IoT Adoption in Indian Agriculture

A 2020 Landscape

April 2021

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Foreword

At 16% of national GDP,USD 421 bn GVA, 44% of nation's workforce employed, 9th position in agricultural exports to the world, and with record absolute production of food grains and horticultural crops (at nearly 300 MTs of each), Indian agriculture has yielded historically high outputs in 2019, despite softening of overall economic growth.

Yet, the biggest employer, of all sectors, is struggling with historically low resources in terms of land, labor, liquidity, and digitalization. Less than 1% of the total farmlands use a tractor, since 87% of the farms are <3 acres in size rendering mechanization unviable. Result – one of the lowest farmer incomes globally, at USD 1,700 per farmer.

NASSCOM and Cisco have collaborated on a study of the Agri value-chain to discover the extent of technology adoption in the sector, primarily the use of IoT-enabled solutions. The study, titled "IoT Adoption in Indian Agriculture: A 2020 Landscape," highlights the major gaps and opportunities with IoT-led digitization of Indian agriculture.

Debjani Ghosh
President, NASSCOM

Globally, high-performing agricultural practices have demonstrated significant positive impact of employing basic farm mechanization, such as tractors, weather SMS alerts, drip irrigation, etc., on yield and crop-mix optimization. IoT-enabled deployments, with even basic sensor technology for real-time alerts, can be game-changing.

This report aims to unearth the transformational potential of IoT solutions, the deep lack of which, is hampering the path to sustainable productivity and profitability in the agriculture sector. The study unveils a first-of-its-kind IoT Adoption Index in Agriculture for India, from farm to market.

Sameer Garde
President, Cisco India and SAARC

A snapshot of emerging IoT adoption practices by enterprises, AgriTech startups, and innovating farmers aims to further highlight the criticality of "connected agriculture" and our recommendations to achieve it.

We hope you find this report a useful read. Your feedback is solicited and welcome!

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Scope of The Study

IoT Adoption in Indian Agriculture is an initial study of the sector to explore current state of economic output, limiting challenges, and potential role of IoT-enabled solutions to bring sustainable growth to the sector

This study aims to combine learnings from primary surveys of a wide cross-section of stakeholders in the agriculture value chain with global best practices to formulate recommendations for enhancing the productivity and profitability of this critical sector.

Specific areas of analysis

- Awareness and usage-based assessment of IoT adoption across the agricultural value chain
- Future roadmap of IoT implementation – areas with low adoption and high potential benefits
- Snapshot of emerging IoT-in-Agri solutions by enterprises and startups, and recommendations

1

Current State of Indian Agriculture

- Economic impact of Indian agriculture
- Emerging agrarian stress points
- Farmer incomes and regional disparities
- PM 7-point agenda on doubling farmer income
- Global agricultural technology transformation cases
- Global IoT in agriculture market trends and enabling developments

2

Twin Challenges of The Non-Digitized Indian Agri Sector

- The twin challenges of low productivity and declining profitability across the Agri value chain
- Nascent but emerging IoT adoption in Indian agriculture
- Four core areas of integrated farm-to-market digitization
- Example of an integrated farm-to-market Agri Digital Architecture

3

IoT – Transforming Agriculture and Ecosystems

- IoT Adoption Index across the Agri value chain based on four parameters of awareness, usage, benefits and time-to-scale
- Adoption gaps and challenges
- Enterprise IoT solutions and value chain adoption cases
- State government AgriTech initiatives
- AgriTech startups and key focus areas
- CSR-led AgriTech investments
- Sector transforming recommendations

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Executive Summary (1/2)

Historic FY 2019-2020 Indian Agricultural Output

I

- 16.5% of GDP FY 2019-20
- $421 bn. in GVA
- 9th largest Agri-exporter at $42 bn., net positive
- ~300 MT of food grains and horticultural crop output in one year

However, Rising Input Costs, Acute Labor Shortage, And Lowest Farm Income Are Serious Stressors

II

- 44% of nation's workforce; with mean income of $1,700 per year, lower than GDPPC of $2,338
- Lowest farm income growth at 3.4%; no surplus
- 87% farms are <3 acres; >45% tenant farmers; < 1% farms use tractors
- Highest input cost at 63% of selling price
- $14 bn. of post-harvest produce lost; 300 mn. people living in food scarcity

Government Policies, With Farm Mechanization And IoT Adoption, Transform Agri Yield, Profits

III

- PM 7-point agenda aims to double farmer income by 2022 with technology, capital, policy, and cost/MSP support.
- More initiatives launched during COVID-19 - VedKrishi and Krishi Mitra platforms
- Productivity and profit disruptions reported in countries combining technology with policy
- Global IoT-in-Agri adoption will grow 3X in 6-7 years, with better economics and effectiveness

Standard usages in the study:

1. $ refers to US Dollars or USD. For forex conversion, 1 USD = INR 70
2. Mn. is million and bn. is billion
3. Agri is used a short form of agriculture in certain references
4. IoT refers to Internet of Things in its most standard definition
5. AgriTech refers to a specific set of companies – enterprises and startups – that are Tech-first in their approach to building/deploying solutions for the sector

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Executive Summary (1/2)

IV

IoT Solutions Can Solve The Twin Challenges Of Productivity And Profitability In Indian Agri

- Twin challenges of Indian agriculture are low productivity and untenable returns
- IoT-based solutions solve for the core problem of timely, actionable, real-time data access
- In India, IoT in farming tools and techniques is nascent – some states are setting up programs
- IoT adoption can be progressively ramped up – from point sensors to “connected agriculture”

V

NASSCOM’S IoT Adoption Index Reveals Massive Gap In Awareness Vs. Use Across the Agri Value Chain

