Annual Progress Report
For 2022-2023 Fiscal Year

Table of Contents

Section A: Year in Review

Throughout 2022-23, IC-IMPACTS achieved consistent progress through pioneering scientific collaborations between Canada and India, with a focus on creating community-based solutions in the fields of Public Health, Safe and Sustainable Infrastructure, Integrated Water Management, as well as Food Security and Agritech.

Under a bilateral MoU, signed in May 2022 between the Department of Biotechnology (DBT), Department of Science and Technology (DST), and Natural Sciences and Engineering Research Council of Canada (NSERC), IC-IMPACTS was identified as the lead delivery agency on Canada-India Science and Technology collaborations. In September 2022, IC-IMPACTS submitted a comprehensive proposal to the Strategic Science Fund (SSF) program. We have received strong support from key Indian stakeholders, including the High Commissioner of India, DST, DBT, and industry partners such as Tata Consultancy Services (TCS), and discussed collaborations with prominent Canadian organizations including Mitacs, Praxis Spinal Cord Institute, Genome Canada, Indigenous Works, Centre for Aging and Brain Health Innovation (CABHI) and many more non-profit, academic, and industry partners.

Throughout the year, IC-IMPACTS continued to demonstrate that the integration of Canadian and Indian scientific research is an effective approach to addressing socioeconomic challenges, leading to high-impact, application-oriented outcomes. Moreover, the table below provides a summary of the Centre's achievements:

	Past Fiscal (2022-2023)	**Overall (2013-2023)**
Active Projects	30	76
HQP (years)	103	1,434
Scientific Publications	130	1,561
Patents and Licenses	1	34
Partnerships	17	400
Start-ups	8	

Impacts of COVID-19

The COVID-19 pandemic posed significant challenges to student mobility, with many international students facing disruptions in studies and difficulties in traveling to their desired academic institutes. In addition, due to visa and immigration processing delays which followed after the pandemic, Canadian researchers continue to struggle hiring HQP form other countries. IC-IMPACTS continues to receive extension requests for project timelines. Some projects continue to operate with limited or reduced capacities, hence, affecting project progress.

New Projects

In July 2022, following the signing of the MoU between DST, DBT, and NSERC, a Canada-India Joint Call for Proposals on *Building Resilient and Carbon-Neutral Communities Post COVID* was announced. The purpose of the Call was to seek applications in the areas of Infrastructure, Water, Agritech and Food Security, and Health – Post COVID Health Issues and Long COVID. In the following months, IC-IMPACTS received over 150 applications, 134 of which were considered eligible for review. Each of these applications were independently evaluated by a Joint Review Committee, comprised of representatives and independent external reviewers from India and Canada, followed by comparison of list of proposals recommended from both Canadian and Indian sides to the Selection Committee. IC-IMPACTS, DST and DBT plan for the results to be announced in Spring 2023 and hope to fund 20

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

new projects under this Call. In November 2022, IC-IMPACTS announced funding for the following two projects under the Call for Proposals in Food Security:

1. **Food Security and the Problem of Fit: Examining Local Innovations to Milk Wastage in India**
   - **Canadian PI:** Jeremy Pittman, University of Waterloo
   - **Indian PI:** Dr. Sanchayan Nath, IIT-Tirupati

2. **Extraction of Protein from Brewer's Spent Grain for Human and Animal Consumption**
   - **Canadian PI**: Chijioke Emenike, Dalhousie University
   - **Indian PI**: Kiran Babu Uppuluri, SASTRA Deemed University

Engagement with Indigenous Communities

IC-IMPACTS continues to engage with communities throughout Canada. Notably, partnerships with Canada's Indigenous communities would soon result in transformative changes within those communities. One particular topic being discussed with the West Moberly First Nation is the possibility of working with 3D printed concrete in cold climates.

IC-IMPACTS was invited to attend the Indigenous Partnerships Success Showcase (IPSS conference) in Vancouver, on May 26 and 27, 2022. The annual conference is built around the growing demand for practical guidance on how First Nations, Métis and Inuit communities and their enterprise partners can work together, in common purpose, for shared success.

Figure 1: IPSS Conference in Vancouver

Through this conference, IC-IMPACTS initiated talks with Ashini Consultants, a First Nations owned and operated engineering firm dedicated to better serving the First Nations communities with design, construction and project management. IC-IMPACTS also hosted a few very productive meetings with Luminary and Indigenous Works to discuss possible collaborations beyond 2024 and under the SSF program.

Section B: Performance Against Program Review Criteria and Objectives

B1 - Excellence of the Research Program (highlighting featured projects)

IC-IMPACTS' bilateral model is identified and driven by community need, with outcomes being deployed internationally, from Canada's Indigenous communities to urban and rural communities in India. The following theme-based examples demonstrate the success of IC-IMPACTS' model.

Agritech and Food Security Theme

- **Variable Rate Application of Nutrients by Developing Nutrient Estimation Sensor and Precision Spraying Mechanism**

  Canadian Lead: Dr. Ahmad Al-Mallahi, Dalhousie University
  Indian Lead: Dr. Narasimha Murty, Indian Institute of Technology – Tirupati

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

In agricultural fields, any test of elements concentrations in soil or plants show usually excessive quantities of nitrogen, phosphorous, and potassium, which are called macro-nutrients. On the other hand, the concentration of the elements known as micro-nutrients, such as boron, zinc, and iron might be in ranges wider than the recommended for plant growth. Excessive quantities applied in the field may cause economic loss and contamination in soil and underground water.


