

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The paper analyses scientific output of India in the discipline of crop sciences as reflected by the coverage of scientific output in three different databases i.e. SCOPUS, CAB Abstracts and ISA (Indian Science Abstracts) during 2008-2010. The analysis indicates that highest number of papers was published on rice and wheat crop. Agricultural universities and institutions under the aegis of Indian Council of Agricultural Research (ICAR) were most productive institutions. Most of the papers were published in Indian journals with low impact factor. Environment and Ecology, Indian Journal of Agricultural Sciences and Research on Crops were the most preferred journals used by the Indian scientists. The major research is focused on 'genetics and plant breeding' followed by 'soil, climate and environmental aspects' and 'agronomic aspects'. The authorship pattern reveals that co-authored papers accounted for 72% of total output.

Keywords: Bibliometrics; Crop science; Scientometrics; India; Grain crops

Introduction

The importance of agriculture in the economic development of any country, rich or poor, is borne out by the fact that it is the primary sector of the economy that provides the basic ingredients necessary for the existence of mankind and also provides most of the raw materials which when transformed into finished products serve as basic necessities of the human race. India is essentially an agricultural country with over three-fourth of its population living in rural areas and depends on agriculture and related occupations. Agriculture contributes nearly half of the national income and provides employment to about 70 percent of the working population in India.

Crop science, especially cereal science is one of the major disciplines in the field of agriculture sciences in India, on which special attention is being given from research point of view. Cereals broadly can be classified into three groups: wheat, rice and coarse cereals, which refer to the collective term for maize, sorghum, and millets. The role of research, especially development of high yielding varieties of seeds for a number of crops like wheat, rice and maize is responsible for a large increase in productivity since the Green Revolution[1]. The green revolution resulted in the increased production of cereals from 69.3 million tons during 1960-61 to 198.8 million tons during 2001-02. Similarly the yield per hectare of cereals increased from 753 kg/ha during 1960-61 to 1983 kg/ha during 2001-02. Agricultural research played a crucial role in achieving this performance[2]. The present study attempts to analyze the Indian publications output in the sub-discipline of crop sciences particularly cereal crops during 2008-2010 as reflected by the coverage in three different databases namely Indian Science Abstracts(ISA), Commonwealth Agricultural Bureau [now Centre for Agricultural Bioscience International(CABI)] and Scopus. The study identifies most prolific institutions and most prolific authors in the field of crop science and examines the communication behavior of Indian agriculture scientists as reflected by the country of publication of papers and the impact factor of journals where the research results were published.

Methodology

The study is limited to six food cereal crops (wheat, rice, barley, maize, sorghum and millets). Data from the above mentioned three databases was downloaded using Hindi names/common names/botanical names of different crops as the keywords. The keywords used in the search strategy for downloading records were as follows:

- Wheat or Gahu or *Triticum aestivum* and India, and not buckwheat, and not buck wheat
- Barley or Jau or *Hordeum vulgare*, and India

- Maize or *Zea mays* or makka or corn, and India, not *Valerinella locusta*
- Rice or chawal or dhan or paddy or *Oryza sativa*, and India, but not rice bean and but not rice bean
- Sorghum or jowar or jwaarie or jondhahlaas or mutthaari or kora or Sudan grass or millet bloom and India
- Millet or Bajra or Pennisetum, and India, or *Eleusine coracana*, or *Setaria italica* or *Echinochloa esculenta*, or *Panicum miliaceum*

The downloaded data was converted into MS-Excel file. The data elements consisted of the name of the author (s) with their affiliation, name of the journals and the number of authors contributing the paper. Data was analyzed on different variables such as prolific authors and their affiliations, journals used for publishing research results and sub disciplines of research. Journals indexed by Science Citation Index Expanded (SCIE) were also identified. Analysis of the data indicates that there were a very large number of records that were not related to field of study and were common among the three databases. This highly inflated the downloaded data. To arrive at an accurate picture of the Indian output in crop sciences, duplicate records as well as those records not related to the field of study were deleted from the downloaded data. After deletion of irrelevant and duplicate records the authors were left with a total of 3530 records.