- 180+ enterprises, across pre- and post-harvest, surveyed, 40 AgriTech startups surveyed
- IoT Adoption Index is a weighted score of IoT awareness, implementation, RoI, and scale-up efforts across the value chain
- Between 27%-37%, the adoption is very low, with a 3X drop from knowing IoT to using it
- Biggest gaps in usage of any advanced IoT solutions beyond point sensors
- Minimum 3-5 years to mainstream adoption if solutions are found to lower TCO, improve usage consistency, and demonstrate RoI

VI

Tech-Driven Self-Sustaining Agri Transformation Will Need Coordinated Ecosystem Action

- More AgriTech innovation CoEs on lines of STPI models; advanced R&D on high-yield inputs
- Cluster-led development; focus on lowest cost tech and highest RoI with capital infusion
- Dedicated farmer training; more formal Agri education avenues
- IoT integration into existing farm tools, greater post-harvest and value-chain digitization
- Market-linked real-time visibility of cost of inputs and product pricing

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Despite a services shift, India continues to be a dominant agrarian economy with a 16% Agri-to-GDP ratio, relative to global 6.4%

Economic Contribution of Indian Agriculture*1, FY2019-20

Agricultural GDP*2

- **16.5%**
- Down from 17.5% in 2015

Agricultural GVA*3

- **$421 bn. or 16.2%**
- Down from 17.7% in 2015

Domestic Consumption

Exports

9th largest exporter, net positive

- $42 bn. of total agriculture output
- $60 bn. by 2025 (E)

Farmer Income

- Below $2,000 per year and less than 2019 GDPPC of $2,338

Crops and Horticultural Output

Staple crops

- 55% of agri GVA in 2019
- Decline to 46% by 2025 (E)
- 7.4% CAGR through 2025

Horticulture (fruits and vegetables)

- **2X of food grains or 14%** CAGR by 2025 (E)

Non-Crop Output

Livestock, dairy, and aquaculture

- 45% of agri GVA in 2019
- Increase to 54% by 2025 (E)
- **2X or 14% CAGR,** of staple crops

High growth sectors by 2025 (E)

- Livestock – CAGR of 37%
- Meat production – CAGR of 15%
- Dairy – CAGR of 13%

*1 - Indian Agriculture comprises crop output – food grains and horticulture (fruits and vegetables) – and non-crop output – poultry and livestock, dairy farming, fisheries and aquaculture

*2 - GDP is the monetary value of all goods and services produced within a country in a defined period. Agri-to-GDP ratio is in real GDP accounting for inflation

*3 - GVA is Gross Value Added, measured in gross value added by all products and services, not net of cost of value creation, in a defined period

Sources: Economic Survey of India 2019, Livemint, Statistics Times, The Sunday Guardian, IBEF, and Business Standard

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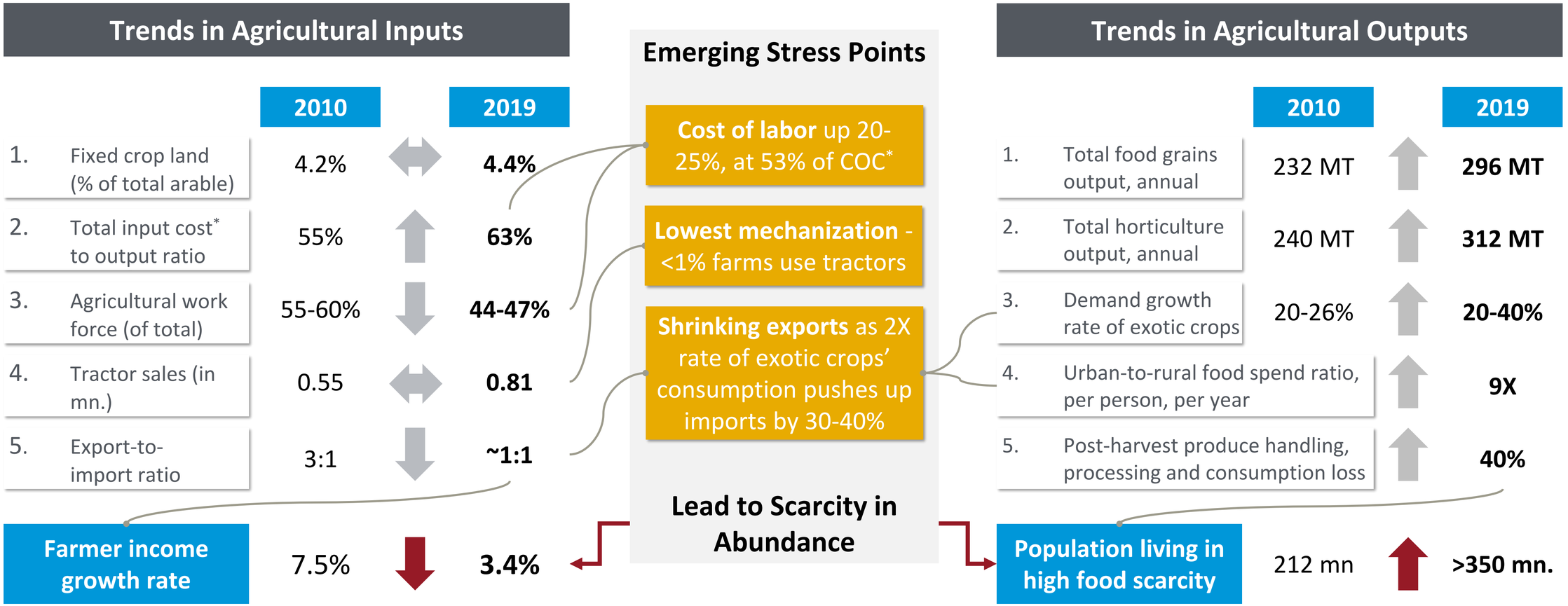
The sector has yielded higher outputs with lesser, costlier inputs, and yet, more Indians face the paradox of "scarcity in abundance"

During 2010-2019, Agri inputs have either flattened or gotten costlier and farmer investible surplus has eroded even while Agri output and consumption have consistently risen. Will this sustain when India becomes a 1.7 bn. people nation in 2050?