Figure 2: Site Visit and Training with Personnel from McCain Foods Limited in New Brunswick

One way to balance the quantities of elements is to precisely apply them based on the plant status and soil content. In this project, the research team is developing sensors to detect elements in the leaves of the plants and in the soil based on spectral data that can be collected by spectrophotometers. Using artificial intelligence techniques, researchers are developing models to estimate the concentrations of elements in the plant and soil without the need for chemical testing in the lab. The shift of estimation from lab testing to sensing will enable scanning wide fields and the information will be used to plan variable rate application of fertilizers by the sprayers whose spraying system will be modified to enable precise application according to the plant need and the conditions of the soil.

In the media: *Star Trek for Potatoes: Can a Hi-Tech Farm Save French Fries from the Climate Crisis?* The Guardian, November 22, 2022

❖ **Irrigation Management Using Deep Reinforcement Learning**

Canadian Lead: Dr. Chi-Guhn Lee, University of Toronto
Indian Lead: Dr. Subimal Ghosh, Indian Institute of Technology – Bombay

Previous studies on optimal irrigation scheduling have primarily relied on static optimization with chance constraints, assuming predetermined distributions of rainfall to determine optimal irrigation plans over a short-to-medium weather forecast range of 1-7 days. However, if farmers deviate from this optimal plan due to unexpected circumstances during the planning window, the original irrigation plan becomes suboptimal, and the entire optimization process must be restarted to obtain optimal decisions for the current soil moisture level.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

In short, static optimization cannot dynamically adjust to any deviations from the optimal irrigation schedule. Therefore, this research aims to develop a dynamic control framework using reinforcement learning agents to make optimal irrigation decisions at any soil moisture level. In this proposed framework, rainfall uncertainty is incorporated into the environment in which the reinforcement learning agent operates through transition dynamics. The model-based reinforcement learning agent learns such dynamics, equivalent to modeling and updating the rainfall distribution. As a result, the chance constraint, which ensures that the soil moisture remains above a prescribed threshold value with a high probability in the static optimization, can be naturally integrated into the reward function. The participation of farmers in the development of this framework will increase its acceptability worldwide.


Figure 3: Sharing Knowledge and Expertise in Irrigation Management, Simulation-Optimization, and Local Farming Practices

Public Health Theme

- **Smart App-Based Rapid Multiplex Screening of HIV Associated Co-Infections of at-Risk Populations at the Point-of-Care: A Demonstration Study in India**

  Canadian Lead: Dr. Nitika Pant Pai, Research Institute of the McGill University Health Centre
  Indian Lead: Dr. Suma Nair, DY Patil Deemed to be University

  In this study, the research team is screening populations for HBV and HPV – two viral infections that are commonly ignored in screening programs. The results from this study will influence testing policy and guidelines for sexually transmitted and blood borne infections. It will allow populations who are not commonly tested for these prevalent infections to know their status, thereby managing the undiagnosed disease burden and mitigating transmission.

  Researchers plan to disseminate the results of this study through the Summer Institutes in Global Health at McGill University, and presentations at international conferences in the STBBI space, as well as through workshops and seminars. In the past year, the research team at RI-MUHC carried out the necessary training with the study staff at DYPU, and they are now primed to begin recruitment.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

The team has also successfully published results from the study on AideSmart! Canada multiplex strategy to the Lancet Microbe, which have been released in preprint. The team has also presented the results of that study, and preparatory work relating to both AideSmart! Canada and AideSmart! India in conferences, seminars, and workshops.

Figure 4: Research Team at RI-MUHC

Integrated Water Management Theme

- **Development and Scale-Up of Technology for Microbial Extraction of Xylose from Agro-Waste Materials and Subsequent Conversion into Xylitol: Conversion of Hydrolysed Lignocellulosic Residues into Biopolymers for Applications in Composites.**

Canadian Lead: Dr. Tatjana Stevanovic, Université Laval
Indian Lead: Dr. Baljinder Kaur, Punjabi University

Agro-waste materials containing cellulose, hemicelluloses, and lignins are the most abundant renewable organic resource on Earth. The utilization of renewable resources for production of chemicals, food additives and energy is expected to increase in the near future. Transforming it into useful products, a natural sweetener xylitol, lignin nanoparticles and cellulose microfiber will bring high added-value and economic benefits, while solving environmental problems caused by these wastes. In this project, researchers are proposing a biorefinery approach to perform the complete transformation of agro-waste into several valuable products.

Researchers used the electrospray method to prepare nanoparticles made from lignin extracted from rice husks, which were then used to produce PLA based films. By grafting the lignin nanoparticles onto PLA, we were able to achieve a more uniform dispersion of the particles in the PLA matrix, resulting in films with improved optical properties, such as higher visible light transmittance compared to blends containing unmodified lignin or un-grafted lignin nanoparticles. Additionally, the PLA-grafted lignin nanoparticles boosted the antioxidant capacity of the films, making them suitable for food packaging applications. The cellulose microfibrils produced from rice husk pulp from which silica has been extracted through a process optimised in this study, will undoubtedly find similar applications in the field of composites.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

The study involves quantifying the major constituents of rice husk and wheat straw; namely hemicellulose, lignin, cellulose, and ash. In the first year, the team optimized the extraction of xylose. In the second year, hydrolyzed rice husk underwent pulping using a patented organosolv process, and the lignin obtained was rigorously analyzed. However, large amounts of silica in the cellulosic pulp made it difficult to determine the properties of the pulp, so the team established and optimized a silica extraction process using Na2CO3. The absence of silica in the cellulose ash was confirmed through elemental analysis. To facilitate spectroscopic analysis, the cellulose was bleached by successive washes with NaClO. The bleached cellulose was then analyzed rigorously. The scaling up of the hydrolysis and pulping processes was necessary to produce biomass and validate its conformity.

