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Advancing Potato Science: A Five-Year Bibliometric Analysis of the Contributions of the Central Potato Research Institute

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Abstract

This study presents a bibliometric analysis of the research output of the Central Potato Research Institute, Shimla, Himachal Pradesh, India, over 5 years from 2019 to 2023. The study utilised advanced bibliometric tools such as Biblioshiny and VOSviewer to examine the institute's research growth, document types, subject areas, keywords, trending topics, leading publication sources, collaboration patterns and funding sources. The findings show a significant growth in research productivity, with a compound annual growth rate of 31.9%, indicating a robust expansion of the institute's research output. The analysis highlights a prominent focus on agricultural and biological sciences and a rich interdisciplinary research theme spanning biochemistry, genetics, molecular biology and environmental sciences. The evolving research emphasis, identified through keyword analysis and thematic clustering, such as "potato", "climate change" and "late blight", reflects the institute's dynamic and proactive research theme. By visualising national and international collaborations and examining funding sources facilitated by the chosen bibliometric tools, the study emphasises the institute's key role in the global agricultural research landscape. This study showcases the Central Potato Research Institute's significant contributions to agricultural research, focusing on potato cultivation. And it also emphasises the critical role of sophisticated bibliometric analysis in mapping and understanding the scope of global agricultural challenges and research activities.

Keywords: Bibliometric, Scientometric, ICAR, CPRI, Potato, Solanum Tuberosum, Research

Introduction

Potato (Solanum tuberosum) stands as the world's third most important food crop in terms of human consumption, following rice and wheat (Ahmadu et al., 2021; del Mar Martínez-Prada et al., 2021; International Potato Center, 2024). Its significance extends beyond mere nutrition; it is critical in global food security and poverty alleviation. Potatoes' versatility, adaptability to different environments and ability to provide high yields make potato science a pivotal area of agricultural research (Lal et al., 2023). Advances in potato science can lead to improved crop resilience, enhanced nutritional profiles and sustainable farming practices, addressing both environmental challenges and nutritional needs (Devaux et al., 2020).

The Central Potato Research Institute (CPRI) is a public non-profit potato research institute in Shimla, Himachal Pradesh, India. It is a premier institution dedicated to potato research in India. CPRI was established in August 1949 at Patna (Bihar, India) on the recommendation of

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the Agricultural Advisor to the Government of India, Sir Herbert Steward, under the Ministry of Agriculture and Farmers Welfare, Government of India. The institute was shifted to Shimla, Himachal Pradesh, in 1956 to facilitate hybridisation work in potato breeding and maintain seed potato health. It was transferred to the ICAR in April 1966. CPRI operates under the aegis of the Indian Council of Agricultural Research (ICAR). It spearheads research and development initiatives to enhance potato production, quality and disease resistance. CPRI's work encompasses various domains, including genetics, plant breeding, agronomy, pest management and post-harvest technology, making significant contributions to the advancement of potato science both nationally and internationally. The institute has created state-of-the-art laboratories for conducting basic and strategic research in the fields of biotechnology, genomics, genetics and plant breeding, plant protection, soil science and agronomy, plant physiology, biochemistry and post-harvest technology (Central Potato Research Institute, 2024).

Bibliometrics uses statistical methods to analyse the research output of a given institution and field. Bibliometric analysis is a powerful tool for assessing the scholarly impact, research trends and collaborative networks within specific knowledge domains (Agarwal et al., 2016; Bihari Sethi et al., 2014; Donthu et al., 2021). It is a well-established discipline for a quantitative and statistical study of patterns of publication within a given subject field or body of literature (Panda, 2021). Institutions such as the Central Potato Research Institute (CPRI) are pivotal in advancing scientific knowledge and innovation in agricultural research. This study conducts a bibliometric analysis of CPRI's research output, focusing on 2019 to 2023 to elucidate its contributions to potato science research and agricultural development. As a premier research institution dedicated to potato science, CPRI, located in Shimla, India, undertakes research initiatives to enhance crop productivity, disease resistance and sustainability practices. The primary purpose of this study is to determine how the research output of CPRI, Shimla, grew over 5 years.

Review of Literature

The advancement of potato science encompasses a broad spectrum of research areas, including genetic improvement, pest and disease management, sustainable cultivation practices and post-harvest technology. This review synthesises recent literature pertinent to the themes of potato research. It highlights the contributions of bibliometric analyses in evaluating the scientific output of research institutions like the Central Potato Research Institute (CPRI) in Shimla.

