

## Collaboration in Research Productivity in Oil Seed Research Institutes of India

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\* **Sudhir Kumar****Surendra Kumar +****Abstract: -**

Presently collaborative research is the trend especially in science. The economics and infrastructure sectors are pressing for more collaborative research. Changing communication pattern have drastically influenced this trend. The study is comprehensive and studies collaboration in research productivity since the establishment of five major Oil seed research institutes in India till the year 2006. The paper studies in all 3330 contributions contributed by scientists' working in these research centers. Analysis includes types of communication channels used and the authorship patterns. Reveals that 33.77% articles have been published in Indian & foreign journals and 33.25% in conferences. Also finds that only 21.33% publications are single authored & the

collaboration coefficient (Q) ranges between 0.709 to 0.845 in various institutes. Overall coefficient is 0.781. Value of Q for top 10 authors in each institute has been analyzed. The paper also studies dominance factor among these 10 top rank contributors in each institute. It reveals that on an average their dominance as first author is less than 40% only. Paper suggests for more research output and more funds for better research.

**1. Introduction: -**

Indian Council of Agricultural Research (ICAR) is a premier body in the field of agricultural research, education and extension in India. On the recommendations of Famine Commission 1901 and Irrigation Commission, 1903, Imperial Agricultural

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Research Institute (IARI) was established at Pusa (Bihar) in 1905. Similarly on the recommendations of the Royal Commission on Agriculture, 1926, Imperial Council of Agricultural Research (ICAR), was established in 1929 for coordination between agriculture based research institutes & colleges. Due to earthquake devastation, the IARI was shifted to New Delhi in 1935. Both were renamed as Indian Agricultural Research Institute and Indian Council of Agricultural Research (ICAR) after independence in 1947. ICAR is an autonomous organization under the Ministry of Agriculture, Govt. of India, New Delhi. (R). Presently it has vast network of institutes throughout India with number of National Research Centres, Project Directorates, Krishi Vigyan Kendra's, etc.

The production and research in oil seeds boosted only after independence. According to Sharma & Reddy (2007) at present India is one among the largest vegetable oil economics in the world, next only to USA, China and Brazil. Currently India accounts in the world for 12-13% oilseeds area, 6-7% oilseeds output, 6-7% oil

meal production, 5-6% oil meal export, 15-17% oil import and 10% edible oil consumption. Out of the nine important oilseeds, India ranks first in the world in the production of castor, safflower, sesame and niger, second in groundnut and rapeseed, third in linseed and fifth in soybean and sunflower. Oilseeds account for nearly 3% of gross national product and 10% of the value of all agricultural products.

To boost oil seeds research in India the ICAR established 5 National Research Centres in Oil Seeds (NRCOS) namely, Directorate of Oilseed Research (DOR), Hyderabad (Andhra Pradesh) (1977); National Research Centre for Groundnut (NRCG) (Junagarh), (Gujarat) (1979); National Research Centre for Soyabean, Indore (NRCS) (Madhya Pradesh) (1987); National Research Centre for Rapeseed and Mustard (NRCRM) (Bharatpur) (Rajasthan)(1993); and National Research Centre for Oil Palm Pedavegi (NRCOPP) (Andhra Pradesh) (1995).

The research in oil seeds is very important to meet indigenous demand and

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control prizes. Very recently, in May 2008 the future trading of Soya oil has been banned to curb its prizes.

Research deficiency in terms of publications in scientific journals became a part of parliamentary debate. According to a note presented in Indian Parliament, India was responsible for only 2.16% of articles in world scientific publications between 1992-2004 as against 2.62% by China as reported by Hindustan Times (2008). It was matter of concern. But many parliamentaries were of the view that by citing publication productivity very little is known about a country's technological ability and feel that more holistic assessment of innovation capability is needed.

This study has identified strength of the five highly productivitic research institutes of ICAR in oil seeds in terms of publications" output. It has implications in terms of setting up research priorities, allocation of resources in the country and in setting the counry's agenda for bringing oil

seed research in the forefront of world scenario.

