Scientometric Analysis of Scholarly Publications of Agronomist Dr. G. S. Khush

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1. Introduction

Individual scientists are more and more becoming the focus of scientometric studies for quite some time. An ever-growing stress is recently being laid on scientometrists to publish data on individual scientists rather than gross statistical "macro" data (Schubert and Glanzel, 1992). Study of bio-bibliometrics is mainly focused on the biographical study of the individual author along with bibliometric analysis of the publications and correlates bibliographical publications or academic and scientific achievements of the individual careers of scientists and researchers.

It has also been defined as the quantitative and analytical method for discovering and establishing functional relationships between bio-data and biblio-data elements. This is different from the study of scientometrics which often focuses on the scientists rather than academicians or researchers from the arts, humanities and social sciences (Mahmood & Rehman, 2009). The present study centres on the contributions of Gurudev S. Khush, the Riceman, agronomist, geneticist, who won the World Food Prize with his mentor, Dr Henry Beachell, for their unparalleled achievements in enlarging and improving the supply of rice in 2006. Dr Khush is known for his strength in feeding the hungry world with high yielding rice varieties.

2. Dr Gurudev S Khush: The Undisputed Hero of Rice Revolution

The man who is often referred to as one of the fathers of the Green Revolution in rice cultivation is none other than Dr Gurdev Khush, a plant breeder and geneticist by profession and is one of the world's authorities on crop breeding and a major force behind the development of productive rice varieties and the Green Revolution in plant breeding.

The trail of Dr. Khush's remarkable career began on a wheat farm in northern India, where his father instilled in him the value of education. After graduating from Punjab Agricultural University (PAU), Ludhiana in 1955, he travelled to England and worked in a factory to save enough money for travel to the United States. Then in 1957, he applied for his doctorate and was accepted by the University of California at Davis, where he studied with two legendary plant geneticists Ledyard Stebbins and Charles Rick. At an early age of 25, i.e in 1960 Khush completed his doctoral degree in genetics in less than three years after joining the University of California and studied the tomato genomics with Dr Rick for seven years.

In 1967, Dr Khush joined the International Rice Research Institute (IRRI), Manila and in less than five years of joining IRRI, Dr Khush became the head of IRRI's plant breeding department and developed his own new variety of "miracle rice", IR36. This was developed using IR8 as a genetic base and cross breeding it with 13 parent varieties from six nations. He led IRRI to the forefront in the improvement of rice varieties. Prior to the beginning of the Green Revolution, varieties of rice took 6-7 months to mature and yielded about 1-2 tons per hectare. Dr Khush modified the plant by reducing its height, shortening maturing time, and increasing response to fertilizers. Under optimal conditions, these plants can yield up to 10 tons per hectare. The combination of these characteristics soon made IR36 one of the most widely planted food crop varieties the world has ever known. IR64 later replaced IR36 as the world's most popular variety and IR72, released in 1990, became the world's highest-yielding variety.

With the aim of **"Rice for a hungry world"**, Dr Khush and his team were able to produce 300 plus improved varieties were distributed to rice-growing countries in Asia, Africa, and Latin America. These modern rice varieties helped prevent a major calamity that is caused by the advancement of an explosion in world population. Because farmers adopted these modern varieties, the world's supply of rice doubled in just 25 years from 257 million tons in 1966 to 686 million tons in 2010. Most of the major rice- producing countries became self-sufficient. Massive starvation had been avoided for the moment. The major force behind this profound increase in the world's food supply is none other than Dr. Gurdev S. Khush. More than 60% of the worlds' rice fields are planted with varieties developed under his leadership. In other words, when we pass or set foot in a rice field anywhere in the world, it is likely the variety you see was developed by Khush and his breeding team.

