



WADHWANI AI

Annual Report

2022

LOOKING BACK ON A YEAR OF TRANSFORMATION

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LETTER FROM THE CEO

For Wadhvani AI, 2022 has been a year of transformation. We met three of our four goals: to actively and meaningfully engage with our ecosystem, including governments at the central and state levels; to define problems holistically and with clarity; and to establish scalable, core competencies in solving problems rapidly using AI. We saw these as mandatory building blocks for our fourth goal—to deploy our AI solutions at scale.

We identified over 20 problems in agriculture and healthcare where AI could be used, and now have a toolset of AI solutions for a variety of problems, along with a repository of pre-fabricated and reusable AI approaches we could use to solve problems with similar underlying patterns.

As an organisation, we value innovation, professionalism, and accountability. We have implemented a systematic and integrated approach to our solution development process that encompasses problem definition, solution design, AI model building and evaluation, user research and interaction design, and program integration, in addition to in-depth monitoring and reporting, to enable informed and agile course correction, when required.

Where we are lagging is in deploying our solutions at scale, and we will correct that in 2023. Our planning will be more quantitative and precise, and we will work closely with the ecosystem to realise the ONLY reason we exist—to create a large-scale impact for the underserved in India. We must do this by building and implementing responsible AI solutions; creating rapid redeployment in the social space; ensuring integration into both existing and new systems and processes; intelligently placing the human in the loop; creating tangible capacity in AI; and constantly demystifying AI for the benefit of the ecosystem.

2023 will be an exciting year, and our focus will extend to a fifth goal: spearheading the implementation of novel technologies in the realm of large language models and generative AI. Our team has already begun integrating these advancements into our existing solutions and is identifying areas where they can provide a significant advantage. Through this pursuit, we aim to stay at the forefront of the rapidly evolving technological landscape.

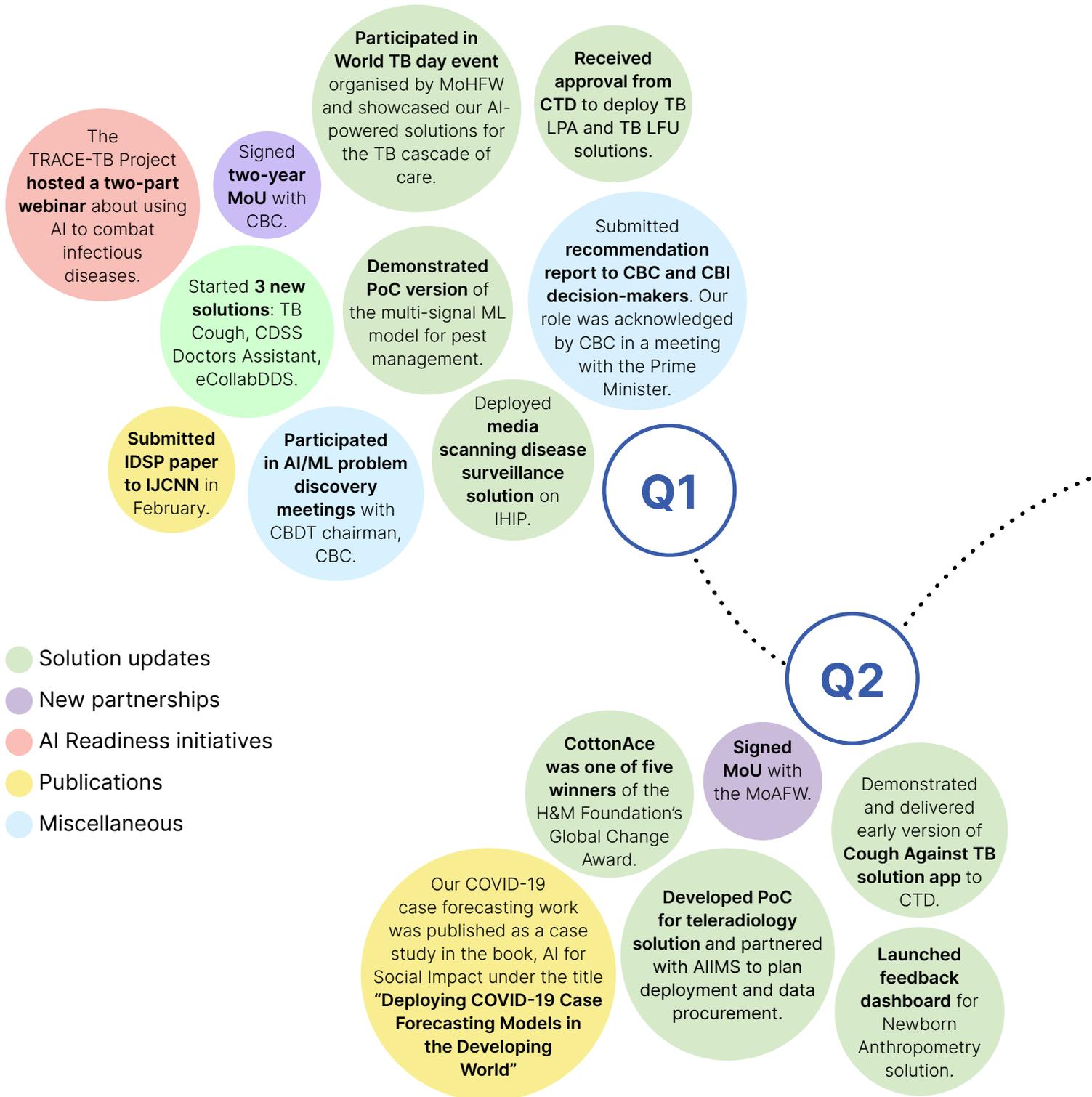
We will continue to engage with the marketplace and aspire to reach 10 crore people in India with our solutions. We are grateful to all our employees, the various government agencies that have supported us, and all our partners, collaborators, and donors.

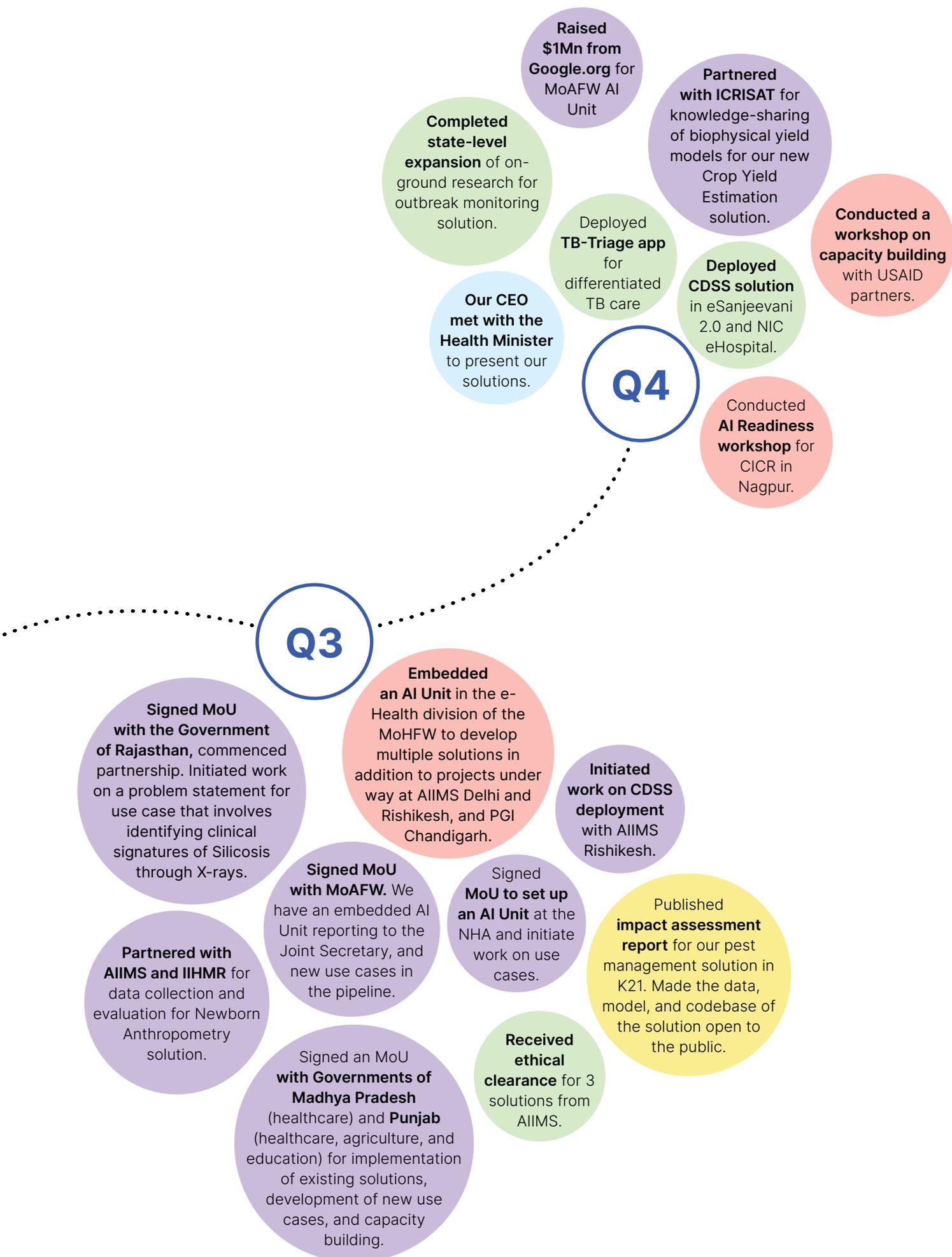


**SHEKAR
SIVASUBRAMANIAN**

CEO, Wadhvani AI

01 The Year at a Glance





02 Our Approach

AS AN ORGANISATION—

Our scope of work starts with problem discovery and ends with scaled solution deployment. Internally, the following teams work closely together to make this happen:



DOMAIN SPECIALISTS

Our team has domain specialists who understand their specific domain, with a particular focus on applying such knowledge to the social sector. This team works closely with external stakeholders, partners, and the government conversing in a language that is completely familiar to the counterparty.