There are many works on productivity & collaboration Mujoo Munshi (1994) (2004) Kabir Humayoon (1996) and Mahesworapha (1992), have worked on Bibliometric studies in agricultural for their Ph.D. thesis. Gupta & Dhawan (2007), Garg & Rao (1988), Kogasnuramath & others (2002), Kannappanavar (2004), Kundra & Srinivas (2004), Kademani & others (2005), Sen and Gan (1990) have worked on productivity in various fields. Sangam (2004, 2007) has worked on collaboration studies. Kumar & Kumar (2000) research is on Oil Seeds in India & used the term Productometrics in their paper for the first time. They have also worked on Bibliometric studies on Journal of Oil Seeds. The works of Macias Chopula and others (2007), Glanzel and Schubert (2004) and have studied collaboration pattern. Sudhir Kumar 2008 has studied Dominance Factor among multi-authored papers (2008).

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## 2. Method and Data Sources: -

The contributions of scientists made in various communication channels over the period of their service, in the institutes have been studied in this paper. For data collection annual reports from the years of the establishment of the institute till 2006 have been collected & lists of papers published by the scientists have been prepared for each institute. Spreadsheets have been prepared for data analysis.

For degree of collaboration formula given by Subramanyam (1983) has been applied which take the proportion of co-authored publications (Nm) in total publications (Nm+Ns), mathematically represented as

$$Q = \frac{Nm}{Nm + Ns} \quad (1)$$

Collaboration index has been calculated with the formula suggested by Lawani, which takes mean number of authors per publication. This has been modified in this study and does not take into consideration single authored

publications, as it is always constant “one”. It is now mean of number of authors (Nam) per multi-authored publication (Npm) mathematically represented as:

$$CI = \frac{Nam}{Npm} \quad (2)$$

Dominance Factor formula has been developed by Sudhir Kumar (2008). D.F. is proportion of number of multiauthored papers of an author as first author (Nmf) to total number of multi authored papers of the author (Nmt). Single authored papers have been omitted due it constant value “one” of single authored papers. Mathematically it is represented as:

$$DF = \frac{Nmf}{Nmt} \quad (3)$$

High DF value shows more dominance of author as first author while low DF value shows low dominance of author as first author.

## 3. Results: -

In this part data has been analysed in various tables and results have been obtained

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from the data collected.

### 3.1 Distribution of Contributions: -

Table 1 analyses contributions of the five research institutes in oil seeds. 36.16% contributions are made from the scientists of DOR, which is the oldest institute in the field. The contributions from the scientists of NRCRM & NRCOP are relatively less. The per year contributions ranges between 18-40 papers in these five institutes with an overall average of 31.7 papers per year.

### 3.2 Communication Channels Used: -

The scientists have used various communication channels for their contributions, which include newspapers, popular magazines, in-house publications, conferences & journals as shown in the Table 1. The contributions in research journals & seminars/conferences at national level are 27.7% and 26.02% respectively each. In International conferences and journals only 7.23 % and 6.06% papers respectively have been published.. Only 50 (1.5%) contributions are in book / monograph form. 326 (9.79%) articles are popular articles published in newspapers and magazines, etc. The study shows that contributions at national level

journals & conferences are most preferred communications channels

### 3.3 Authorship Pattern:-

In Table.2 authorship pattern of contributions have been analyzed. Only 21.33% contributions are single authored. Most of the papers are double-authored papers (29.75%) and triple authored papers (25.19%). Only 9.57% papers have five or more authors. Thus the table reveals high degree of collaboration among scientist engaged in oil seed research. .

In table 3 values of Collaboration Coefficients (Q) of each institute have been calculated. It ranges between 0.709 to 0.847. The mean value of Q is 0.781, which is very high. It means most of the contributions have been collaborated with two or more authors

Similarly values of Q for various communication channels have been calculated as also given in Table 3. The average value of Coll. Coefficient Q is 0.70 or below in three communications channels viz -In-house publications, books chapters and books & others like souvenir, etc. It is highest in journals (0.883), higher (0.82) in newsletters and high (0.78) in conferences/seminars. It

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means that more scientists prefer to contribute as single author in newspapers, books chapter & souvenir. On the other hand while contributing in journals & conferences, they usually collaborate with fellow scientists.

In Table 4, values of Q for five years blocks for each institution have been calculated. It reveals an over all increase of Collaboration Coefficient in the five research institutes from first block to last block of time.