In 1994, Dr Khush announced a new type of "super rice", which has the potential to increase yields by 25 percent. His final work on what is called the New Plant Type (NPT) for irrigated rice fields is complete. Developing NPT almost took 12 years and the plants were yielding strongly in temperature areas of China and are tropical Asia. It is a complete redesign of the rice plant from the roots up, making it higher yielding, more vigorous, and better able to resist pests and diseases without the use of environmentally damaging pesticides. It is designed to yield up to 12 tonnes per hectare in irrigated tropical conditions, but adjusting its genetic characteristics to match tastes and environment conditions.

Awards and Honours:

- For his monumental contributions to the World Food Security, Dr Khush has been honoured with numerous awards and honours. Perhaps no other NRI scientist has received as many awards and honours as Dr Khush. He has received honorary doctorates from ten universities, including a doctorate from Cambridge in 2000 and a doctorate from Guru Nanak Dev University in the year 2007 in India. In 2007, Dr Khush was awarded the Golden Sickle Award, honouring researchers who have made a considerable contribution or accomplishment in rice research. In addition, Dr Khush received the Borlaug Award in 1977, the Japan Prize in 1987, the 1996 Wolf Prize in Agriculture, the 2001 International Scientific and Technological Cooperation Award from the Government of China, and the Prestigious Padma Shree award from President of India in 2001. Dr Khush is the author of three books, and more than 80 book chapters and 160 scientific papers.
- Dr Khush has served as consultant to rice breeding programs of 15 national governments, including India, China, and Russia as well as The Rockefeller Foundation, The Third World Academy of Sciences, Italy, Indian National Science Academy, U.S. National Academy of Sciences, The Royal Society and the International Science Foundation, Sweden. He also served as a member of Scientific Advisory Committee (overseas) to the Department of Biotechnology, Government of India.
- Dr Khush shared the 1996 World Food Prize with his mentor, Dr Henry Beachell, for their unparalleled achievements in enlarging and improving the supply of rice, one of the world's largest food crops. He has since played a key role in developing more than 300 rice varieties in IRRI's race to keep rice production ahead of population growth.

- Another significant contribution of Dr Khush is the training of numerous rice scientists from all over the world. His contributions to rice genetics and biotechnology are equally well recognized. In 2002, after 35 years of unprecedented service, he retired from IRRI and returned to University of California-Davis as an adjunct professor to share his knowledge and experience with students and faculty.
- During his career at IRRI, Khush has visited more than 60 rice-growing countries and has been a consultant in rice improvement programs in many of them. He has also trained rice breeders from around the world, served as major professor for MSc and PhD students, and laid the groundwork for rice breeding programs in many places.
- Dr Khush has worked closely with the Indian rice scientists and supplied numerous rice varieties which are grown widely in India. It is solely due to his untiring efforts, perseverance, scientific bent and visionary thought, which has ushered into a food self sufficient, and food secure India and many other countries world over.

3. Review of Literature

Earlier, a number of biobibliometric & bibliometric studies have been conducted in India on eminent persons here some of the notable studies from India are by Angadi et. al. (2005), Devarai and Ramesh (1998), Gupta (1983), Kademane, Kalyane and Vijai (2002), Kademani, Kalyane and Balakrishnan (1994), Kademani and Kalyane (1998), Kademani, Kalyane and Kademani (1996), Kalyane and Kademani (1997), Kalyane and Sen (2003), Kalyane (1995), Kalyane and Devarai (1994), Kalyane and Kalyane (1994), Kalyane and Munnolli (1995), Kalyane, Prakasan and Vijai (2001), Koley and Sen (2006), Munnolli and Kalyane (2003),Parvathamma and Devendra (2008), Sangam and Savanur (2006), Sinha and Ullah (1994), Sinha and Bhatnagar (1980), Sinha and Dhiman (2001), Swarna and Kalyane (2004), Upadhye.et al.,(2004), Mulla et.al(2010). Detail description of few biobibliometric studies conducted on the works of well-known personalities are analysed.

