Grand Challenges India

Our Journey So Far

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Ignite Innovate Incubate

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science and Technology

BILL & MELINDA GATES foundation

wellcome

Program **M**anagement **U**nit at **BIRAC**

A partnership of the Department of Biotechnology, Govt. of India, the Bill & Melinda Gates Foundation and Wellcome

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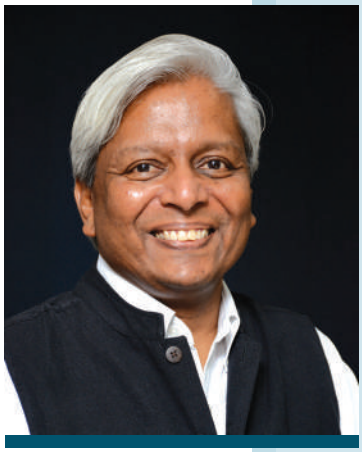


FOREWORD

PROFESSOR K. VIJAYRAGHAVAN
Secretary, Department of Biotechnology, Government of India & Chairman, Biotechnology Industry Research Assistance Council (BIRAC)

The Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India, is proud to be the Indian partner to Grand Challenges India (GCI), with the Bill & Melinda Gates Foundation and managed by the Program Management Unit at BIRAC.

This partnership aims to encourage Indian innovation to solve challenges that the Indian population is facing today; with the idea that these innovative solutions could also impact the lives' of people beyond our country's borders. The mandate of Grand Challenges India resonates with that of the DBT, which encourages innovation in the space of biotechnology within the country to ensure that we achieve social justice and improve the lives' of the poorest among us.

GCI is an unique partnership and opportunity for two organizations united by their common goals to address some of the greatest challenges that India faces, such as maternal and child mortality, malnourishment and sanitation.

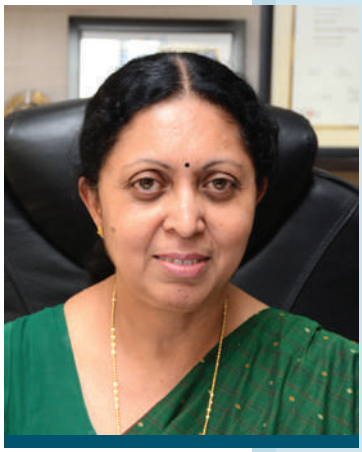
The other programs supported by this partnership are the Healthy Birth Growth and Development *knowledge initiative* India (HBGD*ki* India) and the Knowledge Integration and Translational Platform (KnIT). HBGD*ki* India focuses on collection, compilation and analysis of

publicly available data and cohorts from the country, which contain data on childbirth, growth and development. KnIT focuses on analyzing studies and research from different sources and share it with state policymakers to enable them to assess available evidence at hand to develop policies for better nutrition and mother and child health. These programs will hopefully be a start in seeking a change that will allow us to translate lessons from scientific studies into implementable and efficient policies so as to serve our country's needs.

I am also pleased that the Wellcome Trust has joined Program Management Unit at BIRAC (PMU-BIRAC) who will be managing the Affordable Healthcare in India program. This partnership provides a translational research thrust into the programs managed by Program Management Unit at BIRAC.

I would like to congratulate BIRAC, the Bill & Melinda Gates Foundation, our partners as well as the Program Management Unit at BIRAC for their work in making Grand Challenges India a success and I wish our partners all the best in ensuring that this program continues its important work.

Prof. VijayRaghavan



PREFACE

DR. RENU SWARUP
Senior Adviser, Department of Biotechnology, Government of India and Managing Director, BIRAC

The Department of Biotechnology and the Bill & Melinda Gates Foundation, came together with a united vision and recognizing the role that collaborative efforts would have in future, and began the Grand Challenges India under a joint partnership. To manage this umbrella program, a Program Management Unit was established at BIRAC, with a very unique governance structure and modalities to implement a series of individually defined and approved initiatives.

BIRAC is proud to host this Unit for this important partnership.

The mandate of BIRAC itself and that of the PMU-BIRAC is broadly similar, as both aim to develop the potential Indian innovation and research thereby encouraging Indian-led solutions to many of the challenges that people face across the world in the areas of health and development. BIRAC runs a host of unique programs that are aimed at creating synergies between Indian academia, government and industry to support small and medium enterprises in the biotechnology industry, to enable this crucial industry to reach its full potential. BIRAC also runs SPARSH, a scheme that invests in ideas and innovations to improve healthcare in the country and supports affordable product development for the social sectors.

Since its inception, PMU-BIRAC has been instrumental in managing the jointly funded programs under Grand Challenges India as well as the individually funded programs of the partners. PMU-BIRAC has amplified its activities strategically focusing on fueling the innovation pipeline to develop pioneering solutions to our most pressing social problems.

We are also pleased that the Wellcome Trust has partnered the PMU-BIRAC, and provide support for the Trust-funded Affordable Healthcare in India program and future calls in this space.

We wish all our partners great success in taking Grand Challenges India, HBGD*ki*, KnIT and GCE-India forward and look forward to new opportunities and partnerships that will help this unique collaborative effort in scaling greater heights.

Dr. Renu Swarup

MESSAGE

DR. M. K. BHAN
Chairman, Scientific Advisory Committee
Grand Challenges India

Grand Challenges India (GCI) was borne out of the realization that, today, despite the immense progress we have made in improving the health of our population we still have large ground to cover, most especially for our children.

GCI was envisaged as a partnership, between the Government of India and the Bill & Melinda Gates Foundation, that aimed at leveraging the expertise and resources of both organizations in the most efficient and productive way possible to encourage Indian innovation, to solve the key health and development challenges that India faces, and then take these solutions to the rest of the world. GCI seeks to address as yet unanswered questions and provide opportunities for research and solutions to myriad health concerns that affect both human and animal lives.

Using challenges to encourage innovative thinking, Grand Challenges in Global Health, the international initiative, and its Indian arm, Grand Challenges India, work to create a host of ideas and translate these ideas into practical solutions that have a positive impact on the health and development of the people that need them the most. GCI, like its parent initiative, focuses on encouraging innovation to develop a host of solutions rather than find the perfect answer, as both partners believe that in India, with its diverse population and geography, finding the 'perfect answer' is neither possible nor is it practical.

Today GCI is encouraging innovation and research in the areas of maternal and child health, sanitation, agriculture and nutrition as well supporting an unique knowledge sharing platform, the Healthy Birth, Growth and Development knowledge initiative India (HBGD*ki* India) and the Knowledge Integration and Translational Platform (KnIT). These programs not only encourage traditional R&D and translational research but also encourage the sharing of knowledge within the country and abroad to understand where we are, how we got here and what we need to do to get to our goal of improving the lives of those around us.

GCI has achieved much in its short life; nevertheless we know that we have a long way to go. We need thousands of young minds to partner in innovation. Therefore, I congratulate and wish the GCI team, our funded researchers, our partners; the Department of Biotechnology, BIRAC and the Bill & Melinda Gates Foundation success in taking this unique effort forward to achieve the potential that it is meant to and to make a difference in the lives of people, not just in India but around the world.

Dr. M. K. Bhan

MESSAGE

CHRIS KARP, M.D.
Director, Global Health Discovery & Translational Sciences
Bill & Melinda Gates Foundation

I am very pleased to be part of the fifth BIRAC Foundation day and in particular the celebration of Grand Challenges India. I have been at the Gates Foundation for over five years, but recently I have taken on a new role as the Director of the Discovery & Translational Sciences team. In this new role I have had a chance to learn more deeply about our work and partnership in India and I am committed to the goals of Grand Challenges India - to continue to explore ways to tap into the vast potential of Indian innovators and scientists, to solve not only challenges in India, but more broadly contribute to health and development solutions around the world. The Grand Challenges India partnership we have developed with the Department of Biotechnology (DBT), with Biotechnology Industry Research Assistance Council (BIRAC) and now with the Wellcome Trust has made important progress and holds great promise for the future.

Grand Challenges India supports an increasingly broad range of initiatives, from an India-specific GCE program executed by IKP Knowledge Park, to the Wellcome – DBT Affordable Healthcare Initiative, to three separate Grand Challenges. I am particularly excited with regard to the evolution of one of these initiatives, both for the promise it has to achieve impact and as a model for future Grand Challenge India work. As part of the 2014 Grand Challenge meeting in Seattle we launched with India, Brazil and South Africa a new All Children Thriving Grand Challenge linked to our Healthy Birth, Growth & Development (HBGD) work. The India challenge was funded jointly the Gates Foundation, India's Department of Biotechnology and USAID,

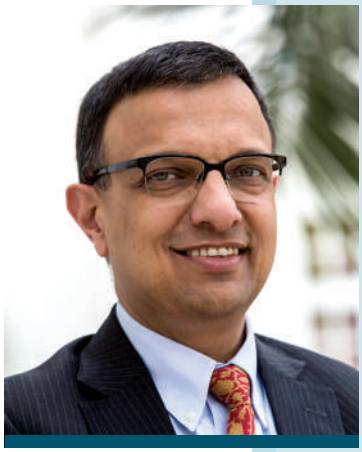
and was focused on new measurement tools and new combinations of interventions to ensure that all children not only survive but also are on a trajectory to live a healthy productive life. The ACT India initiative funded 6 seed grants and one multi-intervention evaluation grant. As part of Grand Challenge India's leadership role here, the team is working to integrate the India projects with the global network of projects.

In a 2nd element, the Grand Challenges India team is leading the creation of an HBGD Knowledge Initiative (HBGDki) data consortium under India Gov't sponsorship to facilitate India investigator integration with the global HBGDki collaboration. Specifically, the India HBGDki will provide technical assistance and supplemental funding to India PIs to facilitate collaborations to permit greater data sharing, and collaborations to ensure that leading projects and studies in India have the opportunity to participate in global data modeling and knowledge collaborations.

And in the 3rd element, the Grand Challenge India team is sponsoring a Knowledge Integration and Transfer (KnIT) initiative. The KnIT funding will facilitate the uptake of new evidence by India state level public health intervention programs particularly focused on child development. To this end KnIT will take the best knowledge available, published literature, new results emerging from research programs like the Grand Challenge India grants or conclusions developed as part the HBGDki data work and rapidly translate them into action. Then, by monitoring the actual effectiveness of these interventions, further refine research questions for which we need answers.

It is with these three elements – a global network of research projects on interventions of which the India All Children Thriving Grand Challenge is a part, a global partnership to optimize sharing and understanding knowledge derived from the data such as the India HBGDki, and an India specific policy and implementation unit that I see the emergence of a fully integrated program to accelerate research to impact – and this is what I am really excited to see, both for the impact I hope we will realize and for the model for future Grand Challenge India work.

Chris Karp, M.D.



MESSAGE

NACHIKET MOR, PhD
Country Director,
India Office
Bill & Melinda Gates Foundation

The India Country office of the Bill & Melinda Gates Foundation is pleased to partner with the Department of Biotechnology, Ministry of Science and Technology, Government of India, on the Grand Challenges India (GCI) programs, managed by the Program Management Unit at BIRAC.

We believe that innovation and new ways of thinking are critical to solving the significant and multiple challenges of infant and maternal mortality, healthy growth, nutrition, agriculture and sanitation in our country. The GCI provides a unique opportunity for the Foundation to collaborate with the Government, and other partners around the country, and the world, to find new solutions to old, complex problems, as well as for emerging new challenges.

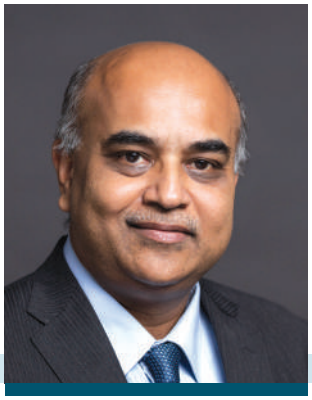
The Foundation's approach in India has been focused on being a supportive partner to the Government, while also working closely with development partners, public and private sector organizations, and the community at large, with the aim to improving the delivery of products and services to less privileged populations. However, we recognize that while improving delivery is important, it is equally imperative to work closely with the Government to catalyze the development of new products and systems that can be effectively and efficiently used in our low resource settings. Examples of such innovation include what emerged from one of the first calls for proposals

focused on creating an affordable next-generation toilet that could capture and process human waste without the need for piped water, a sewer connection, or electricity. Some of thenew toilet designs could potentially change the face of sanitation by integrating fecal sludge management– these are currently undergoing testing in the field. Another example is the creation of a public good in bringing to the fore the best tools to model, infer and visualize from Big Data – the Healthy Birth Growth and Development knowledge initiative (HBGD*ki*) India that can provide insights into big picture questions such as 'what makes a healthy child at the age of 2'? Large datasets allow us to query longitudinal relationships from pre-conception to the age of 2, and help understand the factors that drive healthy birth and growth. Analysis of such data allows us to understand what interventions can be studied to increase the positive impact on children and mothers. We look forward to the March 2017 GCI meeting and accompanying exciting HBGD*ki* discussions to make significant progress in our understanding.