In Table 5 a Collaboration Index has been prepared for each time block for multiauthored papers only. The single authored papers have been ignored. The table shows an increase of collaboration index value in various time blocks. It shows that the value is increasing from one block to another block. Overall the values have increased from 2.99 to 3.45 from first block to last block of time. On an average there are 3.31 authors per multiple authored papers.

### 3.4 Relative Frequency of Single vs. Multi-authored Contributions: -

The distribution of authorship patterns in various time blocks have been given in Table 6 A. It reveals that percentages of single authored publications have come down from 22.2% to 20.1% in first block period to the last block. The table 6A also reveals an increase in percentages of contribution made by 5 or more authors. It means that the number of authors in a collaborated paper is increasing from first to last block periods.

On the basis of the table, the relative frequencies of papers have been calculated for various blocks of time in Table 6 B and progressive distributions in Table 6 C. The number of papers in each time block in each authorship pattern has been divided by total number of papers to find out a relative frequency, e.g. for 1982 – 86 block there are total 126 papers. Dividing this 126 by total number of the papers the value obtained is  $126/3330 = 0.038$  . Similarly relative frequencies are calculated for other time blocks. The overall values of relative frequencies ranges between 0.038-0.471 in

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first block to 0.427 to 0.773 in last block of time.

### 3.5 Collaboration Pattern of Top Ten Contributors: -

The collaboration patterns of top ten highly productive contributors have been studied for each institute in Tables 7A- 7E. The average collaboration coefficient ( Q ) value in DOR is 0.721. The minimum value is 0.421 & highest is 0.911. In NRCG, average value of Q 0.893 with minimum 0.671 to maximum 1.000. In NRCS the average value of Q is 0.901 with minimum 0.705 to 1.000. In NRCRM & NRCOP the average value of Q is 0.867 & 0.88 respectively. The overall value of Q of all institutes is 0.852. From this we can infer that most of the scientists in these institutes have collaborated with other scientists in contributing publications in various communication channels.

The categorization of values of Q in high, medium & low degree in each institute for top ten contributors has been done in Table 8. 52% contributors have high (0.900 & above), 28% medium (0.700 to 0.899) and 20 % low (below 0.7) degree of

collaboration coefficient. Thus we can infer that top contributors have very high degree of collaboration.

### 3.6 Dominance Factor: -

The values of Dominance Factors of top ten contributors have been calculated for each institute in tables 7A – 7E. The overall DF value calculated is 0.399 for all institutes, which means on an average top ten authors dominate only in approximately 40% of their collaborated publications where they are listed as first author. These tables also show that DF value ranges between 0.00 to 0.97. There are very few authors who are very dominating. In NRCG one author has DF value 0.97 i.e. to say his/her most of the multi authors papers are contributed as first author. Similarly in case of another author in NRCG the value of DF is as low as 0.00, which means author's all the contributions are collaborative without a single as first author though the author has contributed 49 collaborated papers and is listed on 5<sup>th</sup> rank.

The Table 9 classify DF values in to high, medium and low dominance degrees in each institution. The analysis shows that only

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36% top ranked authors have high (0.50 & above) DF values while 36 % have medium (0.30-0.49) and 28% have low (0.29 & below) DF values. It reveals that top ranked authors are not always first authors in collaborated articles inspite of the fact that they are highly productive authors. The analysis is encouraging to young authors to collaborate with their senior colleagues in paper publication & research activities.

#### 4. Discussions: -

This bibliometric investigation is helpful in understanding research and patterns in the oil seeds scientists. The single author papers are more in the beginning of the establishment of the institutes. As soon as, the institute grows, there are more collaborated papers. It has been observed from the study that in each institute there are few very productive scientists who regularly contribute to knowledge. On the other hand majority of scientists are less productive. In research institutes, the scientists are engaged in research continuously and publish papers in various communication channels. Each paper costs heavily for the government as funding agency. The scientists should regularly

publish research papers in large number. They should also make their research work more popular by way of articles in newspapers and popular magazines in local and regional languages. It is also observed that highly productive authors are very collaborative. Also they are not very dominant over collaborators.

The study is inspiring for research scientists to collaborate with other scientists in publication productivity, which will help not only for more research out but also in their personal career advancement. The globalization has brought scientists together and they should collaborate not only intra-institutionally but also nationally, & internationally. The government must provide more funds for research. The poor pay price for any slash in research due to less yield and as such high costs. Any cut in research budget cost high for every family.