Tiew analyzed the publication productivity, authorship pattern, channels of communication, journal preference and language preference of Professor Dato Khoo Kay Kim, Professor of Malaysian History in the University of Malaya, Kuala Lumpur (Tiew, 1999). The study analyzed 271 articles written by Rudraiah‘s published between 1962 to 2004. The

collaboration co-efficient was 0.54. Highest collaborations were with M. Venkatachalappa and B.C.Chandrasekhara.

Sangam and Savanur (2006) carried out study on Communication and collaborative research pattern of Sivaraj Ramaseshan, physics scientist. They have analysed 178 research papers written by Ramaseshan from 1944 to 2000.

Another study is based on 251 papers of Prof. B. N. Koley,published during 1958-2001. This study examines year-wise distribution of papers, research group of the scientist and scattering of papers in different communication channels. In addition,the study finds out author productivity, spectrum of research activity through analysis of the title keywords, and productivity of Koley's research group. Finally, the study shows that the data setdoes not follow Bradford distribution. (Koley & Sen, 2006).

Parvathamma and Devendra carried out another biobibliometric study on Aminabhavi. They have analyzed 521 research articles and 94 conference papers in eight domains of polymer science; collaboration coefficient was 0.9 and 1.0 showing the interdisciplinary nature of his research. (Parvathamma & Devendra, 2008). Similarly Mahmood and Rehman (2009) analyzed Dr. Anis Khurshid contributions towards library literature. This study covered his all kind of publications in total 182 articles published during the period of 47 years has been analyzed.

Another study carried by Mulla et.al (2010) analyzed 452 popular research articles of Prof. C. N. R. Rao‘s publications in the fields of Chemistry. Collaboration coefficient is 0.91 for all types of publications. Average authorship per paper is 1.95 and 3.22 for popular articles and conference papers, respectively.

4. Objectives of the Study

Main objectives of the present study were to analyze the data under following headings:

- To know domain wise productivity of research art
- To sketch the domain wise collaboration,
- To assess the authorship pattern and collaboration coefficient,
- To examine the chronological distribution of research articles v/s authorship position,
- To study the core journals used for publishing research articles, and
- To find out country wise distribution of journals.
- To study the association with institution wise publications.

5. Methodology

The requisite information was gathered from the Web Of Science SCI. Dr G. S. Khush has published more than 160 articles, 4 books and edited but in this study we have limited to only 126 popular research articles published during 1989 to 2014 years (26 years) of his research career. The data was analyzed with correlated to the objectives of the study.

An attempt is made to study collaborative pattern of authorship using:

i. Collaborative Index (CI) suggested by Lawani (1980) is the mean number of authors per joint authored publications given by: $CI = \sum_{j=1}^{A} \frac{j*F_j}{N}$

ii. Degree of Collaboration (DC) by Subramanyam K (1980) is a measure of proportion of multiple authored papers given by: $DC = 1 - \frac{F_j}{N}$

iii. Collaboration coefficient (CC) suggested by Ajiferuke et.al, is based on fractional productivity defined by Price and Beaver and is given by: $CC = 1 - \frac{\sum_{j=1}^{A} \frac{F_j}{j}}{N}$

iv. Modified collaborative coefficient: The derivation of the new measure is almost the same as that of CC, as given in Ajiferuke et al. is given by: $CC = \left(\frac{A}{A-1}\right) * (1 - \frac{\sum_{j=1}^{A} \frac{F_j}{j}}{N})$

Where Fj = the number of papers having j authors in collection K;

N = the total number of papers in K.

A = the total number of authors in collection K.

6. Results and Discussion

6.1 *Subject Wise/Domain Wise Productivity of Research Articles*

Dr. Gurudev Khush has research communications in Agriculture - Dairy and Animal Science; Agronomy and Plant Science ; Biochemistry ,Molecular Biology; Food and Nutrition ; Genetics and Heredity; Biotechnology andApplied Microbiology; Ecology and Environment; Multi disciplinary Science and Others. Table 1 reveals that subject wise productivity of research articles by Dr. Khush during 1989 to 2014. Maximum number of research articles (76 articles(60.32%),was published in the subject of Agronomy and Plant sciences, followed by 11 articles (8.73%) in Genetics and heredity.74.6% of the total research articles were published in subjects of agronomy, genetics ,biotechnology and heredity. Collaboration coefficient lies between 0.67 and 1.00 for all the domains. This indicates that the collaborative trend is near total in all the subjects.