Using the electrospray method, rice husk organosolv lignin was transformed into nanoparticles. The team optimized various parameters, including lignin concentration, flow rate, applied voltage, and tip-to-collector distance, using response a surface methodology with the Box-Behnken design to obtain small, spherical, stable, and homogeneous nanoparticles. The properties of the nanoparticles could be predicted based on the initial parameters. Finally, the lignin particles were incorporated into a PLA matrix to enhance the antioxidant properties of PLA films used for food packaging.

- **Carbon Neutrality through Combined CO_2 Capture and Novel H_2 Technology with Production of Non-Conventional Fuels for Smart Cities**

Canadian Lead: Dr. Ibrahim Dincer, Ontario Tech University
Indian Lead: Dr. Subrata Borgohain Gogoi, Dibrugarh University

Photonic Hydrogen Production: Three novel photoelectrochemical (PEC) reactors have been designed, developed, and experimentally tested in Clean Energy Research Laboratory (CERL), Ontario Tech University. Those PEC hydrogen reactors bring a new perspective to PEC process via novel photoelectrodes' geometries improving the effectiveness of the process considerably. Several semiconductor materials and coating processes have been investigated to fabricate the photoelectrodes for solar PEC reactors. Various electrochemical tests have been conducted to the developed PEC designs, including open circuit potential, cyclic voltammetry, linear sweep voltammetry, and PWR test for hydrogen production. Moreover, thermodynamic and CFD analyses for the investigated reactors have been conducted. The PEC cells have been integrated in multigeneration energy systems as a green fuel production source. Furthermore, life cycle analysis for the new PEC designs has been performed to evaluate the environmental impact of the PEC based hydrogen production per kilogram of the generated hydrogen. The conducted research has produced seven full research articles published in highly ranked international journals.

Carbon Capturing: Renewable energy and ammonia-based carbon capturing systems that produce ammonium bicarbonate are developed and experimentally tested. Thermodynamic and exergoeconomic models of the developed carbon capturing systems are established. The findings of the research have been reported in one PhD dissertation and four associated research articles. Biomass Based Hydrogen Production: Various waste-to-energy multigeneration including hydrogen production have been designed and comprehensively evaluated. The developed systems are chemically and thermodynamically modelled as well as economically investigated.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

Two master's students have completed their dissertations within the research topic. Findings of conducted research have been reported in research papers published within internationally recognized journals.

Safe and Sustainable Infrastructure Theme

❖ Development of Cost-Effective, Energy Efficient, and Resilient Housing Technologies for First Nations Communities

Lead: Drs. Ashutosh Bagchi and Bruno Lee, Concordia University

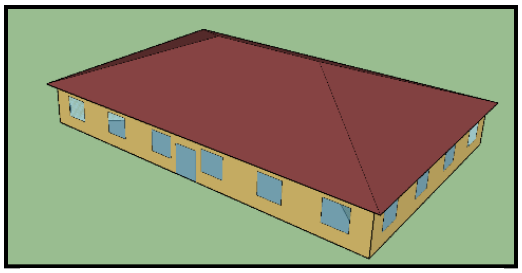


Figure 6: Community Centre Model

This research aims to evaluate and improve the resilience of housing in First Nation Communities by implementing energy-efficient technologies. For this purpose, a holistic approach is adopted to incorporate renewable energy technologies and thermal storage into conventional heating and cooling systems for buildings to support the development of resilient First Nations Communities. The proposed integrated energy system (IES) incorporates photovoltaic solar panels for on-site solar energy generation with batteries and air source heat pumps (ASHPs) coupled with a Thermal Energy Storage (TES) tank to maintain the heating and cooling demand in a cold climate. The IES has been sized for the needs of a community center in Montreal, according to NECB 2020 (figure below). This research is divided into two parts. In the first part, the envelope performance of the community center has been evaluated under future climate and power outage scenarios. The figure below shows the heating and cooling demand variation of the community center in Montreal (climatic location, including a few First Nation communities in the vicinity) for historical, TMY, and future weather scenarios. As shown in this figure, the reduction in heating energy demand under the impacts of climate change will be more or less balanced by the increase in cooling demand. Therefore, it is important to consider these variations in the building and energy system design process. In this project, several Master's and Ph.D. students have collaborated and trained to develop the framework and platform for detailed analysis. The platform is developed by coupling EnergyPlus and Python, which brings strength and flexibility to the analysis of resilient housing. For this purpose, a systematic literature review has been conducted to evaluate the state-of-the-art research in the field. As part of this research, several conference and journal papers have been published.

Figure 5: Heating and Cooling Demand for Historical, TMY and Future Weather Scenarios (NECB building)

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

❖ **Smart Infrastructure with High Fracture Toughness, Durable Concrete Employing Large Amounts of Industrial Wastes**

Lead: Dr. Nemkumar Banthia, University of British Columbia

Repairing aged and deteriorated sewer infrastructure is an ongoing challenge for municipalities and is often complicated by the fact that sewer pipes are located in crowded and developed areas that have changed significantly since the original design and installation. To tackle this issue, the research team at UBC is collaborating with Metro Vancouver to develop a carbon-neutral, geopolymer coating with biocides (called multi-phase composite coating, MCC) that when applied on sewer infrastructure, will resist bacterial attack, prevent further corrosion and extend the infrastructure's existing service life.

The team continues to explore new applications in 3D printing of the developed material. There is also a new subset of this project which focuses on understanding the influence of graphite in cementitious system by studying its mechanical, durable and anti-bactericidal properties. Results from preliminary data have shown a 68% enhanced resistance against acid attack in case of Calcium Aluminate Cement (CAC) doped with graphite. It is envisaged that the developed coating will not only extend the service life of existing sewers, but also provide a cost-effective alternative lining solution for new infrastructure. The benefits of this project include extending the service life of corroded sewerage assets, achieving carbon neutrality, managing waste, and realizing the potential for commercialization. The development of green MCC materials will enable cost-effective retrofitting of Metro Vancouver's extensive sewer infrastructure while preventing catastrophic collapses.