Review of literature

In the past several studies dealing with agriculture and related aspects have been reported in literature. These studies dealt with different aspects of agriculture research like authorship trends in agriculture research[3], information use pattern of researchers in veterinary sciences and animal husbandry[4], and bibliometric analysis of agriculture journals[5-6]. In addition, studies have also been reported on mapping of research output in different sub-disciplines of agriculture sciences. For example, Arunachalam and Umarani[7] analyzed 11855 publications on agricultural research output of Indian scientists indexed by CAB Abstracts 1998. Authors found that majority of papers were published on pests, pathogens and biogenic diseases of plants (1301 papers), plant breeding and genetics (1135 papers) and plant production (786 papers). Agricultural universities contributed 4039 and Indian researchers preferred to publish in journal originated from UK, USA and India with 587, 368 and 208 journals respectively. Majority of papers were published in non-SCI journals. Garg et.al.[8] analyzed 16891 papers published by Indian agricultural scientists indexed by Science Citation Index Expanded (Web of Science) during 1993-2002 and found that the publication output in the agricultural sciences is on the decline since 1998 onwards. The major research focus was on 'dairy and animal sciences' followed by 'veterinary sciences'. Agricultural universities and institutes under the aegis of Indian Council of Agricultural Research (ICAR) produced maximum research output. Majority of papers were published in domestic low impact factor journals. Balasubramanian and Ravanan[9] analyzed scientific output in agricultural sciences during last 66 years. The study indicated that global agricultural research output showed an upward trend. Regarding country-wise distribution of publications in agriculture research, the USA produced the highest number of papers and the most preferred journal was *Agriculture Ecosystems and Environment* publishing 533 papers. National Science Foundation of the US made highest contributions. Garg et al[10] analyzed 32,574 papers published by USA, UK, China, India and Brazil in the field of 'plant genetics and breeding' research during 2005-2009 and found that USA produced the maximum number of publications followed by China. India produced about 9 per cent of the world publication output. Indian output formed a part of the mainstream science as seen by the pattern of publication and citation of the research output. Senthilkumaran and Amudhavalli[11] examined literature on spices for the period of 1968 to 2002 with respect to Asia and India using HORT-CD database. The study revealed that India dominates research and development activities on spices in the Asian continent and Indian Institute of Spices Research, Calicut, is a significant contributor whose scientists top the list of prolific authors. Farahat[12] examined authorship patterns in 19 Egyptian journals of agricultural science and found that multi-authorship was predominant. Also, no significant differences in patterns of collaboration were observed in the agricultural sciences in Egypt, India and Pakistan. Seetharam and Rao[13] compared the trends in growth of Food Science and Technology (FST) literature produced by CFTRI (Central Food and Technology Research Institute) scientists, Indian food scientists and food scientists of the world during 1950-90. Garg et.al.[14] analyzed 2899 research papers on 'genetics and heredity' of Indian scientists indexed

by Science Citation Index Expanded (Web of Science) during 1991-2008. The analysis indicates a slow growth in the initial stages and the focus of research was on molecular genetics. A majority of papers were published in journals that originated from Western countries and in journals having impact factor less than one. Academic institutions had the highest number of papers. Suryanarayana[15] analysed global research output in Tobacco and found that the research output decreased globally after 1987. Tripathi et.al.[16] analysed 1610 scientific papers produced by 18 animal science research institutes of the *Indian Council of Agriculture Research* (ICAR) during April 2009-March 2010. Authors found that Indian scientists preferred to publish in Indian journals. The major research focus was on agriculture breeding and genetics and Indian Veterinary Research Institute published the highest number of papers.

Objectives of the study

The study aims to analyze the Indian publication output in the sub-discipline of crop sciences (grain crops) during 2008-10 as reflected by the coverage in three different databases namely ISA, CABI and Scopus. Specific objectives of the study are the following:

- To identify the output of different crops in different databases during 2008-2010;
- To identify the different performing sectors and the prolific institutions in the field of crop science;
- To study the communication behavior of Indian agriculture scientists as reflected by the country of publication of papers and their impact factor;
- To identify most prolific authors in the field of crop sciences;
- To identify the sub-disciplines where the crop science output is concentrated.

Analysis

Publication output in different cereal crops in different databases

The total number of papers indexed in three databases was 3791. However, authors have analysed 3530 papers as some papers were classified under two crops. Table 1 gives the output in different cereal crops in different databases during 2008-2010. Data presented in Table 1 indicates that the highest number of papers was published in the rice crop followed by wheat. Lowest number of articles was published in barley. Scopus and CAB abstracts indexed highest number of papers.