Recent advancements in potato breeding have focused on enhancing disease resistance, improving nutritional value and increasing yield. Jansky et al. (2016) emphasised the role of molecular breeding techniques in accelerating the development of potato varieties that can withstand biotic and abiotic stresses. Additionally, the application of CRISPR/Cas9 technology for genome editing in potatoes has been explored as a promising approach for precision breeding (Andersson et al., 2017). Effective pest and disease management strategies are crucial for ensuring the sustainable production of potatoes. Research by Alptekin (2011) provided insights into integrated pest management (IPM) approaches, highlighting bio control agents and resistant varieties as critical components in controlling potato pests and diseases. Advances in post-harvest technology aim to reduce losses and improve the quality and shelf life of potatoes. Research by Singh and Kaur (2016) highlighted the potential of innovative storage techniques and value-added processing methods to extend the usability of potatoes and diversify their applications.

Bibliometric and scientometric studies have emerged as vital tools in assessing scientific institutions' research performance and impact. These analyses offer insights into publication patterns, citation impact and collaboration networks, providing a systematic approach to examining contributions to fields like potato science and beyond. Bibliometric analyses have become increasingly important in assessing scientific institutions' research performance and impact. Studies by González-Alcaide et al. as in agricultural sciences. Specifically, applying bibliometric indicators, such as the h-index and citation analysis, provides valuable insights into the quality and influence of research outputs.

A series of studies conducted between 2009 and 2024 have painted a comprehensive picture of the research productivity within Himachal Pradesh. From Chauhan's (2018) comparative bibliometric analysis across 10

institutions to Sharma's (2009) focused exploration of CPRI's publications, these studies highlight the significant contributions to scientific knowledge emanating from the region. Notably, the analyses extend beyond CPRI, with studies by Parabhoi and Sahu (2019) on Himachal Pradesh University (HPU) and Patel and Malhan (2018) on the National Institute of Technology, Hamirpur. Muruli and Harinarayana's (2023, 2024) work expands the analytical lens to include faculty publications from central universities in the Western Himalayan region, revealing an increase in scholarly publications and international collaborations. Their studies elucidate significant research areas, preferred journals, and the citation behaviour within specific scientific communities, such as physics and astronomy, thereby enriching our understanding of the regional research landscape's depth and breadth.

In the context of CPRI, Shimla bibliometric analysis offers a systematic approach to examining the institute's contributions to potato science. By analysing publication patterns, citation impact and collaboration networks, stakeholders can understand CPRI's role in advancing potato research and its alignment with global research trends. The literature review highlights the dynamic nature of potato science and the critical role of research institutions like CPRI in addressing challenges and leveraging opportunities in potato production. Furthermore, applying bibliometric analysis in evaluating scientific contributions enriches our understanding of research impacts and trends, guiding future initiatives in potato science.

Objectives

The bibliometric analysis of CPRI's research output from 2019 to 2023 aims to:

- Analyse the 5-year research output of CPRI, Shimla.
- Identify the most selected subject areas for research at CPRI, Shimla.
- Determine the publication source types utilised by CPRI, Shimla.
- Highlight the top countries collaborating with CPRI, Shimla.
- Identify the top funding sponsors of CPRI, Shimla.

Methodology

Data Collection: The data for this bibliometric study was retrieved from the SCOPUS database, a leading indexing and citation database that covers over 25,000 journals across various disciplines (Elsevier, 2023). The retrieval process involved executing a query for the institution's name ("CPRI, Shimla") under the organisation search feature. The search query used to retrieve the data was (AF-ID("ICAR - Central Potato Research Institute Shimla" 60012532) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019))). This search was confined to the period of 2019-2023 to capture the most recent research outputs. A sum of 562 data sets was exported in CSV and BibTeX file formats for detailed analysis. The study included peer-reviewed articles, conference papers, review articles and other scholarly works affiliated with CPRI and published within the specified period.

Analysis of Data: Advanced bibliometric tools, including Biblioshiny and VOSviewer, were employed for the analysis. These tools facilitated the examination of various bibliometric indicators such as publication counts, citation metrics, h-index, g-index and collaboration networks (Aria & Cuccurullo, 2017; van Eck & Waltman, 2014; Van Eck & Waltman, 2017). These indicators provide insights into the research impact, productivity and international collaboration efforts of CPRI, Shimla, contributing to a comprehensive understanding of its global scientific contributions in potato research.