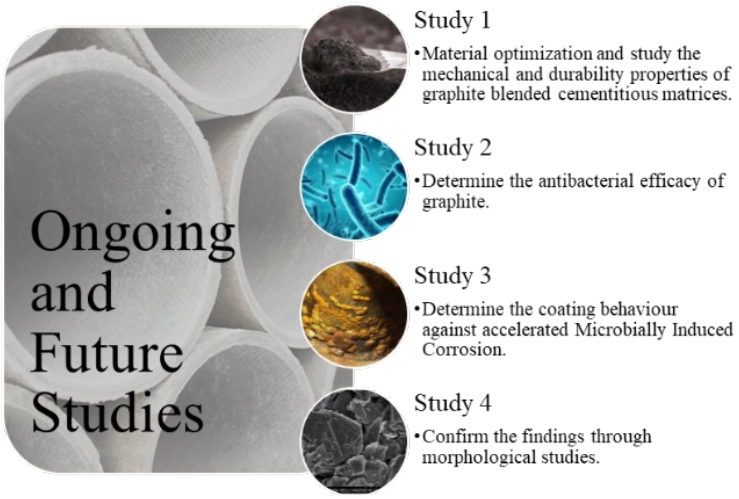


Figure 7: Summary of New Studies Proposed

With more than 25 research publications, the project has resulted in significant milestones over the last year. The work includes two theses, nineteen peer-reviewed articles published in high-impact factor journals and one book chapter. Moreover, additional journal articles have been forwarded for publication, and a review paper is currently in progress. The project has provided ample training opportunities for Highly Qualified Personnel (HQP).

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

B2 - Development of Highly Qualified Personnel

Highly Qualified Personnel (HQP) at IC-IMPACTS are involved in all aspects of our funded projects, from early stages of a project, proposal development, to engagement with stakeholders and commercialization. HQP are exposed to unique training and learning opportunities. Working with both Canadian and Indian researchers, our HQP get to exchange ideas and are trained to broaden their field of knowledge and develop new international connections. Technology development, service delivery, and entrepreneurship are amongst the few things that HQP get to experience while working on IC-IMPACTS projects.

Since 2013, IC-IMPACTS has trained a total of 1,434 HQPs (reported here as HQP-Years). These include graduate students, postdoctoral fellows, research associates and research staff, 34% of whom are female and one individual self-declaring as non-binary. The following charts provide a breakdown of our HQP gender distribution. HQP working on bi-lateral projects often have the opportunity to travel to India (or from India to Canada) and experience working with the co-PI, and their team of researchers. An opportunity is also provided for them to use the research infrastructure located outside their own institution, and country.

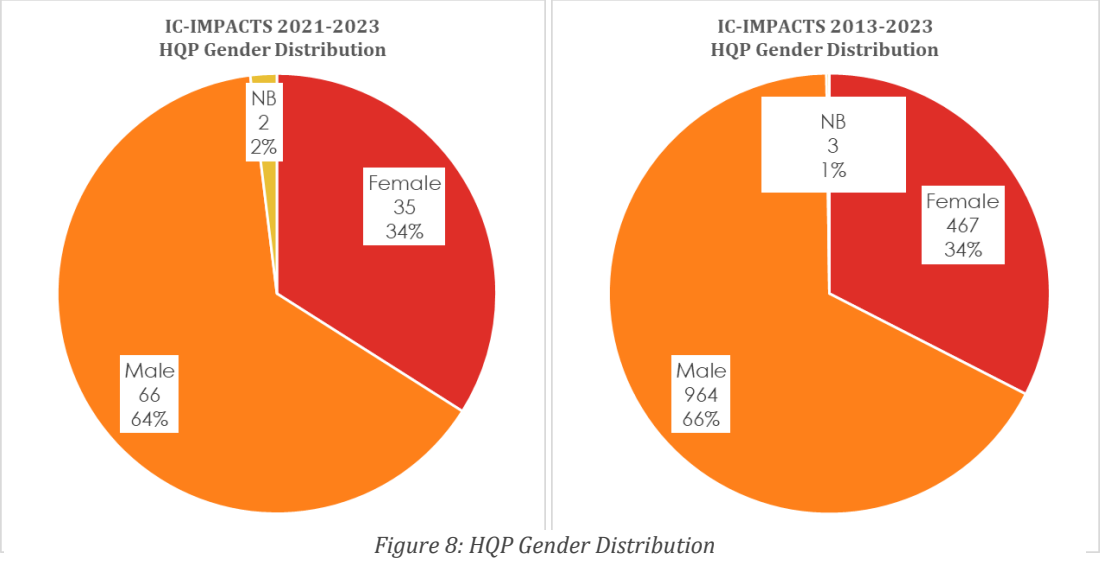


Figure 8: HQP Gender Distribution

In addition to being trained through IC-IMPACTS funded projects, HQP are trained through workshops, cohorts, and special skills sessions such as sessions on scientific communication.