Table 1 : Subject - wise Distribution of Research Articles

Number	A	B	C	D	E	F	G	H	Total (A-H)	%	Authors	%	Coefficient*
One		3	2	2	1	1		1	10	7.9	10	1.4	-
Two		8	1	1	1	1		1	13	10.3	26	3.6	0.87
Three	1	9	1		3	1			15	11.9	45	6.2	0.83
Four		11		2		1	4		18	14.3	72	9.9	0.82
Five		12	1		1			2	16	12.7	80	11.0	0.76
Six		10						1	11	8.7	66	9.1	0.65
Seven		5	1		2		1	2	11	8.7	77	10.6	0.61
Eight	1	5				2			8	6.4	64	8.8	0.50
Nine		4				1		1	6	4.8	54	7.5	0.40
Ten		2			1			1	4	3.2	40	5.5	0.29
Eleven		1			1			2	4	3.2	44	6.1	0.27
Twelve		1						1	2	1.6	24	3.3	0.14
Thirteen		1							1	0.8	13	1.8	0.07
Fifteen		1						1	2	1.6	30	4.1	0.12
MT Fifteen		3			1			1	5	4.0	80	11.0	0.24
Total	2	76	6	5	11	7	5	14	126	100	725	100	**0.92**
%	1.6	60.3	4.8	4.0	8.7	5.6	4.0	11.1	100				
Coefficient*	1	0.96	0.67	0.6	0.91	0.86	1	0.93					

A - Agriculture - Dairy and Animal Science; B - Agronomy and Plant Science ; C - Biochemistry ,Molecular Biology; D - Food and Nutrition ; E- Genetics and Heredity; F-Biotechnology and Applied Microbiology; G-Ecology and Environment I - Multidisciplinary Science and Others

*Group Coefficient for Collaborative author publications **g = Nm/(Nm+Ns)**

6.2 Authorship Pattern and Collaboration Coefficient

The details about the authorship pattern with number of articles contributed by authors are given in Table 2. The data shows that, out of 126 articles published with different authors' pattern. The single authorship pattern with 10 (1.38%) articles, two authorship patterns with 10(10.32%) articles, three authorship pattern with 15(11.90%) articles, more than three-authorship pattern with 88(69.84%) articles.

Table 2 : Authorship Pattern and Collaboration Coefficient

No. of Authors (j)	F_j	j*fj	Collaborative index (CI)	Degree of Collaboration (DC)	Collaboration Coefficient (CC)	Modified Collaborative Coefficient (MCC)
1	10	10	-	-	-	-
2	13	26	0.206	0.897	0.948	0.956
3	15	45	0.357	0.881	0.96	0.968
4	18	72	0.571	0.857	0.964	0.972

5	16	80	0.635	0.873	0.975	0.983
6	11	66	0.524	0.913	0.985	0.993
7	11	77	0.611	0.913	0.988	0.996
8	8	64	0.508	0.937	0.992	1
9	6	54	0.429	0.952	0.995	1.003
10	4	40	0.317	0.968	0.997	1.005
11	4	44	0.349	0.968	0.997	1.005
12	2	24	0.19	0.984	0.999	1.007
13	1	13	0.103	0.992	0.999	1.007
15	2	30	0.238	0.984	0.999	1.007
16	5	80	0.635	0.96	0.998	1.006
Total	126					

6.3 Chronological distribution of articles and Authorship position

Table 3 shows that, year wise distribution of research articles of Dr. Khush between the age of 33 to 58 years. He has published maximum of 10 research articles in the years 2000 and 2003 (8%). More ever he has maintained uniformity in publishing 95 articles (75.39%) between 1990 and 2003. He is either the second, third or the fourth author in 56 papers (44.44%).