AI/ML SCIENTISTS

We bring AI/ML scientists with deep applied experience in the space, backed by strong research experience to solve the core AI/ML problem. This team works on data science, algorithm development, formal hypothesis testing, and related aspects of problem solving to create and iterate multiple versions of the AI model. This team brings together deep knowledge of their domain, and applies it in a pragmatic manner, given the constraints of the operating environment.



USER RESEARCH AND DESIGN

This team works on formal user research, and designing experiences and interfaces for our end-users. Their work spans formal user interviews and research to determine archetypes and use-case scenarios, and developing core workflows and interaction design elements for our applications.



MEASUREMENT, EVALUATION, AND LEARNING (MEL) SPECIALISTS

The MEL team is responsible for the effective measurement of the solution to ensure that it meets the stated objectives. This team works in an applied setting, recognising the complexities of measurements in this space, while providing guidance towards the critical parameters that need to be captured in the solution design.



ENGINEERING

The engineering team works to define the problem formally, builds out the application that includes the AI model, user research recommendations, and measurement-oriented requirements, and integrates it into an existing technology backbone, where relevant. The team is responsible for developing and maintaining the final applications that incorporate our AI models and smoothly deploying our AI solutions at scale.

These five functional teams work together supported by analysts within the context of a well-defined, phased approach for AI problem-solving, and are managed by a **Solutions Manager**.

PROBLEM-SOLVING AT SCALE USING AI/ML

This has been a breakout year in terms of pivoting the organisation as a whole, and the ML team in particular, to a focused and execution-oriented mindset that befits an applied AI team whose charter is to build sound machine learning models for the good of humanity. I am pleased that the team is largely aligned on this focus, and that many team members have started holistically understanding the problem spaces in which we work by directly engaging with government partners, participating in the problem definition process, and going on field trips. I am proud of the fact that various relatively junior members of the team have taken on, with little experience or previous preparation, management and solution ownership roles. Without prioritising publications over solutions, academic collaborations have nevertheless started mushrooming. We expect these collaborations to play a meaningful role for our work in the future. In all these matters, government and founder support has been excellent.



Alpan Raval
Chief Scientist – AI/ML

Our team must be committed to solving problems, using AI, for the end user, regardless of problem complexity. We will find, and indeed are already finding, that the deployment constraints and the level of effort required to obtain good data will naturally define rich problem spaces that are ripe for innovation. In this regard, there are various tech motifs that we must eventually incorporate into nearly all of our work, not just because they are interesting areas of research, but more so because they are necessary in order to build robust solutions. Some of these motifs are: optimisation of human-in-the-loop, uncertainty estimation, model interpretability, few-shot learning, augmentation using synthetic data. We also expect a lot of projects to tap into overlapping data sources, and that contextual, public datasets will play an increasing role in our solutions starting 2023.

THE IMPORTANCE OF INNOVATING WITH THE PUBLIC SECTOR

For Wadhvani AI, it is important to engage with both the central and state governments through the entire life-cycle of our solution development and deployment process. For each ministry and state we work with, we work closely with decision-makers who are fully focused on execution. We are also cognisant that it is important to build partnerships that are impervious to personnel change or political upheaval. Working closely with relevant personnel across the board in government organisations is critical to building a trust-based relationship with them, and is a necessary aspect of successful scaled deployment. We also actively seek feedback and strive to incorporate it through the rank and file of the institute.

Our innovations can be scaled faster and more efficiently by our partners in the public sector. Wadhvani AI's mission is steadfast and clear—to ensure that our innovations are truly adopted at scale, and to socialise AI so that all ecosystem partners are ready for defining and solving problems using this promising technology. This way, we fulfil our mission of creating as large an impact as we possibly can, to reach the poorest of the poor across the globe.

The importance we accord to government partnerships is reflected in the AI Units and Centres of Excellence that we have set up within government ministries. Having our teams on the ground and inside public sector offices, interacting with beneficiaries, partners, donors, and other stakeholders is very critical. Equally important for us is to not just display, but also fulfil our intent. This is why we have set up AI Units within various government ministries, staffed with domain experts, AI/ML scientists, business analysts, and solution managers, among others. We are completely changing the methodology of how technology solutions are built in a public-sector setting, from the inside out.



Janak Shah
Associate Director –
Strategic Programs and
Partnerships

BUILDING EMPATHY FOR SUSTAINABLE SOLUTIONS

When defining solutions, it is important for us to understand the perspectives of all stakeholders in the ecosystem. A successful solution depends heavily on building trust and providing value to everyone in the ecosystem. This includes state and central government administrators as well as solution implementers such as healthcare workers and farmers. Only once we truly understand their workflows, concerns, and motivations, can we build an inclusive solution that seamlessly integrates with and adds value to existing systems, which is our ultimate goal.

The challenge for us continues to be how to maintain this quality and rigour in building solutions as we scale up. In the past year, we have realised that it takes more than just user research experts to continue this effort. In 2022, we have been laser-focused on building internal capacity through training to allow folks such as solution managers and business analysts along with everyone else to learn the tools that will help them empathise with stakeholders without biases. This effort has also required designers at all levels to step up and take a more applied research mindset. Such an effort has been unprecedented in the social impact space. There is continuous engagement with users, from the stage of problem-definition to post-deployment, so that we can be iterative in our approach and improve the solution.

Instead of just looking for solutions, there has been a shift to ensure we as a team understand the problem really well first. This approach has also helped us build digital interfaces that are easy to use and are designed to encourage trust and transparency in how the AI solution works.



Aayushi Bhotica
Lead UI/UX Designer

LIGHTS, CAMERA, PRODUCTION!

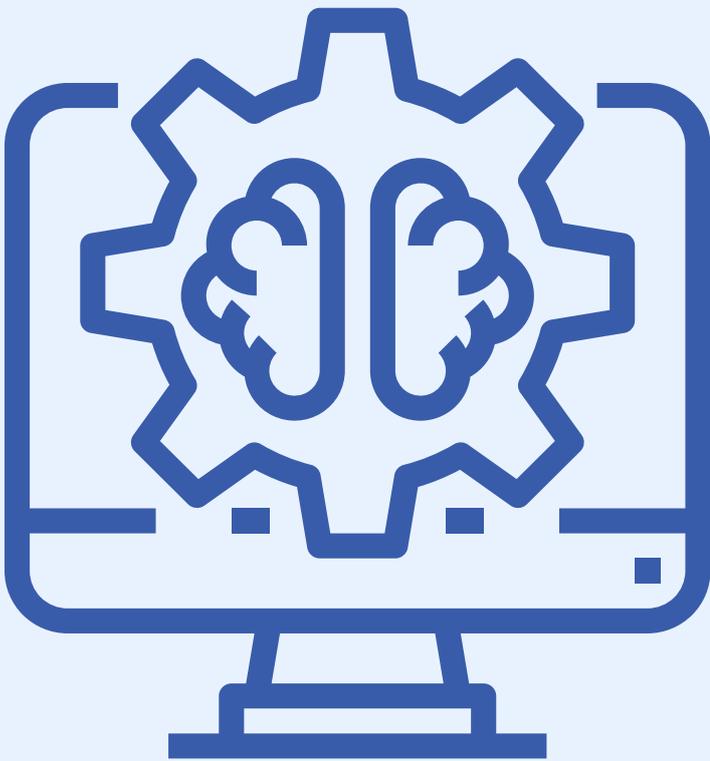
Any tech solution with innovative AI/ML at its core requires an even better engineering ecosystem for it to reach its maximum potential and ensure that the value created by our models reaches our end-users without friction. As an engineering unit, nothing is more gratifying than seeing your code go into the real world, into production. 2022 was an enriching year for us—not only did we build quick proofs of concepts, but we were also able to deploy multiple solutions.

With the institute reinventing itself and evolving as an impact-first organisation, we were able to align ourselves with the engineering mantra of BuDI (build, deploy, iterate), and roll out solutions in a time-sensitive manner. It has been a delight to see the team step up to the task of delivering impact by quickly building and deploying solutions, while ensuring the products rolled out are robust, scalable, and top-quality. This year, we added some structure to the engineering team to have focused units working on a set of problems in a dedicated area, which has empowered team members with clear responsibilities and ownership.

With the growing number of problems the institute is working to solve, we understand that all these problems, though unique in their own way, are connected by some common threads. Along with building unique solutions for specific problems, we will focus in the coming year on following these common threads to build systems in an abstract and reusable manner, including some core components such as data collection and annotation platforms.



Abhishek Kumar
Engineering Manager



04 AI Solutions

EFFECTIVE PLANNING, DEVELOPMENT, AND DEPLOYMENT THROUGH SOLUTIONS MANAGEMENT

2022 was a year of exponential growth through well-structured solution organisation. The focus was on problem identification through various engagements with government ecosystems. Our efforts reaped great returns. We started the year with six solutions, and were quickly able to increase this number to twenty.