IC-IMPACTS' community-based projects provide unique opportunities for HQP to directly transfer technology from labs to markets. In doing so, HQP working with community members become extremely experienced on finding the right solutions to challenges faced by those communities and, in turn, are also able to receive feedback from the end-users. IC-IMPACTS remains committed to training the next generation of leaders for a fast-changing future. In addition to what HQP gain through

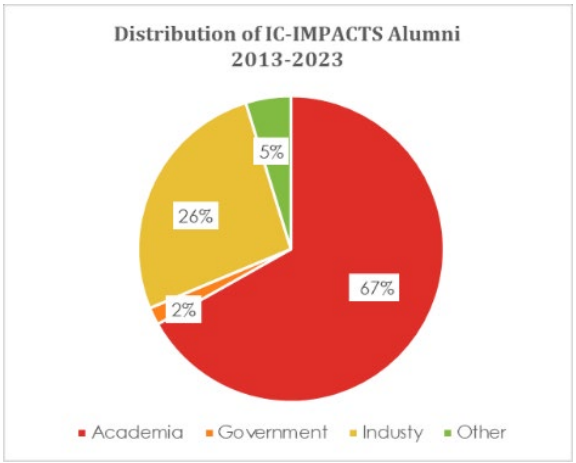


Figure 9: Alumni Employment Fields Distribution

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

involvement in research projects, IC-IMPACTS' diverse programs provide further opportunities for our HQP to learn through volunteering. Skills are strengthened as HQP participate in diverse events and build connections. They also get a chance to network with industry leaders and strengthen various critical competencies. We are proud to report that 97% percent of our graduates are employed in either academic, industry, or government bodies.

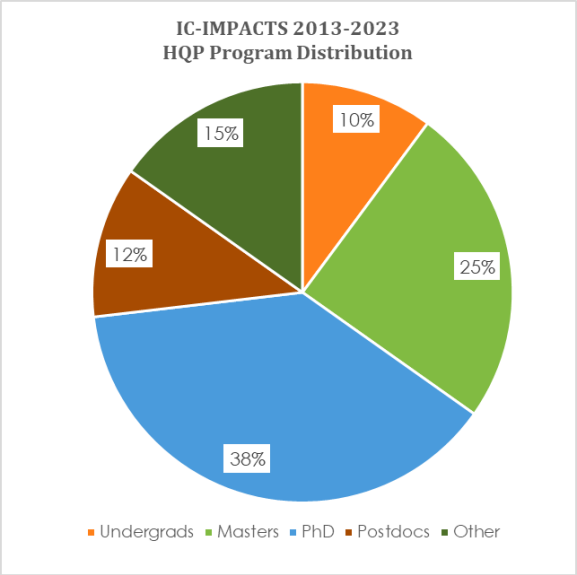


Figure 11: HQP by Program Distribution

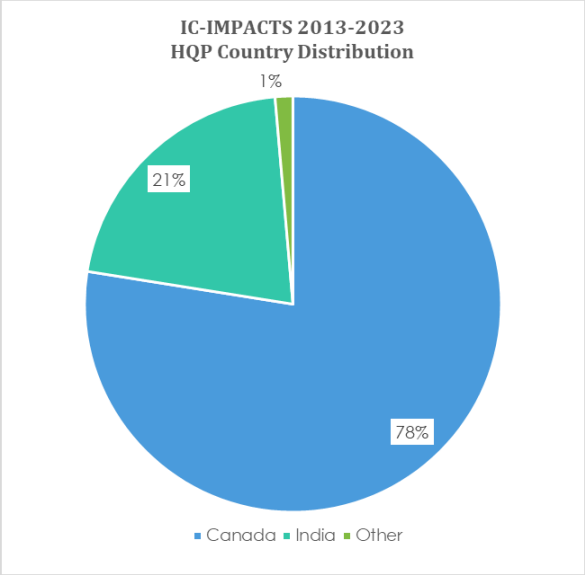


Figure 11: HQP by Country Distribution

IC-IMPACTS HQP launched 8 start-ups with multiple employment opportunities in Canada and India:

1. Raah Health & Social Development Foundation, Delhi, India
2. INpact, Ontario, Canada
3. Buyuanxiar Inc., Ontario, Canada
4. Mithra Sustainable Solutions, British Columbia, Canada
5. Boost Environmental Systems Inc., British Columbia, Canada
6. HRG Infrastructure, British Columbia, Canada
7. ChipCare, Ontario, Canada
8. Tricca Technologies Inc., Alberta, Canada

IC-IMPACTS Student Engagement Committee (SEC) hosted the following programs:

- Securing Canadian Federal Scholarships Special Session at McGill University – March 30, 2022
- Workshop on Sensors for Scour Monitoring with Tata Consulting Services at UBC – July 15, 2022
- Water Think Tank Conference at Laval University – May 1-2, 2023

IC-IMPACTS hosted the seventh annual Pradeep Khare Memorial Scholarship (PKMS) in honor of Board Member, Pradeep Khare. The Scholarship was established in 2016 by Pradeep's family. It is awarded in memory of Pradeep, an immigrant to Canada in 1972, who worked hard to establish a fulfilling life in Canada, give back to the community, and move up to senior positions within the Canadian government. The award is presented to Indian students studying in Canada, who

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

demonstrate leadership, drive, self-reflection, academic excellence, and a desire to use their privileged education in order to give back to the community. The 2023 PKMS Awards Ceremony was held on February 5, 2023. The ceremony was held on Zoom with all scholarship recipients attending online.