**Please see the tables in last para.**

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**Table 1: Distribution of Communication Channels of Contributors**

S.N	Publications Est.	DOR 1977		NRCG 1979		NRCS 1987		NRCRM 1992		NRCOP 1995		Grant total	
		Papers	%	Papers	%	Papers	%	Papers	%	Papers	%	Papers	%
1.	Indian Journals	363	30.15	182	23.57	231	30.76	86	32.95	061	17.83	0923	27.71
2.	Foreign Journals	061	05.06	079	10.23	036	04.79	10	03.83	016	04.68	0202	06.06
3.	Nat Conf/ Seminars	317	26.33	203	26.29	149	19.84	70	26.82	128	37.43	0867	26.02
4.	Int. Conf / Seminars	065	05.40	040	05.18	086	11.45	15	05.75	041	11.99	0247	07.23
5.	In house Publications	040	03.32	100	12.95	027	03.59	29	11.11	022	06.43	0218	06.54
6.	Newsletters	035	02.90	037	04.79	057	07.59	09	03.45	005	01.46	0143	04.29
7.	Chapter of Books	109	09.05	088	11.39	048	06.39	08	03.07	012	03.51	0265	07.95
8.	Edited Books	016	01.33	010	01.29	011	01.47	04	01.53	009	02.63	0050	01.50
9.	Popular Articles	168	13.95	031	04.01	072	09.59	25	09.58	030	08.77	0326	09.79
10.	Others	030	02.49	002	00.26	034	04.53	05	01.92	018	05.26	089	02.67
	<b>Total</b>	<b>1204</b>	<b>100</b>	<b>772</b>	<b>100</b>	<b>751</b>	<b>100</b>	<b>261</b>	<b>100</b>	<b>342</b>	<b>100</b>	<b>3330</b>	<b>100</b>
	%	<b>36.16</b>	-	<b>23.18</b>	-	<b>22.55</b>	-	<b>7.84</b>	-	<b>10.27</b>	-	<b>100</b>	-
	<b>Average / year</b>	<b>40.10</b>		<b>27.6</b>		<b>37.6</b>		<b>17.4</b>		<b>28.5</b>		<b>31.7</b>	

Note : \* Home country \$ Other country Journal

**Table 2–Distribution of Authorship Pattern of Contributions**

Sr. No.	Authors	DOR		NRCG		NRCS		NRCRM		NRCOP		Grant total		Author ship
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	
1.	Single	350	29.07	118	15.28	132	17.57	59	22.60	068	19.88	727	21.33	<b>0727</b>
2.	Two	364	30.23	224	29.51	243	32.35	50	19.15	110	32.16	991	29.75	1982
3.	Three	253	21.01	204	26.42	226	30.09	69	26.44	087	25.44	839	25.19	2517
4.	Four	136	11.30	145	18.78	084	11.18	44	16.86	045	13.16	454	13.63	1816
5.	Five	067	05.56	044	05.67	043	05.72	21	08.05	017	04.97	192	05.76	0960
6.	Six	023	01.91	025	03.24	014	01.86	06	02.30	010	02.92	078	02.34	0468
6.	Seven	006	00.50	006	00.77	005	00.66	03	01.15	002	00.58	022	00.66	0154
7.	Seven +	005	00.42	006	00.77	004	00.53	09	03.45	003	00.88	027	00.81	0442
8.	<b>Total</b>	<b>1204</b>	<b>100</b>	<b>772</b>	<b>100</b>	<b>751</b>	<b>100</b>	<b>261</b>	<b>100</b>	<b>342</b>	<b>100</b>	<b>3330</b>	<b>100</b>	<b>8966</b>
9.	<b>Q</b>	<b>0.709</b>	--	<b>0.824</b>		<b>0.678</b>		<b>0.845</b>		<b>0.773</b>	--	<b>0.781</b>		

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**Table3 Distribution of Collaboration Coefficients by types of Communication Channels**