Data Analysis and Interpretations

Year-Wise Publication Growth at CPRI, Shimla

Table 1 illustrates the progressive increase in research productivity at the CPRI from 2019 to 2023. The publication output saw a significant rise from 51 papers in 2019 to a peak of 163 in 2023. This growth direction shows a substantial year-over-year increase in publications, with 2023 marking the highest of research productivity,

accounting for 29% of the total output in the 5 years. The highest annual growth rate was observed in 2020, with an 84.31% increase over the previous year, followed by a notable 70.21% rise in 2022. The cumulative research output of CPRI during this period amounted to 562 papers, with a Compound Annual Growth Rate (CAGR) of 31.9%.

The CAGR is an important indicator for quantifying the steady growth rate over multiple periods, offering a clear picture of expansion trends in various sectors, including academic research outputs (Verma & Shukla, 2019). The CAGR explains a consistent and compound annual increase when evaluating the publication growth at CPRI, Shimla, from 2019 to 2023. Starting from an initial count of 51 publications in 2019 and culminating in 163 publications by 2023 over 4 years, the calculation of CAGR reveals a compound growth, resulting in a CAGR of approximately 31.9%. This percentage signifies an average annual growth rate, indicating that CPRI's research output has escalated by an average of 31.9% each year throughout the observed 5-year timeframe. This growth rate signifies the dynamic growth in CPRI's research activities over the years analysed.

Table 1: Yearly Publication Growth at CPRI, Shimla (2019-2023)

Year	*No. of Publications*	*%*	*Annual Growth Rate*
2019	51	9.1	-
2020	94	16.7	84.31%
2021	94	16.7	0.00%
2022	160	28.5	70.21%
2023	163	29	1.88%
Total	562	100	CAGR=31.9%

Table 2: Distribution of Research Output by Document Type at CPRI, Shimla

Sr. No.	*Document Type*	*TP*	*%*
1	Article	354	62.99
2	Review	94	16.73
3	Book Chapter	91	16.19
4	Editorial	8	1.42
5	Note	6	1.07
6	Book	5	0.89
7	Conference Paper	2	0.36
8	Erratum	2	0.36
Total		562	100

Distribution of Research Outputs by Document Type

Table 2 shows that CPRI primarily publishes research articles, which make up 62.99% of its total research output. This highlights the institute's preference for the conventional and highly respected format for sharing research findings. Reviews and book chapters also make up a significant part of the output, accounting for 16.73% and 16.19%, respectively. This indicates that CPRI is actively engaged in analysing and critically assessing existing research through reviews, as well as contributing to scholarly works through in-depth book chapters. Less common document types, such as editorials, notes, books, conference papers and errata, together make up a smaller fraction of the total output, amounting to 4.09%. This distribution indicates a focused effort towards contributing to the foundational research literature while also engaging in a broader scholarly conversation through various other formats.

Top Ten Subject Area of CPRI, Shimla

Table 3 displays the various research interests at CPRI, Shimla, with a significant emphasis on agricultural and biological Sciences, constituting 83.45% of the institution's research portfolio. This highlights CPRI, Shimla's foundational commitment to agricultural research and development, showcasing its critical role in providing valuable knowledge. Additionally, biochemistry, genetics and molecular biology stand out as the second most prominent area, contributing 27.58% of the research output, emphasising the interdisciplinary nature of the institution's research efforts, blending life sciences with agricultural development. Environmental sciences constitute 13.52%, showcasing the institution's involvement with sustainability and ecological studies, further affirming its commitment to addressing modern-day challenges. Engineering, chemistry and medicine, among others, depict a well-rounded research agenda that spans critical scientific domains, contributing to a comprehensive academic and research environment at CPRI, Shimla. This broad range of subject areas illustrates the institute's wide academic range and strategic focus on fields of prime importance to local and global communities.