*Input cost or Cost of Crop (COC) follows the Cost (A1+FL) model in India, A1 being the cost of all paid inputs and FL being family labor

Sources: Review of Agrarian Studies, APEDA, UNDP, IBEF

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Regional disparities in land size, input costs and farmer incomes make a "one-size-fits-all" solution implementation ineffective

Regions that have focused on maintaining a minimum viable farm size, sustainable crop mix to suit local demand and farm productivity, and use of tractors and irrigation techniques, have yielded higher outputs and superior margins.

Select Agri Metrics by Farm Income, *2015-19*	Average income *(per farmer pa)*	Average acreage *(per farmer)*	Average input cost *(% of output)*	Share of total population | Rural population	States and UTs in income zones
High Income ***(> $2000 pa)***	$2,602	>6 acres	<50%	15% | 51%	Delhi, Lakshadweep, Punjab, Haryana, Meghalaya, Arunachal Pradesh, J&K, Kerala, Karnataka, Andaman & Nicobar Islands
Medium Income ***($1700 - $2000 pa)***	$1,798	2-6 acres	60-70%	6% | 57%	Tamil Nadu, Mizoram, Nagaland
Low Income ***(< $1700 pa)***	$1,259	<2 acres	>70%	79% | 68%	Manipur, Sikkim, Goa, Gujarat, MP, HP, Daman & Diu, Andhra Pradesh, Puducherry, Maharashtra, Rajasthan, Telangana, Assam, Jharkhand, UP, Tripura, WB, Chhattisgarh, Odisha, Uttarakhand, Bihar

National average **$1,700/farmer/pa**

Middle-income farm states need focused credit infusion and market access to move up

High-income states focus on demand-led crop mix, more tech, and cooperative markets to boost margins

States contributing most to Agri GVA generate **lowest farmer income due to small farm sizes**

State-wise farmer income information is available in the Appendix.

Sources: MoSPI, MoA&FW

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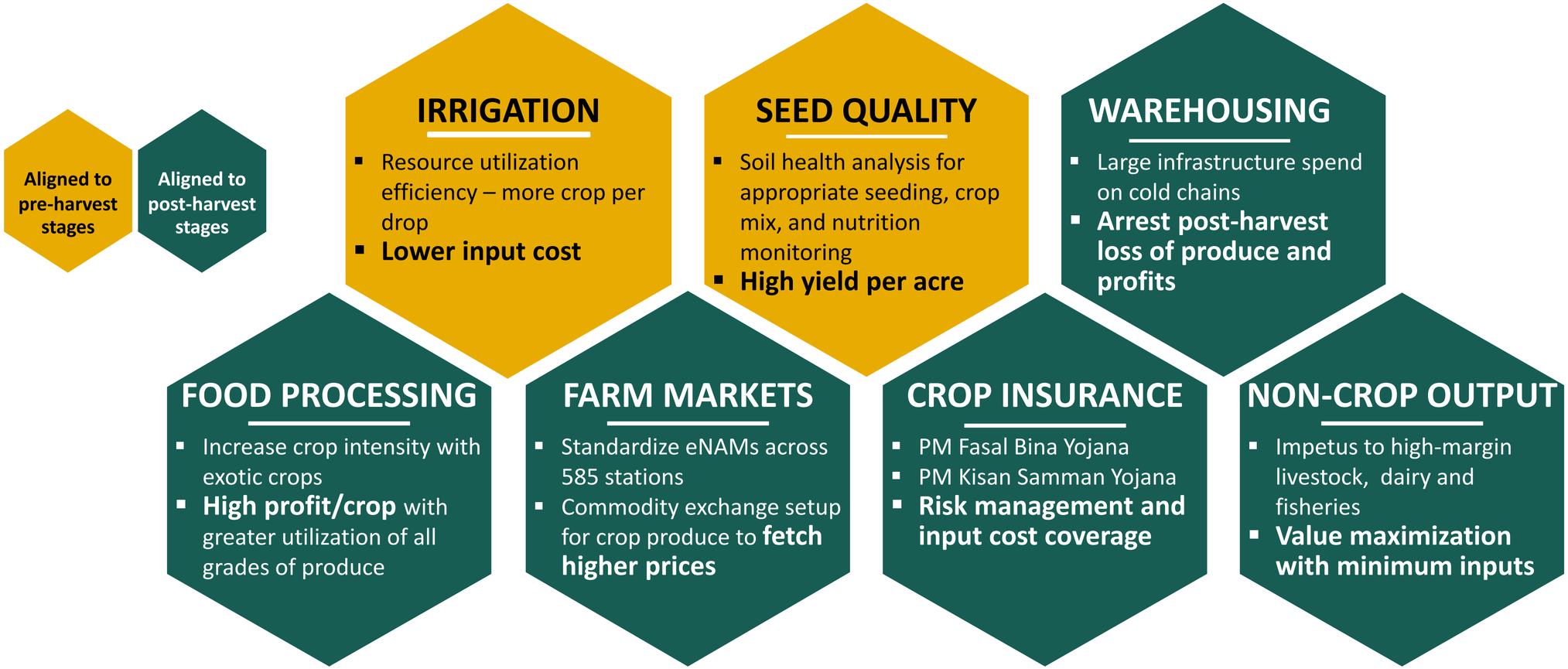
PM's 7-point agenda is an in-progress, coordinated set of strategies to minimize regional disparities and double farmer income by 2022

Raising crop production, reducing cultivation costs, arresting post-production losses, and reforming farm-to-market ecosystem and access with policies and technology are the primary focus areas to double farmer incomes.