Institute	Block Periods					Total
	77-86	87-92	92-96	97-01	02-06	
DOR	2.80	2.53	2.92	2.94	3.1	3.03
NRCG	3.19	2.74	3.14	3.39	3.44	3.42
NRCS	NA	2.35	2.58	2.78	3.31	3.02
NRCRM	NA	NA	NA	3.40	4.24	3.95
NRCOP	NA	NA	NA	2.92	3.12	3.11
<b>Total</b>	<b>2.99</b>	<b>2.54</b>	<b>2.88</b>	<b>3.08</b>	<b>3.45</b>	<b>3.31</b>

**Table 4: Change of Degree of Collaboration during Blocks Periods**

Institute	All Publication	Journals only	Conferences only	In house	NL	BOB	SOU
DOR	0.709	0.824	0.69	0.57	0.59	0.75	0.84
NRCG	0.847	0.935	0.86	0.75	0.92	0.69	0.80
NRCS	0.824	0.921	0.78	0.77	0.91	0.63	0.65
NRCRM	0.773	0.948	0.81	0.41	0.84	0.92	0.50
NRCOP	0.801	0.844	0.85	0.86	0.40	0.57	0.33
<b>Total</b>	<b>0.781</b>	<b>0.883</b>	<b>0.78</b>	<b>0.68</b>	<b>0.82</b>	<b>0.70</b>	<b>0.64</b>

**Table 5: Collaboration Index of Multiple Authored Contributions**

Institute	Block Periods					Total
	82-86	87-91	92-97	97-01	02-06	
DOR	NA	0.500	0.695	0.742	0.706	0.709
NRCG	0.778	0.854	0.866	0.878	0.839	0.849
NRCS	NA	0.839	0.822	0.666	0.868	0.824
NRCRM	NA	NA	0.066	0.818	0.816	0.773
NRCOP	NA	NA	0.076	0.720	0.0878	0.801

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**Table: 6A Distribution of Contributions in Blocks Periods during 1982-2006**

Blocks Periods	Total	1 Author	2 Authors	3 Authors	4 Authors	5 Authors	6 Authors	7 Authors	7+ Authors
1982-86	126	28(22.2)	40(31.7)	26(20.6)	27 (11.4)	04(3.1)	00	00	00
1987-91	248	67(27.0)	82(33.1)	68(27.4)	26 (10.5)	04 (16.1)	00	00	01
1992-96	384	83 (21.6)	125(32.5)	113(29.4)	44 (11.4)	15(3.9)	03(0.8)	00	01(0.2)
1997-01	1004	233 (23.2)	321(32.0)	218(21.7)	131(13.0)	57(5.7)	33(3.31)	05(0.5)	06(0.6)
2002-06	1568	316 (20.1)	423 (27.0)	414(26.4)	226(14.4)	112(7.1)	42(2.77)	17(1.7)	19 (1.2)
<b>Total</b>	<b>3330</b>	<b>727 (21.8)</b>	<b>991(29.7)</b>	<b>839(25.1)</b>	<b>454(13.6)</b>	<b>192(5.8)</b>	<b>78(2.3)</b>	<b>22(0.7)</b>	<b>27(0.8)</b>
<b>Mean</b>	<b>666</b>	<b>145</b>	<b>198</b>	<b>168</b>	<b>91.0</b>	<b>39</b>	<b>16</b>	<b>4</b>	<b>5</b>
<b>%</b>	<b>100</b>	<b>(21.7)</b>	<b>(29)</b>	<b>(25.2)</b>	<b>(13.7)</b>	<b>(59)</b>	<b>(2.4)</b>	<b>(0.6)</b>	<b>(0.7)</b>

**Table 6B: Relative Frequency of Authorship Pattern of Contributions in Different Time Blocks**

Block Period	Total	1 Author	2 Authors	3 Authors	4 Authors	5 Authors	6 Authors	7 Authors	7+ Authors
1982-86	0.038	0.038	0.040	0.031	0.060	0.021	0.000	0.000	0.000
1987-91	0.074	0.092	0.083	0.081	0.057	0.021	0.000	0.000	0.037
1992-96	0.115	0.114	0.126	0.135	0.097	0.078	0.038	0.000	0.037
1997-01	0.301	0.320	0.324	0.260	0.288	0.297	0.423	0.227	0.222
2002-06	0.471	0.435	0.427	0.493	0.498	0.583	0.538	0.773	0.704
<b>Total</b>	<b>3330</b>	<b>727</b>	<b>991</b>	<b>839</b>	<b>454</b>	<b>192</b>	<b>78</b>	<b>22</b>	<b>27</b>