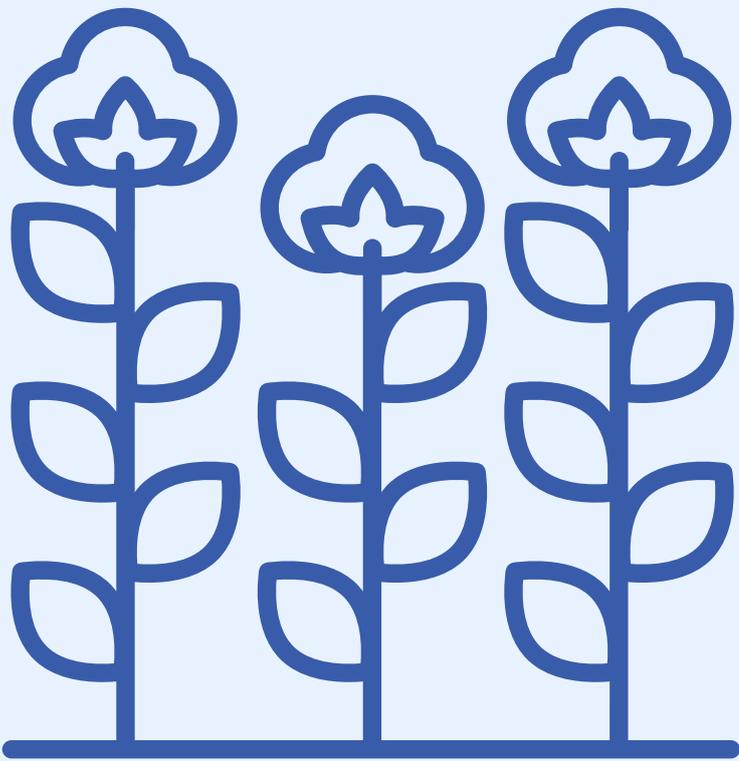
For each of these solutions, we changed the strategy from primary data collection to identifying and collaborating with programs and institutes that already hold such data sets. While primary data collection is still required for some of our solutions, the availability of datasets has become an important part of our internal use-case validation process for perusal.

Data quality was a significant issue in a lot of the data sets that were collected by various central/state programs. As a part of our system-strengthening efforts, we guided platforms on collecting high-quality data and, in some cases, built plug-in-ready data collection mechanisms. We further leveraged this approach to facilitate the early deployment of some of our models to collect more data in field settings. We planned for the highest level of safety to ensure the responsible use of our AI solutions through stringent validations, appropriate disclaimers, humans in the loop, and close monitoring.

While we could achieve a lot in just one year due to our constant hustle, we still have a long way to go. 2022 was the year of definition and development. In 2023, the focus will shift to deployment and scale.



Nakul Jain
Director – Solutions



05 **Agriculture**

STRENGTHENING SYSTEMS BY BUILDING TRUST

2022 has been a mixed bag, with successes to celebrate and a few challenges to introspect on. The highlights of the year have included being awarded the Global Change Award by the H&M Foundation, and entering into a partnership with the Ministry of Agriculture and Farmers' Welfare (MoAFW), Government of India.

Through the year, we observed that good relationships with farmers and extension workers led to a direct rise in the usage of the CottonAce app. Our focus for the next season will be on reaching as many farmers as possible, and strengthening our relationships with extension volunteers and officers, field facilitators, and other program staff.

The support of the central government has been crucial, but even so, the acceptance of the CottonAce solution by state agriculture departments and other institutions has been gradual. And past trends have indicated that it has taken about a month for our work in the lab to be reflected on the field, and this has occasionally been found to lower motivation among field teams, resulting in lower adoption. In the coming season, we are making an early start with key new partnerships and other capacity building initiatives, in addition to improving the accuracy, scope, and efficiency of the solution. A good beginning is half the battle won.

Feedback arrived from various corners in 2022, and our team was able to listen, learn from our mistakes, and ideate for the future, learning to work better together in the process. We expect that this will positively impact our work in 2023. Systems are strengthened with trust.



JP Tripathi
Associate Director –
Agriculture

CottonAce

AI-POWERED PEST MANAGEMENT

CottonAce is Wadhvani AI's AI-powered early warning and advisory system for cotton farmers in India. The solution helps farmers protect their crops by determining the right time to spray pesticides, in the right amounts, through immediate and localised expert advice, delivered onto their smartphones.

We developed the CottonAce system to help cotton farmers quickly identify the threat to their farms from infestation caused by pests such as pink bollworms and American bollworms. The solution ecosystem includes farmer welfare programs to manage pest infestations, with the primary users being the farmers that are under the purview of these programs (called lead farmers). Lead farmers or extension officers install the CottonAce app and upload a photo of pests collected in the installed pheromone traps, on a periodic basis, to the CottonAce app. The AI model at the heart of the app identifies and counts the pests in the uploaded photos and determines the level and type of infestation, based on which a set of actionable advisories are generated. The farmers and extension officers benefitting from these advisories are encouraged to share them with neighbouring farmers (called cascade farmers), who can then take the required actions, even without access to smartphones.

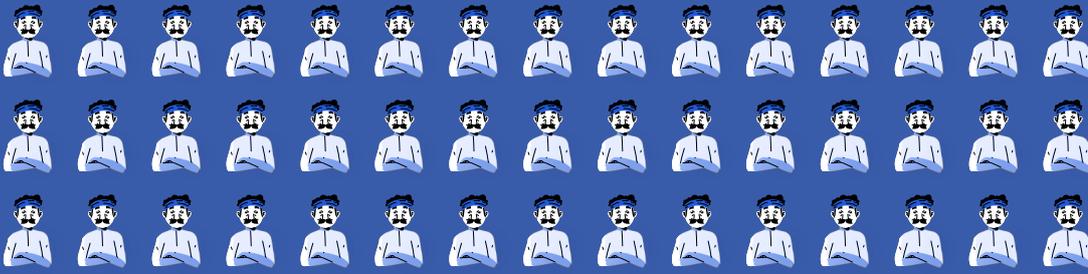
The CottonAce app can work offline in remote areas that have intermittent connectivity, and is multilingual, supporting English and eight other Indian languages. Along with the app, a web-based dashboard supports program implementation with a real-time (as well as historical) view on the pest occurrences in monitoring plots as well as the village.

Our CottonAce solution aims to reduce pesticide use, increase crop yield, and raise incomes for smallholder cotton farmers.

We were able to achieve a significant impact during the Kharif 2021 season, with the app being deployed in 60 districts across 10 states of India (a detailed impact report is available on our website). Following that season, 2022 saw a greater emphasis on monitoring and evaluation for all of our AI solutions, including CottonAce.

However, 2022 was different from the previous year for a few reasons. Many cotton-growing states experienced a delayed monsoon followed by a heavy rainfall, leading to later sowing dates, re-sowing, and losses to the farmers who had sown cotton with the first flush of the monsoon. Heavy and continuous rainfall resulted in stunted crop growth and early flowering, which was a blessing in disguise for farmers because their crops were able to survive Pink bollworm attacks. In many districts, farmers shifted to other crops due to the short growing window that remained in the Kharif season due to weather-related damages. Many farmers were left with no option but to abandon their efforts during the Kharif season and pin their hopes on Rabi crops.

Despite these limitations, we were able to deploy the solution across six states—Maharashtra, Telangana, Punjab, Rajasthan, Karnataka, and Gujarat—and onboard several new partner organisations to further extend the reach of the solution. These liaisons will boost our efforts in 2023 as well.



140+

talukas

30+

districts

33,000+

6

states

farmers reached

This year, cotton farmers benefited from **3,094 alerts** generated by the CottonAce app, indicating whether their farms had high, medium, or no infestation, with the accompanying advisories. We are currently in the process of evaluating the impact of the solution in 2022. The evaluation framework has been designed, and data has been collected from **500 farmers** to begin impact assessment.

The pest management program onboarded 13 new partners, and entered into a partnership with the MoAFW, Government of India. The ministry has extended its support to Wadhvani AI and has been instrumental in the new partnerships we have been forging with state governments.



Global Change Award

An innovation challenge
by H&M Foundation

We were one of five winners of the H&M Foundation's Global Change Award in 2022, and were invited to attend accelerator programs in Stockholm and New York City as part of the GCA program.

Being a part of the GCA cohort and availing of the industry interactions, support and mentorship that it offers is helping to drive us further towards realising our goal of improving the lives of cotton farmers in India and other developing nations.



HIGHLIGHTS IN 2022

We open-sourced the pest management codebase for other developers and researchers to experiment with and expand on, with the repository published on GitHub.

We launched two ML competitions in September, with Zindi, FAIR Forward, and GIZ, inviting ML experts from around the world to build models that accurately count bollworms present in an image, and classify images as positive (containing bollworms) or negative (no bollworms).

Our paper on the rejection of out-of-distribution images in pest management was accepted at the NeurIPS workshop on 'Challenges in Deploying and Monitoring Machine Learning Systems'.



NEW AI APPLICATIONS IN AGRICULTURE



Crop Yield Estimation

Enabling the ecosystem to better forecast crop yield estimates at regular intervals.

Enabling the government to optimise exports and imports, formulate policies, prevent price fluctuations, and process insurance claims more efficiently.



Integrated Agriculture News Monitoring

An AI-powered system for the Ministry of Agriculture to track infestation, crop diseases, and other events of interest across the country, on an ongoing basis.

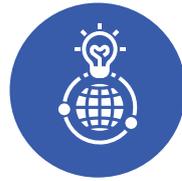
This system will monitor media sources across a range of locations and languages and generate alerts to enable early preventive measures.



Digital Farm Diary

An easy-to-use, multilingual, voice-based digital diary for farmers to record vital farming information that will be analysed to evaluate and optimise crop harvesting based on the time, efforts, and resources available.

This solution can be incorporated with the AgriStack data repository to facilitate future AI innovations.



Automating KCC and KKMS

A scalable response system and smarter knowledge base to improve the existing Kisan Knowledge Management System (KKMS) scheme.

Digitising call data and using modern AI to augment and optimise the Kisan Call Centre (KCC) system, resulting in reduced call and wait times and quicker resolutions for farmers.



National Pest Surveillance System (NPSS)

An AI-powered dashboard to enable pest monitoring and management across multiple types of crops.