Besides inventing new products or new ways of analysis, we must also act to find ways to translate existing evidence to policy and implementation. The KnIT platform provides an excellent opportunity for key stakeholders to study the available evidence (both local and global) to recommend ideas to our policy makers. We are proud to be partners to the KnIT platform.

Finally, I congratulate BIRAC, our partners as well as the Program Management Unit at BIRAC and wish the Grand Challenges India a wonderful success.

Nachiket Mor, PhD



EXECUTIVE SUMMARY

DR. SHIRSHENDU MUKHERJEE
Mission Director,
Program Management Unit at BIRAC

It gives us immense pleasure to introduce you to the work that Grand Challenges India (GCI) has undertaken in the country since its inception in 2012.

The Program Management Unit at BIRAC (PMU-BIRAC) was created to manage GCI, on behalf of the partners, the Government of India, through the Department of Biotechnology and the Bill & Melinda Gates Foundation. This unit provides technical, financial, administrative support to the programs and projects that are funded under this partnership as well as directly funded programs by the partners. Our unit is also supported by United States Agency for International Development (USAID) for projects related to nutrition within the ambit of GCI.

PMU-BIRAC is unique in that it brings together global funders with Indian stakeholders on to a common platform, with the aim of not only leveraging funding from these bodies to address some of the greatest challenges we face today, but to also promote best practices and share knowledge among partners by bringing in international expertise into the country. PMU-BIRAC works to encourage Indian innovation to address Indian problems, in line with the mandates of the partners.

Today, the PMU-BIRAC manages Grand Challenges India, Healthy Birth, Growth and Development *knowledge initiative* India (HBGD*ki*- India), and the Knowledge Integration and Translational Platform (KnIT), with other programs in the pipeline. These programs fall within the broader themes of addressing challenges in maternal & child health, sanitation & hygiene and nutrition through agricultural interventions in India among others.

GCI has three on-going calls; Achieving Healthy Growth through Agriculture and Nutrition, Reinvent the Toilet Challenge and All Children Thriving, launched between 2013 and 2015, to address three of the greatest problems that the country faces in the areas of public health and development; malnutrition, mother and child health and sanitation. Grand Challenges Explorations- India (GCE-India), also under GCI, is a fast-track funding program aimed at anyone who has an idea, but lacks sufficient funding to generate preliminary data or validation needed to apply for larger and more advanced funding.

HBGDki India and KnIT are two unique knowledge sharing initiatives that aim to change the way we gather, collate and analyze data in order to provide policymakers and academicians with real time and validated evidence to base policies on.

HBGDki India focuses on collating and analyzing publicly available data from Indian cohorts, on preterm birth, impaired neuro-cognitive development and growth faltering. Analyses of this data will play a crucial role in allowing scientists, statisticians and policymakers to identify trends in these areas to design interventions to manage these. KnIT, is also a unique initiative, specifically designed for India that aims to bridge the gap between scientists, academicians and policymakers. The platform is aimed at synthesizing and collating evidence regarding interventions and trends in maternal and child health and nutrition from India, to identify gaps as well as to enable evidence based policy development and implementation.

In 2016, the Wellcome Trust entered into a partnership with PMU-BIRAC where we provide support in managing the Trust funded Affordable Healthcare in India portfolio of projects which aim to encourage Indian-led research to develop and test a host of medical and healthcare interventions that are affordable and accessible to those that need it.

In the following pages, we take you through the work that the GCI partnership has undertaken in India since its inception, showcasing the stories behind some of the most interesting and innovative projects from our programs.

Dr. Shirshendu Mukherjee

The birth of the partnership

India has come a long way in addressing some of the public health and development challenges that its large, culturally and geographically diverse population faces. Over the last half century, the country has made slow but steady progress in addressing many aspects of public health, such as reducing maternal and child mortality rates, improving nutrition indices, and increasing rates of immunization against vaccine preventable diseases, among many others. Indian science and innovation has also come a long way, with a concerted push from national bodies to create an environment that is conducive for research and development to encourage us to find solutions to the problems that we and our fellow countrymen still face.

However, we still have a long way to go. With the changing nature of the disease burden that the country faces such as the disproportionate growth of the population against available infrastructure, and social, cultural and economic challenges that are proving barriers to attaining equitable health and access to healthcare services, we need to provide a concerted thrust to encourage further innovation to address these challenges and many more.

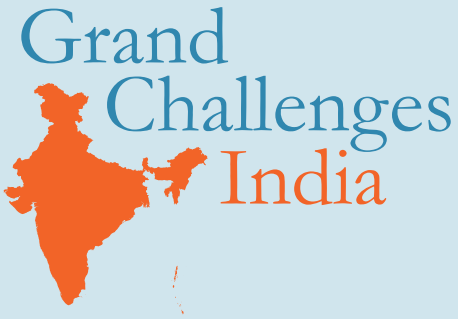
Recognizing this, in 2012, the Department of Biotechnology, Government of India, and the Bill & Melinda Gates Foundation, united by their common goal of addressing some of the most critical global health and development issues, came together

and signed a Memorandum of Understanding (MoU). Both partners agreed to collaborate on scientific and technological research for the benefit of the people of India and the rest of the world.

The partnership seeks to identify opportunities to initiate and promote scientific and technological research in the country and provide India-specific solutions, which can then be adapted for use in other developing countries. The partnership focuses on encouraging research and exploring avenues to reduce maternal and child mortality and morbidity; developing scientific and technical solutions for infectious diseases; strengthening India's scientific translation capacity; developing scientific and technical advances related to agriculture, food and nutrition, sanitation and hygiene among others.

The Biotechnology Industry Research Assistance Council, a Public Sector Enterprise set up by the Department of Biotechnology (BIRAC) in New Delhi, houses the Program Management Unit (PMU-BIRAC) that has been set up to implement the programs under this partnership.

The flagship program of this partnership is **Grand Challenges India (GCI)**, which has now been joined by a group of programs that are funded either individually or jointly by the partners. GCI includes thematic calls as well as Grand Challenges Explorations-India (GCE-India. PMU-BIRAC also manages two unique knowledge sharing platforms, the Healthy Birth, Growth, and Development knowledge integration (HBGD*ki*) platform, and the Knowledge Integration and Translational Platform (KnIT) that are individually funded by the partners. ■



Grand Challenges India

Grand Challenges India (GCI) is the Indian arm of Global Grand Challenges, launched in 2012 and is the flagship program managed by the PMU at BIRAC for the Department of Biotechnology and the Bill & Melinda Gates Foundation partnership.

The journey of GCI began with the inception of Global Grand Challenges, originally as Grand Challenges in Global Health in 2003. Grand Challenges use 'challenges' to bring attention to and focus on encouraging innovation to address or solve specific problems.

Inspired by mathematician David Hilbert in 1900, who listed 23 unanswered questions in mathematics that drove thinking and research in the field for decades, the Bill & Melinda Gates Foundation decided to use the same principle to bring attention to a host of problems and questions, particularly those relevant to the developing world.

Grand Challenges initially focused on 14 major scientific challenges that, if solved, could lead to improving the health of people in the developing world.

These Grand Challenges originally focused on the field of global health, and have now expanded to include pressing issues in global development. Till date, Grand Challenges has awarded over 2000 grants across 87 countries funded through the Bill & Melinda Gates Foundation as well as other funders, both independently and in partnership.

GCI was launched with the aim of directing funding and research to address some of the most daunting health and development challenges we face today. It does this by fostering Indian-led innovation to develop affordable and sustainable solutions to these challenges, both in the country and across the globe.

The ambit of GCI is intentionally diverse in an effort to include a wide range of research areas that have direct or indirect impacts on public health and development, in order to maximize benefits. GCI also funds projects at various stages in their lifecycle; from basic science research in laboratories, to proof-of-concept projects and potentially to scale-up to innovation projects. GCI is also mandated to work across different disciplines, such as maternal and child health, infectious diseases, vaccines, point-of-care diagnostics, agricultural development, food and nutrition, sanitation and hygiene among others.

GCI is committed to seeking and rewarding both established researchers, young entrepreneurs and other innovators, from academia and industry, with the ambition of expanding the pipeline of ideas for developing new preventive and curative therapies, piloting new technologies, and exploring new ideas.

Today, apart from Grand Challenges Explorations- India, GCI has launched three thematic calls across India with the aim of addressing three of the greatest challenges that we in the country face; malnourishment, sanitation and mother and child health (MCH) through the *Achieving Healthy Growth through Agriculture and Nutrition, Reinvent the Toilet Challenge and All Children Thriving* programs.

Achieving Healthy Growth through Agriculture and Nutrition

Agricultural development has been the backbone of the Indian economy for approximately 40 years now, with impressive gains having been made in food productivity and technology since Independence. Despite these advances though, including those in science, medicine, and information technology, over a third of India's children remain malnourished[1], a shocking statistic.

Malnourishment is a widespread and deep-rooted health problem that has long-term impacts on the mother's health and development of the child in utero and subsequently after birth, development and growth. Many malnourished babies are born to adolescent mothers in India; three-fourths of these adolescent mothers in India are anemic and gain an average of five kilograms during pregnancy compared to the worldwide average of closer

Rural Indian women form a large percentage of the agricultural workforce

to ten kilograms[2]. Approximately 30 percent of women in the 15 – 49 years age group was found to have a Body Mass Index (BMI) below 18.5, indicating severe nutritional deficiency and under-nutrition, in the National Family Health Survey, 2014-2015[3]. Malnourished women are less likely to deliver healthy babies, thereby perpetuating the cycle of malnutrition and developmental problems in mothers and their babies.

The role played by poverty, inadequate feeding practices, poor nutritional status, and the low socioeconomic status of women are known to be significant in contributing to malnourishment.

Malnourishment in children, particularly undernourishment, manifests as low birth weight, early stunting and wasting among infants and children below the age of two years. World Health Organization statistics in 2013, showed that India had the largest number of stunted children aged less than five years, nearly 61.7 million[4]. Rates of malnutrition among India's children are almost five times higher than those in China, and twice those in Sub-Saharan Africa[5]. The recently released National Family Health Survey IV 2015-2016 shows that 38 percent of Indian children below the age of five remain stunted, 21 percent below the age of five remain wasted and more than a third of the country's children are underweight.[6]

Traditionally providing nutritional supplementation has been used to treat malnourishment in mothers and children. Lately nutrition programs have been looking at integrating nutrition and agriculture, to promote the development of fortified foods in an effort to address this problem.

While the causes for malnourishment are complex and inter-linked, the role played by poverty, inadequate feeding practices, poor nutritional status, lack of counseling and training and the low socioeconomic status of women are known to be significant in contributing to malnourishment.

With the goal of addressing some of these challenges, the GCI partnership announced the first Grand Challenges India call titled *Achieving Healthy Growth through Agriculture and Nutrition*

in August 2013. The overall goal of the program was to target the linkage and relationship between agriculture, nutrition and health. The program is supported by the DBT, Bill & Melinda Gates Foundation and our supporting partner USAID.

The program was launched with the mandate of encouraging innovation and research in the areas of agriculture, nutrition and social empowerment, which would lead to the larger goal of improvement in health of women and children. Proposals for the program were sought in the areas of agricultural innovation, where the thrust was to develop interventions to improve nutritional and economic outcomes of women farmers; innovations in nutrition, where the focus area was understanding the causes, determinants and developing interventions to address low birth weight, stunting and wasting; and social innovation, where the emphasis was on identifying and designing tools to improve communication around nutrition and agriculture especially among women farmers.

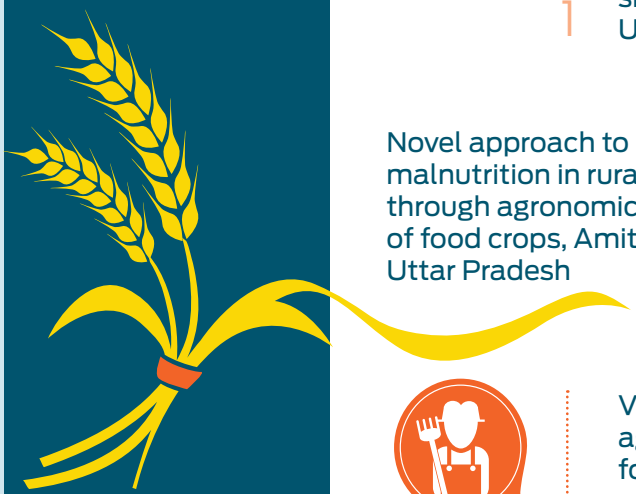
The initiative has funded a portfolio of five Indian-led pilot projects that sought to target this relationship between agriculture, nutrition, and health to reduce the high incidence of low birth weight, early stunting and wasting among Indian infants and aims at empowering women, through interventions, in their multiple family roles. Most of the projects under this call are currently nearing completion.