**Table 6C: Progressive Distribution of Publications Classified by Number of Authors in Different Period Blocks during 1980-006**

Block Period	Total	1 Author	2 Authors	3 Authors	4 Authors	5 Authors	6 Authors	7 Authors	7+ Authors
1982-86	126	28	40	26	27	04	00	00	00
1987-91	374	95	122	94	53	08	00	00	01
	500	123	162	120	80	12	00	00	01
1992-96	758	178	247	207	97	23	03	00	02
1997-01	1762	411	568	425	228	80	36	05	08
2002-06	3330	727	991	839	454	192	78	22	27

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**Table 7A: Authorship Pattern of Contributions by top 10 Contributors  
7A: Directorate of Oil Seeds Research (DOR)**

Rank of Authors	Authorship											
	Single 1	Two 2	Three 3	Four 4	Five 5	Six 6	Total 7	Score 8	Re Ranks9	Q 10	First Author 11	Dominance Factor 12
1	49	40	26	19	12	04	150	84.73	I	0.673	105	0.55
2	45	27	16	02	05	03	098	64.73	II	0.541	065	0.38
3	08	30	26	11	14	01	090	52.21	III	0.911	046	0.46
4	30	20	11	14	07	07	089	48.53	IV	0.663	057	0.79
5	15	45	15	09	-	02	086	45.00	VI	0.825	045	0.42
6	06	39	14	08	07	02	076	33.52	VIII	0.421	020	0.20
7	20	26	08	11	06	-	071	39.59	VII	0.719	057	0.72
8	21	13	09	06	05	06	060	46.71	V	0.650	046	0.64
9	18	15	13	02	-	-	048	30.29	IX	0.625	032	0.46
10	15	19	06	-	05	01	046	27.63	X	0.674	034	0.61
<b>Total</b>	<b>227</b>	<b>274</b>	<b>144</b>	<b>82</b>	<b>61</b>	<b>26</b>	<b>814</b>	<b>448.12</b>		<b>0.721</b>	<b>507</b>	<b>0.55</b>

**Table 7B : National Research Center for Groundnut (NRCG)**

Rank of authors	Authorship											
	Single	Two	Three	Four	Five	Six +	Total	Score	Re-Rank	Q	First Author	Dominance Factor
1	22	24	25	15	07	10	103	48.90	I	0.786	77	0.68
2	05	33	22	17	08	08	093	35.81	III	0.946	38	0.37
3	03	15	40	13	02	02	075	27.95	V	0.954	49	0.50
4	24	22	15	06	02	04	073	42.45	II	0.671	00	0.00
5	08	20	26	14	02	03	073	30.93	IV	0.890	71	0.97
6	07	09	17	12	07	04	056	22.11	VI	0.894	24	0.34
7	-	05	17	11	11	12	056	17.36	X	1.000	11	0.19
8	01	16	17	12	02	05	053	20.01	VIII	0.981	23	0.43
9	03	24	08	10	03	04	052	21.34	VII	0.942	29	0.53
10	-	10	32	08	-	01	051	17.71	IX	1.000	07	0.14
<b>Total</b>	<b>73</b>	<b>178</b>	<b>219</b>	<b>118</b>	<b>44</b>	<b>53</b>	<b>685</b>	<b>28.30</b>		<b>0.893</b>	<b>329</b>	<b>0.42</b>

**Table 7C National Research Center for Soyabean (NRCS)**

Rank of Authors	Authorship											
	Single	Two	Three	Four	Five	Six +	Total	Score	Re Ranks	Q	First Author	Dominance Factor
1	07	37	78	38	18	04	182	64.34	I	0.966	34	0.15
2	12	55	27	12	04	06	116	52.21	IV	0.896	43	0.30
3	33	32	27	12	06	02	112	62.11	II	0.705	55	0.28
4	--	24	53	22	11	01	111	37.19	V	1.000	53	0.47
5	12	50	34	09	02	--	107	62.09	III	0.887	72	0.70
6	07	08	25	14	08	04	066	24.35	VIII	0.893	23	0.27
7	--	09	36	14	05	02	066	20.88	IX	1.000	39	0.59
8	03	11	16	17	11	06	064	20.23	X	0.953	09	0.01
9	08	21	15	02	08	--	054	25.55	VII	0.852	22	0.30
10	10	25	12	02	01	--	050	27.16	VI	0.727	35	0.62
<b>Total</b>	<b>92</b>	<b>272</b>	<b>323</b>	<b>142</b>	<b>74</b>	<b>25</b>	<b>928</b>	<b>388.64</b>		<b>0.901</b>	<b>354</b>	<b>0.31</b>