This will allow for better decision-making, faster problem-solving, and increased efficiency in dealing with challenges, operations, planning, and management.

Google.org

We received a generous grant of \$1 million from Google.org towards developing these new use cases in agriculture.

The sustained support of Google.org is an enormous boost as we work on building AI solutions to improving agriculture systems in India at scale.



06 **e-Health**

PROGRESS OVER PERFECTION

In 2022, we have taken calculated risks and avoided waiting to build a perfect solution before its deployment in the field. Our approach has been to focus on delivery, with an understanding that our work is not done once a solution is deployed; we must continuously monitor, evaluate, and improve the model. Adopting an agile approach has helped us build quickly, deploy, evaluate, and iterate.

We believe our e-Health engagement has been a game changer for us, opening up a plethora of opportunities. We need to work even harder now to make the most of it.

Our work with AIIMS Delhi is in progress, with three solutions in full flow and one solution in the exploration phase. We have been working with AIIMS Rishikesh and PGIMER to explore more use-cases. Our work is expected to expand manifold: there has been considerable interest from the medical community, across various institutions, to collaborate on use cases that would benefit from AI interventions.

This year, we also had an opportunity to work on a vision document for the Ministry of Health and Family Welfare (MoHFW), envisioning the part AI will play in India's healthcare landscape. Among other things, it gave us yet another opportunity to bring our vision to the table, and lead the initiative to enhance the country's healthcare system using AI.

Being included in multiple Ministry-led projects has been exciting for the team, but the work ahead of us is challenging. Now is the time to grow our team and ramp up our efforts to meet the ever increasing demand for the work we do.

Our AI-powered disease monitoring solution has already been deployed and is being used actively by the Government of India's Media Scanning and Verification Cell, and we're looking forward to our Clinical Decision Support System being integrated with eSanjeevani 2.0, the updated version of India's national telemedicine platform, early in the coming year.

There has been considerable progress in all our work with the Ministry of Health and Family Welfare's e-Health division, and they have been appreciative of our efforts. The next step is to have solutions deployed on the field.



Nakul Jain
Director – Solutions

Event-Based Disease Surveillance

USING AI TO AUTOMATE THE EARLY DETECTION OF DISEASE OUTBREAKS

The Integrated Disease Surveillance Programme (IDSP) was established by the National Centre for Disease Control in 2004, as a decentralised, laboratory-based, and IT-enabled disease surveillance system for epidemic-prone diseases. One of the stated objectives of the IDSP, under the aegis of the Ministry of Health and Family Welfare, is to “develop and maintain an Information Communication Technology—for collection, collation, compilation, analysis, and dissemination of real-time data”.

We have developed an AI solution to automate the process of disease surveillance, with the aim of augmenting the capabilities of existing public healthcare frameworks at the central and state level in India. In April 2022, our solution was integrated with the IDSP’s Integrated Health Information Platform (IHIP), and continues to be in active use by officials. It employs natural language processing and other machine learning techniques to filter, extract, and collate events of interest, pertaining to potential disease outbreak indicators, at scale.

These are leveraged by the Media Scanning and Verification Cell (MSVC) of the National Centre for Disease Control (NCDC)—the body responsible for event-based disease surveillance in India—to generate alerts and offer insights into disease outbreaks.

Our AI model automatically and continuously scrapes the web to collect data via news reports and digital media on the internet. A Relevance Classifier identifies news articles that contain specific events of interest. Information is then extracted from these selected articles using ML algorithms, stored in a database, and presented in the form of an easy-to-use dashboard, which is integrated

into the IHIP portal operated by the Government of India. MSVC personnel then use the dashboard to keep track of potential outbreaks and create alerts, as required, for public healthcare officials. Central Surveillance Units share the alerts with State Units, and eventually, District and Block Units are notified, for specific actions to be carried out.

Our solution now supports 10 Indian languages in addition to English, allowing the MSVC to cover more ground by scanning news reports in various regional languages. The model has been improved to cluster the same news articles across different publications to reduce duplication, and a secondary database has been created to improve app performance and reduce latency.

We also provide translated versions of reported articles, so that reviewers at the MSVC are able to raise alerts based on articles written in a language other than those they may be familiar with (English, Hindi).



Since its launch, the solution has analysed over 9 million articles and raised hundreds of flags about potential events of significance. The MSVC has already raised over 450 alerts using our application.



We are exploring improvements to the solution’s effectiveness through the addition of newer media sources and types and continuing to refine our AI model to enable the expanded use of the disease monitoring system.

Clinical Decision Support System

ASSISTING DOCTORS AND HEALTHCARE WORKERS FOR MORE EFFICIENT AND INFORMED DECISION-MAKING

In rural India, where over half of the country's population resides, there is an acute shortage of trained medical personnel and resources. To address these shortages, we are developing a suite of AI-powered tools that can assist doctors and other healthcare staff with diagnosing and managing patients.

Patient Assistance

The first in the Clinical Decision Support System (CDSS) suite of AI-powered tools is a multilingual Patient Assistance solution in the form of a smart interactive form. As they wait at the healthcare facility to consult with a physician, patients are asked to answer a series of pertinent questions in the line of diagnosis. This solution translates patient inputs in English and several other Indian regional languages.

Diagnostic Assistance

Another tool in development is a Diagnostic Assistance solution to assist physicians during consultations. Based on the signs and symptoms collected via the Patient Assistance form, the Diagnostic Assistance tool suggests a list of probable differential diagnoses, along with suggestions for diagnostic tests.

OTHER TOOLS IN THE SUITE

PATIENT TRIAGING

Triaging emergency patients for consultation, referring to the nearest healthcare facility, and optimising appointment scheduling.

TREATMENT REGIMEN ASSISTANCE

Prescribing generic drugs (as per SNOMED CT), along with dosage and duration for treatments, based on diagnoses confirmed by doctors.

TREATMENT ADHERENCE ASSISTANCE

Predicting treatment adherence for patients through monitoring patients' lifestyles and treatments at home.

MORBIDITY RISK PROFILING

Predicting the development of chronic or lifestyle-based diseases based on symptoms, lab and radiological investigations, treatment adherence, and past diagnoses.



Decrease the duration and improve the quality of doctor-patient consultations.



Improve the quantity and quality of patient symptom data.



Predict workloads for healthcare facilities in the system for more efficient and informed resource management.

Use Cases in Development

EXPLORING THE POTENTIAL OF AI INTERVENTIONS IN DIGITAL HEALTH

Ophthalmology

We are developing AI solutions to detect the presence of eye conditions and diseases, in order to empower frontline healthcare workers to identify diabetic retinopathy (DR) and corneal opacity at the onset, to improve patient outcomes.

One of our proposed solutions may be used at primary and community healthcare centres to screen for DR using a fundus camera (handheld or table-top), along with a registered and trained practitioner.

We have developed a PoC ML model for this solution, and data collection and annotation to train the model is underway, in collaboration with AIIMS. We are exploring deployment pathways, as well as new use-cases, for uveitis and predicting neurological disorders through fundus images.

Dermatology

We are developing an AI solution to help medical practitioners and first responders to efficiently screen and diagnose skin conditions, for the 15 most common skin diseases, and provide an appropriate treatment plan as per NHSRC guidelines.

Our AI model has been trained on an open-source dataset of 7,000 images. We plan to integrate it with our CDSS suite of tools, and we are also exploring other potential deployment pathways.

Teleradiology

We are building computer vision solutions to provide automated radiological feature detection services at remote healthcare facilities. So far, we have developed a PoC AI model for radiological feature detection in chest X-rays (trained using publicly available datasets), which has been integrated with eCollabDDS, the government's teleradiology platform.