Table 3: Top Ten Research Subject Areas at CPRI, Shimla (2019-2023)

Sr. No.	*Subject Area*	*TP*	*%*
1	Agricultural and Biological Sciences	469	83.45
2	Biochemistry, Genetics and Molecular Biology	155	27.58
3	Environmental Sciences	76	13.52
4	Engineering	70	12.46
5	Chemistry	40	7.12
6	Medicine	39	6.94
7	Immunology and Microbiology	21	3.74
8	Computer Sciences	19	3.38
9	Health Profession	18	3.20
10	Multidisciplinary	16	2.85

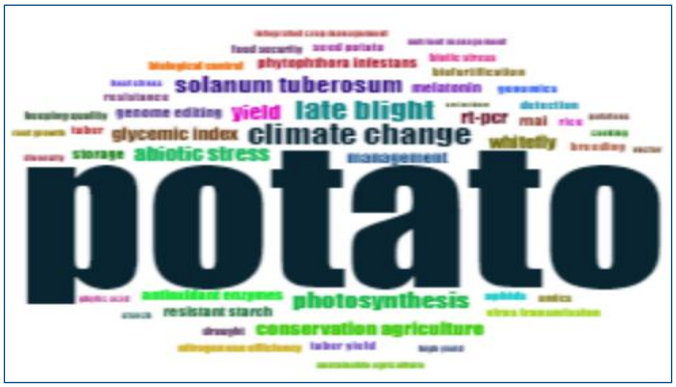

Fig. 1: Word Cloud of Top 50 Author Keywords

Most Frequently Used Author Keyword Analysis

Fig. 1 and Fig. 2 showcase the focus areas in potato research, with "potato", "climate change" and "late blight" among the most prominent keywords. These highlight the agricultural community's emphasis on environmental factors, disease management and crop yield optimisation. Keywords like "photosynthesis" and "abiotic stress" point to scientific enquiries into plant growth and resilience. At the same time, terms such as "conservation agriculture" and "glycemic index" reflect diverse interests, from sustainable practices to nutritional value studies. Additionally, mentions of "genome editing" and "antioxidant ensymes"

stress advanced research into genetic improvement and plant health. This analysis provides a succinct overview of the multifaceted research efforts to enhance potato cultivation and address critical challenges in agriculture.