Productivity by performing sectors and highly productive institutions

The distribution of output by different performing sectors indicates that State Agriculture Universities (SAUs)/agricultural colleges, universities and colleges produced 2528 (71.6%) papers. The share of institutions under the aegis of Indian Council of Agricultural Research (ICAR) was 639 (18%). Thus, these two performing sectors published about 90% of the total output in crop science research. Remaining 10% of the output came from other institutions under the aegis of other central/state government agencies as well as private institutions. Table 2 presents data on the distribution of output by prolific institutions. The total output came from 460 institutions located in different parts of India. The 25 prolific institutions (Table 2) produced about 46% of the output and the rest 415 institutes produced 54% of the output. The top three highly productive institutes are University of Agricultural Sciences (Dharwad), followed by Punjab Agricultural University (Ludhiana) and Indian Agricultural Research Institute (New Delhi). The share of these prolific institutions in the total output is about one-fifth of the total output.

Communication behavior of Indian crop scientists

Papers published by Indian crop science researchers appeared in 200 journals which were published from different parts of the globe. Of these, 97 journals were published from India and the rest 103 were published from 20 different countries from abroad. Table 3 presents the data on the number of papers published by Indian crop scientists in journals published from different countries. Among the journals published from abroad about (16%) papers were published in journals published from The Netherlands, UK and USA. Further analysis of data indicates that more than one-third (36%) papers appeared in SCIE indexed journals and the rest in non SCIE journals. This indicates that the major proportion of papers published by Indian crop scientists appear in non-SCIE indexed journals and most of them being journals that originated from India.

Distribution of papers by impact factor

Table 4 shows the distribution of output by impact factor of journals where the research results were published. It indicates that about 64% (2255) papers were published in journals with no impact factor and

the rest 36% papers appeared in journals with impact factor. Further analysis of data indicates that about one-fourth of the papers (24%) were published in journals having impact factor between 0 and 1. Rest of the papers was published in journals having impact factor more than 1. Only a minuscule proportion of papers were published in journals having impact factor more than 3. Table 5 lists number of papers in journals with impact factor three and more than three.

Most common journals used by Indian scientists

Data was analyzed to identify the most common journals used by Indian scientists for publishing their research results. It indicates that 24 most common journals (Table 6) originated from India. There other preferred journals were *Euphytica* (The Netherlands), *Archives of Phytopathology and Plant protection* (UK) and *International Journal of Plant Sciences* (USA).

Table1—Research output in different cereal crops in different databases during 2008-10

Crops	Scopus	CAB abstracts	ISA	Total	Output after deletion of duplicate records
Rice	6026	2439	1569	10034	1665
Wheat	4496	1435	825	6756	945
Barley	1745	118	76	1939	83
Maize	3601	933	434	4968	477
Millet	1288	482	249	2019	316
Sorghum	1509	530	306	2345	305
Total	18665	5937	3459	28061	3791

Table 2—Highly productive institutions

Sl.no.	Name of the institution	No. of papers
1	University of Agricultural Sciences, Dharwad (Karnataka)	251
2	Punjab Agricultural University, Ludhiana (Punjab)	208
3	Indian Agricultural Research Institute (IARI), New Delhi	207
4	Tamilnadu Agricultural University, Coimbatore (Tamilnadu)	204
5	CCS Haryana Agricultural University, Hissar (Punjab)	164
6	GB Pant University of Agricultural & Technology, Pantnagar (Uttara Khand)	98
7	Acharya NG Ranga University, Hyderabad (Andhra Pradesh)	84
8	Bidhan Chand Krishi Vishvavidyalaya, Mohanpur (West Bengal)	78
9	Assam Agricutural University, Jorhat (Assam)	73
10	Sher-E-Kashmir University Of Agricultural Sciences & Technology, Jammu & Kashmir	69
11	Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra)	64
12	CS Azad University of Agricultural & Technology, Kanpur (Uttar Pradesh)	62
13	Annamalai University, Annamalai Nagar (Tamilnadu)	61
14	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) , Patancheru, Hyderabad (Andhra Pradesh)	60
15	Orissa University of Agricultural & Technology, Bhubaneswar (Orissa)	50
16	Directorate of Wheet Research, Karnal (Haryana)	49
17	Indira Gandhi Krishi Vishvavidyalaya, Raipur (Chhatishgarh)	49
18	Banaras Hindu University (BHU), Varanasi (Uttar Pradesh)	43
19	ND University of Agricultural & Technology, Faizabad (Uttar Pradesh)	43
20	Marathwada Agiculture University, Parabhani (Maharashtra)	40
21	Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra)	39
22	Rajendra Agricultural University, Samastipur (Bihar)	38
23	Central Rice Research Institute, Cuttack (Orissa)	36
24	Junagadh Agricultural University, Junagarh (Gujarat)	34
25	Directorate of Rice Research	34
	Total	1918
	Remaining 415 institutions	1612
	Total	3530