Four of the five funded projects were in pilot phase and tested a wide range of concepts. 'Designing on-farm participatory models of Integrated Farming System (IFS) for the enhancement of household diet diversity and livelihoods of small-holder women farmers' tested the viability of an alternative farming system on productivity, economic return and women empowerment. The domestic solar conduction dryer project tested a new technology to assess its impact on diet diversity of the participants and economic returns. VeggieLite piloted a supply chain innovation to assess its impact in improving access to fresh vegetables and fruits to supplement nutrition at affordable prices in rural and peri-urban areas. An ICT based pilot project, Digital Education, tested the impact of a combination of ICT and

infographic

FUNDED PROJECTS

Achieving healthy growth through **agriculture and nutrition**



1. Designing on-farm participatory models of Integrated Farming Systems for enhancement of household diet diversity and livelihoods of women small holder farmers, Annamalai University, Tamil Nadu

2. Novel approach to reduce zinc malnutrition in rural woman and children through agronomic bio-fortification of food crops, Amity University, Noida, Uttar Pradesh

3. Veggie Lite - Conjunction of agriculture, nutrition, and health for inclusive development of women, eKutir, Odisha

4. Digital Technology enabled and Community-Driven Integrated Agriculture and Nutrition Intervention to Promote Maternal and Child Nutrition in Odisha, Digital Green, Odisha

5. Ensure year-wise nutritional food security to Indian Women through Community level implementation of Domestic Solar Conduction Dryer, Science for Society, Maharashtra

Icons are only for representational and design purposes and are not representative of the projects themselves.

participatory approaches to improving knowledge of women on nutrition. Finally, the Zinc Bio-fortification project tested an agricultural intervention that used foliar application of zinc on rice and wheat crops to potentially address micronutrient deficiency through supplementation of food crops.

We take you through the stories behind four of these projects to exhibit the breadth of work that was undertaken by researchers using this funding opportunity. ■

Agriculture, nutrition and social empowerment are linked with health

Women sorting agricultural produce

Ensure year-wise nutritional food security to Indian Women through Community level implementation of Domestic Solar Conduction Dryer from Science for Society, Maharashtra

Dr. Vaibhav Tidke, from Science for Society (S4S) developed a patented technology Solar Conduction Dryer (SCD) with the intention of addressing three interlinked themes in rural settings in India; under-/mal-nourishment, economic and social inequality.

Concerns over food security in India are partly a result of the seasonal nature of our agrarian economy. The lack of storage spaces and affordable post-harvest technologies to store seasonal produce results in farmers and their families being dependent on seasonal produce for their nourishment and for generating future income. In the lean season, when demand and prices for these products is high, farming communities are unable to procure them due to their low purchasing power. In this period, diet diversity is severely restricted, forcing farmers and their families to rely on their staple diet, which does not often provide them with adequate nutrition. In the post-rain surplus season, when produce is available in abundance, with supply outstripping the demand for seasonal vegetables resulting in significant post-harvest losses in the produce and the earnings from selling these products. This results in

The pilot project showed marked economic benefits for the 200 participating women.

the double burden of poverty and malnourishment that is rampant across rural as well as urban India.

The underlying challenge in this scenario is the lack of accessible, low-cost easy-to-use post-harvest technologies that prolong the shelf life of seasonal produce. Recognizing this, the Society of Science developed a solar dryer, called the Solar Conduction Dryer (SCD), an electricity-free dryer capable of being deployed in rural section. The team applied for funding through the 'Achieving healthy growth through Agriculture and Nutrition' call to help them fund complete their assessment of the impact of this dryer on nutrition, agricultural productivity and social empowerment of women. The fundamental idea behind the use of the SCD was that it is an easy and low-cost method by which food produce can be dehydrated and stored for up to a year, ensuring nutritional and economic security throughout the year, instead of just in the post-harvest season. This technology would allow women farmers, who were chosen in particular to promote women empowerment in the traditionally male-dominated society of the pilot project area, to consume and sell the dehydrated products in the off-season, increasing their income as well as improving dietary diversity.

The pilot project showed marked economic benefits for the 200

A beneficiary of the project using the Solar Conduction Dryer to dry and preserve produce

participating women. More than half of the women in the experimental group sold surplus SCD dried food materials, with the project team recording the sale of an estimated 30,000 kg of dried agricultural products which included products like dried ginger, onion, fenugreek, spinach, drumstick leaves and moth beans. Typically, the sale of dried products provided small farmers more than 50 percent additional profit than selling fresh produce in the open market. Usage of the SCD therefore reduced post-harvest waste and converted it into economic benefit for rural women farmers.

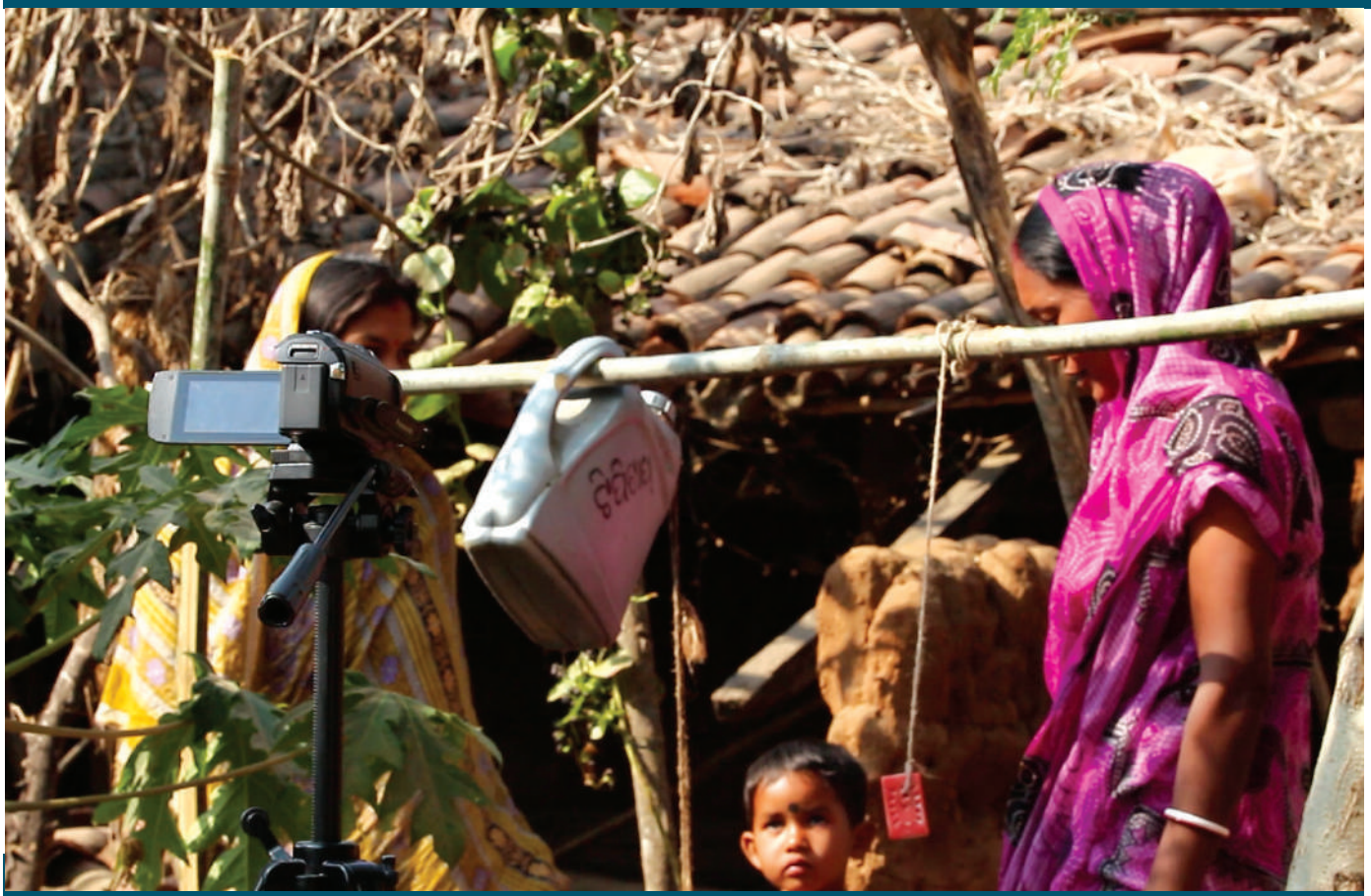
From a social perspective, the pilot project also delivered minor but important benefits, by focusing on women farmers and encouraging them to take the lead in operating the machine and selling the surplus products.

The project was not without its challenges, both social and scientific. For instance, due to high illiteracy rates, completion of the modified Food Frequency Questionnaire and the modified Calendar, two of the evaluation methodologies used by the team, proved a key challenge. The team then adopted an innovative method by involving the school-going children of the participating families to fill out these surveys. A competition for the 'Best Calendar' served as a source of encouragement for the children. The implementation partner also sent an 'Urja-mitra' (community worker) to each household, at least twice a week to ensure that the form was completed.

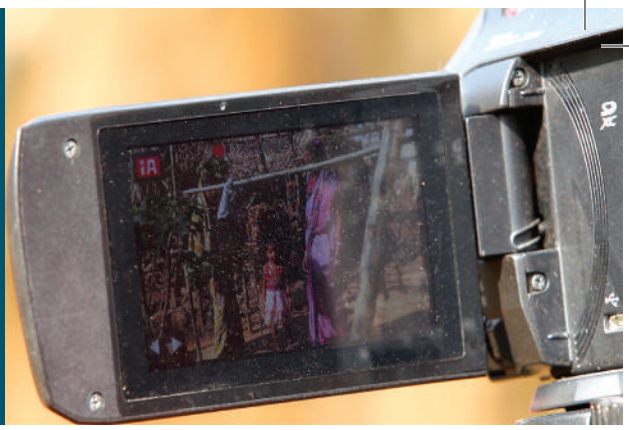
Project beneficiaries consumed and sold dried produce processed in the Solar Conduction Dryer

The pilot project was completed in late 2016 and the team is planning a multi-pronged approach to scale up the project by undertaking policy inclusion, forming strategic partnerships with other organizations to support this effort, partnering with private players to make the SCD a commercial product to increase its availability and encouraging similar studies in other geographies. The pilot project successfully demonstrated the use of a new tool to preserve locally available food to ensure nutritional and food security, instead of relying on an external supply of expensive packaged food. ■

Usage of the SCD therefore reduced post-harvest waste and converted it into economic benefit for rural women farmers.



The project employed participatory videos and participatory learning and action (PLA) methods in the study



Digital Technology enabled and Community-driven integrated agriculture and nutrition intervention to promote maternal and child nutrition in Odisha' from Digital Green, Odisha

This is an education and information and communications technology (ICT) project from Digital Green and its Non- Governmental Organization NGO partners Ekjut and VARRAT, London School of Hygiene and Tropical Medicine and DCOR, as research partner. Mr. Vinay Kumar and his team, aimed at assessing the effectiveness of two social approaches in disseminating information and inculcating behavior change in the way recipients approached nutrition. The project employed participatory videos, a tool that the organization pioneered use of, and participatory learning and action (PLA) method, a well-known technique to encourage community participation, to strengthen behavior change programs in the area of agricultural and nutrition.

Encouraging behavioral change in any area is a complex challenge, and often more so in terms of changing behaviors related to health and medicine. Socio-cultural norms further complicate any attempts in this area, as certain behaviors and practices are deeply entrenched in society. Changing such behavior then requires consistent and

The study found that the participatory videos and the PLA approach did produce some improvement in the knowledge of the participants in the intervention group.

long-term messaging. Traditional behavior change interventions have been found to have limited reach and impact. Preliminary research from Digital Green, in the area of education and behaviour change suggested that the use of participatory videos, where participants are involved in the content production and dissemination, was found to result in seven times higher adoption of better agricultural practices and was found to be ten times more cost-effective than traditional methods to reach farmers through these messages.

Beneficiaries in a Participatory Learning Approach (PLA) meeting

A feasibility study conducted by Digital Green in 2013-14 with USAID funded Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING) project and the International Food Policy Research Institute (IFPRI) showed positive outcomes in applying the Digital Green approach to promote nutrition behavior change and provided some suggestions for greater impact. The key recommendations were to strengthen the capacity of women's self help groups and also enhance their technical expertise in the area of nutrition. The objective of the GCI funded project was to implement these recommendations and establish in quantitative terms, the effectiveness of this approach in changing nutrition behavior in rural communities in an underdeveloped district of Odisha.