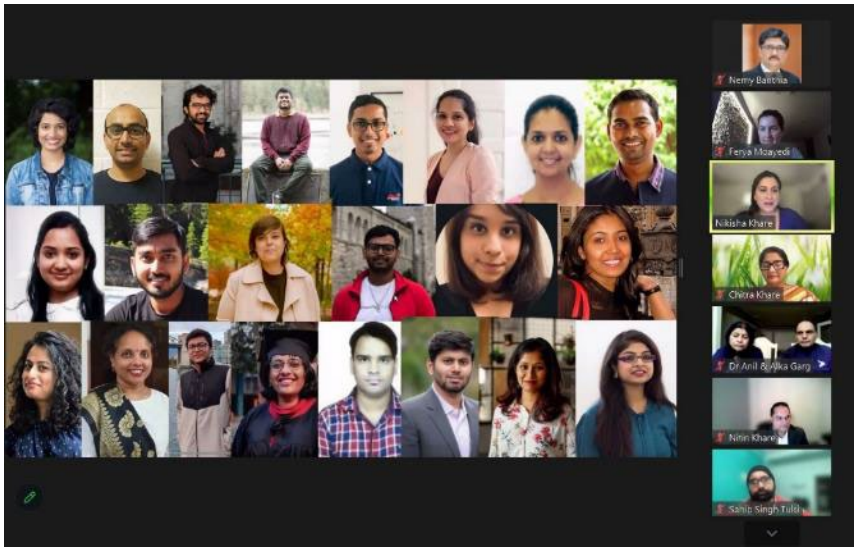


Figure 12: Past and Current Winner of PKMS Awards

B3 - Networking and Partnerships

During the year, IC-IMPACTS continued to work with a network of innovative researchers, industry leaders, community members and government officials to develop unique solutions for the challenges faced by communities in Canada and India. IC-IMPACTS' collaborations with the Department of Science and Technology (DST) and the Department of Biotechnology (DBT) continue to grow with a renewed focus on demonstrating technologies in communities. With 11 Indian Institutes of Technology (IITs) collaborating with IC-IMPACTS, we are recognized as the Canadian Center for Science and Technology collaborations with India.

Figure 13: Dr. Mona Nemer and Dr. Nemy Banthia at the 7th JSTCC Meeting

Figure 14: Signing of the MoU between NSERC, DST and DBT

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

IC-IMPACTS was a key participant of the 7th Canada-India Joint Science Technology Cooperation Committee (JSTCC) Meeting which took place in Ottawa on May 19, 2022. We are pleased to inform that a Memorandum of Understanding between NSERC, DST and DBT was signed shortly before the commencement of the 7th JSTCC meeting, on May 17, 2022, in Vancouver.

With the MoU signed, IC-IMPACTS, DST and DBT launched a joint Calls for Proposals in the areas of:

(i) Agritech and Food Security (IC-IMPACTS and DBT)
(ii) Carbon Reduction in Our Built Environment (IC-IMPACTS and DST):
(iii) Water (IC-IMPACTS and DST):
(iv) Health, Post COVID Health Issues and Long COVID (IC-IMPACTS and DBT):

Figure 15: Launch of Call for Proposals with DST and DBT

B4 - Knowledge and Technology Exchange and Exploitation

IC-IMPACTS' researchers continued to be very productive in dissemination of knowledge and produced a vast amount of work, including 130 publications in the 2022-23 fiscal year, bringing the total number of scholarly publications to 1,561.

Through his research, Dr. Sreekanta Das, (University of Windsor, project titled: *Metawall: Metamaterial Based Lightweight Panel Wall for Enhanced Building Acoustic and Seismic Resistance)* is providing a pathway to design a novel panel wall using metamaterials, having negative engineering properties, for both the acoustic and seismic purposes. New analytical, computational and experimental framework are being developed to realize this paradigm shift where the theories of standard panel wall need to be extended for the frequency dependent laminated sandwich with metamaterial or honeycomb core. This research is expected to develop a new research area on several aspects of acoustic and seismic insulation using metamaterial composite. The pathway originating from this work will provide a breakthrough in the field of seismic and acoustic attenuation which will instill essential confidence for a quantum leap from scientific curiosity to the design of a real metamaterial-based panel wall.

Dr. Tony Yang (University of British Columbia, project titled: *High-Performance Connections for a Tall Indigenous Timber Sculpture*) is leading one of IC-IMPACTS demonstration projects, encouraging the transfer of existing research and technology to communities. The HQP involved have been working hard to raise awareness for preserving Indigenous arts, culture and heritage. In this project, five 20-foot-long timber segments will be connected to form a 100-foot-tall timber sculpture. The project is part

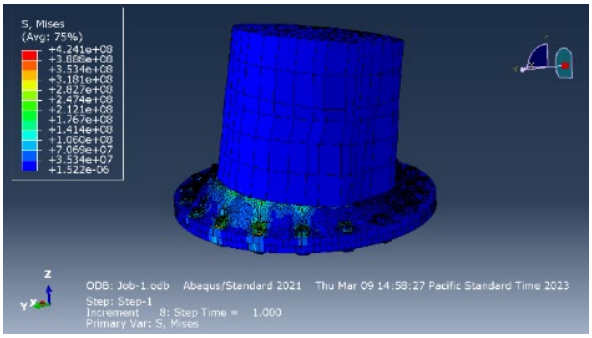


Figure 16: Steel Plate Design for the Sculpture

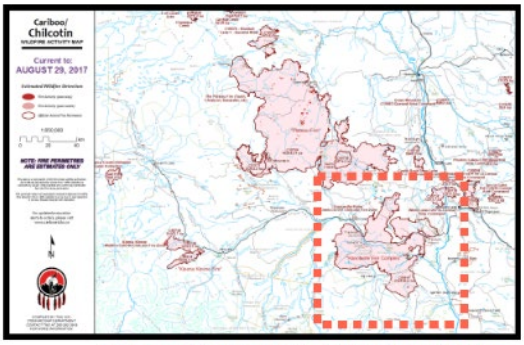
Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

of the Indigenous Medicine Wheel Puzzle Project, with IC-IMPACTS researchers assisting in the fabrication of structural engineering components. This project will soon demonstrate the scalability of the innovative structural technologies in the Canadian and Indian marketplace.