Subject distribution of research output

Crop science is the study of scientific approaches used to improve the quality of crops. It is a multidisciplinary research which deals with areas such as plant breeding and genetics, crop physiology, crop production and management and weed science etc. Using several keywords related to crop science research, authors identified six disciplines where the research output was published. The distribution of output in these disciplines is shown in Table 7. It indicates that highest number of papers was published in the discipline of genetics and plant breeding closely followed by soil climate and environmental aspects. These two sub-disciplines together constitute more than half the total output. Rest half was scattered in the remaining four sub-disciplines. The number of papers in plant genetics and breeding are more, because, the agricultural scientists are working on increasing the field of rice and wheat crops.

Authorship pattern

Total contribution was made by 1336 authors. Table 8 presents data about the authorship pattern in crop sciences. It indicates that more than three fourth of the papers were published as multi-authored (3 and 4 authors) and mega-authored (> 4 authors). Similar classification has been used earlier in a study by Garg and Padhi[17] in their study on laser science and technology. The share of papers written by single authors is the lowest. This is because the discipline of crop science is multidisciplinary which involves several researchers from different disciplines. Table 10 lists top 20 authors who have published 10 or more paper during 2008-2010 in journals only. Rest of the authors published papers ranging from 1 to 19. Out of 20 top authors, four belonged to CCS Haryana Agricultural University, Hisar followed by Punjab Agricultural University, Ludhiana and International Crops Research Institute for the Semi-Arid Tropics, Patancheru. These three authors contributed 52, 40 and 36 papers respectively.

Table 3—Distribution of research output in domestic and foreign journals

Publishing country of journals	No. of papers in SCI journals	No. of papers in non-SCI journals	Total
India	719	2026	2745
Netherlands	203	23	226
UK	105	91	196
USA	113	49	162
Germany	40	00	40
Hungary	19	14	33
Japan	22	06	28
Australia	18	08	26
Italy	13	03	16
Ireland	11	00	11
Other 11 countries	12	40	52
Total	1275	2255	3530

Table 4—Distribution of papers by impact factor of journals

Range of IF	No of papers
Papers in no IF journals	2255
0-1	838
>1<2	280
>2<3	122
>3<4	35
Total	3530

Table 5—Journals having impact factor ≥ 3

Journals	Country	Impact factor JCR 2011	No. of papers
Plant Physiology	USA	6.545	3
Plant Cell and Environment	UK	5.22	3
Plant Molecular Biology	Netherlands	4.15	4
BMC Plant Biology	UK	3.45	7
Agronomy for Sustainable Development	France	3.34	5
Rice	USA	3.11	2
Agriculture, Ecosystems and Environment	Netherlands	3.01	11
Planta	Germany	3.00	5
21 journals		Less than 3	117
28 journals		Less than 2	280
24 journals		Equal and Less than 1	838
119 journals		Not available in JCR	2255
Total			3530

Table 6—Most common journals used by Indian researchers

Sl. no.	Name of journals	No. of papers	Country	Impact factor
1	*Environment and Ecology*	273	India	
2	*Indian Journal of Agricultural Sciences*	210	India	0.27
3	*Research on Crops*	146	India	0.13
4	*Indian Journal of Genetics and Plant Breeding*	117	India	
5	*Asian Journal of Soil Science*	84	India	
6	*Karnataka Journal of Agricultural Sciences*	82	India	
7	*International Journal of Agricultural Sciences*	80	India	
8	*Agricultural Science Digest*	78	India	
9	*Journal of Agrometeorology*	72	India	0.13
10	*Ecology, Environment and Conservation*	65	India	0.13
11	*Indian Journal of Agronomy*	65	India	0.37
12	*Crop Research*	64	India	
13	*Advances in Plant Sciences*	58	India	
14	*Allelopathy Journal*	54	India	0.39
15	*Euphytica*	54	Netherlands	0.73
16	*Journal of Maharashtra Agricultural Universities*	50	India	
17	*Archives of Phytopathology and Plant Protection*	48	UK	0.23
18	*Electronic Journal of Plant Breeding*	48	India	
19	*Green Farming*	48	India	
20	*Pestology*	48	India	0.19
21	*Annals of Plant Protection Sciences*	46	India	
22	*International Journal of Plant Sciences*	46	USA	0.78
23	*Indian Phytopathology*	43	India	
24	*Journal of Soils and Crops*	41	India	
	Total	1920		
	Other 176 journals	1610		
	Grand Total	3530		