Table 3 : Year - wise Distribution of Research Articles

APL	Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	12th	16th	> 20th	MT	TP	AA
1	1989		3	1	1										5	5	33
2	1990		2	5	1	1									9	9	34
3	1991	1	3	2	1		2								8	9	35
4	1992		2	2	1										5	5	36
5	1993			2	1										3	3	37
6	1994		2	2	1		2								7	7	38
7	1995			1		2	1								4	4	39
8	1996			2	1	1	1								5	5	40
9	1997	1	1	2					1	1	1				6	7	41
10	1998		1	2		1			1				1		6	6	42
11	1999	1				3	2	1							6	7	43
12	2000		2	2		1	3	1	1						10	10	44
13	2001	2	1	2				1	1	1	1				7	9	45
14	2002		1					1			2				4	4	46
15	2003		2		1	1	3			1			2		10	10	47
16	2004						1	1	1						3	3	48
17	2005	1	1				1								2	3	49

18	2006	1			1			1			1				3	4	50
19	2007	1													0	1	51
20	2008		1					2							3	3	52
21	2009	1										1			1	2	53
22	2010	1				1	1					1		1	4	5	54
23	2011					1									1	1	55
24	2013	1					1		1						2	3	57
25	2014											1			1	1	58
Total		**11**	**22**	**25**	**9**	**12**	**18**	**8**	**6**	**3**	**5**	**3**	**3**	**1**	**115**	**126**	

APL - Age of Productive Life, TP-Total Publications, MT-Total multi- authored Publications ,
AA -Biological Age Of Author

6.4 Collaborators wise distribution of articles

Table 4 shows the list of collaborators and the years of collaboration. Total of 538 researchers have collaborated with Dr. Khush in 126 research papers during the 26 years of his research career (1989 -2014). Dr Khush collaborated with Brar, DS with 21 papers (16.67%) between 1991 and 2010. The period of international collaboration is significant with Brar, DS(20 years), Huang N (10 years with 20 articles collaboration(15.87%)), Li ZK with 15 years of collaboration, Benette J (20 years), Jenna KK(15 years) are remarkable in the disciplines of agronomy.

Table 4: Authorship credits of researchers collaborating with Dr. Khush in chronological order

Sl. No	Collaborators	Authorship credits	%	Period of Association	Total Years
1	Khush GS	126	100.00	1989-2014	26
2	Brar DS	21	16.67	1991-2010	20
3	Huang N	20	15.87	1994-2003	10
4	Li ZK	12	9.52	1999-2013	15
5	Ogawa T	11	8.73	1990-1997	8
6	Fukuta Y	9	7.14	2003-2010	8
7	Angeles ER	9	7.14	1994-2007	14
8	Mew TW	9	7.14	1990-1999	10
9	Datta SK	7	5.56	1998-2006	9
10	Kobayashi S	7	5.56	2003-2010	8
11	Yamamoto T	7	5.56	1990-1998	9
12	Bennett J	7	5.56	1995-2014	20
13	Datta K	6	4.76	1998-2006	9
14	Jena KK	6	4.76	1989-2003	15
15	Ebron LA	5	3.97	2000-2010	11
16	Kato H	5	3.97	2000-2010	11

17	KUMAR I	5	3.97	1989-1994	6
18	Osaki M	5	3.97	2003-2006	4
19	Peng SB	5	3.97	2003-2014	12
Number of authors with 4 publications each		17		1992-2014	22
Number of authors with 3 publications each		20		1991-2014	23
Number of authors with 2 publications each		56		1989-2014	26
Number of authors with 1 publications each		436			
Total Number of Collaborative Authors :		548			

6.5 Channels of communication:

Distribution of Dr. Khush's 104 publications was in 46 journal and remaining chapters in books, conference proceedings. Journal wise scattering of publications of DR. Khush is provided in Table-5. Top ranking journals with a number of publications are: Theoretical and applied genetics (23), Euphytica (11), Japanese Journal Of Breeding (11), Breeding Science (6), Field crops research(6), genetics (5), heredity(5), genome (4), plant breeding (4). Sixty three percent of his research papers are published in these top ranking ten journals.