Figure 17: Dr. Tony Yang and Dr. Nemy Banthia Examining the Material Being Used to Build the Sculpture

Dr. John Bass' "Wildfire House Prototype" is a great example of how IC-IMPACTS researchers are working hand-in-hand with Indigenous communities to design a high-performance, durable, and resilient house prototype. Locally sourced and produced material will be used in the construction of the prototype.

Much of the early work focused on technical development and energy performance of the housing assemblies. The first explorations of the wall and roof assemblies were based on leveraging Yunesit'in's existing capacity by using its two wood milling facilities.



Cariboo / Chilcotin Wildfire Activity Map,
TNG Stewardship Dept., Aug 29, 2017

More recently, the research team developed a hybrid system with hempcrete block walls and a wood framed roof for the house. This decision stems from an interest among the Tsilhqot'in to produce construction-grade hemp, a regenerative, carbon-sequestering material.

B5 - Management of the Network

IC-IMPACTS Board of Directors is responsible for the overall strategic direction of the Centre towards its objectives, milestones, and deliverables and maintains its three sub-committees which meet on regular basis; (1) Executive Committee, (2) Nominations and Governance Committee, (3) Finance Committee, and the newly structured (4) Equity, Diversity, and Inclusion Committee. The Executive Committee provides critical support between Board meetings and formulates agendas and key policies for Board approval. The Nominations and Governance Committee is responsible for Board nominations, governance, government relations and relations with the Host Institution. The Finance Committee oversees financial aspects and recommends audited statements to the Board members.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

The EDI Committee provides an overview of the role that Equity, Diversity, and Inclusion plays within the network. It also supports efforts to advance inclusion and is responsible for policy reviews and revisions. The Board of Directors met three times during 2022-23 to ensure that acts, bylaws, funding and international agreements are adhered to. In addition, during the Board meetings, there were open dialogues and discussions about the benefits of having a more diverse Board as well as how to adopt policies relating to a balanced representation.

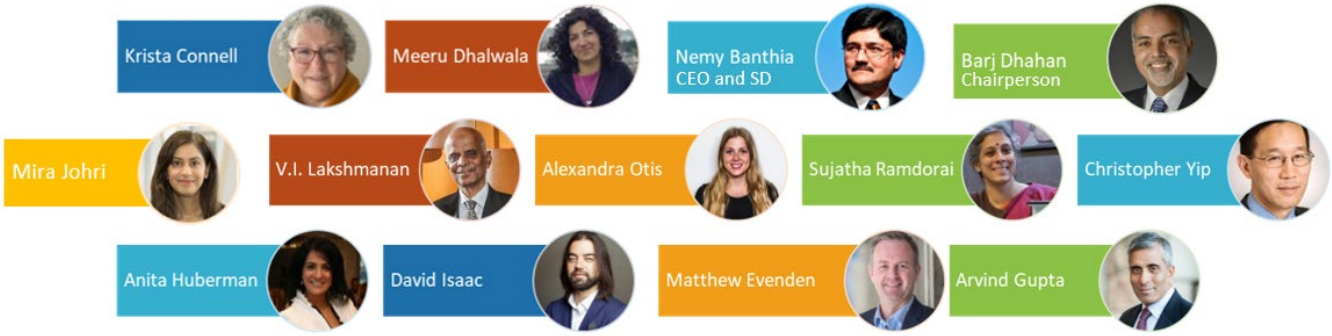


Figure 18: IC-IMPACTS Board of Directors

For more information and bios of Board Members, please visit our website: www.IC-IMPACTS.com

IC-IMPACTS Research Management Committee (RMC) is comprised of a regionally diverse, inspiring group of researchers who are top world experts in a variety of disciplines. IC-IMPACTS is fortunate to have the dedication and continued support of such highly skilled professionals who help build connections between Canada and India. In the past year, the RMC was extremely active and continued to advise the Board of the research direction of the network.

SECTION C: TRENDS AND JUSTIFICATIONS

Feedback from NCE Monitoring Committee on Previous Annual Report

IC-IMPACTS is grateful for being granted a second extended term with NCE, now ending March 2025. In spite of setbacks faced through 2020 to 2022, due to COVID-19, we are excited to continue our mandate with renewed enthusiasm in the post-COVID era.

The Monitoring Committee was pleased to see IC-IMPACTS continuing progress and achievements as well as its nimbleness in tackling pandemic-related challenges. The Committee noted with interest the increase in regional diversity that has been achieved through the addition of new members to the Board of Directors. The Monitoring Committee showed interest in seeing plans for IC-IMPACTS legacy beyond the NCE funding period. We are pleased to share that in September 2022, IC-IMPACTS submitted a comprehensive proposal to the Strategic Science Fund (SSF). In addition, the RMC drafted the Terms of Reference for a new join Call for Proposals with DST and DBT which was launched in the second quarter of 2022. The Monitoring Committee members indicated interested to learn particularly the plans for continued involvement of Indigenous communities. As IC-IMPACTS continues to improve and expand on our collaborative initiatives with Indigenous communities in Canada, we partnered up with a team of experts at UBC and are working towards submitting an application to the CMHC Housing Supply Challenge, which is funding up to $80M and looking for solutions to improve Canada's housing supply chain in northern and remote regions. Other feedback received from NCE Monitoring Committee on IC-IMPACTS 2021-22 annual report were very constructive. The Committee concluded that IC-IMPACTS appears to have been as productive as expected.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

The Board continues to implement key strategies to embed diversity in the governance of the Centre. Board members were tasked to explore opportunities for expanding the Board of Directors, with regional diversity and EDI principles as priorities. IC-IMPACTS is pleased to inform the appointment of one new Board member, regionally diverse, who has varied expertise and exceptional track record and will certainly strengthen leadership and bring additional insight to our work. Moreover, IC-IMPACTS continues to participate in Canada's 50-30 Challenge as a means to ensure and improve equity and diversity. We look forward to another productive year ahead and to continue exploring and implementing innovative solutions to the challenges faced by communities in Canada and in India and to enhance community transformation and sustainability.