The project was conducted in 30 villages in a district of Odisha, with an intervention and comparison arm. In the comparison group, the villages were exposed to video production and dissemination in a manner

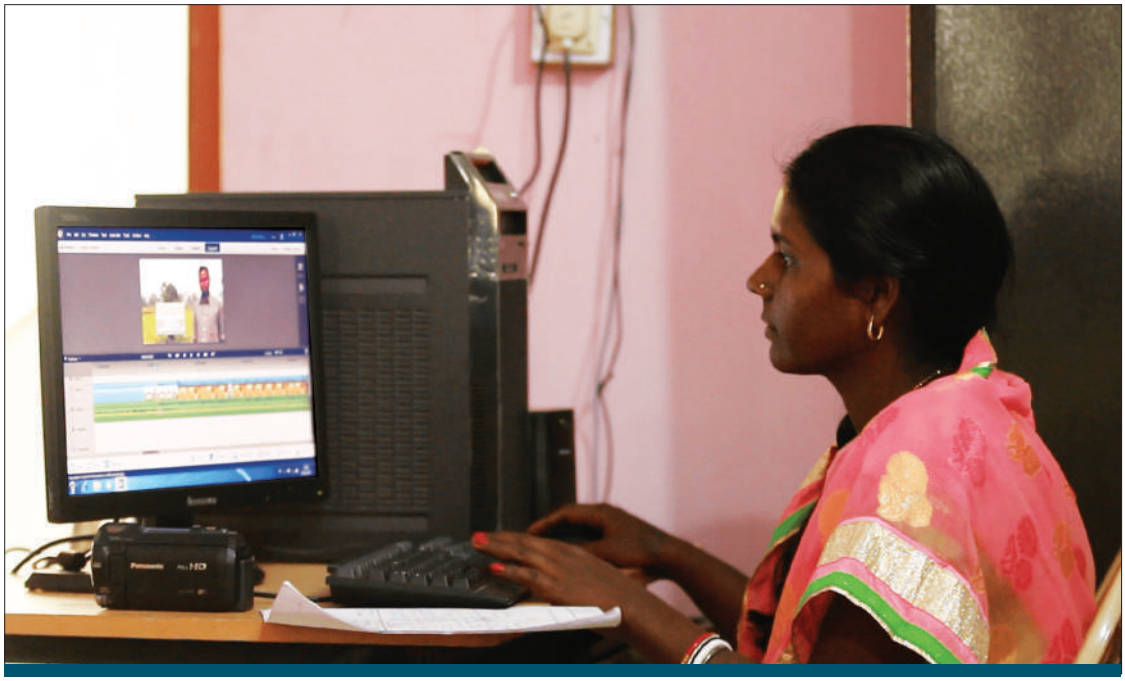
that was consistent with Digital Green's existing approach. In the intervention group, the villages accessed video production and dissemination with a special emphasis on enhancing content identification, content development, and facilitation through a participatory learning approach (PLA). The target audience in both arms of the study were village women from self-help groups. The topics that the videos dealt with were diverse and primarily dealt with mother and child nutrition issues, and topics ranged from the importance of diet diversity during complementary feeding, age appropriate complementary feeding to the prevention and care of sick children.

Participants were shown Digital Green videos specifically on the theme of nutrition, which were typically 10-12 minutes long, moderated by a trained mediator from the local NGO partner. This was followed by discussions and question and answer sessions to clarify and reinforce the messages around the videos. The PLA method involved mobilizing women in a series of facilitated meetings to identify nutrition issues in their communities, identify solutions to overcome these issues, implement the identified strategies and finally evaluate these strategies. These sessions further strengthened the message and reinforced the importance of nutrition in the intervention arm of the study. The study was evaluated through baseline and end line research.

Project film crew working in the field

The study found that the participatory videos and the PLA approach did produce some improvement in the knowledge of the participants in the intervention group.

As with any intervention, this project was not without its challenges. Behavior change, while difficult to inculcate in



A project participant working on the video

people, is even harder to measure and project timelines meant that the team from Digital Green had to demonstrate and measure behavior change over a short period of time. The project used proxies for measuring behavior change by measuring knowledge of behaviors among the target audience, and also focused on a single theme within the gamut of topics under nutrition, which was improving dietary diversity among children.

The team is now in the process of undertaking a larger and more detailed impact evaluation of this intervention on nutritional status of rural communities in terms of childhood wasting and maternal body mass index. This evaluation is using randomized control trails to provide robust evidence supporting the use of digital technologies and participatory approaches to strengthen nutrition behavior change programs in rural communities. ■

Designing on-farm participatory models of Integrated Farming System (IFS) for the enhancement of household diet diversity and livelihoods of small-holder women farmers' from Annamalai University, Tamil Nadu

This project from Annamalai University in Tamil Nadu aimed at addressing multiple challenges in the area of agriculture and nutrition. The pilot project employed an Integrated Farming System or IFS to improve cropping productivity of farmers, as well as augment household diet diversity and improve nutritional standards of poor women farmers, who were the primary targets of this intervention.

Rice farmers, especially those with smaller land holdings in many areas in the south of India, remain at the mercy of the monsoon to nourish their crops. They often face total crop failure either due to drought, or due to excessive rain and flash floods. This results in a poor economic return from rice, the staple food crop that is often grown in monoculture in the area, which in turn affects livelihoods and results in the poor nutritional status of the dependent communities.

The uncertainty faced by farmers prompted Dr. R. M. Kathiresan and the team at Annamalai University to think of an Integrated Farming System

A rice field with the Integrated Farming System with poultry coops and fish production

(IFS) that uses a mix of crop and animal components as a resource management strategy to address the multiple problems of low yield, low profit and poor nutritional status of the farmers in the area. Integrated farming, emphasizes on sustainable agricultural production, while preserving the resource base and maintaining environmental quality. By focusing on resource poor women farmers, the team also created avenues for women empowerment through agriculture.

The team designed IFS strategies for this project based on previously carried out institutional

field experiments. A combination of fish, poultry and rice in the same field was found to be a particularly effective method, which was standardized for size of poultry and fish culture, through DBT funded research projects, and involved on-farm participatory field experiments. Poultry were keep in specially designed cages with mesh flooring directly over the field and trenches containing fish were dug into the field.

The fish, rice and poultry integrated system benefitted farmers through simple but effective practices. First, droppings from the poultry cages, falling directly into the field, reduced dependence of farmers on external application of manure. Second, the fish in the trenches in the field provided biological control of rice weeds and other pests reducing dependence on agro-chemicals such as pesticides. Third, poultry waste, dissolved in the trench water, also served as feed for the fish. This allowed three different agricultural products to be grown in the space that was previously supporting a single agricultural product. Now the women farmers had fish and poultry meat that could be consumed by them as well as sold in the market, positively impacting both their

An impact evaluation of the project showed that in a single year, in a single cluster of villages with the IFS design, poultry meat intake per household increased by 400 per cent and fish meat intake per household increased 24 times.

financial remuneration as well improving their diet diversity.

The project design included a control group that would continue to farm using prevalent practices and an experimental group that would farm through the IFS system.

From a nutritional perspective, the project demonstrated that 150 participating women farmers' overall health improved

An impact evaluation of the project showed that in a single year, in a single cluster of villages with the IFS design, poultry meat intake per household increased by 400 per cent and fish meat intake per household increased 24 times. Women farmers in the experimental group also had a threefold increase in their total earnings. From a nutritional perspective, the project demonstrated that 150 participating women farmers' overall health improved, through various blood tests for haemoglobin, folic acid, calcium levels, which showed an increase in all these parameters.

In order to meet some of the challenges of the project, which included availability of feed, chicks and the opportunity to scale up the IFS system, women farmers were organized into Commodity Interest Groups with a bank account, in which they saved the money after the sale of broiler meat. These groups were also encouraged to establish their own retail outlets for selling meat produce and were also linked to input suppliers for bulk procurement, to ensure availability of inputs like chicks, chick feed and fish fingerlings.

The team having demonstrated the effectiveness of the IFS system at a pilot scale, now plan to replicate and scale-up the model in other farming tracts, both in India and abroad. They are also planning research into expanding the production base by including additional components into the system such as cultivation of lotus. ■

VeggieLite – Conjunction of Agriculture, Nutrition and Health for Inclusive Development of Women' from eKutir, Odisha

This project was designed to test the impact and viability of a platform that used micro-enterprise retail outlets and distribution channels to make fresh and healthy produce of women smallholder farmers accessible to low- income rural and urban consumers.

It fundamentally aimed to increase consumption of healthy vegetables, and improve the livelihood of small farm holders, particularly women. The project partners, McGill Center for the Convergence of Health and Economics (MCCHE) and Daisa Enterprises, Quebec Canada helped define the monitoring and evaluation metrics and also led field research, enumeration, and coordination.

The project intervention used a quasi-experimental design with baseline and end line measures over the period of a year so as to capture possible seasonal variations in the effects of the intervention on urban and rural households in the state of Odisha.

Mr. Suvankar Mishra led the project with the idea to showcase a for-profit intervention that could foster behavioral change in purchases of nutritious food produce and in turn positively benefit smallholder farmers.

Approximately 1,350 farmers engaged in the intervention received agricultural support products and services through the pilot project.

VeggieKart paid the farmers approximately 20 percent more for the vegetables they purchased from them than middlemen and brokers associated with the traditional supply chain (correlating with the farmer survey data), with fluctuations based on market and climate issues.

VeggieKart purchased vegetables from eKutir farmers at local aggregation points and transported them to a central warehouse, where quality control checks were undertaken. After weighing, sorting, grading, packaging, and re-weighing the vegetables, the produce was sent to the farmers' markets established in different parts of the capital city, Bhubaneswar. The distribution channels of VeggieKart included e-commerce platforms and direct doorstep delivery; VeggieMart –that converted existing small shops into farmers' markets, branded by VeggieKart; VeggieWheels– that converted existing vegetable vendors into valued vegetable entrepreneurs with push carts across thoroughfares in the city; and VeggieLite– that established vegetable entrepreneurs in low-income communities to sell vegetables at reduced prices.

By coordinating the entire vegetable value-chain, eKutir ensured that there were more economic benefits for farmers who would not otherwise be able to sell their vegetables, while simultaneously increasing the availability of vegetables for consumers.

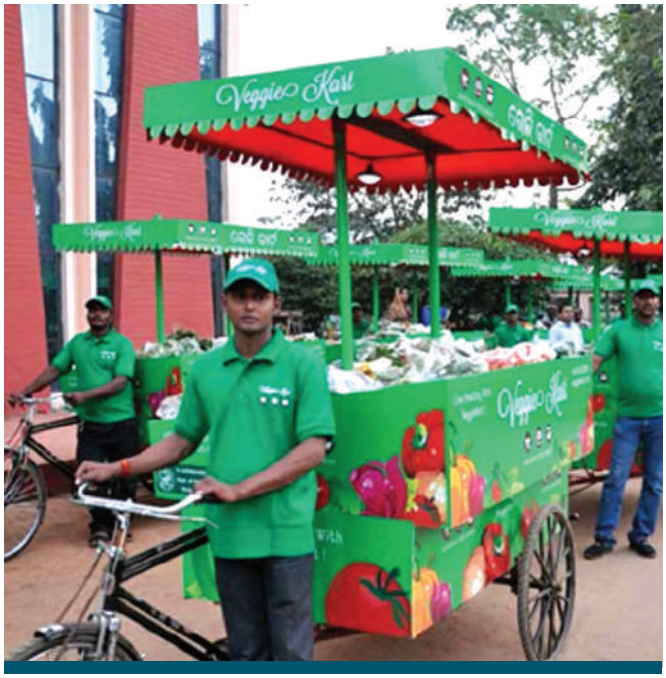
To ensure maximum increase in vegetable consumption amongst the target segment of pregnant and lactating women, eKutir brought in methods anchored in behavioral economics and integrated the same with existing community and health ecosystems to ensure affordable and self-sustaining delivery outside of formal commercial channels.

Approximately 1,350 farmers

Women participants sorting and packing the produce

engaged in the intervention received agricultural support products and services through the agri-entrepreneurs, who by now were well trained with farmer mobilization, procurement, and marketing methodologies and ICT usage. By May 2016, eKutir established roughly 90 vegetable entrepreneurs in the city of Bhubaneswar.

The project faced its share of challenges during the year and a half that it was in operation. Among these challenges were identifying small holder farmers in remote locations, bringing them on- board and encouraging them move to vegetable cultivation during the first couple of seasons. This was overcome by engaging local civil society organizations to help coordinate these activities. Similarly, equipping agri-entrepreneurs with an adequate knowledge base was also a challenge. A digital platform was used extensively on field with pre-fed knowledge in the tools and timely field support to the agri-entrepreneurs helped them deliver services effectively to farmers. Detecting the effects of VeggieLite on urban consumers was more challenging, particularly given the different consumer options available and the greater difficulty in tracking consumer– purchasing behavior in urban India.