Table 5. Dissemination of the channels of communication used by Dr Khush

S no	Channel of communication	No. of papers	%	Cumulative	Cumulative %	Period of journal	TY
1	Theoretical and applied genetics	23	18.3	23	18.25	1990-2013	23
2	Euphytica	11	8.7	34	26.98	1990-2008	19
3	Japanese journal of breeding	11	8.7	45	35.71	1989-1992	4
4	Breeding science	6	4.8	51	40.48	1997-2010	14
5	Field crops research	6	4.8	57	45.24	2004-2010	7
6	Genetics	5	4.0	62	49.21	1996-2001	6
7	Heredity	5	4.0	67	53.17	1992-1996	5
8	Genome	4	3.2	71	56.35	1989-1999	11
9	Plant breeding	4	3.2	75	59.52	1989-2013	25
10	Proceedings of the national academy of sciences of the united states of America	4	3.2	79	62.70	1996-2006	11
11	Crop science	3	2.4	82	65.08	1999-2000	2
12	Plant molecular biology	3	2.4	85	67.46	1997-2005	9
13	Science	3	2.4	88	69.84	2000-2013	4
14	Cereal chemistry	2	1.6	90	71.43	1991-1993	3
15	Journal of heredity	2	1.6	92	73.02	1994-1998	5
16	Molecular breeding	2	1.6	94	74.60	1997	1
17	Nature	2	1.6	96	76.19	1990-2002	13
18	Plant biotechnology journal	2	1.6	98	77.78	2003-2006	4
19	Advances in agronomy	1	0.8	99	78.57	1991	1

20	Animal feed science and technology	1	0.8	100	79.37	1991	1
21	Annual review of phytopathology	1	0.8	101	80.16	1992	1
22	Food security	1	0.8	102	80.95	2009	1
23	Genetic resources and crop evolution	1	0.8	103	81.75	1999	1
24	Hereditas	1	0.8	104	82.54	1999	1
25	Hortscience	1	0.8	105	83.33	2006	1
26	Insect science and its application	1	0.8	106	84.13	1990	1
27	Japanese journal of genetics	1	0.8	107	84.92	1991	1
28	Jarq-japan agricultural research quarterly	1	0.8	108	85.71	2010	1
29	Journal of animal and plant sciences	1	0.8	109	86.51	2008	1
30	Journal of genetics	1	0.8	110	87.30	1995	1
31	Journal of plant biology	1	0.8	111	88.10	2011	1
32	Journal of plant growth regulation	1	0.8	112	88.89	2014	1
33	Molecular & general genetics	1	0.8	113	89.68	1997	1
34	Molecular plant-microbe interactions	1	0.8	114	90.48	2000	1
35	Mycopathologia	1	0.8	115	91.27	1996	1
36	Nature biotechnology	1	0.8	116	92.06	2006	1
37	Nature reviews genetics	1	0.8	117	92.86	2001	1
38	Phytopathology	1	0.8	118	93.65	2003	1
39	Plant and cell physiology	1	0.8	119	94.44	2005	1
40	Plant disease	1	0.8	120	95.24	1989	1
41	Plant production science	1	0.8	121	96.03	2003	1
42	Plant science	1	0.8	122	96.83	1989	1
43	Proceedings of the nutrition society	1	0.8	123	97.62	2001	1
44	Sabrao journal of breeding and genetics	1	0.8	124	98.41	2007	1
45	Sexual plant reproduction	1	0.8	125	99.21	2008	1
46	Starch-starke	1	0.8	126	100.00	1990	1

Table 6 shows the scattering pattern of papers by Dr. Khush. There is constant increase i.e 3.33% in the number of journal titles from one zone to another which are equi-productive by number of papers.