Actual Versus Expected NCE Grant Expenditures

Over the fiscal year, without additional NCE grant, IC-IMPACTS continued to follow its prudent financial policies, keeping its overall percentage of expenditures for administration operations below 15% and its active disbursement of research funding to academic institutions in Canada at 56%.

IC-IMPACTS knowledge transfer (including research networking, technology transfer, and communications expenses) was at approximately 9% of the NCE funding.

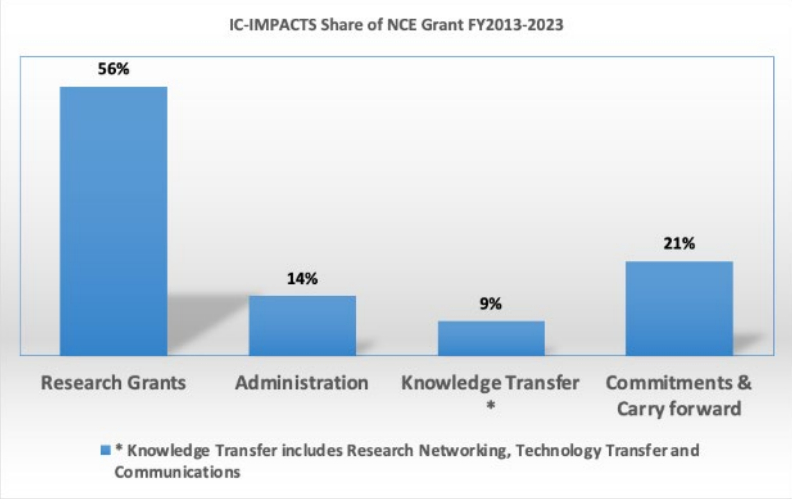


Figure 19: Distribution of NCE Funds

SECTION D: NETWORK-LEVEL PERFORMANCE

IC-IMPACTS' bilateral model has proven to be very successful since its inception in 2013, and has consistently exceeded its established targets.

Progress on Goals and Objectives Defined in Last Year's Annual Report

IC-IMPACTS made great progress on the goals and objectives identified in the 2021-2022 NCE Annual Progress Report. The following list highlights some of these achievements:

1. **Continue developing a multidisciplinary and cutting-edge research program, capable of delivering solutions towards community problems in Canada and India:**
   The research program had two calls for proposals in the past year and saw the addition of 2 new projects under the new theme (Agritech and Food Security).

2. **Further strengthening engagement with Indigenous communities:**
   We continue to fund multiple projects directly related to the housing challenges faced in First Nation communities. In addition, in order to initiate new community demonstration projects, IC-IMPACTS engages with multiple Indigenous communities and has recently signed an MoU with one target community (West Moberly First Nation) for a technology deployment.

3. **Supporting and training HQP in activities that are innovative and entrepreneurial:**

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com

IC-IMPACTS continued to participate in Canada-India start-up cohorts, training and advising students on their entrepreneurial activities. In addition, throughout 2022-23, IC-IMPACTS hosted HQP-led conferences and workshops on the topics of Water Management.

4. **Ensuring sustainability beyond March 2024:**
   India has expressed very strong support for the IC-IMPACTS program beyond 2024. Both the Department of Biotechnology and the Department of Science and Technology continue to collaborate with IC-IMPACTS on projects on a dollar-for-dollar basis. In the meantime, IC-IMPACTS worked towards the submission of two major proposals: (i) the Strategic Science Fund Program and (ii) Housing Supply Challenge. DST and DBT have informed us of their strong support of both proposals.

5. **Prioritizing equity, diversity and inclusion:**
   Principles of EDI remain a top priority for IC-IMPACTS. Incorporating diverse voices on the Board and its Committees, as well as at the executive level is what empowers IC-IMPACTS as a successful and forward-thinking Centre. The Board continues to work towards having a gender balanced and regionally diverse membership.

Commitment to the Principles of Equity, Diversity and Inclusion

IC-IMPACTS respects, honours, and celebrates the diversity in our network and as an international Research Centre, IC-IMPACTS is fully aware of the benefits brought on by having a diverse team. We remain committed to fostering and maintaining an inclusive environment that brings together diverse perspectives from our HQP, researchers, partners, and members of the community.

Sheetal Rimal worked on IC-IMPACTS project throughout her PhD studies at Laval University. She continued to stay in involved with IC-IMPACTS student programs during her maternity leave.

Sheetal was one of the recipients of the IC-IMPACTS HQP Leadership Awards which helped her organize the International Water Think Tank Conference in Quebec. She recently graduated and published her thesis titled "*Hydrophytoremediation by Wetland Macrophytes and its Docial Acceptability*"

Figure 20: Sheetal Rimal Presenting a Poster at IC-IMPACTS Research Conference in Vancouver

Throughout the past year, we have continued to develop and promote equity, diversity, and inclusion initiatives in our programs. Our HQP network has surpassed the 33% female ratio this year (currently at 34%) which we see as a small but notable achievement. Our Board of Directors is currently at 46% female ratio and our Administration Office is currently at 66% female ratio.

Unit 305, TEF3
6190 Agronomy Rd., University of British Columbia
Vancouver BC V6T 1Z3
Phone: 604.822.3013
www.ic-impacts.com