Several state governments have initiated Agri reform programs, some of which are briefly discussed in later sections, as part of the overall PM 7-point agenda that has been in progress since mid of 2017 with irrigation techniques as the core focus in boosting cultivation.

Sources: MoA&FW, LiveMint

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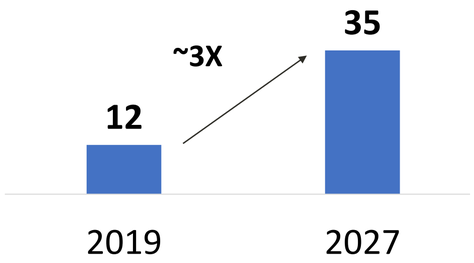
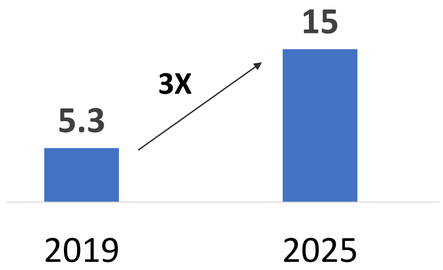
3X growth of IoT adoption in agriculture, globally, is indicative of the potential of this technology to transform the Agri value chain

Trends in Global Agriculture IoT Adoption



I. **Global Agri-IoT Market, $ bn.**



II. **Global Smart Agriculture Market, $ bn.**

III. **75 Million IoT device installations in the agricultural sector globally, by 2020**

Maturing IoT technologies
+
global standards
+
investor interest
+
enabling tech (AI, Edge)
=
IoT-enabled Agri value chain transformation

Improving Economics of IoT in Agriculture

- 70% fall in sensor cost, from $1.3 in 2004 to $0.4 in 2019
- Tech standardization – IoT, M2M, and IOTA
- $20 bn. AgriTech funding – 1.3% up in pre-harvest farm robotics & software, sensors, IoT
- AgriTech startups – 3,000+ global | 450+ Indian

Growing Effectiveness of IoT Solutions

- More sensitive and accurate tracking
- Tech convergence with Edge and data analytics
- Diverse solutions – point-to-platform – and convergence

Agri-IoT is the combined use of specialized equipment, wireless connectivity, software and IT services that lead to precision farming.
Smart Agriculture is the idea of combining precision farming with the optimization economics of quantity and quality to maximize profits
Sources: Meticulous Research, Statista, Crunchbase, NASSCOM Research

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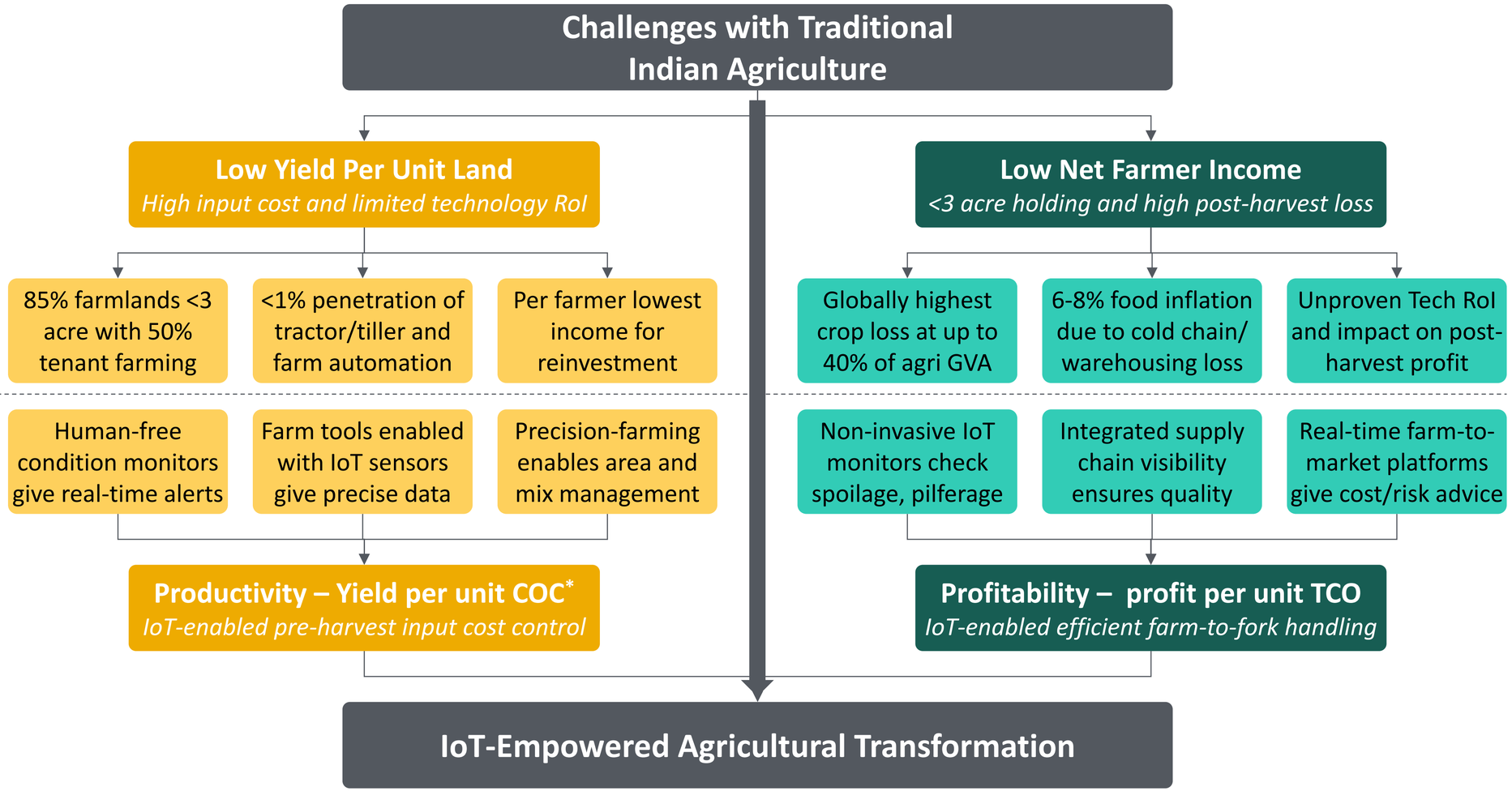
The twin challenges of productivity and profitability in Indian agriculture have sustainable solutions in IoT-enabled approaches

