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Growth and productivity of agricultural and biological sciences research in state agriculture universities of Gujarat (India)

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ABSTRACT: This paper presents a scientometric analysis of growth and productivity of agricultural and biological sciences research in state agriculture universities of Gujarat, India. The publications, which have been published during 2010-2019, are considered for the present research. The required data was extracted from the indexing database SCOPUS for the analysis, which includes 1,742 publications. Necessary metric-based indicators are considered to draw the conclusion about the growth and status of research outputs of selected samples. Several aspects like patterns and trends about authorship and publications, are also discussed. These include a ranking of authors based on a number of publications and citations, highly productive University from among the sample, degree of collaboration between authors, highly cited papers and preferred publication by the authors from these Universities.

KEYWORDS: Agricultural Research, Agriculture Universities – Gujarat, Research Productivity, Authorship Pattern, Scientometrics

1. INTRODUCTION

Agriculture is dominant to the economies of most developing nations, as it represents the means of livelihood of a substantial proportion of their population. Six hundred fifty million people or 58% of Indian households are directly or indirectly dependent on agriculture and other related activities. It also contributes a significant figure to the Gross Domestic Product (GDP). The contribution of agriculture to the GVA in 2019-20 was 16.5%.

Indian Council of Agricultural Research recognized the reputation of agricultural research in India in early 1929 on the recommendations of the Royal Commission on Agriculture. Indian Council of Agricultural Research plans, conducts and encourages research, education, training and transmission of new technology for the development of agriculture, fisheries, and animal husbandry. Also, envisages their applications at the field level through extension agencies under the Central and State Governments.

Indian Council of Agricultural Research involves in 3 Central Agriculture Universities, 65 Central institutes, 14 National research related centres, 13 Project directorates, and 6 National Bureaux 90+ All India coordinated research projects and employs about 30000+ personnel, of which approximately 7000+ are involved in active research and its management. In addition to this, 4 Deemed Universities 64 State agricultural universities employ about 30000+ scientists for teaching, research, and other agricultural-related education.[3] Therefore, India has a massive infrastructure of research in agricultural sciences.

2. OBJECTIVES OF THE STUDY

The present study attempts to quantify the activity and growth of research (publications) output of state agriculture universities in Gujarat using SCOPUS database for the period 2010-2019. The present study

uses time-series data for ten years and makes the quantitative as well as qualitative assessment such as publications growth and citations, area-wise distribution of publications and citations, activity index, collaboration, highly productive organizations, highly preferred journals, prolific authors based on the number of papers published and highly cited publications.

3. REVIEW OF LITERATURE

Nasir, et al. (1994) has carried out a bibliometric analysis of agricultural literature published in Malaysia during 1981-1990. This research emphasized on the most preferred journals that published in agricultural literature by authors from Malaysia and the publishing practice of corporate bodies.

Arunachalan & Umarani (2001) have carried out 11,855 Indian agriculture publications during 1998-1999 and data were extracted from the CAB database. They found that Plants of economic importance was the leading area of research in India. They also identified top Indian institutions in different subfields, different journals with their impact factors.

Garg, et al. (2006) have carried out scientometric analysed 16891 publications by Indian agricultural scientists during 1993-2002 using Science Citation Index Expanded (Web of Science) and came up with the outcome that the publication output in the agricultural sciences is on the decline between 1998 to 2002.

Bartol (2010) has evaluated the characteristics of documents published in national journals and other publications in the countries, which participate on the editorial board of the Journal of Central European Agriculture (JCEA). Total 89,000 agriculture-related documents were identified from the CAB abstracts database during 2000-2008. The study found out that Poland is the major contributor of documents and English (48,230) was the principal language of agricultural scientific communication.

Sagar, et al. (2014) have studied 22615 Indian agriculture publications during 1993-2012 using Science Citation Index Expanded (Web of Science) and observed that the highest number of publications 1917 (8.48 %) were published in the year 2008 along with the highest number of citations 8714 (8.81 %) in 2007. International collaborative publication of India was 1744 (7.71 %) collaboration from 104 countries.

Amin & Parekh (2019) have studied 400 publications in the field of biochemistry, genetics and molecular biology from the Gujarat University, Ahmedabad during 1980-2018 using the SCOPUS database and observed that the trend with qualitative publishing from 2012 to 2017 in national and international journals had increased substantially.

4. MATERIALS, METHODOLOGY AND SOURCE OF THE DATA

The research publication data of major four sectoral universities in agriculture sector belongs to the state of Gujarat-India, i.e. Anand Agricultural University, Junagadh Agricultural University, Navsari Agricultural University and Sardarkrushinagar Dantiwada Agricultural University, are selected for this research. The data have been retrieved from the SCOPUS database, which is the most common multidisciplinary bibliographical database providing abstracts and index of publications across the world. From total publications covered by the SCOPUS, only agricultural and biological sciences related publications published during 2010-2019 were considered for this study. The refined data was selected by searching for the institutional affiliation as follow:

AF-ID ("Anand Agricultural University" 60018537) OR AF-ID ("Junagadh Agricultural University" 60077665) OR AF-ID ("Navsari Agricultural University" 60097227) OR AF-ID ("Sardarkrushinagar Dantiwada Agricultural University" 60115425) AND (LIMIT-

TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010)) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ch") OR LIMIT-TO (DOCTYPE, "re") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (SUBJAREA, "AGRI"))

The available result after performing the above search formula was exported as CSV and BibTex file format for further analysis. The final data consisted of 1742 research publications authored by the researchers from the selected four universities from the year 2010 to 2019.

5. DATA ANALYSIS, RESULTS AND DISCUSSION

The overall number of publications from the selected four agriculture universities during 2010-2019 has been extracted from the database as per Table 1.

Table 1: Number of publications in the area of "agriculture and biological science" 2010-2019 by the authors from selected four Agriculture Universities of Gujarat, India.