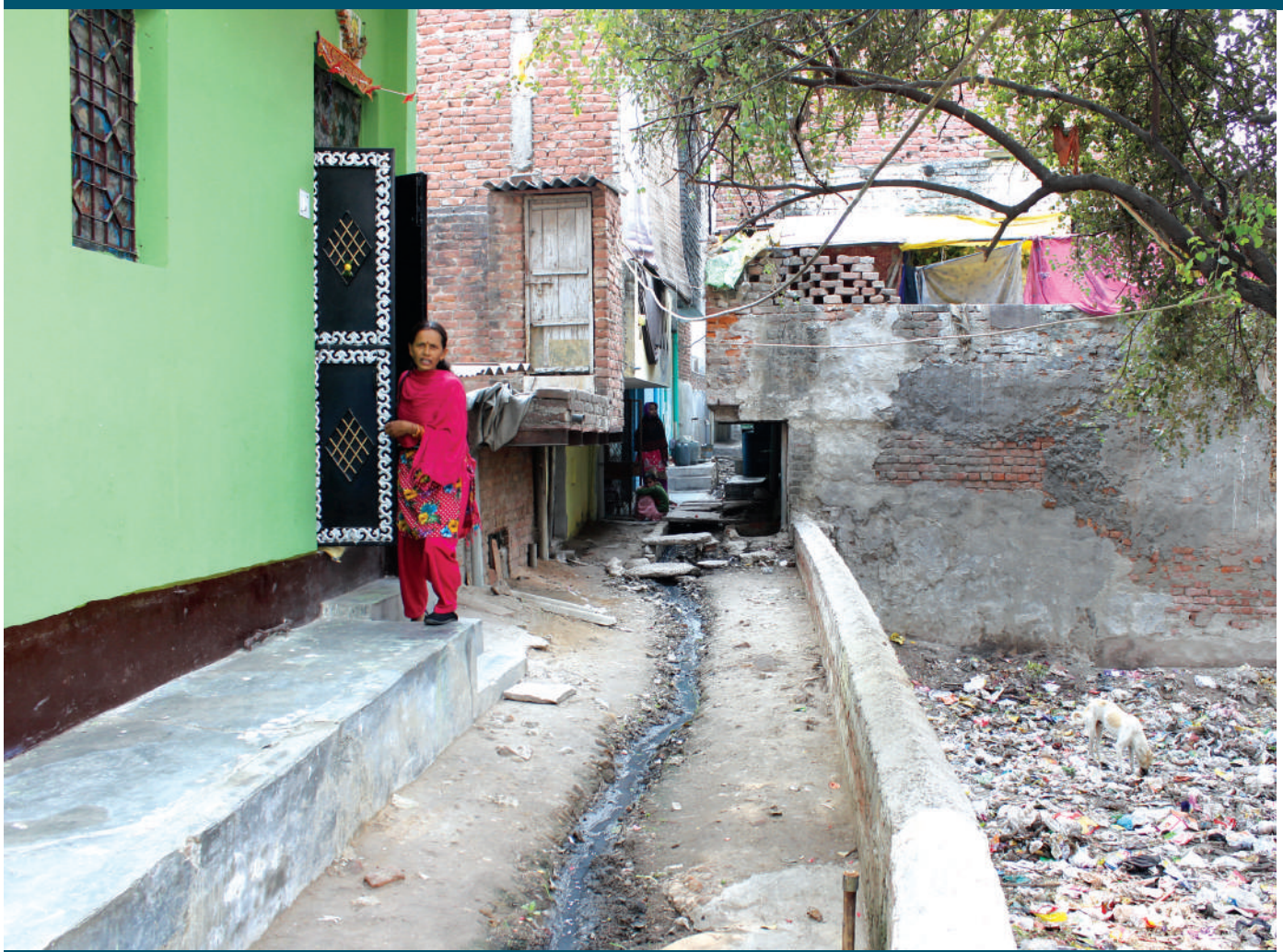


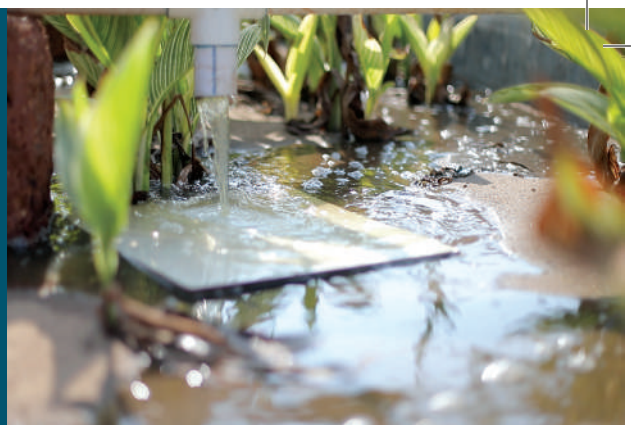
Picture credit: eKutir team

Carts selling the produce

This pilot program has demonstrated that the VeggieKart model of improving access to vegetables and improving livelihoods is a viable one. Based on the success of this pilot program, the team is ready to expand the project to attain sustainability and scaling within Odisha and plans to replicate it in new states within India. The project will be sustained by revenues from sales of produce, and incentive funding from public and private partners in the healthcare sector. This project is testing and building partnerships with the Odisha government as well as other state governments, the federal ASHA program, and a private insurance company. ■

This pilot program has demonstrated that the VeggieKart model of improving access to vegetables and improving livelihoods is a viable one.





Reinvent the Toilet Challenge

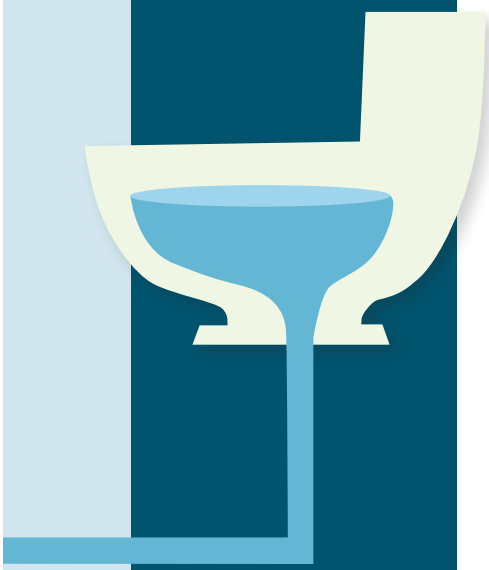
The second call under GCI focused on a different, but equally crucial developmental concern that has a major impact on health which is sanitation, though this fundamental relationship is often overlooked. The most obvious manifestation of this link is that infectious diseases are spread through poor hygiene and sanitation. For instance, diarrhea, among the most common complaint of infants and young children, is a direct result of poor sanitation combined with poor hygiene practices. Such practices not only cause diseases to spread, but also promote environmental conditions through pollution, whereby the overall health and immunity of the people in the community remains constantly poor, making them more vulnerable to communicable diseases and perpetuating a cycle of ill-health.

Poor sanitation does not just have a public health or medical impact on the community. There are wide ranging social impacts of a lack of sanitation infrastructure in the country, especially for women. Fears over safety result in girls dropping out of formal education on attaining puberty, jeopardizing their hope of a better future over the lack of basic infrastructure such as functional toilets. Fear of harassment, molestation and rape leads to women feeling unsafe and unable to perform the simple task of relieving themselves.

Recent statistics released from the National Family Health Survey IV (NSFW IV) 2015-2016[7] show that that the percentage

infographic

FUNDED PROJECTS



Reinvent the **Toilet Challenge**

1

Eco-toilet, Pradin Technologies, Bangalore

2

Field testing of off-grid, self-sustained, modular, electronic toilet for slums, with solar energy for Indian weather and integrated with mixed waste processing unit, with water, energy/ fertilizer recovery, Eram Scientific, Kerala and University of South Florida

3

Use of viral agents, microbial fuel cell and effective recycling strategy to improve the economics human waste disposal, Amrita University, Kerala

4

Hygienic Water-free toilet, Institute of Chemical Technology, Mumbai

5

Empowered septic tank as decentralized wastewater treatment system, BITS Pilani, Goa

6

Enterprise-driven high-quality community toilet system sustaining on commercial values generated by Black soldier Fly larvae grown on human faeces and by fertilizer derived from urine, IIT Roorkee, Uttar Pradesh

Icons are only for representational and design purposes and are not representative of the projects themselves.

of households with improved sanitation facilities has increased in the last decade from 29 percent to 48 percent from the National Family Health Survey III in 2005-2006[8]. However, there is a disparity in the access of the rural and urban populations to improved sanitation facilities. 68 percent of the country's population is rural[9], with only 36 percent[7] of this population having access to improved sanitation, whereas 31 percent[9] of the population is urban with 70 percent[7] of this population with access to improved sanitation. This is an inequality that needs to be addressed.

There has been a concerted effort from the government to improve sanitation facilities across the country through the *Swachh Bharat Abhiyaan*. However, India is a large and complex country, where a one-size-fits-all solution is neither viable nor practical. Therefore, a large basket of end-to-end solutions is required to provide us with different options for different settings. The advantage that the country has today is that science and technology have advanced to such a degree that Indian innovators and entrepreneurs can lead the charge in conceptualizing truly novel and sustainable technologies to address the needs of our people.

There has been a concerted effort from the government to improve sanitation facilities across the country through the *Swachh Bharat Abhiyaan.*

Given the central importance of hygiene and sanitation in India, the partnership launched the Reinvent the Toilet Challenge under Grand Challenges India in late 2013, inviting academics, entrepreneurs or individuals with ideas on how to improve the current toilet system or even overhaul the way we currently manage waste.

The mandate of the call was broad to ensure that the most innovative and cutting-edge projects were funded. The call also focused on Indian entrepreneurs and innovators, in keeping with the mandate of GCI and its funding partners. The call for proposals was also mandated to focus on stand-alone, affordable, environmentally and economically sustainable solutions that did not require connection to the sewer or

Poor sanitation does not just have a public health or medical impact on the community.

electrical grid, to enable their deployment in rural and poor urban communities that often need them the most.

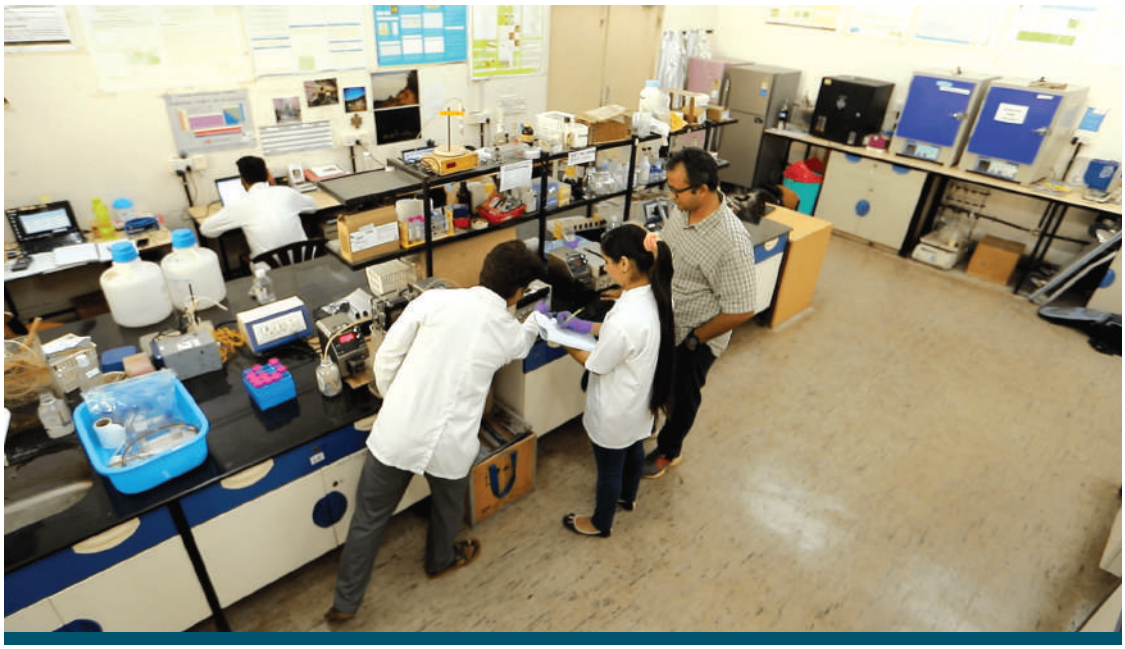
Six projects were funded under this program. These spanned the life of the waste collection and management cycle. Pradin Technologies' 'Eco-toilet' and Institute of Chemical Technology's 'Hygienic Water-free toiler' aimed to redesign the way human waste is collected by employing different scientific principles. Eram Scientific and University of South Florida's collaborative project titled 'Field testing of off-grid, self-sustained, modular, electronic toilet for slums, with solar energy for Indian weather and integrated with mixed waste processing unit, with water, energy/ fertilizer recovery' and BITS Pilani's 'Empowered septic tank as decentralized wastewater treatment system' project were proof-of-concepts for employing new technologies for the entire waste management process. Finally, Amrita University's 'Use of viral agents, microbial fuel cell and effective recycling strategy to improve the economics human waste disposal' and IIT Roorkee's project 'Effect of environmental parameters on the treatment of human fecal waste by Black Soldier Fly larvae' assessed the feasibility of involving biological agents in waste management, particularly for Indian conditions and tested these concepts in the laboratory.