- Traditional agriculture focuses on fixed farmland capacity utilization
- Misses out on input cost reduction and margin improvement strategies

IoT enables:

- Timely, error-free real-time data
- Intelligence from multiple field conditions and market factors
- New value metrics and reporting methods



Our analysis and research of global best practices indicates modifying the key output metrics to focus on productivity per unit input cost and profitability per unit TCO includes debt or credit taken, long-term capital expenditures in technology, training costs, and cost burden due to broken infrastructure and unfavorable pricing-led losses.

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Current state of IoT deployment in Indian Agri is nascent and disparate, both in available solutions, and in the initiatives taken

Cultivation or pre-harvest stages have lowest IoT adoption, despite most critical need to precisely optimize soil, crop, nutrient, and final produce health, due to unproven viability with small farms, tenant farming, and high input costs.

	Pre-Harvest	Post-Harvest
Current state of IoT adoption in agriculture	▪ 90% AgriTech startups are focusing on pre-harvest solutions, but scale-up will take 5+ years ▪ Only 2% farmers use mobile Apps for farm-related activities and real-time alerts	▪ 50% enterprise adopters at PoC or Proof of Trial ▪ Mainstream adoption to take 2-3 years or more ▪ Higher adoption in Agri-distribution and Agri-processing sectors
AgriTech focused government initiatives	▪ Govt. of Maharashtra building AI/ML for crop yield modeling and crop surveillance ▪ Govt. of Tamil Nadu uses AI/ image analytics tool to alert on crop diseases in real-time, as well as, a comprehensive Agri-Tech portal for insights, policies, alerts, and real-time support	▪ Govt. of Maharashtra has plans for an exclusive dashboard with integrated DSS and a geo-portal for holistic agriculture management ▪ Govt. of Tamil Nadu has the Uzhavan App to track and alert at each value chain stage, and give a real-time market view on crop pricing

Early Steps, Need More

- **$910 mn. or 2% of $50bn FDI in 2019-20 came into the Agri-processing sector**
- **$245 mn. funding put into AgriTech startups in 2019, up 350% YoY**
- **3-4 state governments have AgriTech policies and are planning investment frameworks**

Sources: Review of Agrarian Studies, APEDA,

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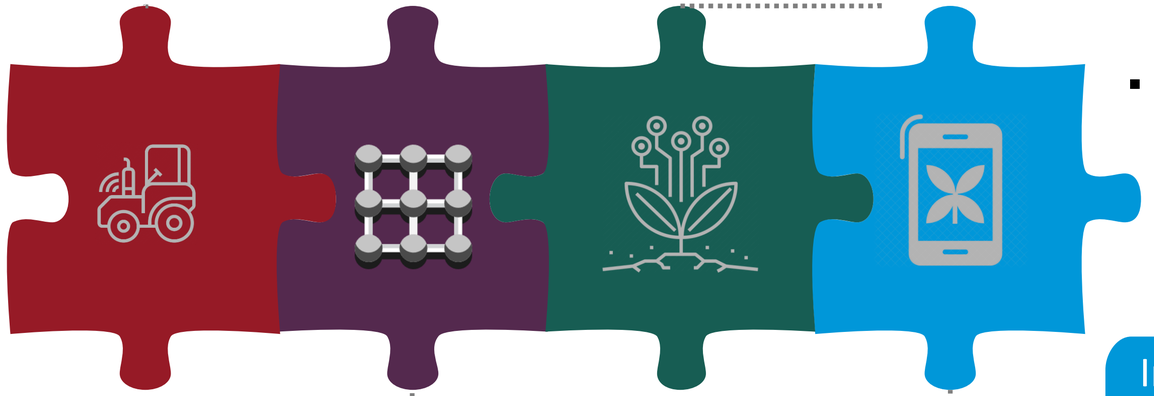
Progressive, step-by-step integration of point IoT solutions into connected farm-to-market solutions will build scale and value-add

Point IoT Sensors Integrated into Basic Farm Machinery

- Tractors, tillers, post-harvest sorting machines, etc., integrated with sensors/RFID and IoT devices

Precision Farming With Intelligent Devices

- Tech-integrated farming using intelligence from IoT-collected data analyzed using AI/ML to build predictive local models
- Redefined cost and value metrics based on emerging farm intelligence



Wider Deployment of Real-Time Condition Monitors

- Land preparation and soil quality remote sensing
- Water utilization sensors
- Crop-health field data analyzers
- Weather-based yield monitors
- Unmanned condition monitors to analyze cultivation factors

Integrated, Real-Time Farm-to-Market Intelligence

- Knowledge platforms that integrate regional inputs – labor, land, climate, market, and pricing information – for single source of truth and market competitiveness
- Empowered farmers with decision tools in local language and context