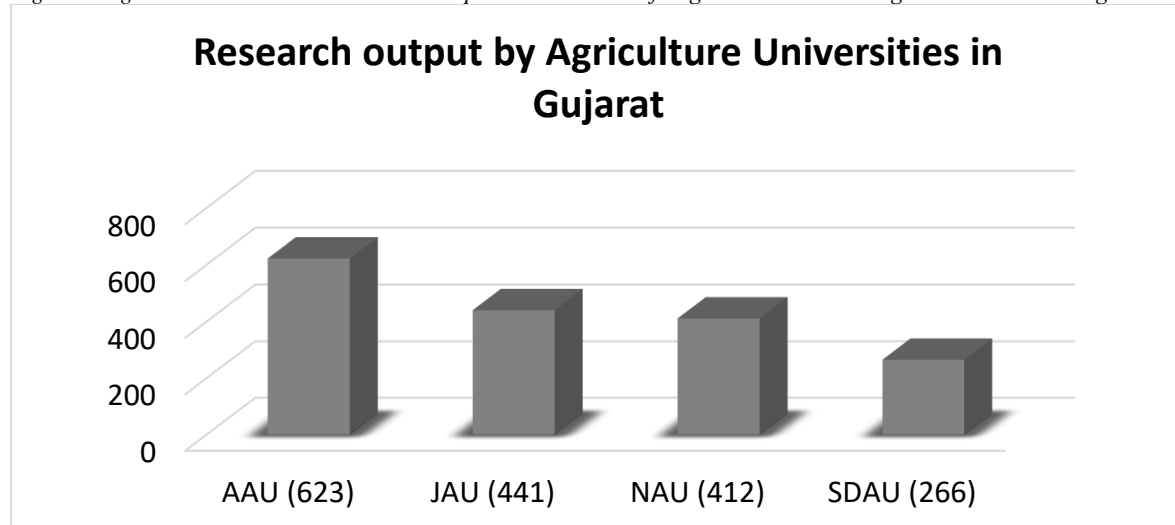
Name of the University	Total Publications in Agricultural and Biological Sciences (as of September 2019)
Anand Agricultural University (AAU)	623
Junagadh Agricultural University (JAU)	441
Navsari Agricultural University (NAU)	412
Sardarkrushinagar Dantiwada Agricultural University (SAU)	266

Data was last accessed on June 08, 2020, from the Scopus

5.1 PUBLICATIONS BY AGRICULTURE UNIVERSITY IN GUJARAT DURING 2010-2019

The Fig.1 shows that there was a total of 1742 publications count in agricultural and biological sciences of the agriculture universities in Gujarat.

Figure 1. Agriculture Universities research output in the domain of "agricultural and biological sciences" during 2010-2019.

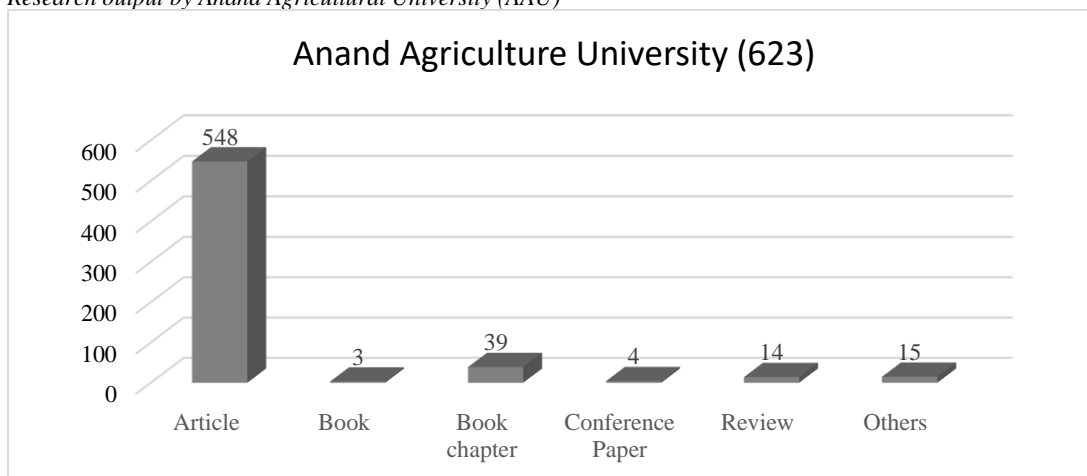


5.2 TYPES OF RESEARCH PUBLICATIONS BY STATE AGRICULTURE UNIVERSITIES IN GUJARAT, INDIA:

5.2.1 ANAND AGRICULTURAL UNIVERSITY

As shown in the Fig.2, there were total 623 publications in agricultural and biological sciences published by the authors from Anand Agriculture University, reveals that 548 (87.96%) are journals articles, followed by book chapters 39 (6.26%), reviews 14 (2.25%), conference papers 4 (0.64%), books 03 (0.48%), and other document types like Editorial, Letter, Note, etc. 15 (2.41%).

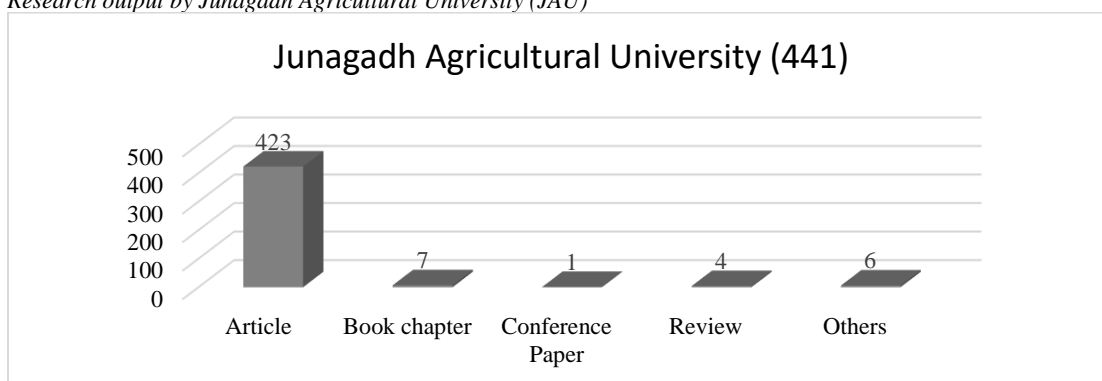
Figure 2. Research output by Anand Agricultural University (AAU)



5.2.2 JUNAGADH AGRICULTURAL UNIVERSITY

The Fig.3 shows that there were total 441 publications count in agricultural and biological sciences of the Junagadh Agriculture University, reveals that 423 (95.92%) journals articles, followed by book chapters 7 (1.59%), others 6 (1.36%), reviews 4 (0.91%), conference papers 1 (0.23%).

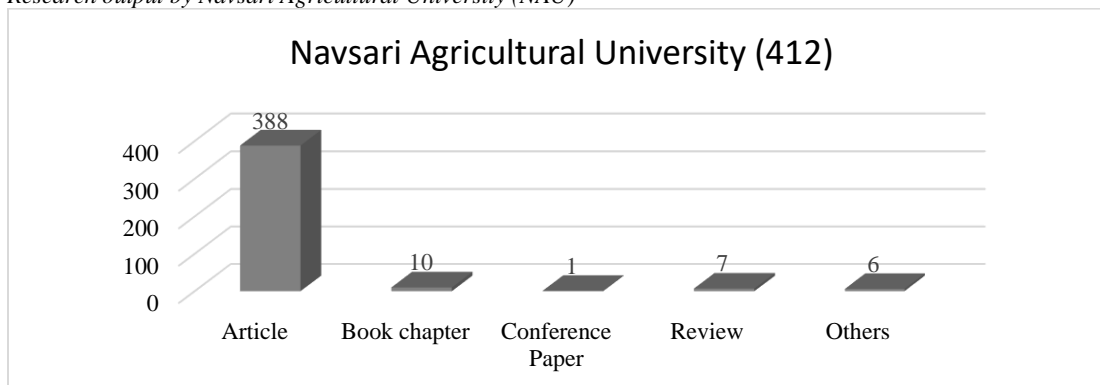
Figure 3. Research output by Junagadh Agricultural University (JAU)



5.2.3 NAVSARI AGRICULTURAL UNIVERSITY

The Fig.4 shows that there were total 412 publications count in agricultural and biological sciences of the Navsari Agriculture University, reveals that 388 (94.17%) journals articles, followed by book chapters 10 (2.43%), reviews 7 (1.70%), others 6 (1.46%), and conference papers 1 (0.24%).