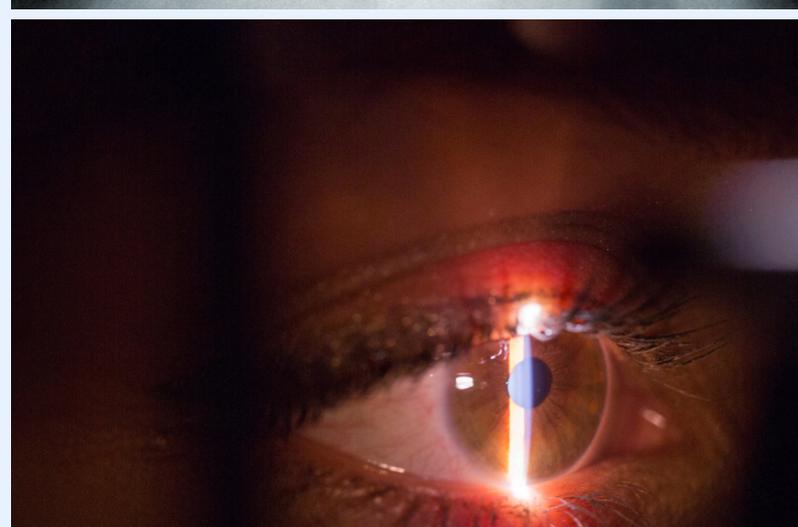
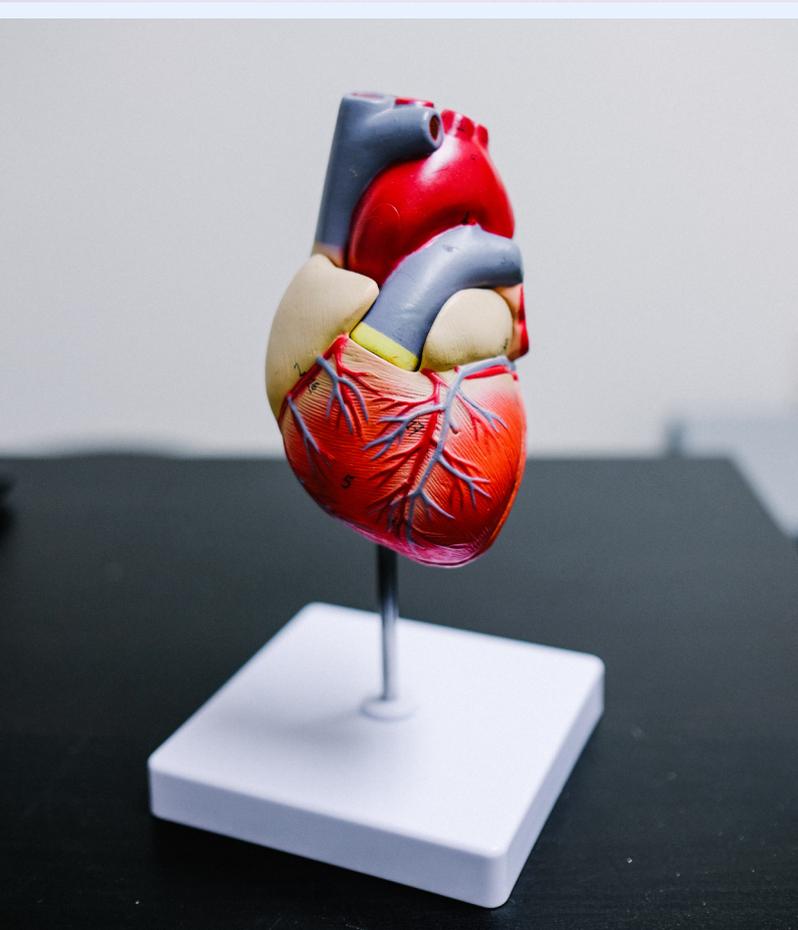
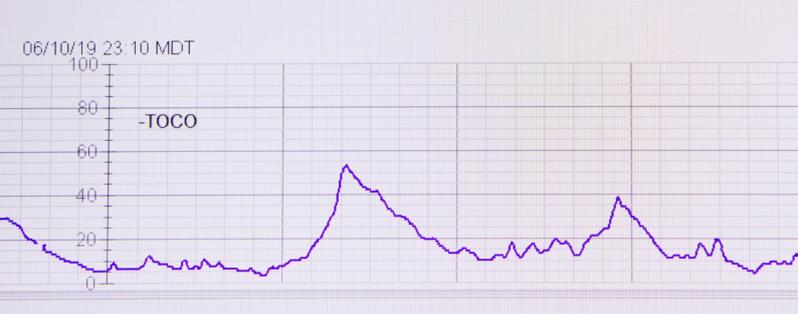
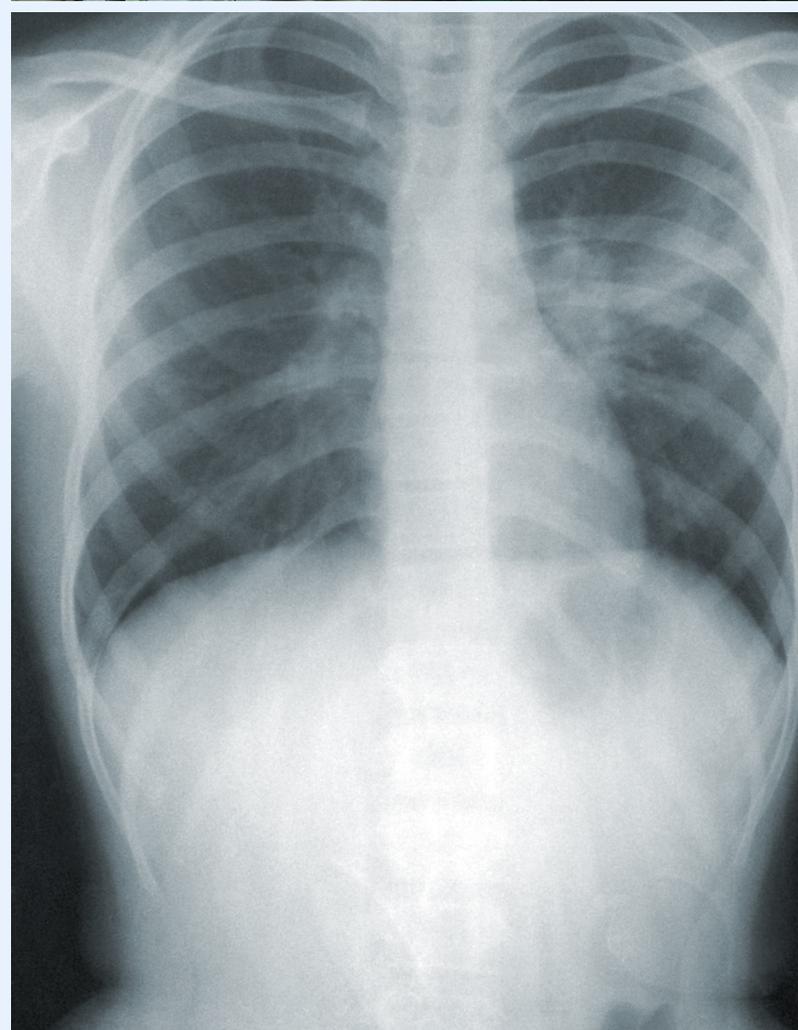
The PoC AI model detects the presence of 17 radiological features (e.g., cardiomegaly, pneumothorax, edema, fibrosis), and aims to reduce the occurrence of missed findings in chest X-rays by providing diagnostic assistance to radiologists and medical practitioners.

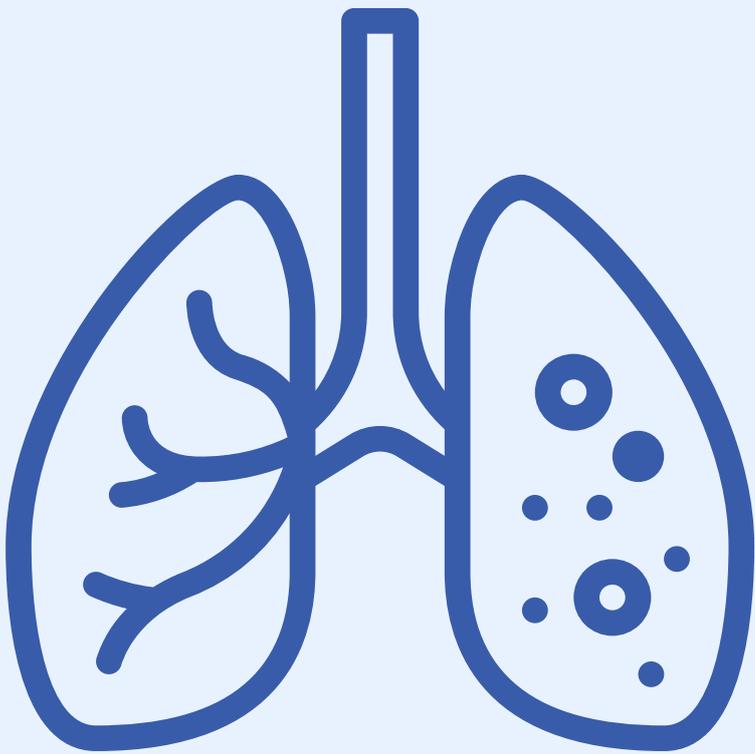
We have partnered with AIIMS to create a solution development plan and procure Indian data, and placed a data entry operator at AIIMS to curate a validation dataset (retrospective X-rays).

We are working towards deploying this model in at least two different solutions for on-field use: abdomen CT scans and extremity X-rays.

Cardiology

We are exploring possible AI interventions for impact use-cases in cardiology, including the estimation of ejection fractions using ECG data to reduce the costs and times involved in identifying cardiac diseases.





07 **Tuberculosis**

DOUBLING DOWN ON TB



Kowshik Ganesh

Chief of Party –
USAID TRACE-TB

2022 was transformational for Wadhvani AI and has seen us evolve as an implementation-first organisation.

We executed two projects in the TB space: the automated reading, interpretation, and transmission of Line Probe Assay results and the prediction of the risk of loss to follow-up (LFU) and mortality among TB patients at the onset of treatment. Two new projects, Cough for TB and Differentiated TB Care, are primed for deployment.

In order to account for wide geographic, socioeconomic, and cultural differences in designing our solutions, we began engaging with State TB Cells to conduct decentralised pilot studies and learn lessons from varied geographies.

The first state AI unit has been established in Madhya Pradesh. We intend to test all our TB solutions in the state, given that it has a wide variation of urban, peri-urban, rural, and tribal populations.

The Wadhvani AI TB team presented our work in several national workshops and conferences, and also won the Outstanding Paper Award at the ML4H symposium, USA, titled 'Predicting Treatment Adherence of TB Patients at Scale'.

We hope to double our scale in 2023 by kickstarting at least four new projects in the TB space.

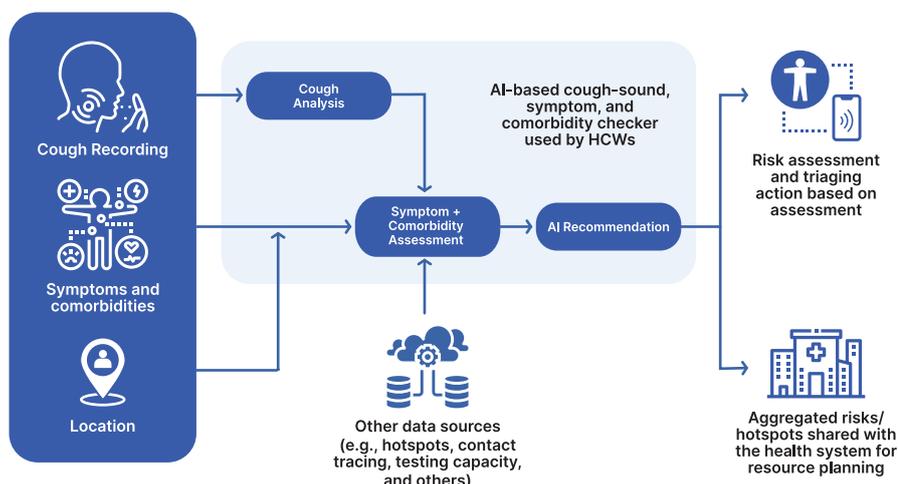
Cough for TB

SCREENING FOR PULMONARY TB USING COUGH SOUNDS

Coughing is one of the predominant presenting symptoms of pulmonary TB, and certain characteristics in the sound signatures of the coughs of TB patients are likely to correspond with TB indicators. Screening people based on these sound signatures using AI techniques may help guide high-probability cases towards early diagnoses and timely care.