Sources: NASSCOM research

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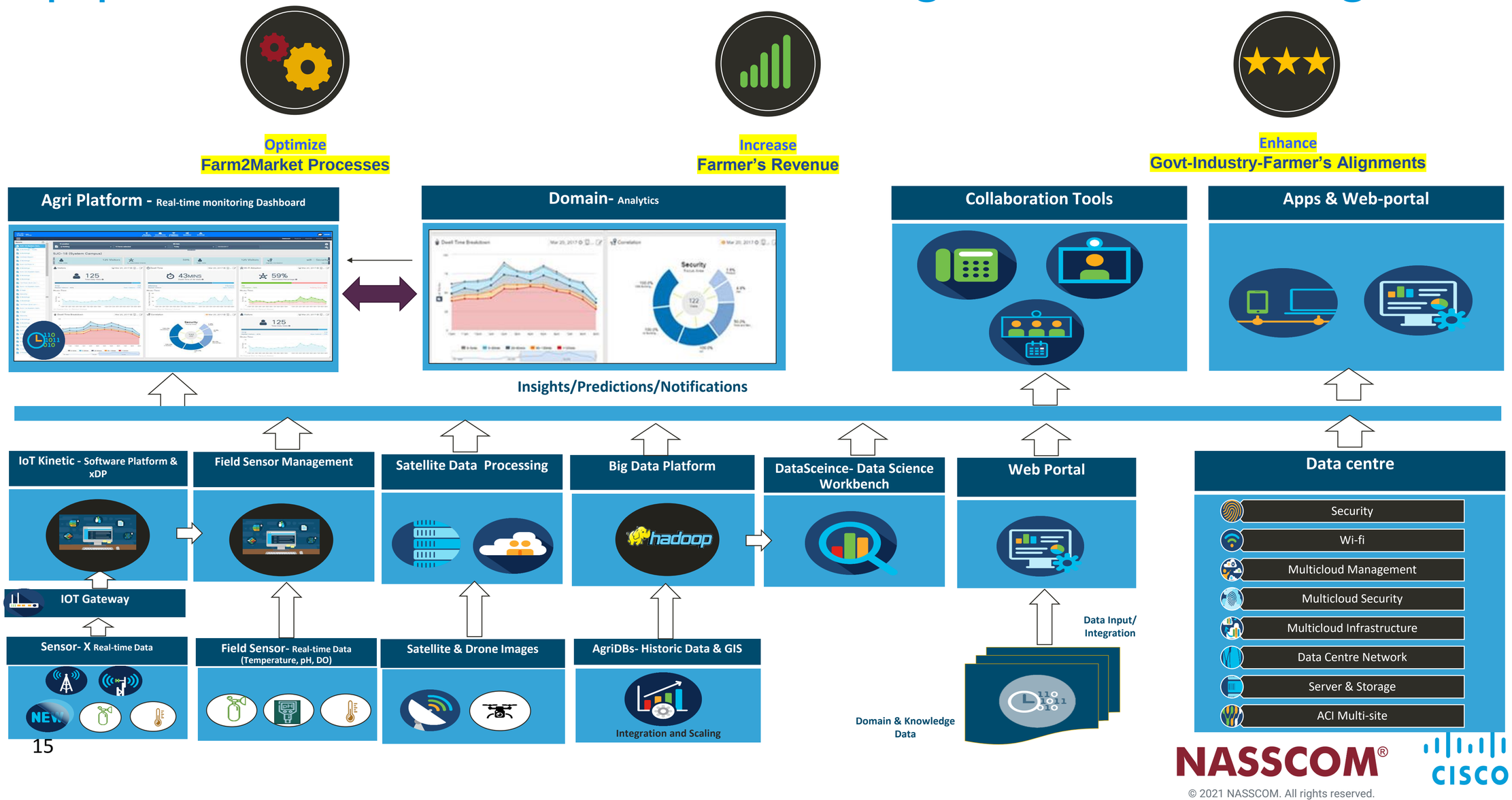
Cisco's modular Agri-Digital Architecture enables all four pillars to equip farmers with contextualized farming and market intelligence



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NASSCOM IoT Adoption Index survey covered 184 enterprises, government departments, and 40 startups across the value chain

Participants' Profile – Primary Research Group

CIO's & Tech Heads in Post Harvest Companies	Technology resources in value chain companies	System Integrators & Large IoT providers in Agri	Start-up CEO and Product Heads in Post Harvest Start-ups	Investors in AgriTech Start-ups (IoT & AI)

Government Departments

- NABARD
- ICAR
- NHB
- International Crop Research Institute
- Mahalanobis National Crop Forecast Centre
- Food Corporation of India
- Central Warehousing Corporation (CWC)
- State Warehousing Corporation (SWC)
- IFFCO Kisan Sanchar Limited
- National Oilseeds and Vegetable Oils Development Board (NOVOD)
- All India Agro Kendra

Surveyed and Interviewed Enterprise Segments

Seeds and Crop Science	Farm and Agro-Machinery	Fertilizers and Pesticides	Warehousing and Bulk Handling	Agri and Food Processing	Logistics and Trucking	Food Retail
18	29	5	12	75	21	13

Value Chain Distribution

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NASSCOM IoT Adoption Index is a composite of weighted scores across awareness, usage, benefits, and time to scaled deployment

This IoT Adoption Index is a first-of-its-kind assessment framework to track various IoT technologies, their deployment and usage maturity, and challenges to mainstream adoption across the agricultural value chain.