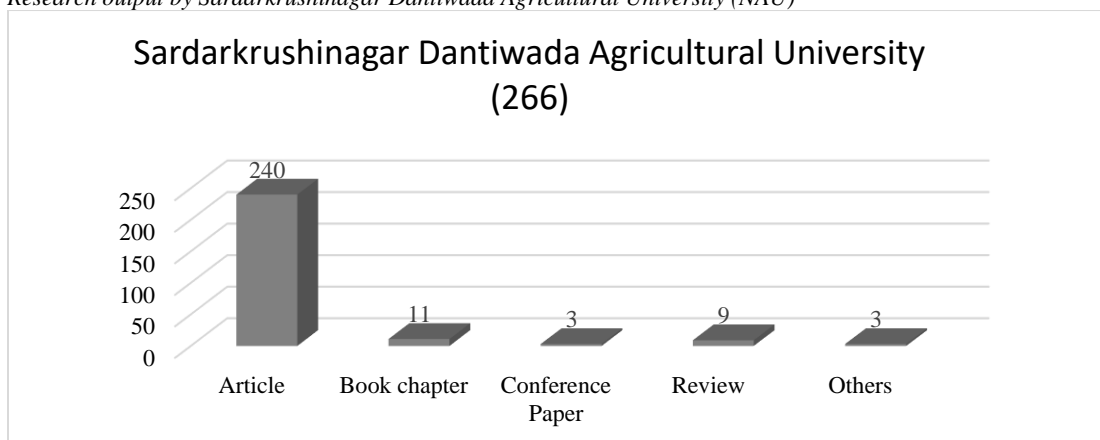
Figure 4. Research output by Navsari Agricultural University (NAU)



5.2.4 SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY

The Fig.4 shows that there were total 266 publications count in agricultural and biological sciences of the Sardarkrushinagar Dantiwada Agriculture University, reveals that 240 (90.23%) journals articles, followed by book chapters 11 (4.14%), reviews 9 (3.38%), conference papers 3 (1.13%), and others 3 (1.13%).

Figure 5. Research output by Sardarkrushinagar Dantiwada Agricultural University (NAU)



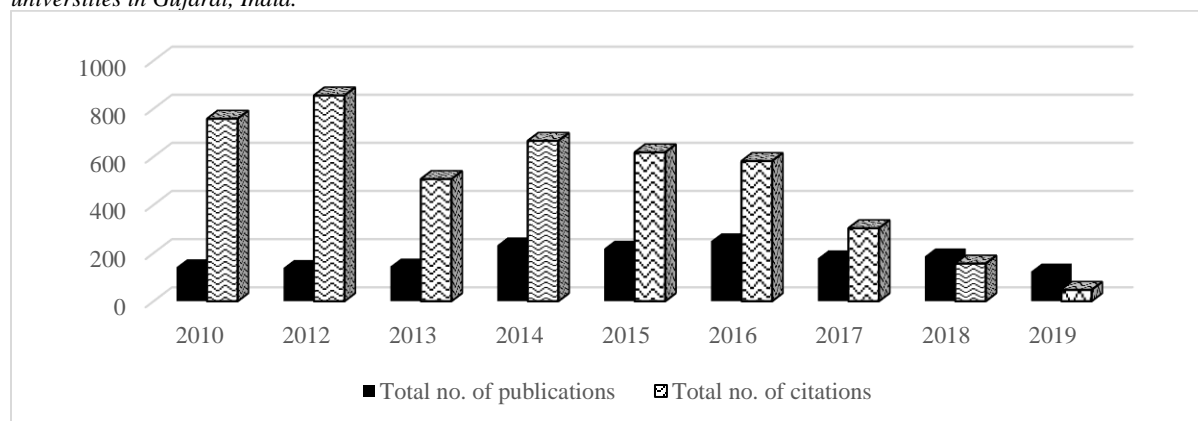
5.3 YEAR-WISE DISTRIBUTION OF PUBLICATIONS AND CITATIONS

A total of 1742 publications were published in agricultural and biological sciences during 2010-2019 by the state agriculture universities in Gujarat, India and these publications were received 5213 citations. Year-wise distribution of publications and citations are given in Table 2 & Fig. 6. The highest numbers of publications, 249 (14.29) were published in 2016. The highest number of citations, 855 (16.40 %) were received in the year 2012. The average citations per publication 6.20 were received in 2012, which is highest from the selected years. Almost half of the publications 864 (49.60 %) were without any citations during the tenure of 2010-2019. The results show that in spite of overall growth over ten years, there has been a decline in the number of research outputs from 2015 to 2019 compared to their previous five years.

Table 2. Year-wise distribution of publications and citations in agricultural and biological sciences research from agriculture universities of Gujarat, India.

Year	Total no. of publications	The growth rate of publications (%)	Total no. of citations	Total no. of citations (%)	Avg. Citation per Article (%)	Avg. Citation per Year
2010	141	8.09	758	14.54	5.38	0.52
2011	133	7.63	721	13.83	5.42	0.56
2012	138	7.92	855	16.40	6.20	0.63
2013	144	8.27	507	9.73	3.52	0.43
2014	232	13.32	666	12.78	2.87	0.46
2015	218	12.51	618	11.85	2.83	0.49
2016	249	14.29	582	11.16	2.34	0.51
2017	178	10.22	303	5.81	1.70	0.52
2018	186	10.68	156	2.99	0.84	0.37
2019	123	7.06	47	0.90	0.38	0.33
Total	1742	100	5213	100.00	31.48	4.82

Figure 6. Year-wise distribution of publications and citations in agricultural and biological sciences research in agriculture universities in Gujarat, India.



5.4 HIGHLY PRODUCTIVE STATE AGRICULTURE UNIVERSITIES IN “AGRICULTURAL AND BIOLOGICAL SCIENCES” RESEARCH

The impact of the research output has been examined using the citations received by the universities. The highest numbers of publications, 623 (52.76% avg. citation per article) were published by Anand Agriculture University followed by Junagadh Agriculture University 441 (18.28 avg. citation per article), Navsari Agriculture University 412 (22.85% avg. citation per article), and Sardarkrushinagar Dantiwada Agricultural University 266 (19.03% avg. citation per article).