Table 6: Bradford's Law of Scattering

Zone	No of Journal Titles	No. of papers
1	3	45
2	10	43
3	33	38

6.7 Country wise Distribution of Dr. G. S. Khush's Publications

Table 7 indicates that among the country wise distribution of publications of Dr. Khush . Majority of articles are published in Publications of Philippines with 69(54.8 %) publications followed by Japan with 25(19.8%), United States Of America with 22(17.5%). Dr G. S. Kush's'

contribution to Indian Agricultural Research stands 5th position in his contributions. First place goes to Philippines having total Global Citation Score of 3946 with 105 publications in terms of Citations Scores and followed by United States of America with 1745 Global Citation Scores, China with 1197 Global Citation Scores and remaining contribution by other countries.

Table 7 shows Country wise Distribution of Dr. G. S. Khush's Publications

Sl. No	Country	Articles	Percent	TLCS	TGCS
1	Philippines	69	54.8	105	3946
2	Japan	25	19.8	22	1110
3	Others	24	19.0	30	1198
4	USA	22	17.5	28	1745
5	India	13	10.3	7	505
6	Peoples R China	13	10.3	14	1197
7	UK	3	2.4	0	25
8	Australia	2	1.6	0	27
9	Ireland	2	1.6	0	4
10	Czech Republic	1	0.8	0	0
11	France	1	0.8	0	6
12	Saudi Arabia	1	0.8	0	4
13	Singapore	1	0.8	0	110
14	South Korea	1	0.8	0	10
15	Switzerland	1	0.8	0	4
16	Tanzania	1	0.8	0	6

6.8 Institution-wise Contribution of Dr. G. S. Khush's Publications

Table 8 indicates that major parts of Khush's contributions are associated with International Rice Research Institution, Philippines with 77% (97 institutional records among 84 institutions)of the total group of institutions, followed by 7.1% with University California Davis and University of Georgia. Khush is also associated with Indian Agricultural Institutions such as IRRI, Punjab Agricultural University with 5 associations each, further associated with IARI and University of Agricultural Science, Bangalore with 3 associations each.

Table 8 : Institution-wise Contribution of Dr. G. S. Khush's Publications

S. No	Institution	Records	%	Period of Association	TY
1	International Rice Research Institution	97	77	1989-2014	26
2	University California Davis	9	7.1	2004-2014	15
3	University Georgia	8	6.3	1992-2013	22
4	China National Rice Research Institution	6	4.8	1996-2013	18
5	Huazhong Agricultural University	6	4.8	1998-2010	13

6	Hokkaido University	5	4	2003-2006	4
7	IRRI	5	4	1993-2013	21
8	Punjab Agricultural University	5	4	2001-2008	8
9	Japan International Research Center Science	4	3.2	2006-2010	5
10	National Agricultural Research Center	4	3.2	1990-1991	2
11	Tohoku University	4	3.2	2003-2005	3
12	University Nebraska	4	3.2	1999-2010	12
13	Indian Agricultural Research Institution	3	2.4	2002-2003	2
14	National Agricultural Research Center Western Reg	3	2.4	2006-2010	5
15	TAISEI CORP	3	2.4	1991-1997	7
16	University Agricultural Science Bangalore	3	2.4	2002-2003	2

7. Conclusions

Dr. Gurdev Khush is a world renowned agronomist and is considered one of the heroes of the Green Revolution, for his leadership in developing rice strains that enhanced the quality and quanitiy of the rice supply in countries facing unprecedented population growth. Under his direction at the Plant Breeding Department, the International Rice Research Institute (IRRI) developed rice varieties that now account for 60% of the world's rice supply.

The study of Dr Khush's research output shows the long time commitment and sustaining efforts are necessary to achieve excellence in one's area of research. The study highlights the various aspects of the career of a scientist such as his productivity according to his biological age, collaborative pattern, authorship status and other characteristics. These studies help to know the work of scientist.

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