Our AI solution for screening of TB cases using cough sounds, is being developed in collaboration with the CTD, as part of the USAID-supported TRACE-TB Project. It has been trained on data that includes cough sounds, symptoms, and comorbidities collected from TB-positive and -negative cases from across India. Audio inputs are converted to spectrograms, which are used, along with symptomatic data, as inputs for a deep neural network that learns to predict the likelihood of an individual being a presumptive TB case.

HCW captures subject data using the Cough for TB smartphone app



Updates

In 2022, we developed two apps as part of this solution: one for healthcare workers to screen individuals in health facilities and community settings, and the other to enable self-screening in the general population. Both apps are ready for deployment.

Our AI model has surpassed the existing symptomatic screening method's sensitivity based on an evaluation dataset of 1,000 individuals from key populations, in community settings.

The AI model is currently being evaluated by the ICMR. Upon validation, we plan to implement and deploy the tool at Ayushman Bharat Health and Wellness Centres across India, starting with Nagaland and Madhya Pradesh.

An easy-to-use and cost-effective AI-powered tool for use by healthcare workers to screen for pulmonary TB at the point of care.

Enabling self-care in the general population, thereby reducing the stigma associated with diagnostic tests for TB.

Up to 1 million people may be positively impacted by the solution in 2023.

Enabling mass community screening for pulmonary TB.

Line Probe Assay

REDUCING DIAGNOSTIC ERRORS AND IMPROVING EFFICIENCY

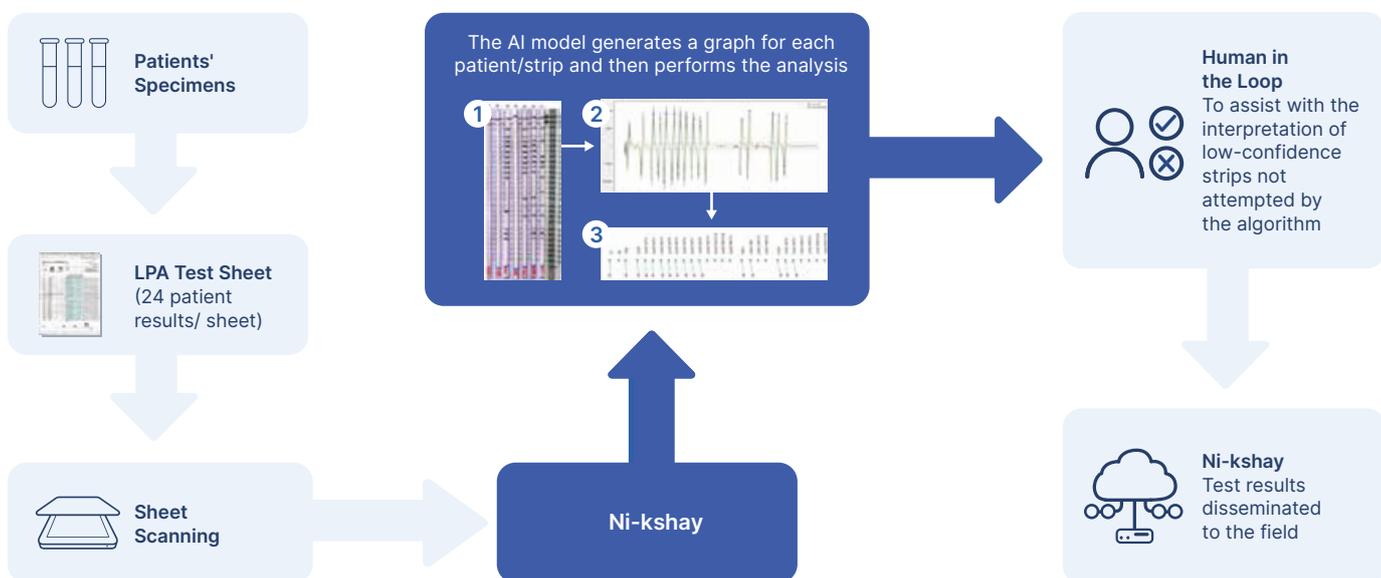
Line Probe Assay (LPA) is a rapid molecular diagnostic technique used to diagnose drug-resistant tuberculosis (DR-TB). We are developing an AI solution that employs computer vision to automate the reading, interpretation, and transmission of LPA test results—a process that is currently manually carried out by lab technicians for an estimated 400,000 results every year across the country.

The solution aims to reduce processing times and manual errors, and improve the accuracy of test results, thus aiding in both early diagnosis and the determination of appropriate treatment regimens for drug-resistant TB patients.

Updates

The CTD has officially approved integrating the solution with Ni-kshay, and integration is underway. Validation of our model by the ICMR has also begun.

Passive evaluation has shown promising results, which have been shared with the CTD. A ground-truth study conducted by a panel of experts nominated by the CTD has been successfully completed, with the model showing a Positive Predictive Value greater than 93% for first-line and 86% for second-line tests.



To be deployed across 87 CDST labs across the country.

An estimated 12,000 additional patients benefited per year from receiving the correct treatment regimen.

Faster treatment initiation, with an estimated 200,000 patient-days saved annually.

Improved reading, interpretation, transcription, and transmission of LPA results.

Estimated to impact 400,000 TB patient tests.

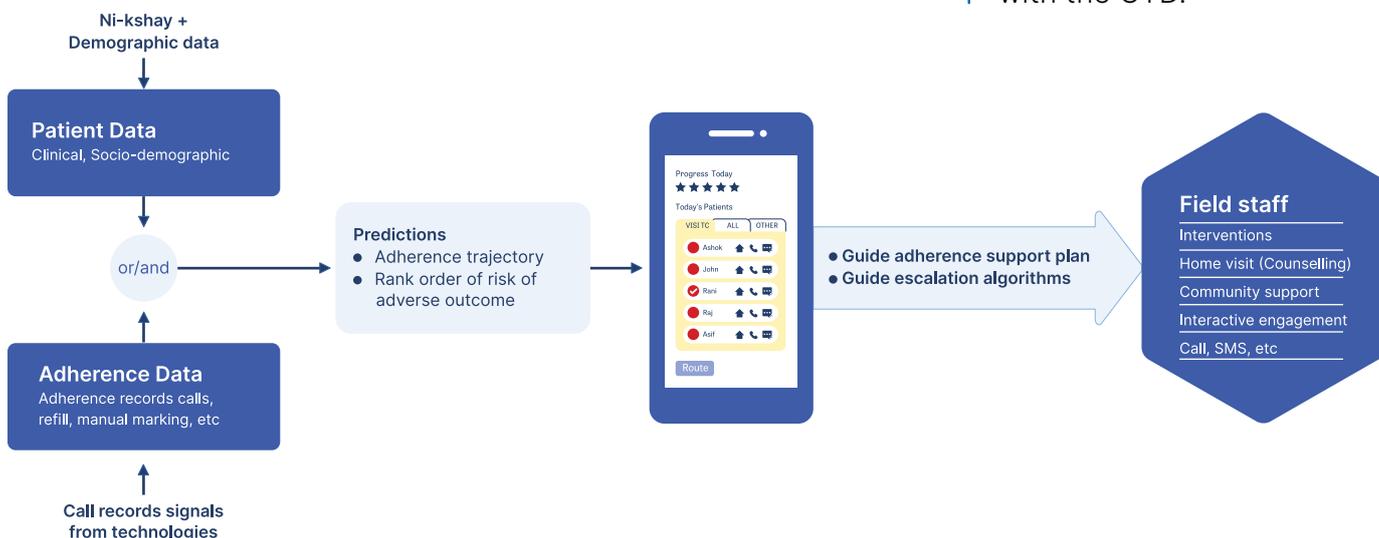
Overall reduction in turnaround times of up to 12 hours for every patient tested.

Predicting Loss to Follow-Up and Mortality

PREDICTING THE RISK OF NON-ADHERENCE AND MORTALITY TO STRENGTHEN DIFFERENTIAL CARE

We are developing an AI-powered solution for the early prediction of the risk of treatment drop-offs in TB patients, also known as loss to follow-up (LFU), and adverse outcomes, such as mortality. LFU is an extreme form of non-adherence to the prescribed TB treatment regimen, where treatment is interrupted for one or more consecutive months. Early prediction of LFU and mortality is of the utmost importance, since these patients may be silent transmitters of TB, and can amplify the spread and development of drug-resistant TB.

The objective of this solution is to stratify the TB patients who are at risk of LFU and mortality in order to support frontline health staff to make proactive decisions in offering differentiated care for high-risk patients.



Updates

In 2022, we built an AI model to predict the risk of LFU and mortality. We have received clearance for conducting pilot studies in several states, and will begin shortly.

As we await further Ethics Committee approvals, we are making plans for a pan-India deployment of the solution, in collaboration with the CTD.

At 35% program efficiency, the solution will aim to save 74% patients from loss to follow-up and other adverse outcomes, including mortality.