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**Table 7D National Research Centre for Rape seed and Mustard (NRCRM)**

Rank. Authors	Authorship											
	Single	Two	Three	Four	Five	Six +	Total	Score	Re-Rank	Q	First Author	Dominance Factor
1	13	09	11	18	13	05	69	32.13	I	0.811	27	0.25
2	-	05	21	18	11	06	61	16.13	IV	1.000	22	0.36
3	-	12	16	18	05	02	53	16.28	III	1.000	11	0.21
4	17	06	08	01	02	01	35	23.54	II	0.514	28	0.61
5	01	07	08	12	04	03	35	11.14	VI	0.971	07	0.17
6	-	03	11	12	02	02	30	08.53	VII	1.000	10	0.33
7	02	03	09	03	03	09	29	07.82	VIII	0.931	12	0.33
8	03	10	05	03	06	01	28	11.60	V	0.892	11	0.12
9	02	02	07	06	03	-	20	07.41	IX	0.900	08	0.33
10	00	00	04	07	04	02	17	04.18	X	1.000	07	0.41
<b>Total</b>	<b>38</b>	<b>57</b>	<b>100</b>	<b>98</b>	<b>53</b>	<b>31</b>	<b>377</b>	<b>147.08</b>		<b>0.867</b>	<b>142</b>	<b>0.31</b>

**Table 7E National Research Centre for Oil Palm (NRCOP)**

Rank Authors	Authorship											
	Single	Two	Three	Four	Five	Six +	Total	Score	Re Ranks	Q	First Author	Dominance Factor
1	28	22	16	09	04	01	80	47.98	I	0.650	50	0.42
2	16	23	13	03	04	02	61	33.64	II	0.737	39	0.51
3	02	13	23	07	04	03	52	19.09	IV	0.937	36	0.68
4	02	23	09	09	03	03	49	19.77	III	0.959	14	0.25
5	02	11	07	15	06	05	46	15.51	VI	0.956	26	0.54
6	-	12	11	11	06	05	45	14.33	VII	1.000	15	0.33
7	02	03	20	08	07	05	45	14.25	VIII	0.955	18	0.37
8	03	09	17	07	05	01	42	16.01	V	0.928	25	0.56
9	-	03	06	12	06	05	32	08.43	X	1.000	18	0.56
10	01	02	10	11	02	02	28	08.75	IX	0.964	08	0.26
<b>Total</b>	<b>56</b>	<b>121</b>	<b>132</b>	<b>92</b>	<b>47</b>	<b>32</b>	<b>480</b>	<b>212.76</b>		<b>0.88</b>	<b>249</b>	<b>0.45</b>

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**Table 8: Categorisation of Degree of collaboration among top 10 contributors**

S.N.	Category	Score	DOR	CG	CS	CM	OP	T	%
3	High	0.900-above	1	6	4	7	8	26	52
2	Medium	0.700-0.899	2	3	6	2	1	14	28
3	Low	Below -0.699	7	1	-	1	1	10	20
	<b>Total</b>		<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>50</b>	<b>100</b>

**Table 9: Categorization of Degree of Dominance Factor in various institutes**

S.N.	Institutes	High (50) above	Medium (30-49)	Low (up to 29)	Total Authors
1	DOR	5 (40%)	4 (50%)	1 (10.0%)	10
2	NRCG	4 (30%)	3 (40%)	3 (30)	10
3	NRCS	3(30%)	3 (30%)	4 (40%)	10
4	NRCRM	1(10%)	5 (50%)	4 (40%)(	10
5	NRCOP	5(50%)	3 (30%)	2( 20%)	10
	<b>Total</b>	<b>18 (36%)</b>	<b>18 (36%)</b>	<b>14 (28%)</b>	<b>50 (100)</b>

% in brackets

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