Figure 7. Highly Productive State Agriculture Universities in “Agricultural and Biological Sciences” Research

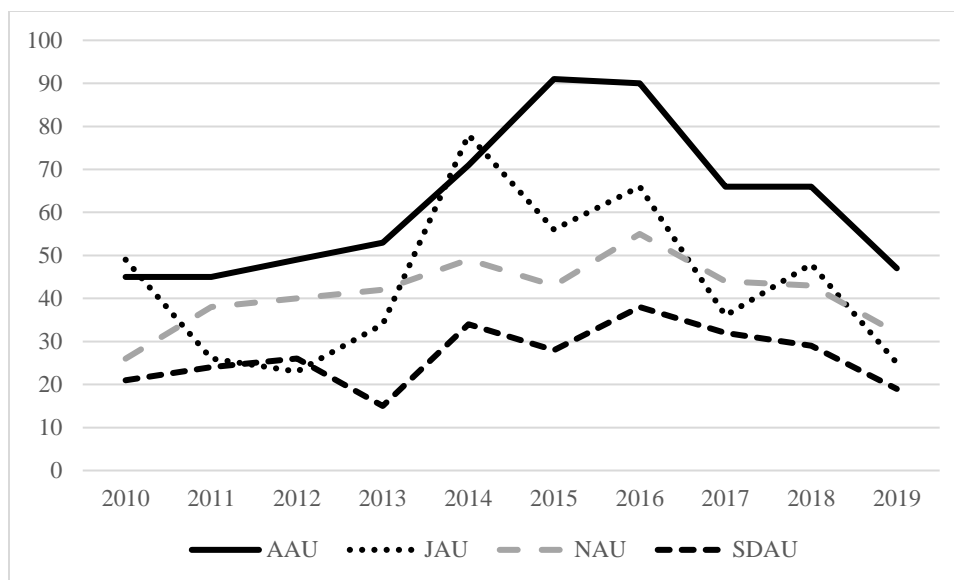


Table 3. Highly Productive State Agriculture Universities in “Agricultural and Biological Sciences” Research

University	Total Publications	Total Citation	Avg. Citation/Paper
AAU	623 (35.76%)	3067 (58.83%)	4.92
JAU	441 (25.32%)	808 (15.50%)	1.83
NAU	412 (23.65%)	820 (15.73%)	1.99
SDAU	266 (15.27%)	518 (9.94%)	1.95

5.5 THE MOST PROLIFIC AUTHORS

The collected data of research publications of selected agriculture university during the last ten years (2010-2019) reveals that total of 3841 authors has contributed to 1742 publications in the field of “agricultural and biological sciences”. The data was sorted in Microsoft Excel by the number of research publications and by with the ranking of top 35 authors in descending order.

Table 4 clearly shows that the list of top 35 authors of selected universities, who had published more than 13 publication (research) outputs during the period. The list was topped by S. Kumar from AAU with 47 publications (340 total citations), followed by C G Joshi again from AAU with 42 publications (147 citations), B A Golakiya from JAU with 40 publications (112 total citations), V Pandey from AAU with 37 publications (82 total citations), D. M. Jethva from JAU with 34 publications (29 citations), and so on. Here mentioned that these 35 authors contributed 717 publications out of total 1742 publications from 2010 to 2019. However, it is remarkable to note that the listing of these 35 most research productive authors, when ranked based on average citations per paper, would slightly differ J. B. Prajapati from AAU leads the top with 1st rank in ACPP (24.21), followed by N. Kumar (14.11), D. C. Joshi (8.85), and so on. Also, mentioned that out of these 35 authors, 16 authors from AAU (365 publications & received 1969 total citations), 11 authors from JAU (240 publications & received 498 total citations), 7 authors from NAU (98 publications & received 261 total citations), and only one author from SDAU (14 publications & received 10 citations).

Table 4: Most prolific authors as per the total number of publications from the State Agriculture University of Gujarat, India from 2010-2019

S.N.	University	Authors	Articles	TC	ACPP	Rank by ACPP
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1	AAU	Kumar S	47	340	7.23	4
2	AAU	Joshi C G	42	147	3.50	13
3	JAU	Golakiya B A	40	112	2.80	15
4	AAU	Pandey V	37	82	2.22	20
5	JAU	Jethva D M	34	29	0.85	30
6	JAU	Gajera H P	30	128	4.27	9
7	AAU	Talati J G	26	32	1.23	26
8	AAU	Rank D N	24	69	2.88	14
9	JAU	Vachhani J H	24	21	0.88	28
10	AAU	Aparnathi K D	23	81	3.52	12
11	AAU	Mehta B M	22	118	5.36	7
12	AAU	Prajapati J B	19	460	24.21	1
13	AAU	Fougat R S	19	116	6.11	5
14	JAU	Mandavia M K	19	25	1.32	25
15	AAU	Kumar N	18	254	14.11	2
16	JAU	Patel S V	18	77	4.28	8
17	AAU	Patel H R	18	40	2.22	19
18	AAU	Patel H K	17	42	2.47	18
19	JAU	Kachhadia V H	17	20	1.18	27
20	NAU	Mahatma M K	16	90	5.63	6
21	JAU	Mehta D R	16	22	1.38	24
22	JAU	Jivani L I	16	13	0.81	31
23	NAU	Chawla S L	15	9	0.60	35
24	NAU	Kumar V	14	58	4.14	10
25	AAU	Shukla Y M	14	31	2.21	21
26	NAU	Kumar S	14	12	0.86	29
27	SDAU	Acharya S	14	10	0.71	33
28	AAU	Joshi D C	13	115	8.85	3
29	NAU	Singh R R	13	46	3.54	11
30	NAU	Arvadia M K	13	36	2.77	16
31	AAU	Patel N J	13	34	2.62	17
32	JAU	Sutaria G S	13	26	2.00	22
33	JAU	Akbari K N	13	25	1.92	23
34	NAU	Kumar N	13	10	0.77	32
35	AAU	Patel J A	13	8	0.62	34

5.6 DEGREE OF COLLABORATION

To determine the strength of collaboration (DC), the following formula suggested by Subramanyam K [19] has been employed in this research.

$$DC = \frac{Nm}{Ns + Nm}$$

Where, *DC* = Degree of Collaboration, *Nm* = Number of Multi Authors, and *Ns* = Number of Single Authors

The Degree of Collaboration (DC) of researchers from the selected universities year wise is presented in Table 5. The ranges of DC are 0.99 to 1.0, and the average of DC is 1.0 during the last ten year (2010-2019). The study clearly shows that there was a higher level of collaboration by the authors.