With an estimated 100,000 patient beneficiaries set to receive AI model risk predictions in the early deployment planned in 2023, 35,000 high-risk patients of whom will be targeted for differentiated care, the solution is expected to avert 1,400 TB patients per year from potential loss to follow-up and other adverse outcomes, including mortality*.

*If the baseline LFU mortality rate is 7%, i.e., 7,000/1 Lakh patients initiated on treatment, a reduction of 20% translates to 1400 patients.

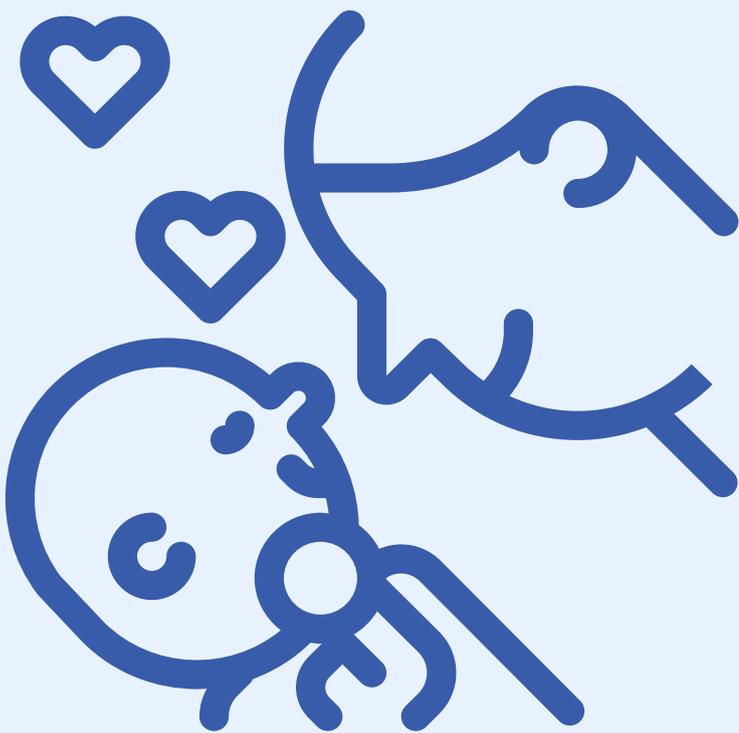
Differentiated TB Care

TRIAGING TB PATIENTS FOR EMERGENCY CARE

We are developing TB-Triage, an AI solution that leverages the differentiated TB care model to mitigate mortality among TB patients that access Health and Wellness Centres in the public sector. TB-Triage will manage and support risk prediction, the stratification of patients, and the collection of intervention data.

The AI model at the heart of the solution assesses 16 variables (BMI, MUAC, pulse rate, temperature, blood pressure, respiratory rate, oxygen saturation, haemoglobin, icterus, oedema, HIV status, RBC, TWC, chest X-Rays, haemoptysis, and general conditions), and arrives at a machine-driven scoring methodology that is meant to strengthen existing systems.

Community Health Officers (CHOs) at the primary healthcare level will screen patients and, after completing a basic clinical assessment of the patients and a risk-based stratification of patients, provide and ensure appropriate care to the patients identified as 'special risk'. While some patients may require no referrals, others may require urgent outpatient care, and there may be those that require in-patient or even critical care.



**08 Maternal, Newborn,
and Child Health**

SHAPING MATERNAL, NEWBORN, AND CHILD HEALTH IN INDIA IN ITS FORMATIVE STAGES

It would not be wrong to say that the challenges for our MNCH team in 2022 were the same as the ones in the year before. While obtaining high-quality data and solving the deployment puzzle are two of the biggest challenges for any solution in the organisation, collecting longitudinal data for our Newborn Anthropometry solution has been quite challenging, and partnerships have taken a significant amount of time to yield data we can use.

Our key learning has been that continuing in this way is not sustainable in the coming year. From a data collection perspective, we are pivoting to a model of proposing data collection, validation, and ground-truth assessment, as a combined effort that we believe will work better. We are aided by good results from our modelling efforts and successful development of the solutions that we will test and validate in the coming year.

We feel gratified to have been able to create a working solution, despite the limited availability of data. We have been further buoyed by strong results from our ML models, and the ML team has pulled off good-to-go performance levels with a combination of additional data and technical improvements. This sets the stage for deployment in 2023.

The MNCH team has an exciting time ahead; we are extending anthropometry to an older age cohort, and are at the cusp of acquiring data pertaining to antenatal visits and pregnancy outcomes from multiple sources. This is sure to enable many promising new use-cases for us to explore.

In many ways, our team is feeling the entrepreneurial spirit that will be required to make 2023 successful. We need to operationalise some of our collaborations at a higher scale. In contrast to the other teams within the organisation working in the healthcare domain, we notice an important difference for MNCH, in that digitisation is at an early stage of development. This is an opportunity as it allows us to be a part of the formative stages of building data pipelines that will eventually result in high-quality data that will facilitate new solutions for us in 2023.



**Vijayalakshmi
Raghavan**

Director – Solutions

Newborn Anthropometry

ASSISTING HEALTH WORKERS IN IDENTIFYING UNDERWEIGHT NEONATES

Neonatal mortality accounts for nearly two-thirds of infant mortality and half of under-five child mortality. Low birthweight (LBW) is one certain indicator of mortality, particularly in the first month of life. Wadhvani AI has developed a smartphone-based technology to help frontline healthcare workers identify underweight neonates and monitor their

growth, without having to rely on bulky and often unreliable equipment. Our AI solution provides accurate, geo-tagged, and tamper-proof estimates of a baby's weight, body length, and other vital measurements. Our solution also incorporates a web-based dashboard for healthcare administrators.

Updates

We launched a web portal for partners to review feedback on the data collected. We integrated an updated AI model with our Digital Tarazu anthropometry app model for passive validation of the solution. We also launched H-Fieldy, a data collection app for use by staff at Niloufer Hospital.

We also created training manuals in multiple regional languages and developed an AR interactive app to train ASHAs at scale to use our anthropometry solution. We have planned for a ground-error estimation study, and data collection in community settings is in progress.

We are partnering with government hospitals and medical colleges that can help us enrol newborns in the hospital and conduct follow-ups at their homes. We believe this can significantly expedite the process of data collection.

What's next

We have prepared an evaluation framework for the solution, and are awaiting a formal approval from the Ethics Committee.

3

active partners in 2022:
SEWA Rural Gujarat,
PGIMER Chandigarh, and
Niloufer Hospital,
Hyderabad

4,799

babies enrolled

12,017

visits

Under-6 Anthropometry

SCREENING FOR MALNUTRITION AND TRACKING GROWTH FOR CHILDREN AGED 6 MONTHS–6 YEARS

Our proposed computer vision solution to assist frontline healthcare workers in measuring the height and weight of children by age was approved in July. We visited Anganwadi Centres in Gujarat, Rajasthan, Uttar Pradesh, and Jharkhand to understand how they currently operate, and conducted secondary research in those states.

We have conducted training on our Child Safety and Protection Policy and are awaiting Ethics Committee approvals. Our data collection protocol has been finalised, as have our implementation partners for the project.

Pregnancy Risk Stratification

PREDICTING RISKS TO PREGNANT WOMEN AND NEWBORNS

One approach to improving antenatal care is the early detection and effective management of risk indicators for women with high-risk pregnancies (HRP). HRP women need differentiated and specialised treatment and care to prevent morbidities and mortality. We are working on an AI solution to enable the early detection of risk indicators in pregnant women and prediction of adverse outcomes for mothers and newborns.

We have developed a technical PoC AI model that predicts a range of peripartum outcomes using synthetic intrapartum data with promising results. We have performed a primary analysis

using data received from Gujarat's Technology Enabled Community Health Operations (TeCHO+), but require more antepartum, intrapartum, and postpartum data points with adverse outcome and complications recorded for a more comprehensive picture. A data ingestion pipeline has been created for this purpose, to obtain the data points required from various sources.

We will develop the first iteration of the ML model using a larger amount of data, once the data hygiene has been checked, and the dataset has been cleaned.

03 AI Centres of Excellence

ACCELERATORS OF AI SOLUTIONS: AI CENTRES OF EXCELLENCE AND AI UNITS

Our AI Centres of Excellence (CoEs) have brought together three entities—the government of India, with their ambitious vision and administrative infrastructure; Wadhvani AI, with our product and AI/ML expertise; and premier academic institutes, with their domain expertise, datasets, and validation platforms. Each AI Centre of Excellence has a multidisciplinary team that is embedded within a partner institute, that works in collaboration with a government agency or ministry.

AI Units are similar teams that we have set up directly within government offices, at the central and state levels.

Teams at both AI-CoEs and AI Units have three objectives: to develop, deploy, and scale custom AI/ML solutions; to provide training on applied AI/ML for the partner; and to co-develop an AI/ML strategy document for our government partners. Our experts, in collaboration with our partners, evaluate existing datasets, program workflows, and digital systems, and a prioritised list of AI use-cases emerges.

After we identify impact use-cases, we start exploring AI solutions using existing data, open-source repositories, or primary data obtained through our partners.