Two of the pilot projects from the call have been presented to showcase some of work that is being carried out in this area.

Empowered septic tank as decentralized wastewater treatment system from the Birla Institute of Technology, Pilani, KK Birla Goa Campus (BITS Pilani, Goa)

Dr. Srikanth Mutnuri and his team at BITS Pilani, Goa, and their collaborators, Prof. Willy Verstraete and Prof. Korneel Rabaey from Ghent University, Belgium conceptualized the Empowered Septic Tank project, as a system that demonstrated simplicity by using minimal mechanical processes to manage septic tank effluent. The team developed and pilot tested a new technology, which is dependent on electrical energy to make septic tank effluent free of pathogens and helminthes eggs.

The team was motivated by Dr. Mutnuri's experience every morning outside the BITS Pilani Goa campus, where neighboring communities were forced to practice open defecation, due to lack of functional toilets and wastewater treatment facilities. Though there has been a concerted effort to increase access to toilets, through government and private channels in the country, these toilets largely rely on septic tanks for holding collected wastewater, which usually end up in an open channel. This is a threat to hygiene and health for the surrounding as well as downstream populations. The team at BITS Pilani was therefore motivated to develop a



Dr. Srikanth Mutnuri and his team first demonstrated the electrochemical technology in the laboratory

simple technology that would be capable of removing pathogens and helminthes from this septic tank effluent so as to reduce the threat from this wastewater.

The empowered septic tank is an electrochemical technology that can be run on photovoltaic power, which is stationed immediately after discharge and utilizes electrical power to change the characteristics of the wastewater by manipulating the pH of the incoming wastewater. The wastewater is exposed to acidic and neutral pH in turns and this sequential exposure results in the killing of pathogens such as bacteria, and is also demonstrated to kill helminthes eggs, which are notoriously hard to kill in wastewater. The electrochemical technology is housed within a container and can be retrofitted on existing toilets or wastewater plants, making it an attractive candidate for managing community toilet wastewater.

The team began testing the electrochemical technology in a laboratory setting to optimize its functioning, and then moved on to testing the system in managing the wastewater from a ten- person household. The team continued modifying the system based on the test data and was then interested in

scaling up the pilot tests for the system, by operationalizing and testing a system large enough to manage wastewater from a 100 person community, to test the performance of this larger system. Here, they were faced with some challenges, which were not technical, but logistical, as the team was unable to demonstrate the system in a slum, as they had originally envisaged doing. However, they then built the 100 person household empowered septic tank and system on their own campus, attached to one of the student hostels.

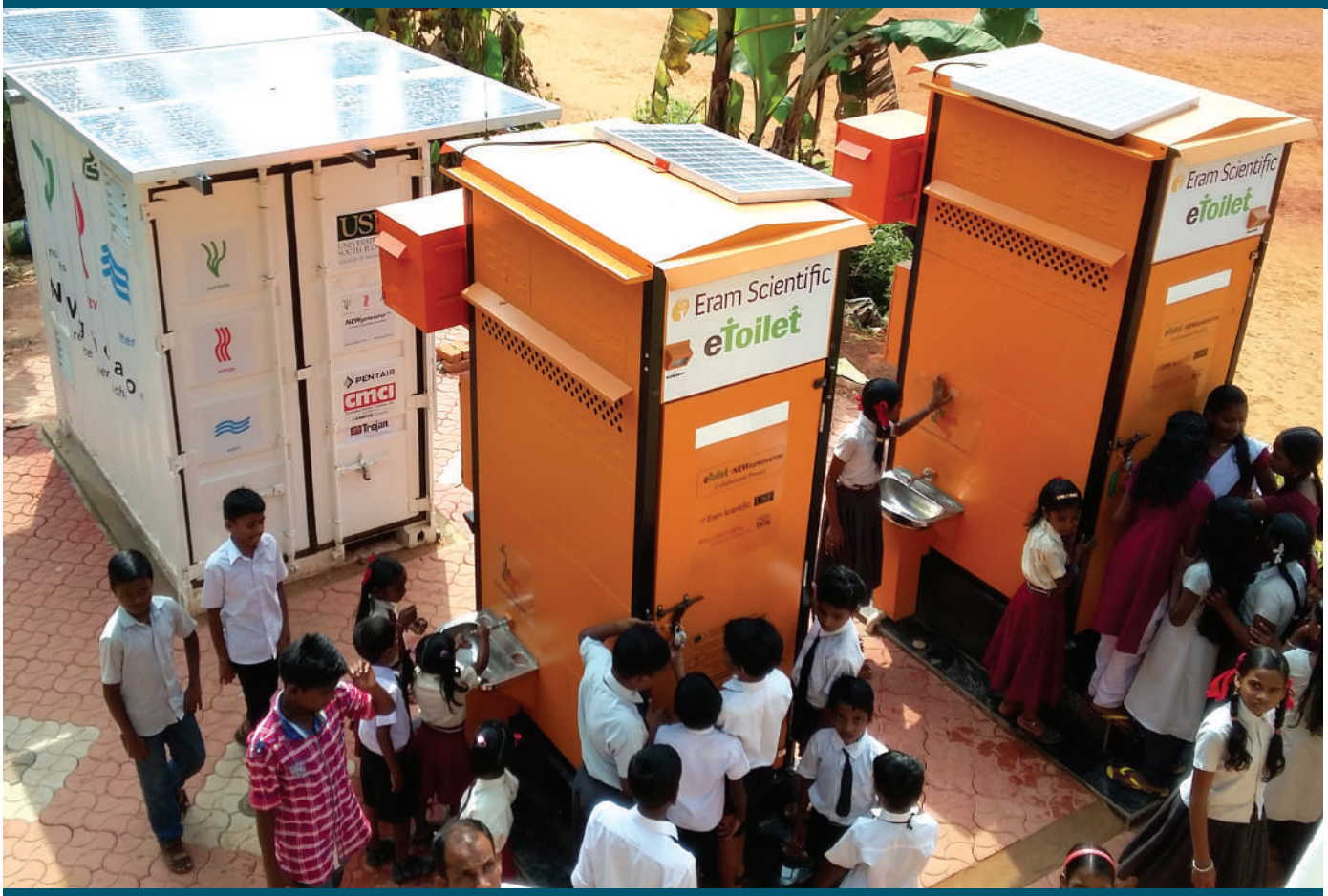
The team is currently collecting data on the working of the 100 person empowered septic tank and planning to scale-up the technology for further testing.

The goal of the project is to not just develop a technology to mange wastewater, but to also encourage resource recovery from the wastewater. The advantages of this system are multi-fold; it does not depend on hazardous chemicals, does not generate unpleasant odors as part of the treatment process, and has a minimal electrical footprint, as the system can be run at a relatively mild voltage and current. Additionally, the technology being encased in a container means that the operator or user does not come into direct contact with the waste, which is important from a health perspective. Since this is a backend technology for managing waste, and the system is meant to work on septic tank wastewater, there are no behavioral changes that would be required on the part of the user, which increases the likelihood of individual and community acceptance for using the system. The lack of loose moving parts in the system means that it can be produced rapidly at large-scale. The technology can also be deployed in urban and densely populated urban areas.

In terms of cost, the team believes that these would be approximately 10 percent of the operation of community toilets, which includes the cost of power as well as basic maintenance of the system, including electrode replacement.

The team is now interested in taking this technology forward by setting up a company. They believe that the base technology can be readied for a market launch within two years of the launch of the company. ■

The team is currently collecting data on the working of the 100 person empowered septic tank and planning to scale-up the technology for further testing.



The combined eToilet and NEWGenerator™ system was immensely popular with the students of the school where the project was piloted.

Field testing of off-grid, self-sustained, modular, electronic toilet for slums, with solar energy for Indian weather and integrated with mixed waste processing unit, with water, energy/ fertilizer recovery from Eram Scientific and University of South Florida

Eram Scientific Solutions and the University of South Florida collaborated on this project where they aimed to develop and demonstrate the working of an innovative sanitation and resource recovery system by combining two existing technologies, Eram's eToilet and USF's NEWgenerator™. This collaborative effort has resulted in the development of a first-in-kind modular technology for toilet systems integrated with a complete water recycling technology.

Mr. Midhu and Dr. Daniel Yeh and their respective teams at Eram Scientific Solutions and University of South Florida were motivated by their vision of a designing a fully integrated compact sanitation system that can be easily installed, in the smallest space, consumes less energy, and benefits the people that need sanitation technologies the most.

Eram Scientific, which is a Kerala-based company has been working in the area of providing public sanitation solutions and were looking to collaborate with teams working on waste management technologies. They then collaborated with Dr. Daniel Yeh from the University of South Florida, whose team had developed the NEWgenerator™ system, a novel, on-site wastewater treatment and recovery system which combines an anaerobic membrane reactor and solar technologies and allows for the complete treatment and recycling of the flush water, as well as localized recovery of nutrients, energy and water from human wastes.

The combined system served over 1500 students and people from the local neighborhood in the current pilot project.

This project had two main goals: first, to design and implement a novel public sanitation platform that met the needs of people living in slums through improvements to the existing eToilet design and second, to demonstrate closed-loop resource recovery by integrating the slum eToilet with the NEWgenerator™ system to provide a complete waste management system.

The eToilet designed by Eram Scientific for this project contained specifications that would tailor it specifically for the population it was meant to serve, namely slum-dwellers. The toilets were designed with auto-flushing and floor washing mechanisms, to reduce the dependence on people having to clean the toilets, and also had remote monitoring capabilities, with a strong structure which was still easy to install, unique maintenance options and multiple revenue generation models. These toilets would have, in the normal course, been linked to the existing sewer line or to a septic tank. However, the team was interested in developing a stand-alone waste management system that would not depend on connections to sewer lines or electricity grids.

The project had planned to pilot the use of this combined technology originally in slums of Trivandrum, in Kerala, however the technology was installed in a school near the city due to challenges in finding an appropriate slum site. The team then tested the working

of the system in the school over several months, and conducted laboratory tests on the quality of water that was being recycled for floor washing and flushing, which were found to be within appropriate limits. The combined system served over 1500 students and people from the local neighborhood in the current pilot project. Data collected shows that the system is working well and the team is currently collecting more data and planning to scale-up the pilot and deploy this system in slums.

Given the success of the pilot project, which demonstrated the adaptability of this combined system in the country, the teams now plan to work on the NEWgenerator™ system to make it more compact, and reduce the cost of the technology by replacing some components with readily available and indigenously developed parts and scaling-up the pilot project to a larger study to assess the working of the system in slums. ■

The project team now plans to scale up the system and pilot it in slum areas.

All Children Thriving

Children are our future, and ensuring their health and optimal development remains the absolute responsibility of each preceding generation. However, statistics show that despite improvement in maternal and child health metrics over the last few decades, we in India still have a long way to go in ensuring this promise though we are on the right path.

As per the National Family Health Survey IV, 2015-2016[10], malnourishment, as measured by stunting and wasting, remains high in the country, despite improvements in these indicators over the last decade. Today, 38 percent of our children below the age of five remain stunted, 21 percent below the age of five remain wasted and more than a third of the country's children are underweight.[11]

The most obvious consequence of poor mother and child health is maternal and child mortality, or the death of the mother during childbirth, and neonatal as well as infant deaths. However, for those mothers and children that do survive birth, there remain several challenges that could impact their future survival and development.