Table 5. Degree of Collaboration (DC)

Years	Single Author (NS)	Multiple Author (NM)	Total Authors (NS+NM)	Degree of Collaboration
2010	5	534	539	0.99
2011	4	539	543	0.99
2012	3	568	571	0.99
2013	4	562	566	0.99
2014	4	959	963	1.00
2015	2	866	868	1.00
2016	3	1069	1072	1.00
2017	1	819	820	1.00
2018	0	947	947	1.00
2019	0	832	832	1.00
Total	26	7695	7721	9.96

5.7 AUTHORSHIP PATTERN

In research publication, a collaboration plays a vital role. Lancaster (1991) had found in his research that more collaboration leads towards more research productivity. Most of the bibliometric studies have shown that over time collaboration in authorship is gaining popularity and more research outputs are being published in collaboration rather than individual efforts. To explore this aspect of authorship patterns further in this study, the data was divided into two-time blocks, i.e. first five years (2010-2014) and the second five years (2015-2020). The CAI (co-authorship index) has been developed by Garg & Padhi (2001) was intended for the four major groups of the different type of patterns in authorship, i.e. single author, two authors, 3-4 authors (multi-authors), and 5 & above authors (mega authors).

Table 6 indicates that the research trend in authorship is moving away from single-author papers to multi and mega authors papers, which signifies collaborative research outputs by more than one author.

Table 6: Collaboration in authorship pattern

Authorship patterns	No. of contributions 2010-2014 (CAI)	No. of contributions 2015-2019 (CAI)
Single Author	20 (16.47%)	6 (3.46%)
Double Authors	264 (31.85%)	236 (19.96%)
Multi Authors (3-4)	1319 (86.31%)	1653 (75.83%)
Mega Authors (5 & above)	1579 (224.48%)	2644 (263.52%)

Table 7: Authorship pattern

Years	Authors															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 & Above	
2010	5	54	75	188	80	60	77	0	0	0	0	0	0	0	0	539
2011	4	42	81	116	140	48	112	0	0	0	0	0	0	0	0	543
2012	3	50	72	124	145	36	133	8	0	0	0	0	0	0	0	571
2013	4	48	93	156	155	24	14	72	0	0	0	0	0	0	0	566
2014	4	70	114	300	230	72	21	152	0	0	0	0	0	0	0	963
2015	2	86	156	212	200	48	42	32	90	0	0	0	0	0	0	868
2016	3	50	210	248	255	54	70	0	72	110	0	0	0	0	0	1072
2017	1	54	123	136	215	48	42	0	0	40	88	60	13	0	0	820
2018	0	34	153	188	115	138	42	0	0	0	0	0	65	84	128	947
2019	0	12	123	104	25	156	14	0	0	0	0	0	0	0	398	832

5.8 HIGHLY CITED PAPERS

The impact of research is a significant standard in the evaluation of any research. Also, counting the citations is one of the essential and collective benchmarks used in calculating the impact of research. Citations are indications of positive recognition to the published work of researcher(s) and also for the journal. In simple words, we can say that the number of citations received is directly related to the credit or impact of the published work. Exploring the citation data, for all the 1742 publications during 2010-2019, 878 (50.40 %) publications have cited, and 864 (49.60 %) publications have not been cited.

Table 8 shows the most cited papers, i.e., top 29 ranks by citation count and these papers received 30 or higher citations during the last ten year (2010-2019)

Table 8: Universities wise highly cited papers

S. N.	Universities	Titles	TC	TC/Year
1	AAU	Food fermentations: Microorganisms with technological beneficial use	308	30.8
2	AAU	The functionality of Milk Powders and Milk-Based Powders for End-Use Applications-A Review	113	11.3
3	AAU	Sourdough Technology-A Traditional Way for Wholesome Foods: A Review	102	10.2
4	SDAU	Microalgae as second-generation biofuel. A review	95	9.5
5	AAU	Probiotics as Potential Antioxidants: A Systematic Review	91	9.1
6	NAU	Expression of a plant defensin in rice confers resistance to fungal phytopathogens	82	8.2
7	AAU	Assessment of genetic diversity in castor (<i>Ricinus communis</i> L.) using RAPD and ISSR markers	76	7.6
8	NAU	Effect of <i>Withania somnifera</i> (L. Dunal) root as a feed additive on immunological parameters and disease resistance to <i>Aeromonas hydrophila</i> in <i>Labeo rohita</i> (Hamilton) fingerlings	67	6.7
9	JAU	Molecular breeding for introgression of fatty acid desaturase mutant alleles (ahFAD2A and ahFAD2B) enhances oil quality in high and low oil containing peanut genotypes	53	5.3
10	AAU	Shoot regeneration from cotyledonary leaf explants of <i>Jatropha curcas</i> : A biodiesel plant	48	4.8
11	AAU	Post-harvest Processing of Banana: Opportunities and Challenges	47	4.7
12	AAU	Blocked Lysine in Dairy Products: Formation, Occurrence, Analysis, and Nutritional Implications	45	4.5

13	SDAU	GGE biplot analysis to evaluate genotype, environment and their interactions in sorghum multi-location data	44	4.4
14	AAU	Bacterial diversity dynamics associated with different diets and different primer pairs in the rumen of Kankrej cattle	43	4.3
15	AAU	Enzymatic added extraction and clarification of fruit juices–A review	42	4.2
16	AAU	Potential of nanotechnology in functional foods	40	4
17	JAU	A review of models for predicting soil water dynamics during trickle irrigation	40	4
18	AAU	Determining the probiotic potential of exopolysaccharide producing lactic acid bacteria isolated from vegetables and traditional Indian fermented food products	39	3.9
19	SDAU	Full-genome sequencing as a basis for molecular epidemiology studies of bluetongue virus in India	38	3.8
20	AAU	Effective moisture diffusivity of pomegranate arils undergoing microwave-vacuum drying	37	3.7
21	AAU	Postharvest hardness and colour evolution of white button mushrooms (<i>Agaricus bisporus</i>)	35	3.5
22	AAU	β -Glucosidase activity and bioconversion of isoflavones during fermentation of soymilk	35	3.5
23	AAU	Implications of genotype <input/> interactions in breeding superior genotypes for favourable and unfavourable rainfed upland environments	34	3.4
24	AAU	Effect of short-term heat stress on total sugars, proline and some antioxidant enzymes in moth bean (<i>Vigna aconitifolia</i>)	32	3.2
25	NAU	Traditional and novel references towards systematic normalization of qRT-PCR data in plants	32	3.2
26	AAU	Manufacturing and quality of mozzarella cheese: A review	31	3.1
27	AAU	Body temperature around induced estrus in dairy cows	31	3.1
28	AAU	Assessment of genetic fidelity of micropropagated date palm (<i>Phoenix dactylifera</i> L.) plants by RAPD and ISSR markers assay	30	3
29	AAU	Antioxidants, their properties, uses in food products and their legal implications	30	3

These 29 publications (**Appendix 1**) together received 1740 citations with an average of 60 citations per publication out of 1742 total publications in the fields of agriculture and biological sciences. The publications include articles and review papers. The seven review papers had received total 737 citations and the highest citations were 303. Twenty-two appeared as a journal articles which received total 1003 citations and the highest citations were 91.