IoT Adoption Index Components and Weights

AWARENESS OF IoT TECHNOLOGY SOLUTIONS — 10%

- Sensors and RFID
- Industrial Robotics
- IoT Devices (Distribution control systems (DCS), Monitoring)
- Networking Technology (Wired and Wireless)

USAGE ACROSS AGRI VALUE CHAIN STAGES — 40%

- 5 pre-harvest stages
- 4 post-harvest stages *(agri retail considered outside direct scope of this study)*

BENEFITS OF USAGE *(perceived or observed)* — 30%

- Ease of data access and shareability
- Reduced risk of human error
- Improved yield
- Improved farm efficiency
- Affordable farming

MAINSTREAM ADOPTION TIMELINE — 20%

Time-to-Scaled Deployment

- 0-2 Years
- 3-5 Years
- 5+ Years

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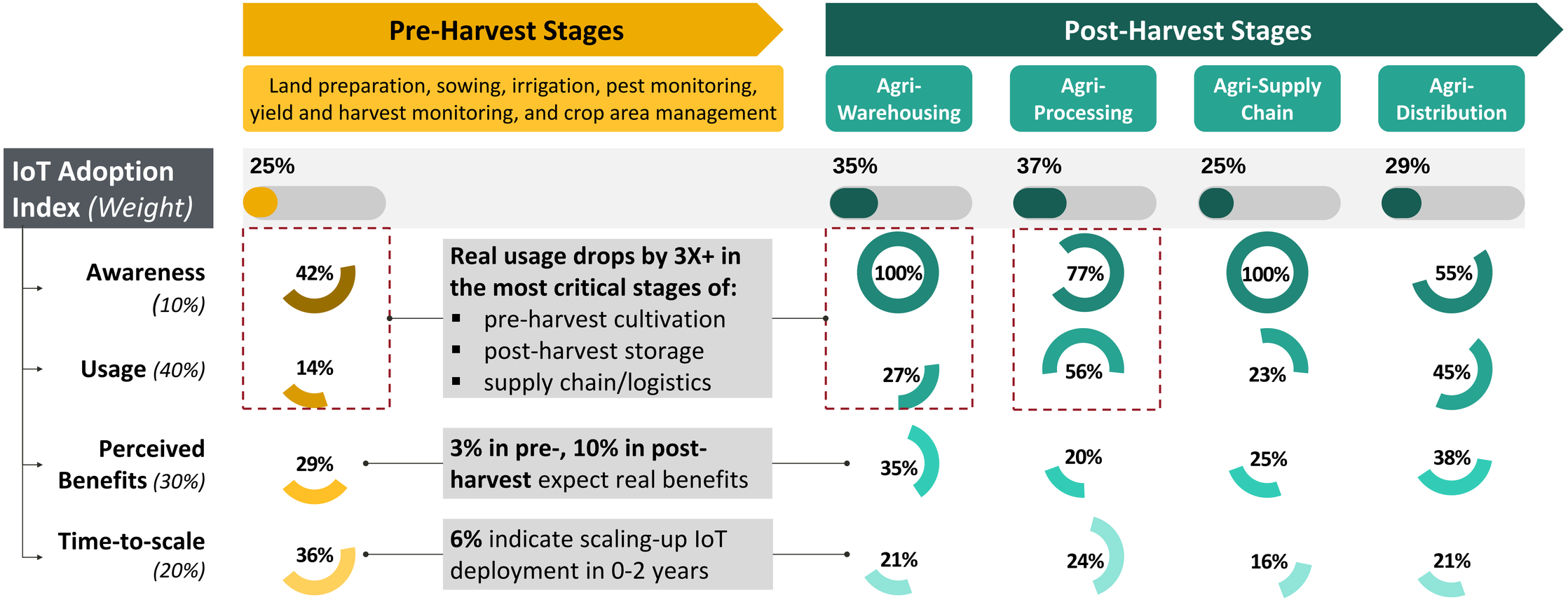
Between 27-37%, IoT adoption is significantly low across the Agri value chain, lowered by unclear benefits and longer time to scale

Lack of IoT advantages in pre-harvest stages stems from low farmer incomes and large-scale tenant farming; while in the post-harvest stages, with more organized companies and higher investment potential, unclear RoI is the stumbling block.



The IoT Adoption Index measures rate of awareness, usage, perceived benefits and time-to-scale on the basis of responses by all survey takers. Ideally, usage should be the base for benefits and time-to-scale. Respondents who are aware, but not using, have a notion of benefits and time-to-scale that can explain the adoption barriers. Further, the weighted sum of all four parameters may not always equal the adoption index, since the index further considered differentially scoring individual response options for each question. For instance, use of sensors was weighted lower than use of industrial robotics.

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Awareness and use of IoT solutions in the pre-harvest stages is limited to basic sensors, RFID, and limited IoT devices

Since 40% farming production occurs through tenant farming done on <3 acre land holdings, need for awareness about technological solutions in the critical pre-harvest stages meets the high barriers of lack of intent, capability, capital, and credit.

Pre-Harvest IoT Adoption

Aware and Using

- **71%** — **Most Used Tech** – Sensors/RFID, IoT devices
- **29%** — **Least Used Tech** – Industrial robotics used only in land preparation
- **57%** — **Most Automated Stages -** >40% adopters use 3 of 4 solutions in land preparation and irrigation
- **57%** — **Least Automated Stages** – Sowing, pest monitoring, and crop harvest
- **Time-to-mainstream adoption** – 5+ years

Aware, Not Using Plan to Adopt

- **57%** — **Tech Likely to be Used –** 50% indicate Sensors/RFID
- **14%** — **Tech Least Likely to be Used** – Networking technologies (wired/wireless)
- **57%** — **Stages of Likely Deployment –** 50% indicate deployment in land preparation
- **0%** — **Time-to-mainstream adoption** – 5+ years

IoT Technologies Legend

- Sensors/ RFID
- Industrial Robotics
- IoT Devices* (DCS, monitors)
- Networking Technologies (Wired/Wireless)

* - IoT devices include multiple monitors, such as Distribution Control Systems (DCS), Condition Monitors, Electronic Shelf Labels (ESL), Cameras, Yield Monitors, Interface Boards, Flow or Application Control Monitors, and Global Positioning Systems (GPS) and Global Navigation Satellite Systems (GNSS) technologies.