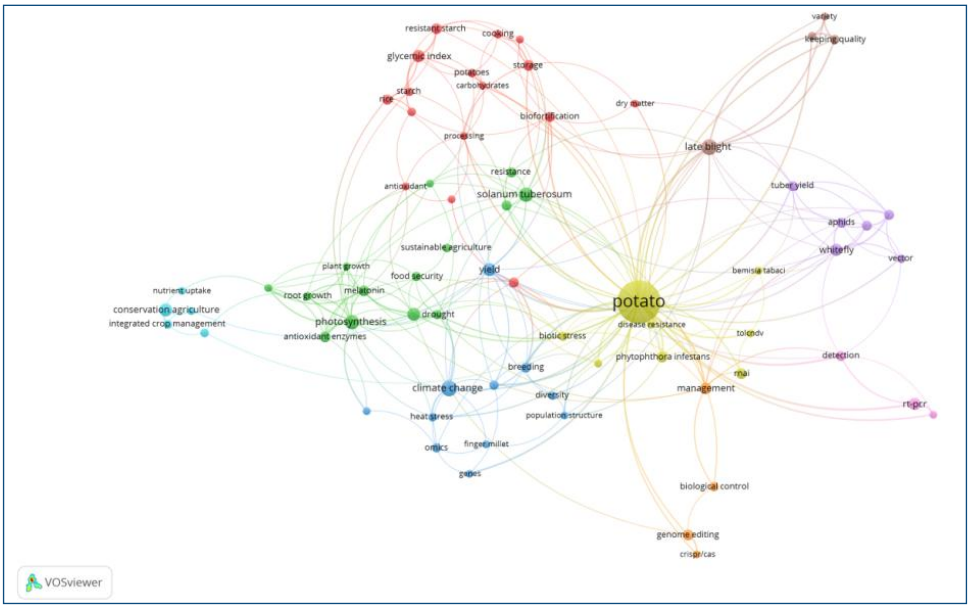

Fig. 2: Co-Occurrence Network of Author Keywords

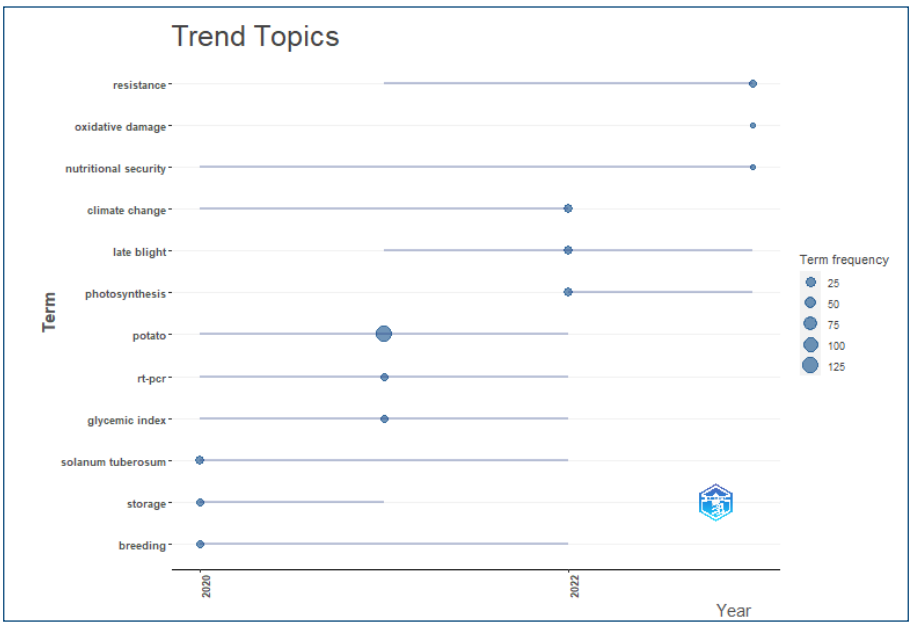

Fig. 3: Global Research Collaboration Map of CPRI, Shimla

Trending Topics

Fig. 3 reveals evolving research interests from 2020 to 2023, with "potato" being the most frequently discussed topic, indicating ongoing, significant attention. Initial focus areas like "solanum tuberosum" and "storage" show early prominence but diversify over time. Topics like "breeding" and "glycemic index" maintain steady interest, evolving through 2022, reflecting sustained research efforts in genetic improvement and health impacts. "Climate change" and "late blight" surge in focus towards 2022 and 2023, emphasising increasing concern for environmental effects and disease management in agriculture. Newer areas of interest,

such as "photosynthesis" and "resistance", have gained traction in recent years, pointing to advanced studies in plant physiology and resilience. Emerging topics like "nutritional security" and "oxidative damage" in 2023 highlight a shift towards addressing broader food security and plant health challenges, indicating a forward-looking research direction emphasising sustainability and crop improvement.

Table 4: Top Ten Sources for CPRI, Shimla's Research Publications

Sr. No.	*Sources*	*TP*	*Country*	*Publisher*	*h-Index*	*SJR*	*Quartile*
1	Potato Journal	66	INDIA	The Indian Potato Association	14	0.22	Q4
2	Potato Research	23	Netherlands	Springer Netherlands	49	0.62	Q1
3	Frontiers in Plant Science	21	Switzerland	Frontiers Media S.A.	187	1.23	Q1
4	Indian Journal of Agricultural Sciences	16	India	Indian Council of Agricultural Research	30	0.18	Q4
5	Journal of Plant Growth Regulation	9	USA	Springer New York	97	O.9	Q1
6	Journal of Soil Science and Plant Nutrition	9	Chile	Sociedad Chilena de la Ciencia del Suelo	53	0.72	Q1
7	Antioxidants	7	Switzerland	Multidisciplinary Digital Publishing Institute (MDPI)	83	1.08	Q1
8	Indian Journal of Entomology	7	India	The Entomological Society of India	4	0.12	Q4
9	Indian Journal of Genetics and Plant Breeding	7	India	Indian Society of Genetics & Plant Breeding.	19	0.32	Q3
10	Indian Phytopathology	7	USA	Springer Nature	11	0.33	Q2

Leading Journals for CPRI, Shimla's Research Publications

Table 4 presents the top 10 journals where CPRI's researchers frequently publish their work. The "Potato Journal", based in India and published by the Indian Potato Association, leads with 66 publications, demonstrating a focused effort in potato research. This preference is followed closely by "Potato Research" and "Frontiers in Plant Science", which are recognised for their high-quality contributions to the fields of potato science and plant science, respectively, both securing places in the first quartile (Q1) of journal rankings. The presence of journals such as "The Indian Journal of Agricultural Sciences" and "The Indian Journal of Entomology" highlights the institution's strong inclination towards agricultural sciences and its sub-disciplines. Moreover, the inclusion of international journals like "The Journal of Soil Science and Plant Nutrition" and "Antioxidants" in the list reflects CPRI, Shimla's commitment to broadening its research impact globally, tackling universal issues in plant and soil science, and contributing to the antioxidant research domain. This diverse selection of publication venues highlights CPRI, Shimla's multifaceted research interests and its significant role in national and international scientific communities.