The authors where 35 from of these publications are affiliated with the National and International Universities and affiliated colleges, one from the IIT Kharagpur, and rest 37 from the National and International research organizations. All of these publications including articles and reviews were published in 29 well-known international journals like Elsevier (9), Springer (7), Wiley (5), Public Library of Science PLOS (2) and each one publication published in Academic Journals, American Chemical Society, ISEKI Food Association, Southern Cross Publishing, Taylor and Francis, and United Arab Emirates University.

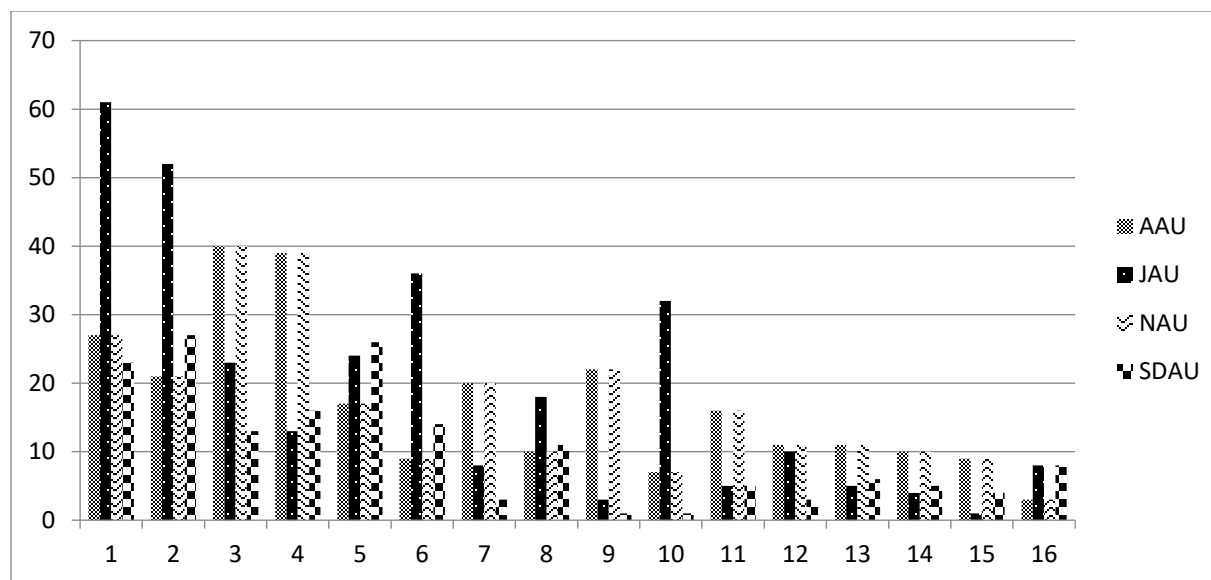
5.9 MOST PREFERRED JOURNALS

The data collected for this study specified that from the 1742 research outputs of the 3841 authors from the selected Agriculture Universities of Gujarat, India since the last ten year (2010-2019). Most of the publications were published in Indian journals. Among these 172 journals, *Electronic Journal of Plant Breeding* was the most preferred journal by all 4 state agriculture universities with 138 papers, followed by *Pestology* (121), *Ecology Environment and Conservation* (116), *Indian Journal of Animal Sciences* (107) and so on. Table 9 shows the list of top 16 Journals where the number of publications published more than 20 by all four selected Universities. It shows the list of journals, ranked by the number of publications published by the authors. The results also show the major publications are published in India only.

Table 9: Most preferred journals by authors from the Agriculture Universities in Gujarat, India from 2010 to 2019

S.N.	Journals	Publisher	Country of origin	AAU	JAU	NAU	SDAU	Total
1	Electronic Journal of Plant Breeding	Indian Society of Plant Breeders (ISPB)	India	27	61	27	23	138
2	Pestology	Scientia Publication	India	21	52	21	27	121
3	Ecology Environment and Conservation	EM International	India	40	23	40	13	116
4	Indian Journal of Animal Sciences	Indian Council of Agricultural Research	India	39	13	39	16	107
5	Research on Crops	Gaurav Society of Agricultural Research Information Centre	India	17	24	17	26	84
6	Legume Research	Agricultural Research Communication Centre	India	9	36	9	14	68
7	Indian Journal of Horticulture	Indian Academy of Horticultural Sciences (IAHS)	India	20	8	20	3	51
8	Buffalo Bulletin	International Buffalo Information Center	Thailand	10	18	10	11	49
9	Plant Archives	Dr R S Yadav	India	22	3	22	1	48
10	Indian Journal of Agricultural Biochemistry	The Indian Society of Agricultural Biochemists	India	7	32	7	1	47
11	Indian Journal of Agronomy	The Indian Society of Agronomy	India	16	5	16	5	42
12	Journal of Agrometeorology	Association of Agrometeorologists	India	11	10	11	3	35
13	Indian Journal of Agricultural Sciences	Indian Journal of Fisheries for the Indian Council of Agricultural Research	India	11	5	11	6	33
14	Indian Journal of Animal Research	Agricultural Research Communication Centre	India	10	4	10	5	29
15	Indian Journal of Ecology	Indian Ecological Society	India	9	1	9	4	23
16	Indian Journal of Agricultural Research	Agricultural Research Communication Centre	India	3	8	3	8	22

Figure 7. Most preferred journals by authors from the Agriculture Universities in Gujarat, India from 2010 to 2019



6. DISCUSSION AND CONCLUSION

The present study provides growth and development of research activities in agricultural and biological sciences from state agriculture universities in Gujarat, India from 2010-2019, although, the publications count from the year 2016-2019 in the national and international journal show slightly decreasing in the ways of qualitative as well quantitative publishing. The present study also analyses that out of 1742 publications, most of the authors published their work in Indian journals (1013) only. The study also shows that international journals received 30 above citations only. The study clearly shows, there was a higher level of collaboration by the authors (single authors 26 and multiple authors 7695). The top 35 most prolific authors together in this area contributed 717 publications out of 1742, with an average of 21% publication per author. These authors had an average of 4 citations per publication.