Children's health is inextricably linked to the mother's, a relationship that we have only begun to understand. A malnourished mother is more likely to have trouble during pregnancy and childbirth which is likely to impact the growth and development of the fetus and could result in a pre-term birth or a host of complications that will have a long-term impact on the child's health

infographic

FUNDED PROJECTS

All Children Thriving

1 Achieving optimal growth and development among infants and children in low-resource settings, Society for Applied Studies, New Delhi

2 Creation of a Bio-repository and Imaging Data Bank for Accelerating Evidence Generation to Facilitate Children to Thrive, Translational Health Science and Technology Institute, Haryana

3 The simple absolute neutrophil count as a measure of mucosal inflammation and as a predictor of linear growth in Indian infants, Translational Health Science and Technology Institute, Haryana

4 Stress outcomes on pregnancy, fetal growth and birth weight Development of methods to identify mothers at risk of preterm birth and intrauterine growth restriction resulting from maternal stress, National Institute of Biomedical Genomics, West Bengal

5 Low-cost salivary progesterone testing for detecting the risk of preterm births in rural community settings of India, Mahatma Gandhi Institute of Medical Sciences, Sevagram, Maharashtra

6 An intergenerational pre-biotic approach to establishment of a healthy colonic microbiome in infants, SRM Institute of Medical Sciences, Chennai, Tamil Nadu

7 Enhancing nutritional security of pregnant women, infants and young children in rural households of Tamil Nadu, India through agricultural intervention, Centre for Plant Molecular Biology and Biotechnology, Coimbatore, Tamil Nadu

Icons are only for representational and design purposes and are not representative of the projects themselves.

Children's health is inextricably linked to the mother's

and development. Emerging research on developmental origins of health and diseases has suggested that an individual's lifelong health and capacity is characterized by fetal nutrition at different stages of gestation and infancy. Likewise, research has also suggested that intrauterine growth restriction is linked to future non-communicable diseases that further exacerbate the magnitude of problems in the child.

Although it has been identified that the etiology of birth defects, adverse pregnancy outcomes and developmental disabilities in children is complex and is thought to result from combination of factors (such as maternal health, nutritional deficiencies, infectious diseases, genetics, enteric health, water, and sanitation), many of these can be tackled through simple and cost-effective interventions. For instance, nutritional deficiencies can often be simply managed by supplementing a mother's diet with selective nutrients.

It was to address some of these issues that the 'All Children Thriving' call was launched as GCI's third thematic call in 2014. The initiative intends to investigate novel cost-effective measurement tools and mechanisms to combat unhealthy birth, growth and development. By creating and measuring integrated solutions for healthy birth and development, the call

We in India still have a long way to go in ensuring this promise though we are on the right path.

is aimed at ensuring not only the survival of children but that they also lead a healthy and productive life.

Seven projects are funded under this program and each project explores a unique aspect of the issue with special emphasis on innovative, impactful research on maternal and child health and development. Three projects are aimed at developing simple low-cost biomarkers that can be applied early in life to detect and predict adverse outcomes in mothers and children. Another three other projects intend to validate or develop individual or packages of targeted interventions to improve maternal and child health. Finally, one of the projects is aimed at developing bio-banks for long-term storage of bio-specimens to reduce time and cost for future research in this area. These projects are funded by DBT, Bill & Melinda Gates Foundation and our supporting partner USAID

Projects under this program are in the initial phases of their study.

We present some background behind two of the funded projects under this grant. ■

Achieving optimal growth and development among infants and children in low-resource settings from Society for Applied Studies (SAS), New Delhi

In India, over a third of children below the age of five are stunted[12], which means that they are shorter in height than they should be for their age. Studies have shown that stunting leads to poor cognitive development, poor performance in school, and increased risk of some diseases as adults, all of which translate to low economic potential of the adult. However, there are still several unanswered questions in terms of understanding the nature and causes of stunting in India.

Dr. Nita Bhandari and her team at the Society for Applied Studies (SAS) aim to answer one of the major questions, which is identifying the causes for the slowdown in the rate of decline of stunting in the country, despite significant improvements in various socio-economic sectors. Studies hypothesize that this paradox could be the result of many factors that may work individually or in combination. Some of these factors identified by the team at SAS are; poor efficacy of delivery of nutrition and non-nutrition related interventions in an integrated manner; a shortfall in the combined efforts both at the household and facility level to accelerate the improvement in linear growth during fetal and postnatal life; less focus on intervening during the pre-

pregnancy period in addition to delivering interventions during pregnancy and postnatal life; and lack of evidence as to what extent intergenerational factors, such as maternal short stature, are rate limiting and lack of interventions to overcome them.

This project aims at understanding the above factors and designing interventions to mitigate the barriers in achieving optimal growth and development in infants and children living in low resource settings by developing an integrated delivery of a package of evidence-based interventions.

This project aims at understanding and designing interventions to mitigate the barriers in achieving optimal growth and development in infants and children living in low resource settings by developing an integrated delivery of a package of evidence-based interventions.

The interventions areas will cover antenatal care, WASH, nutrition and healthcare. The project is unique as it uses innovative methods to deliver these interventions, and effectively engage households and facilities through peer-supporters. It will also cover the entire period between pre-pregnancy to early childhood, thereby impacting both mother and child health.

The project has been conceptualized on two scientific principles. First, that improving the nutritional and health status of women before and at the time of conception is essential to optimize the environment for growth in-utero and early childhood. Second, that nutrition, healthcare interventions and water, sanitation and hygiene (WASH) interventions that individually or synergistically promote growth of children may be modified by maternal height. So far, single component interventions to promote growth in children have not yielded more than modest effects and this study will be examining whether maternal short stature limits the effect of the integrated intervention package and will attempt to quantify this effect.

The study proposes to follow a large cohort of women (nearly 12,000) from pre-conception, through to gestation, childbirth and to two years after the birth of the child. The integrated

package of interventions will be given to women before and during pregnancy, and to mothers and children after childbirth, through home-based engagement. Additionally, this study will be examining whether maternal short stature limits the effect of the integrated package of interventions on child growth and to what extent.

The complexity of the project is concurrent with the challenges in its implementation. A major challenge faced during initial phases of formative research was conceptualizing the delivery of the multiple-pronged interventions at home. The team plans to adopt a pretested method of delivering the interventions through peer-supporters who will be attached to woman at all times. In addition to the challenges of delivering multiple interventions at home, the team will have to put in major effort in ensuring high compliance rates with the interventions being delivered. Innovative ways are being developed to achieve the same. Besides, the project also has all the challenges of a large community-based study i.e. the need for large number of personnel, need for intensive training of the staff among others. As the study period is long, special care will need to be taken to reduce attrition rates in staff and in the participants enrolled.

From a policy perspective, the study is expected to generate crucial lessons, which will help us develop and implement evidence-based interventions to address stunting in Indian children. Results from this study could potentially indicate whether multiple and simultaneous interventions would be necessary rather than single-component interventions to improve the nutritional status of children,, or that there may be a need to strengthen the support systems for delivering these interventions. Most crucially, this study will provide much needed evidence on whether intergenerational effects on linear growth of children can be overcome in India and to what extent. ■

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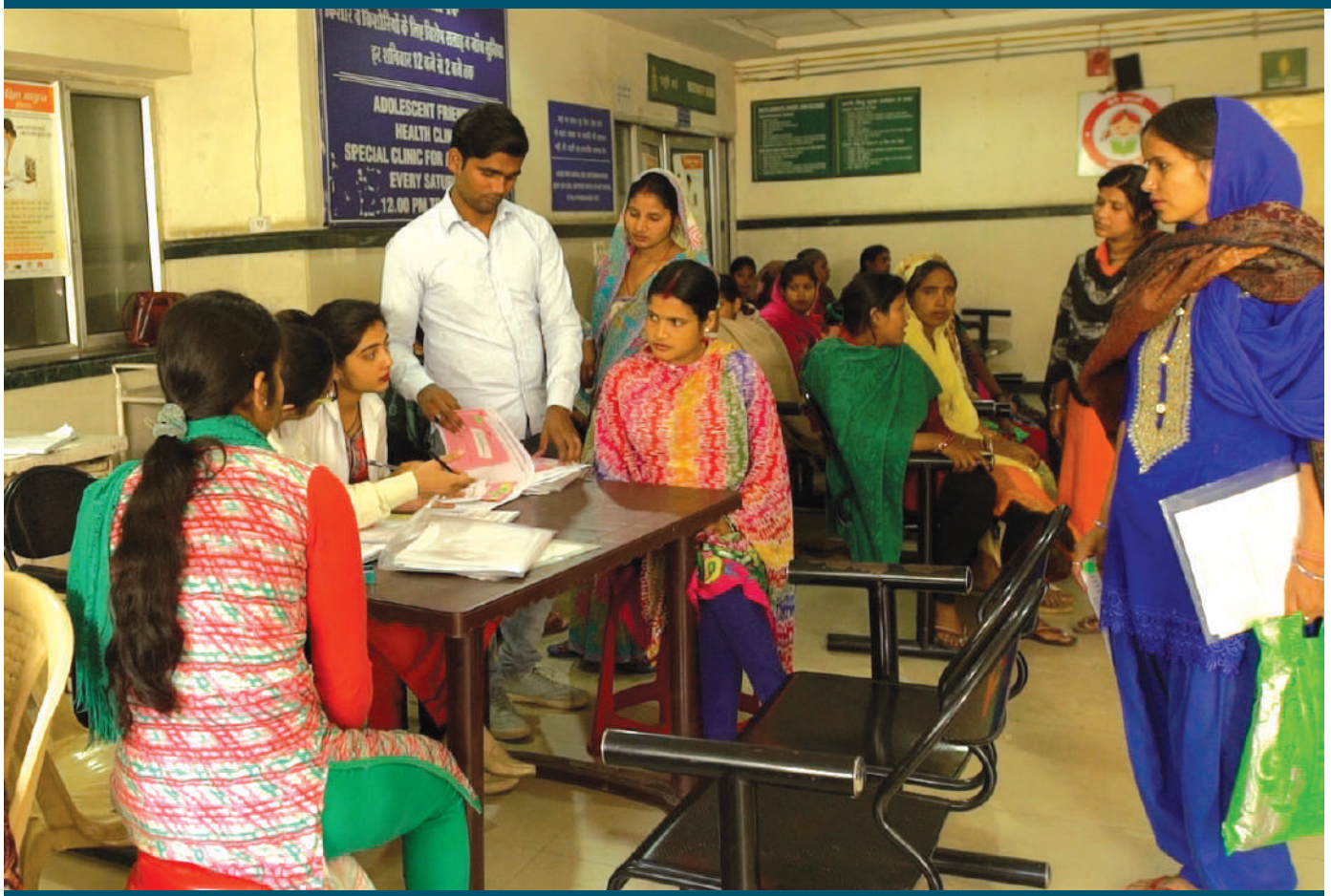

Patients being enrolled in the study at the project hospital site.

Creation of a Bio-repository and Imaging Data Bank for Accelerating Evidence Generation to Facilitate Children to Thrive from the Translational Health Science and Technology Institute (THSTI), New Delhi

This project aims to create India's first bio-bank or repository of longitudinally collected biological specimens from pregnant women, accompanied by well characterized information on the associated environmental, clinical, social and epidemiological determinants through the course of the pregnancy. The project plans to create, operationalize and manage long-term, stable infrastructure to allow better-standardized collection, storage and retrieval of bio-specimens collected from the pregnancy cohort.

As with any medical or scientific study, researchers working in the area of mother and child health, especially in the pregnancy and ante-natal period, are often faced with the uphill and very expensive task of collecting samples each time they plan a new study. This is often a result of the fact that there are few bio-banks and almost none that contain specimens from pregnant women, causing researchers to spend large amounts of time, money and effort in collecting the same samples each time.

This state of affairs prompted the team to conceptualize plans for a bio-repository that would contain samples from an already established cohort at a hospital.

This state of affairs prompted Dr. Shinjini Bhatnagar and her team of researchers at THSTI to conceptualize plans for a bio-repository that would contain samples from an already established cohort at a hospital in Gurugram, India. This cohort forms the base sample for two other ACT funded projects under GCI that are either contributing to the bio-repository or using samples from the collection.

The project is based out of a district hospital in Gurugram, India from where they will recruit approximately 8000 pregnant women using a multi-disciplinary approach which includes clinical, epidemiological, statistical, genetic, microbial, proteomic and imaging sciences. The project proposes to enroll pregnant women starting at less than 20 weeks of pregnancy and will follow the same cohort till six months after delivery. The team will collect serial bio-specimens such as maternal serum, saliva, urine, high vaginal swabs, feces, cord blood, placental punches, paternal saliva and neonatal heel prick venous blood, through pregnancy and delivery. The project also plans to collect 3-4 serial ultrasound scans of the participants to form an imaging data bank, which will be crucial for developing simple non-invasive ultrasound based image processing tools and methods to assess likely adverse pregnancy outcomes, which will be crucial for monitoring programs at every stage of pregnancy and early life. Additional data on environmental, social and epidemiological determinants will also be collected and stored. The storage facility for the project will be based at THSTI in New Delhi.