Table 5: Top Ten Affiliations of CPRI, Shimla

Sr. No.	*Name of the Affiliation*	*NP*	*%*
1	Indian Council of Agricultural Research	142	25.27
2	ICAR - Indian Agricultural Research Institute, New Delhi	130	23.13
3	ICAR - National Rice Research Institute	56	9.96
4	Lovely Professional University	42	7.47
5	Hainan University	35	6.23
6	Shoolini University	34	6.05

Sr. No.	Name of the Affiliation	NP	%
7	Dr. Yashwant Singh Parmar University of Horticulture and Forestry	33	5.87
8	ICAR - Central Institute for Research on Cotton Technology, Mumbai	31	5.52
9	Presidency University, Kolkata	27	4.80
10	ICAR - Indian Grassland and Fodder Research Institute, Jhansi	24	4.27

Collaboration with Other Institutions

Table 5 showcases CPRI's collaborations with critical institutions, emphasising a strong partnership with the Indian Council of Agricultural Research (ICAR), which leads with 25.27% of total research collaborations. Other notable partners include the ICAR - Indian Agricultural Research Institute and the ICAR - National Rice Research Institute, highlighting the institution's active role in India's agricultural research community. The list also features domestic and international universities such as Lovely Professional University and Hainan University, underlining CPRI, Shimla's diverse and global research network. These collaborations reflect CPRI, Shimla's comprehensive approach to agricultural research, spanning national and regional priorities.

Table 6: Top Ten Country Collaboration with CPRI, Shimla

Sr. No.	Country	TP	%
1	China	45	8.01
2	United States	41	7.30
3	Pakistan	20	3.56
4	Australia	17	3.02
5	Saudi Arabia	16	2.85
6	Ethiopia	15	2.67
7	Germany	15	2.67
8	Poland	15	2.67
9	Egypt	11	1.96
10	United Kingdom	7	1.25

Global Research Partnerships

Table 6 and Fig. 4 present CPRI's international research collaborations, with China, the United States and Pakistan as leading partners, contributing 8.01%, 7.30%, and 3.56% to the institute's collaborative publications, respectively. This underlines strong partnerships across key research domains, particularly with China's prominent role. The collaboration network includes Australia, Saudi Arabia, Ethiopia, Germany, Poland and Egypt, demonstrating CPRI's global research engagement. The United Kingdom, though a smaller contributor, signifies the institute's wide-reaching international research connections. These partnerships reflect CPRI, Shimla's commitment to addressing global agricultural challenges through international cooperation and knowledge exchange.