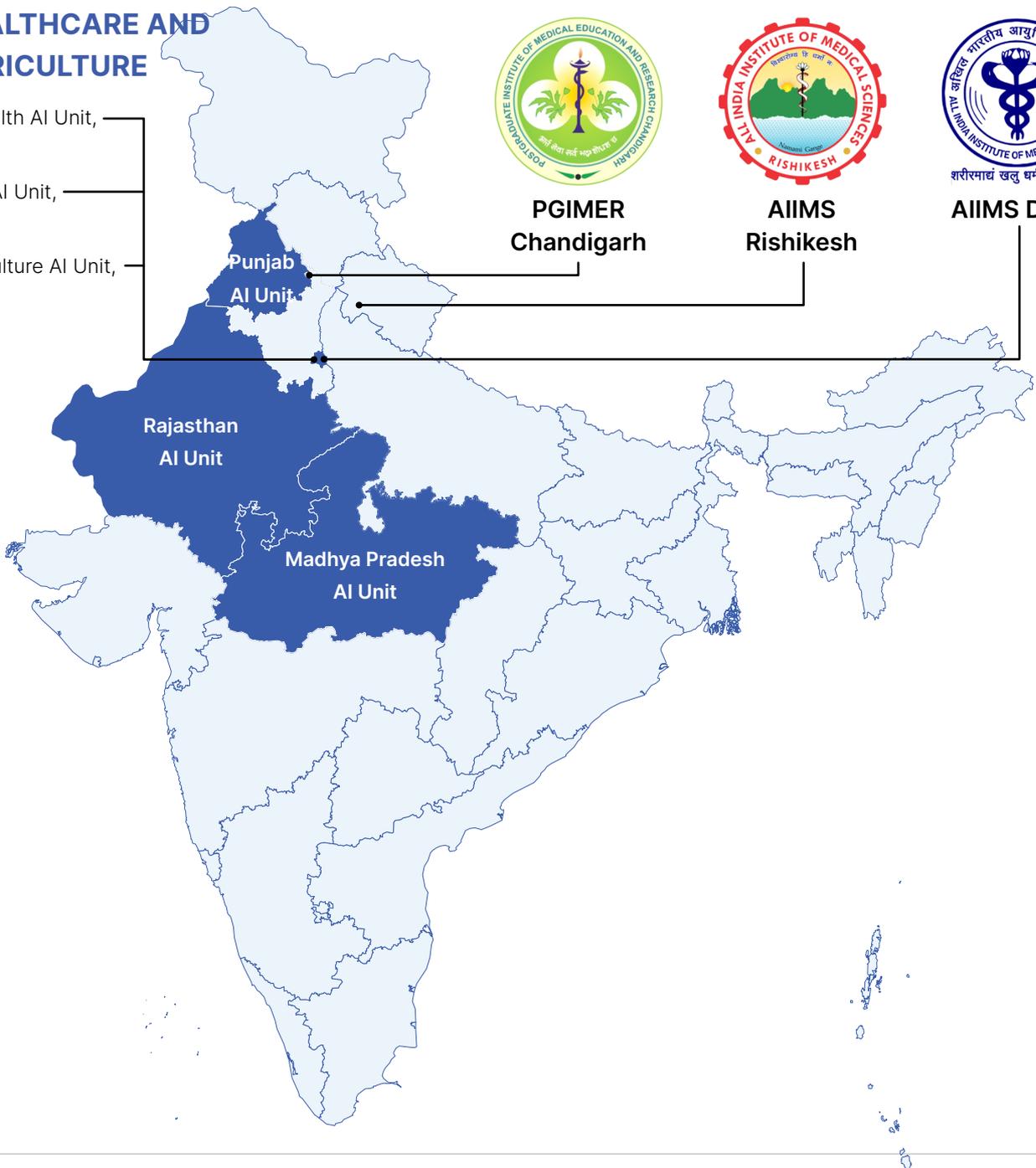
Our aim is to demonstrate a proof-of-concept AI model within three months of starting work on a solution, conduct tests and pilots within six months, and make improvements, and prepare for scaled deployment in 12–24 months. In addition to AI solution development, we conduct deep user research, and conduct monitoring and evaluation for each solution.



We have established CoEs at AIIMS Delhi, AIIMS Rishikesh, and PGIMER Chandigarh. As we gain momentum, we will partner with other institutes of national importance, and make them a part of this ecosystem. We will also look to establish domain-specific COEs, with each institute being the centre of a specific department, such as radiology or cardiology. That will provide an opportunity to medical students to learn from and engage with various ongoing solutions, and gain hands-on experience of AI applications.

AI UNITS FOR HEALTHCARE AND AGRICULTURE

- E-Health AI Unit, **Delhi**
- CTD AI Unit, **Delhi**
- Agriculture AI Unit, **Delhi**



AI CENTRES OF EXCELLENCE



**PGIMER
Chandigarh**



**AIIMS
Rishikesh**



शरीरमाद्यं खलु धर्मसाधनम्
AIIMS Delhi

AI Readiness Initiatives in 2022

Ensuring AI-readiness for our partners is integral to our work as an applied AI institute. We regularly conduct workshops for our stakeholders on introductory and intermediate-level concepts pertaining to AI and its cross-domain applications, data-readiness, measurement and evaluation of AI solutions, core methodologies and maturity models.

USAID TRACE-TB webinars

As part of the USAID-supported TRACE-TB Project we hosted a two-part webinar series in January that showcased how data science and artificial intelligence can be leveraged to bolster responses to infectious diseases in India.



Webinar 1: 18 January



Webinar 2: 25 January

CICR workshop

In December, the Central Institute for Cotton Research (CICR) in Nagpur invited Wadhvani AI to conduct AI Readiness training for CICR staff. As part of this workshop, we jointly explored new impact use-cases and collaboration opportunities for AI interventions in agriculture.

USAID AI Readiness workshop ▶

In November, we organised a USAID-led AI Readiness Workshop in New Delhi. The day-long workshop included multiple sessions that delved into what artificial intelligence is, its applications in public healthcare, what it takes to make an organisation AI-ready, data considerations, and the deployment and evaluation of AI technology.



09 Acknowledgements

Our work this year would not have been possible without the support of our government partners—the Ministry of Agriculture and Farmers' Welfare, the Ministry of Health and Family Welfare and its e-Health division, the Central TB Division, NITI Aayog, the National Health Authority, the Capacity Building Commission, the Central Bureau of Investigation, and all of our state government partners. We are immensely grateful for continuing to receive this opportunity to work closely in collaboration with the government towards achieving positive social impact at scale.

Our donors and partners in the private sector who have continued to engage with our work and believe in our mission have enabled us to grow rapidly this year. We would like to thank the United States Agency for International Development (USAID), the Bill and Melinda Gates Foundation, Google.org, the H&M Foundation, the Children's Investment Fund Foundation (CIFF), and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

We owe thanks to our implementation partners who helped make the deployment of our solutions a seamless process. For our agriculture solutions, this list includes Action for Food Production (AFPRO), Ambuja Cement Foundation, Self-Reliant Initiatives through Joint Action (SRIJAN), Aga Khan Foundation, Welspun Foundation, Suminter India Organics, Spectrum Cottfibers LLP, Sustainable Cotton Solutions Pvt. Ltd. (SCSPL), Lupin Foundation, Deshpande Foundation, Basil Commodities, and Arvind Ltd. For our healthcare solutions, our partners include PATH, Jhpiego, SAATHII, Clinton Health Access Initiative (CHAI), World Health Partners (WHP), CARE, Sambodhi, Piramal Swasthya, Christian Medical College Vellore, Indian Institute of Health Management Research (IIHMR) Delhi, Niloufer Hospital Hyderabad, SEWA Rural Jhagadia, the All India Institute of Medical Sciences (AIIMS) in Delhi and Rishikesh, and the Post Graduate Institute of Medical Education and Research (PGIMER) in Chandigarh.

OUR FOUNDER-DONORS



Romesh Wadhvani
Founder Donor

Dr. Romesh Wadhvani is the founder of the Wadhvani Foundation. A Silicon Valley entrepreneur and philanthropist, he has built three successful companies, including the \$3.5 billion Symphony Technology Group. He is a member of the Gates-Buffett Giving Pledge, and was appointed by President Barack Obama on the Board of Trustees of the John F. Kennedy Center.



Sunil Wadhvani
Founder Donor

Mr. Sunil Wadhvani is the founder of WISH Foundation, which runs over 300 technology-enabled health clinics in some of the poorest areas in India. He was the co-founder and CEO of iGate Corporation, an IT services firm which grew to over 34,000 employees and was sold for \$4.5 billion in 2015, and has served on the boards of several institutions including Carnegie-Mellon University, George Washington University and United Way Worldwide.

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IMPLEMENTATION PARTNERS



ACRONYMS USED

AR	Augmented reality
CBI	Central Bureau of Investigation
CBC	Capacity Building Commission
CDSL	Culture and Drug Sensitivity Lab
CDSS	Clinical Decision Support System
CHO	Community Health Officer
CICR	Central Institute for Cotton Research
CTRI	Clinical Trials Registry - India
CTD	Central Tuberculosis Division
E-Health	E-Health Division of Ministry of Health and Family Welfare, Government of India
HMIS	Health Management Information Systems
HMSC	Health Ministry Screening Committee
HWC	Health and Wellness Centres
IANM	Integrated Agriculture News Monitoring
ICAR	Indian Council of Agricultural Research
ICMR	Indian Council of Medical Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDSP	Integrated Disease Surveillance Programme
IHIP	Integrated Health Information Platform
KCC	Kisan Call Centre

KKMS	Kisan Knowledge Management System
LFU	Loss to Follow-Up
LPA	Line Probe Assay
MEL	Monitoring, Evaluation and Learning
MoAFW	Ministry of Agriculture and Farmers' Welfare
MoHFW	Ministry of Health and Family Welfare
MNCH	Maternal, Newborn, and Child Health
NCIPM	National Centre for Integrated Pest Management
NITI	National Institution for Transforming India
NIRT	National Institute for Research in Tuberculosis
NHA	National Health Authority
NHM	National Health Mission
NPSS	National Pest Surveillance System
NTEP	National Tuberculosis Elimination Program
PoC	Proof-of-concept
PRS	Pregnancy Risk Stratification
RCH	Reproductive and Child Health
SOP	Standard Operating Procedure
STO	State TB Officer



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