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Appendix 1: Highly Cited Papers (2010-2019)

Sr. No.	Authors	Title	Source title	Publisher	Year	Doc Type	TC	TC per Year	Affiliations
1	Bourdichon, F., Casaregola, S., Farrokh, C., Frisvad, J.C., Gerds, M.L., Hammes, W.P., Harnett, J., Huys, G., Laulund, S., Ouwehand, A., Powell, I.B., Prajapati, J.B., Seto, Y., Ter Schure, E., Van Boven, A., Vankerckhoven, V., Zgodar, A., Tuijtelaars, S., and Hansen, E.B.	Food fermentations: Microorganisms with technological beneficial use	International Journal of Food Microbiology	Elsevier	2012	Review	308	30.8	Nestlé Research Centre, Switzerland AgroParisTech, France; Centre National Interprofessionnel de l'Economie Laitière (CNIEL), France; Technical University of Denmark, Denmark; Cargill Texturizing Solutions, United States; University of Hohenheim, Germany Fonterra Co-operative Group Ltd., New Zealand; Ghent University, Belgium; European Food and Feed Cultures Association, Denmark; Danisco Innovation, Finland; Dairy Innovation Australia, Australia; Anand Agricultural University, India; Milk Science Research Institute, Japan; Laboratory and Quality Services, Netherlands; CSK Food Enrichment, Netherlands; University of Antwerp, Belgium; Groupe Lactalis, France; International Dairy Federation, Belgium
2	Sharma, A., Jana, A.H., and Chavan, R.S.	The functionality of Milk Powders and Milk-Based Powders for End-Use Applications-A Review	Comprehensive Reviews in Food Science and Food Safety	Wiley	2012	Review	113	11.3	Anand Agricultural University, India; National Institute of Food Technology Entrepreneurship and Management, India
3	Chavan, R.S., and Chavan, S.R.	Sourdough Technology-A Traditional Way for Wholesome Foods: A Review	Comprehensive Reviews in Food Science and Food Safety	Wiley	2011	Review	102	10.2	Gujarat Cooperative Milk Marketing Federation Ltd., India; Anand Agriculture University, India
4	Singh, N.K., and Dhar, D.W.	Microalgae as second-generation biofuel. A review	Agronomy for Sustainable Development	Springer	2011	Review	95	9.5	Sardarkrushinagar Dantiwada Agricultural University, India; Centre for Conservation and Utilisation of Blue-Green Algae, India
5	Mishra, V., Shah, C., Mokashe, N., Chavan, R., Yadav, H., and Prajapati, J.	Probiotics as Potential Antioxidants: A Systematic Review	Journal of Agricultural and Food Chemistry	American Chemical Society	2015	Article	91	9.1	National Institute of Food Technology Entrepreneurship and Management, India; Anand Agricultural University, India; National Agri Biotechnology Institute, India

6	Jha, S., and Chattoo, B.B.	Expression of a plant defensin in rice confers resistance to fungal phytopathogens	Transgenic Research	Springer	2010	Article	82	8.2	Navsari Agricultural University, India; The Maharaja Sayajirao University of Baroda, India
7	Gajera, B.B., Kumar, N., Singh, A.S., Punvar, B.S., Ravikiran, R., Subhash, N., and Jadeja, G.C.	Assessment of genetic diversity in castor (<i>Ricinus communis</i> L.) using RAPD and ISSR markers	Industrial Crops and Products	Elsevier	2010	Article	76	7.6	Anand Agricultural University, India
8	Sharma, A., Deo, A.D., Tandel Riteshkumar, S., Chanu, T.I., and Das, A.	Effect of <i>Withania somnifera</i> (L. Dunal) root as a feed additive on immunological parameters and disease resistance to <i>Aeromonas hydrophila</i> in <i>Labeo rohita</i> (Hamilton) fingerlings	Fish and Shellfish Immunology	Elsevier	2010	Article	67	6.7	Central Agricultural University, India; Navsari Agricultural University, India; Central Institute of Fisheries Education, India
9	Janila, P., Pandey, M.K., Shasidhar, Y., Variath, M.T., Sriswathi, M., Khera, P., Manohar, S.S., Nagesh, P., Vishwakarma, M.K., Mishra, G.P., Radhakrishnan, T., Manivannan, N., Dobariya, K.L., Vasanthi, R.P., and Varshney, R.K.	Molecular breeding for introgression of fatty acid desaturase mutant alleles (ahFAD2A and ahFAD2B) enhances oil quality in high and low oil containing peanut genotypes	Plant Science	Elsevier	2016	Article	53	5.3	International Crops Research Institute for the Semi-Arid Tropics, India; Indian Council of Agricultural Research, India; Tamil Nadu Agricultural University, India; Junagadh Agricultural University, India; Acharya N G Ranga Agricultural University, India
10	Kumar, N., Vijay Anand, K.G., and Reddy, M.P.	Shoot regeneration from cotyledonary leaf explants of <i>Jatropha curcas</i> : A biodiesel plant	Acta Physiologiae Plantarum	Springer	2010	Article	48	4.8	Anand Agricultural University, India; Council of Scientific and Industrial Research, India
11	Mohapatra, D., Mishra, S., Singh, C.B. and Jayas, D.S.	Post-harvest Processing of Banana: Opportunities and Challenges	Food and Bioprocess Technology	Springer	2011	Review	47	4.7	Anand Agricultural University, India; Central Agricultural University, India; University of Manitoba, Canada
12	Mehta, B.M., and Deeth, H.C.	Blocked Lysine in Dairy Products: Formation, Occurrence, Analysis, and Nutritional Implications	Comprehensive Reviews in Food Science and Food Safety	Wiley	2016	Article	45	4.5	Anand Agricultural University, India; The University of Queensland, Australia