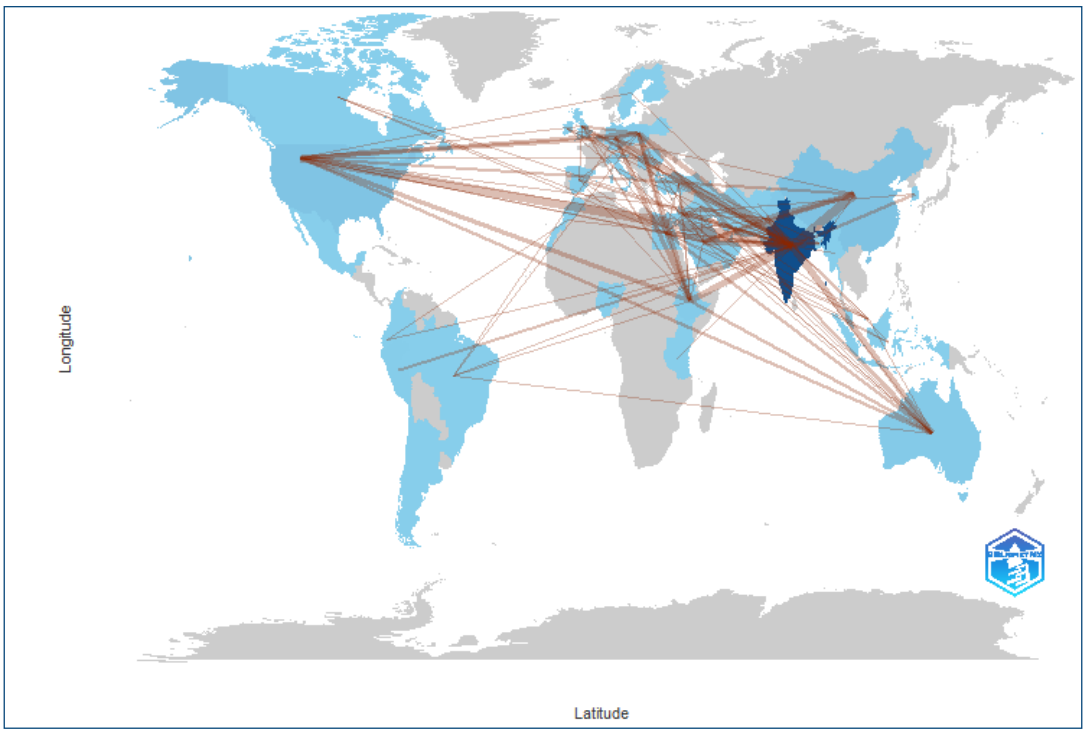

Fig. 4: Global Research Collaboration Map of CPRI, Shimla

Table 7: Top Ten Funding Sources

Sr. No.	*Funding Sponsor*	*NP*	*%*
1	Indian Council of Agricultural Research	131	23.3
2	Department of Science and Technology, Ministry of Science and Technology, India	26	4.6
3	Department of Biotechnology, Ministry of Science and Technology, India	17	3.0
4	Indian Agricultural Research Institute	15	2.7
5	Science and Engineering Research Board	15	2.7
6	Council of Scientific and Industrial Research, India	8	1.4
7	National Rice Research Institute, Indian Council of Agricultural Research	8	1.4
8	King Saud University	7	1.2
9	University Grants Commission	7	1.2
10	ICAR - Indian Agricultural Statistics Research Institute	6	1.1

Funding Sources for Research

Table 7 highlights the primary funding sources for CPRI, Shimla's research, with the Indian Council of Agricultural Research leading at 23.3%. Other significant contributors include the Department of Science and Technology and the Department of Biotechnology, Ministry of Science and Technology, India, reflecting the importance of governmental support in research funding. The presence of both national and international funding bodies, like King Saud University, indicates a diverse funding landscape supporting CPRI and Shimla's research endeavours.

Findings and Conclusions

The data analysis and interpretation of research activities at the CPRI reveal several key insights into the institution's research dynamics, thematic concentrations

and scholarly communications. A consistent upward direction in publication output, with a notable compound annual growth rate of 31.9%, signifies a strong and increasing research culture. This growth is primarily articulated through articles, highlighting the traditional academic output, but is complemented by reviews and book chapters, indicating a rich engagement with comprehensive scholarly discourse.

The subject area analysis indicates a strong agricultural and biological sciences foundation, reflecting CPRI's core mission. However, the diversification into biochemistry, genetics and molecular biology, alongside environmental sciences and other fields, demonstrates an interdisciplinary approach to addressing complex agricultural challenges. The prominence of keywords such as "potato", "climate change" and "late blight" in research publications emphasises a focus on critical issues affecting potato cultivation, including environmental impact and disease management. Moreover, as highlighted by the trending topics, the evolving research interests indicate a responsive and forward-looking research agenda that adapts to emerging challenges and opportunities in agriculture.

Collaborations and national and international partnerships underline CPRI's role as a key player in the global agricultural research community. These partnerships facilitate the exchange of knowledge and resources and enhance the institute's capacity to tackle pressing agricultural issues on a broader scale. Funding sources from national and international bodies highlight the recognition and support for CPRI's research initiatives, highlighting the importance of sustained funding for advancing agricultural research and development.

In conclusion, the comprehensive analysis of research outputs and trends at CPRI, Shimla, from 2019 to 2023 emphasises the institute's important role in advancing agricultural science, focusing on potato research. The significant growth in research productivity, driven by a diverse and interdisciplinary research programme, reflects CPRI's commitment to excellence and innovation in addressing the multifaceted challenges of agriculture. The emphasis on environmental sustainability, disease management and crop improvement, coupled with robust national and international collaborations, positions CPRI as a key contributor to global agricultural research and policy-making. As the institute continues to evolve its research priorities in response to emerging challenges, its contributions are expected to remain crucial for the sustainable development of agriculture, not only in India but globally.

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