Table 7—Distribution of output according to sub-disciplines of crop science research

Sl. no.	Subject	No. of papers	Percent
1	Genetic and plant breeding	931	26.4
2	Soil, climate and environmental aspects	901	25.5
3	Agronomic aspects	671	19.0
4	Pest, diseases and weed control	608	17.2
5	Physiological and biochemical aspect	348	9.8
6	Harvest, storage & agricultural engineering	71	2.0
	Total	3530	100.00

Table 8—Authorship pattern

Number of authors	Number of publications	Percentage
One	185	5.24
Two	806	22.83
Multi-authors	1725	48.87
Mega authors	814	23.06
Total	3530	100.00

Table 9—Highly productive authors

Authors	Affiliation	Output
Yadav, D	CCS Haryana Agricultural University, Hisar (Haryana)	15
Walia, U. S.	Punjab Agricultural University, Ludhiana (Punjab)	15
Kukal, S. S.	Punjab Agricultural University, Ludhiana (Punjab)	15
Shetty H.S.,	University of Mysore, Manasagangotri, Mysore (Karnataka)	14
Malik, R. K.	CCS Haryana Agricultural University, Hisar (Haryana)	13
Ashok Yadav	CCS Haryana Agricultural University, Hisar (Haryana).	13
Nirmalakumari, A.	Tamil Nadu Agricultural University, Coimbatore (Tamilnadu)	13
Thakur, R P	International Crops Research Institute for the Semi-Arid Tropics, Patancheru, AP	13
Singh A K	Indian Agricultural Research Institute, New Delhi	12
Upadhyaya, H. D.	International Crops Research Institute for the Semi-Arid Tropics, Patancheru (Andhra Pradesh)	12
Punia, S. S.	CCS Haryana Agricultural University, Hisar (Haryana).	11
Sahrawat, K. L.	International Crops Research Institute for the Semi-Arid Tropics, Patancheru (Andhra Pradesh)	11
Yadvinder-Singh,	Punjab Agricultural University, Ludhiana (Punjab)	10
Prashar, M.	Directorate of Wheat Research (IARI Regional Station), Shimla (Himachal Pradesh)	10
Shivay, Y. S.	Indian Agricultural Research Institute (IARI), New Delhi	10
Biradar B.D.,	University of Agricultural Sciences, Dharwad (Karnataka)	10
Prasanna, B M	Indian Agricultural Research Institute (IARI), New Delhi	10
Seetharama, N.	National Research Centre for Sorghum, Rajendranagar, Hyderabad (Andhra Pradesh)	10
Jayadeva, H M	University of Agricultural Sciences, Dharwad (Karnataka)	10
Singh S	Banaras Hindu University, Varanasi (Uttar Pradesh)	10

Conclusion

Using scientometrics as an assessment technique, the study identifies different performing sectors and institutions in crop science research in India besides identifying the pattern of authorship as well as the communication behavior of Indian scientists. The study indicates that State Agricultural Universities and the institutions under the aegis of the Indian Council of Agriculture Research are most productive. The research was mainly focused on rice and wheat crops. Indian scientists preferred to publish in domestic journals with low impact factor and only a miniscule portion of research output was published in journals originated from the advanced countries of the West. "Genetics and plant breeding" was the priority area of research. The pattern of authorship indicates that the discipline of crop science is dominated by multi-authored papers. The findings of the present bibliometric study will be beneficial for the scholars, who are engaged in research on various disciplines of crop science as well as to policy makers in the field of agriculture sciences.

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Corrigendum

On page 319 of *Annals of Library and Information Studies*, Volume 60, No. 4, references stand corrected as follows:

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