13	Rakshit, S., Ganapathy, K.N., Gomashe, S.S., Rathore, A., Ghorade, R.B., Kumar, M.V.N., Ganesmurthy, K., Jain, S.K., Kamtar, M.Y., Sachan, J.S., Ambekar, S.S., Ranwa, B.R., Kanawade, D.G., Balusamy, M., Kadam, D., Sarkar, A., Tonapi, V.A., and Patil, J.V.	GGE biplot analysis to evaluate genotype, environment and their interactions in sorghum multi-location data	Euphytica	Springer	2012	Article	44	4.4	Directorate of Sorghum Research, India; International Crops Research Institute for the Semi-Arid Tropics, India; Dr Panjabrao Deshmukh Krishi Vidyapeeth, India; Acharya N G Ranga Agricultural University, India; Tamil Nadu Agricultural University, India; Sardarkrushinagar Dantiwada Agricultural University, India; University of Agricultural Sciences, India; CS Azad University of Agriculture and Technology, India; Marathwada Agricultural University, India; Maharana Pratap University of Agriculture and Technology, India; Tamilnadu Agriculture University, India; Mahatma Phule Krishi Vidyapeeth, India; National Academy of Agricultural Research Management, India
14	Pitta, D.W., Parmar, N. Patel, A.K., Indugu, N. Kumar, S., Prajapathi, K.B., Patel, A.B., Reddy, B., and Joshi, C.	Bacterial diversity dynamics associated with different diets and different primer pairs in the rumen of Kankrej cattle	PLoS ONE	Public Library of Science	2014	Article	43	4.3	University of Pennsylvania, United States; Anand Agricultural University, India; Sardar Krushi Nagar Dantiwada Agricultural University, India
15	Sharma, H.P., Patel, H., and Sugandha	Enzymatic added extraction and clarification of fruit juices–A review	Critical Reviews in Food Science and Nutrition	Taylor and Francis	2017	Article	42	4.2	Anand Agricultural University, India; Sant Longowal Institute of Engineering and Technology, India
16	Momin, J.K., Jayakumar, C., and Prajapati, J.B.	Potential of nanotechnology in functional foods	Emirates Journal of Food and Agriculture	United Arab Emirates University	2013	Article	40	4	Anand Agricultural University, India; Indian Institute of Technology, India
17	Subbaiah, R.	A review of models for predicting soil water dynamics during trickle irrigation	Irrigation Science	Springer	2013	Review	40	4	Junagadh Agricultural University, India
18	Patel, A., Prajapati, J.B., Holst, O., and Ljungh, A.	Determining the probiotic potential of exopolysaccharide producing lactic acid bacteria isolated from vegetables and traditional Indian fermented food products	Food Bioscience	Elsevier	2014	Article	39	3.9	Anand Agricultural University, India; Lund University, Sweden
19	Maan, S., Maan, N.S., Belaganahalli, M.N., Rao, P.P., Singh, K.P., Hemadri, D., Putty, K., Kumar, A., Batra, K.,	Full-genome sequencing as a basis for molecular epidemiology studies of bluetongue virus in India	PLoS ONE	Public Library of Science	2015	Article	38	3.8	The University of Veterinary and Animal Sciences, India; Pirbright Institute, United Kingdom; Ella Foundation, India; Indian Veterinary Research Institute, India; National Institute of Veterinary Epidemiology and Disease Informatics, India;

	Krishnajyothi, Y., Chandel, B.S., Reddy, G.H., Nomikou, K., Reddy, Y.N., Attoui, H., Hegde, N.R., and Mertens, P.P.C.								Acharya N G Ranga Agricultural University, India; Biological and Research Institute, India; Sardarkrushinagar Dantiwada Agricultural University, India; Veterinary Biological and Research Institute, India
20	Dak, M., and Pareek, N.K.	Effective moisture diffusivity of pomegranate arils undergoing microwave-vacuum drying	Journal of Food Engineering	Elsevier	2014	Article	37	3.7	Anand Agricultural University, India; Mohanlal Sukhadia University, India
21	Mohapatra, D., Bira, Z.M., Kerry, J.P., Frias, J.M., and Rodrigues, F.A.	Postharvest hardness and colour evolution of white button mushrooms (<i>Agaricus bisporus</i>)	Journal of Food Science	Wiley	2010	Article	35	3.5	Anand Agricultural University, India; Agricultural Research Institute, Tanzania; University College Cork, Ireland; Dublin Institute of Technology, Ireland; University College Cork, Ireland
22	Hati, S., Vij, S., Singh, B.P., and Mandal, S.	β -Glucosidase activity and bioconversion of isoflavones during fermentation of soymilk	Journal of the Science of Food and Agriculture	Wiley	2015	Article	35	3.5	Anand Agricultural University, India; National Dairy Research Institute (Deemed University), India
23	Mandal, N.P., Sinha, P.K. Variar, M., Shukla, V.D., Perraju, P., Mehta, A., Pathak, A.R., Dwivedi, J.L., Rathi, S.P.S., Bhandarkar, S., Singh, B.N., Singh, D.N., Panda, S., Mishra, N.C., Singh, Y.V., Pandya, R., Singh, M.K., Sanger, R.B.S., Bhatt, J.C., Sharma, R.K., Raman, A., Kumar, A., and Atlin, G.	Implications of genotype <input/> interactions in breeding superior genotypes for favourable and unfavourable rainfed upland environments	Field Crops Research	Elsevier	2010	Article	34	3.4	Anand Agricultural University, India; Narendra Dev University of Agriculture and Technology, India; Indira Gandhi Krishi Vishwavidyalaya, India; Birsa Agricultural University, India; Orissa University of Agriculture and Technology, India; Central Rice Research Institute, India; Maharana Pratap University of Agriculture and Technology, India; Vivekananda Parvatiya Krishi Anusandhan Sansthan, India; International Rice Research Institute, Philippines
24	Harsh, A., Sharma, Y.K., Joshi, U., Rampuria, S., Singh, G., Kumar, S., and Sharma, R.	Effect of short-term heat stress on total sugars, proline and some antioxidant enzymes in moth bean (<i>Vigna aconitifolia</i>)	Annals of Agricultural Sciences	Elsevier	2016	Article	32	3.2	Swami Keshwanand Rajasthan Agriculture University, India; Anand Agricultural University, India
25	Kumar, V., Sharma, R., Trivedi, P.C., Vyas, G.K., and Khandelwal, V.	Traditional and novel references towards systematic normalization of qRT-PCR data in plants	Australian Journal of Crop Science	Southern Cross Publishing	2011	Review	32	3.2	Swami Keshwanand Rajasthan Agriculture University, India; Deen Dayal Upadhyay Gorakhpur University, India; Institute of Applied Science and Biotechnology, India; Navsari Agricultural University, India
26	Jana, A.H., and Mandal, P.K.	Manufacturing and quality of mozzarella cheese: A review	International Journal of Dairy Science	Academic Journals Inc., USA	2011	Article	31	3.1	Anand Agricultural University, India; Rajiv Gandhi College of Veterinary and Animal Sciences, India

27	Suthar, V.S., Burfeind, O., Patel, J.S., Dhama, A.J., and Heuwieser, W.	Body temperature around induced estrus in dairy cows	Journal of Dairy Science	Elsevier	2011	Article	31	3.1	Freie Universität Berlin, Germany; Anand Agricultural University, India
28	Kumar, N., Modi, A.R., Singh, A.S., Gajera, B.B., Patel, A.R., Patel, M.P., and Subhash, N.	Assessment of genetic fidelity of micropropagated date palm (<i>Phoenix dactylifera</i> L.) plants by RAPD and ISSR markers assay	Physiology and Molecular Biology of Plants	Springer	2010	Article	30	3	Anand Agricultural University, India
29	Thorat, I.D., Jagtap, D.D., Mohapatra, D., Joshi, D.C., Sutar, R.F., and Kapdi, S.S.	Antioxidants, their properties, uses in food products and their legal implications	International Journal of Food Studies	ISEKI Food Association	2013	Article	30	3	Global Center of Excellence for Design and Application Development, India; Anand Agricultural University, India; Central Institute of Agricultural Engineering, India