The team believes that results from studies supported through the bio-repository will be a crucial input to furthering our understanding of the factors that threaten the lives of mothers and children during pregnancy and childbirth.

To ensure that the samples in the bio-repository comply with the highest standards of sample management, the team has developed standard operating procedures and a quality control data management unit for storing, tracking, retrieving data and specimens. An interesting aspect of the project is that it includes a Young Investigators Program to mentor young researchers

from clinical and life sciences background to encourage them in the area of hypothesis driven research in mother and child health (MCH).

Given the scale of the project, challenges are only to be expected. Being an infrastructural endeavor with several associated nuances, such as the need for trained manpower and quality control, ensuring the sustainability of this large system is a major challenge. The team plans to address some of these challenges by building in training for manpower, designing Standard Operating Procedures and initiating a data management unit to ensure the quality of the samples and data in the collection. The team has also initiated a platform for future research activities in the area of MCH, which could use the data and samples from the bio-repository.

Data, being a large proportion of the knowledge being stored in the collection, poses some challenges of its own, especially when it comes to sharing and distributing clinical data and bio-specimens for future research. The team is in the process of finalizing an access and data-sharing policy based on existing rules, regulations, laws and policies, and a committee is framing defined procedures for accessing the collection.

The team will be collecting extensive data on the cohort of pregnant women enrolled in the study

The team believes that results from studies supported through the bio-repository will be a crucial input to furthering our understanding of the factors that threaten the lives of mothers and children during pregnancy and childbirth. ■

GRAND CHALLENGES
EXPLORATIONS INDIA
innovating for global health

Grand Challenges Explorations-India

Grand Challenges Explorations- India (GCE-India) is the Indian arm of the Grand Challenges Explorations (GCE), and is part of the joint partnership of the Department of Biotechnology and the Bill & Melinda Gates Foundation under Grand Challenges India.

GCE is a global program that focuses on providing people with ideas with small seed funds through a fast-track grant process, to allow them to develop and provide initial evidence on the workability of their plans or concepts or ideas.

GCE-India is targeted at developing those ideas and innovations that are in the very early stages of the pipeline, usually at the ideation stage. The program's aim is to provide a mechanism to increase the number of ideas in the early stages and to provide researchers and entrepreneurs the opportunity to provide initial evidence to demonstrate the workability and the viability of their usually fledging idea. The innovation pipeline is not a forgiving one; only one of several hundred ideas and innovations actually make it past various barriers in each stage of pipeline and reach the market to impact people's lives. GCE-India aims to populate the early stages of the pipeline with more ideas, so that we increase the probability of

innovative and impactful products and ideas coming out the other end.

The program acts as a feeder program for the larger programs of the partners, such as Grand Challenges India and the programs of BIRAC and DBT, among other funding programs in the country and abroad. GCE-India's unique characteristic is that applicants don't need to have any data to apply for the grant, as long as they have a workable idea. The program provides the selected grantees funding for a period of 18 months to the tune of $100,000 to test their idea and generate initial evidence. In keeping with this idea, the calls for application require only a two-page proposal on the basis of which ideas are chosen.

GCE-India is open to anyone with an idea in the country. The goal of the program is to encourage the pursuit for developing new medical technology devices, drug delivery systems, diagnostics, and technology enabled service models that can potentially be made available to people from all socio-economic strata.

GCE- India is implemented by IKP Knowledge Park based in Hyderabad, India with PMU-BIRAC as the managing partner on behalf of the DBT and the Bill & Melinda Gates Foundation.

HBGDki India

Healthy Birth, Growth and Development *knowledge integration* India

The importance of data, of quality and in adequate quantities, cannot be underscored, especially when it comes to using this data to design policies to address some of the greatest health challenges that our children, the most vulnerable among us, face. Over the last few decades, substantive amounts of research have already been done all over the world, and some are underway, in the areas of mother and child health and the factors and variables that affect these.

However, generation of data is only one aspect of the larger picture. Analyzing and packaging this data in useable forms is often the missing step when it comes to using this data to develop evidence based policy.

Though there is a wealth of data available on mother and child health, it is fragmented; some of this data comes from published data, some from manuscripts form and some as unpublished datasets, with little work on analyzing macro trends in this area. Research is also geographically specific with very little research that is done simultaneously in multiple regions across the world. This leads to valuable data being siloed and not being capitalized to its fullest extent. Collating and analyzing this data across the world to unlock its potential is a crucial step.

In an effort to address this, the Bill & Melinda Gates Foundation

initiated the Healthy Birth, Growth and Development knowledge initiative (HBGDki) which supports the rapid aggregation and comparison of data from these fragmented sources by providing a single platform for this data to be stored. The platform will allow contributing academics, statisticians and ultimately policymakers to access this data which would enable them to obtain a much clearer picture on trends and patterns which will in turn help design packages of interventions to address these issues as well as identify gaps in research to direct future efforts.

The overall goal of creating this platform is to facilitate accelerated progress in our understanding of the multiple interrelated issues that result in poor growth outcomes for the world's children and to use this evidence to design interventions and policies to address these often fatal complications.

HBGDki India is the Indian arm of this global platform and is funded by the Bill & Melinda Gates Foundation. This initiative will focus on collecting and collating data on Indian children and cohorts to allow Indian and global researchers and policymakers to access this data analysis. The initiative has now gained momentum, with many contributors already uploading their valuable data and cohorts to the platform.

Knowledge Integration and Translational Platform
Evidence for health policy

Knowledge Integration and Translational Platform

Knowledge Integration and Translational platform (KnIT) is a unique India-specific platform that has been launched with the aim of collating and analyzing available evidence within the country, to aid in the development of evidence-based policy to address the inequalities in health outcomes in our country. The platform will work by collecting and analyzing currently available evidence, identifying existing gaps in our knowledge and directing research to these areas, and will work to improve our understanding of current or new interventions or packages of interventions to address the inequalities in our healthcare system.

This platform was launched in 2016 and will specifically target the Indian State Governments for development and implementation of cost-effective, sustainable interventions or packages of multi-sectoral health interventions. Funded by the Bill & Melinda Gates foundation the platform is managed by PMU-BIRAC.

At this time, KnIT focuses on two tracks, maternal and child health (MCH) and nutrition. MCH focuses on identifying the health system

challenges that are barriers to effective, equitable, impactful delivery of health services and identifies strategies how to overcome them. It also focuses on designing delivery strategies based on evidence, and piloting and evaluating programs aimed at improving program delivery, directing implementation research to optimize primary and secondary level healthcare, and generating evidence-based, human resource linked strategies relevant to MCH. The Nutrition track examines public health and medical interventions to mitigate stunting, wasting, severe malnutrition, low birth weight, optimal body composition and metabolic unfitness or obesity. In addition, KnIT also aims to address multi-sectoral interventions for health; nutrition; family planning; water and sanitation hygiene; air pollution; child development; food fortification; and agri-nutrition linkages.

Currently, the Society for Applied Studies (SAS) and the International AIDS Vaccine Initiative (IAVI), both in New Delhi, are the two domain centers that are working on nutrition and Maternal and child health respectively.

The Team

Left to right: Dr. Arpita Gupta, Dr. Richa Vashishtha, Mr. Murali Menon, Dr. Chandra Madhavi, Dr. Renu Swarup, Dr. Shirshendu Mukerhjee, Mr. Joseph Torres, Ms. Arshi Mehboob, Ms. Anjana Seshadri, Mr. Ritesh K. Jaiswal

Program Management Unit at BIRAC

A partnership of the Department of Biotechnology, Govt. of India, the Bill & Melinda Gates Foundation and Wellcome

Program Management Unit at BIRAC

The Program Management Unit at BIRAC (PMU-BIRAC) was set up under the Memorandum of Understanding (MoU) signed by the Department of Biotechnology, Government of India and the Bill & Melinda Gates Foundation, to bring together global funders with national stakeholders to a single platform, with not only the aim of leveraging funding from these bodies to address some of the greatest challenges we face today, but to also promote best practices, share knowledge among partners, by bringing in international expertise into the country. Since its inception, PMU-BIRAC has been instrumental in managing the jointly funded programs and projects of the partnership, with Grand Challenges India as the flagship program.

PMU-BIRAC is responsible for executing, managing, and providing technical and financial oversight of collaboratively funded projects and initiatives. Currently, the team manages a wide-ranging portfolio of projects that are located across the country.

In 2016, Wellcome Trust UK joined this partnership and PMU-BIRAC provides technical and management support to the Affordable Healthcare in India portfolio of programs of the Trust.

PMU-BIRAC is housed at the Biotechnology Industry Research Assistance Council (BIRAC), in New Delhi and is currently a team of nine.

Our host and home

Biotechnology Industry Research Assistance Council (BIRAC)

BIRAC was set up by the Department of Biotechnology (DBT), Government of India as an Interface Agency with the aim of strengthening and empowering emerging Biotech enterprises to facilitate them in undertaking strategic research and innovation that addresses nationally relevant product development needs.

BIRAC functions as an industry-academia interface and implements its mandate through a wide range of impact initiatives, such as by providing access to risk capital through targeted funding, technology transfer, Intellectual Property management and handholding schemes that help bring innovation excellence to biotech firms and make them globally competitive.

Since its inception, BIRAC has initiated several schemes, networks and platforms that help bridge the existing gaps in industry-academia innovation and research, and facilitates novel, high quality affordable products development through cutting edge technologies. BIRAC has initiated partnerships with several national and global partners to participate in various collaborations.

BIRAC hosts the Program Management Unit (PMU-BIRAC) in its offices in New Delhi and provides intellectual, infrastructural and logistical support to the team.

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science and Technology

Department of Biotechnology, Ministry of Science and Technology, Government of India

The Department of Biotechnology under the Ministry of Science and Technology, Government of India (DBT) is the designated representative of the India side of the joint partnership.

The Department of Biotechnology was set up in 1986, making India one of the few countries in the world that has a government body dedicated solely to the advancement of biotechnology to improve the lives' of people.

Today, the DBT not only encourages innovation in biotechnology, by funding research organizations and forming strategic partnerships with industry across the country, but also encourages research in social areas such as healthcare, nutrition and food security, environmental sustainability and energy security. DBT also works through international collaborations and partnerships with organizations in multiple countries across the world.

DBT provides financial, technical and operational support in partnership with the Bill & Melinda Gates Foundation for the Grand Challenges India and Grand Challenges Explorations- India programs.

Our Partner

BILL & MELINDA GATES *foundation*

Bill & Melinda Gates Foundation

Guided by the belief that every life has equal value, the Bill & Melinda Gates Foundation works to help all people lead healthy, productive lives. In developing countries, it focuses on improving people's health and giving them the chance to lift themselves out of hunger and extreme poverty. In the United States, it seeks to ensure that all people—especially those with the fewest resources—have access to the opportunities they need to succeed in school and life.

Based in Seattle, Washington, the foundation is led by CEO Sue Desmond-Hellmann and Co-chair William H. Gates Sr., under the direction of Bill and Melinda Gates and Warren Buffett.

The foundation's work in India started a decade ago with the purpose of developing a model HIV-prevention program. Since then, its work has expanded to include maternal and child health, health and nutrition services, vaccines and routine immunization, family planning, agricultural development, sanitation, control of infectious diseases, and financial inclusion. Together with its partners, the foundation aims to deliver results none of them could achieve by acting alone.

Wellcome Trust

The Wellcome Trust has funded PMU-BIRAC to support a project entitled "Maximizing patient Impact through affordable healthcare innovations". This involves PMU-BIRAC engaging with awardees funded under the Affordable Healthcare in India funding scheme (2008 – 2015), which was aimed at funding supporting Indian-led research to develop safe, effective and affordable healthcare interventions for India and beyond. In addition PMU-BIRAC will undertake outreach activities and help identify funder-synergies in India.

The Wellcome Trust is a global charitable foundation dedicated to improving health. We support bright minds in science, the humanities and the social sciences, as well as education, public engagement and the application of research to medicine.

Our investment portfolio gives us the independence to support such transformative work including the sequencing and understanding of the human genome, research that established front-line drugs for malaria and Wellcome Collection - our free venue for the incurably curious that explores medicine, life and art.

Supporting partner

United States Agency for International Development (USAID)

The U.S. Agency for International Development works to end extreme poverty and promote resilient, democratic societies. USAID is an independent government agency that provides economic, development, and humanitarian assistance around the world in support of the foreign policy goals of the United States. In all sectors of its activities, USAID builds private sector partnerships to foster in-country sustainability and ownership with a focus on issues such as health, water and sanitation, food security, climate change, early-grade reading, and women's empowerment as a cross-cutting issue.

USAID/India is a supporting partner for the Achieving Healthy Growth through Agriculture and Nutrition program and the All Children Thriving program under Grand Challenges India.

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