Sources: NASSCOM IoT Adoption Index survey analysis

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Post-harvest Agri-warehousing and supply chain have low adoption, close-to-retail Agri-processing and distribution stages use more IoT

Encouraging growth in post-harvest IoT adoption is largely attributable to traceability using RFID and processing using robotic processing operations and packaging. Post-harvest warehousing and supply chains stages need automation to minimize losses.

Aware and Using

Post-Harvest IoT Adoption

67-100%

0-12%

21-90%

0-7%

Most Used Tech

- Sensors/RFID – heaviest use in processing operations and packaging (agri-processing), storage (agri-warehousing), and logistics (agri supply chain)
- IoT Devices – only deployed tech solution in agri-distribution; used across all agri-processing stages

Least Used Tech – no sensor/RFID use in agri-distribution; networking tech use not seen in supply chain/distribution

Most Automated Stages – Agri-processing stages comprising processing operations and packaging, Agri-distribution

Least Automated Stages – Agri-warehousing (except storage), Agri supply chain

Time-to-mainstream deployment

- 3-5 years – in case of providers in processing and distribution – closer to retail
- 5+ years for warehousing and supply chain solutions

Aware, Not Using Plan to Adopt

Perceived usage trends are vague as many providers cited lack of awareness about the solution benefits

IoT Technologies Legend

Sensors/ RFID

Industrial Robotics

IoT Devices* (DCS, monitors)

Networking Technologies (Wired/Wireless)

*- IoT devices include multiple monitors, such as Distribution Control Systems (DCS), Condition Monitors, Electronic Shelf Labels (ESL), Cameras, Yield Monitors, Interface Boards, Flow or Application Control Monitors, and Global Positioning Systems (GPS) and Global Navigation Satellite Systems (GNSS) technologies.

Sources: NASSCOM IoT Adoption Index survey analysis

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Pre-harvest benefits – few human errors in data access and analysis; post-harvest – less time-to-market, waste control, and lower prices

Perceived or realized benefits suggest that IoT solutions need to be built and deployed at scale such that the impact is measurable in real-time and in the local context, and interdependent value-chain benefits reinforce greater adoption.

Pre-Harvest IoT Adoption Benefits

Real-Time Data Access	Direct benefit of low-cost sensor/RFID tech
Usable Field Data Capture	Field data captured and shared in a usable format
De-risked Human Error	Lower data collection errors, more use of robotics will lower process errors also
Improved Yield	Land and irrigation monitors improve yield, but soil quality must be addressed
AgriTech Startup Impact	75% of adopters plan to partner with AgriTech startups for focused solutions

Post-Harvest IoT Adoption Benefits

Operational Ease/Efficiency	Direct benefit of low-cost sensor/RFID tech and IoT monitors
Faster Time-to-Market	IoT devices monitor loss, waste, pilferage and diversions in distribution
Ease of Deployment	More effective monitors in smaller, tamper-proof packaging ease adoption
Solution Scalability	Standardized sensor and monitors enable cross-segment application
AgriTech Startup Impact	75-100% of adopters plan to partner with AgriTech startups for EoS

Sources: NASSCOM IoT Adoption Index survey analysis

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Adoption gaps and challenges emerge from lack of awareness, workforce resistance to change, and unproven RoI

Adopters are hesitant to scale-up rapidly as they have not clearly established the RoI on their initial investments, further creating internal resistance, constraining access to funds, and delaying R&D and innovations.

Pre-Harvest IoT Adoption Barriers

Unwillingness to Change	Majority pre-harvest non-adopters cite workforce resistance as a key barrier
IoT Tech Not User Friendly	Adopters rated IoT tech very low on ease of access and adoption, and cost
Affordability Concerns	Aside of the cost of solutions, impact on reducing cost of farming unproven
Deployment indecision	Non-adopters are undecided on whether to self-deploy or partner
Stretched timeframe	Most adopters suggest 5+ years to scale adoption, giving a sense of non-urgency

Post-Harvest IoT Adoption Barriers

Privacy and security	Data privacy and security concerns of companies using IoT monitors
Limited IoT awareness	Knowledge of existence and applicability of IoT in agriculture
Trust in value of IoT lacking	Point solutions make it difficult to assess the impact on an overall process
Unwillingness to Change	Adopters cite workforce resistance as the key reason for not scaling up
Insufficient funds	>75-80% IoT solutions adopt basic, low-cost sensors with limited functionality

Sources: NASSCOM IoT Adoption Index survey analysis

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“Connected Agriculture” planning and architecture is needed to converge sporadic IoT solutions into integrated, intelligent platforms

	Pre-Harvest Stages					Post-Harvest Stages				
	Land Tilling	Seeding/ Sowing	Irrigation	Fertilizer/ Pest Monitoring	Harvest/ Yield Monitoring	Agri Ware-housing	Agri-Processing	Agri-Supply Chain	Agri-Distribution	Agri Retail
Sensors/ RFID	▪ Precision agriculture with defining and monitoring soil health, local data collection and analysis ▪ Smart fertigation and ambient nutrition management ▪ Smart irrigation management					▪ Smart produce health monitoring and ambient conditions management (cold chain solutions) ▪ Non-invasive in-transit quality monitoring				
Industrial Robotics	▪ Automated farm management ▪ Water shed management system					▪ Contactless automated crop processing and packaging				
IoT Devices (DSS, monitoring)	▪ Crop early or late sowing intelligence to improve quality and productivity of crops ▪ Weather advisory and warning system ▪ Early large-scale pest/ disaster warning and risk profiling					▪ Produce sorting based on crop grade and quality using computer imaging				
Networking Tech (Wired/ Wireless)	▪ Ground water resource estimation ▪ Crop acreage estimation ▪ Large area crop monitoring and classifications ▪ Farm and livestock asset monitoring					▪ Post-harvest distribution and supply chain traceability ▪ Real-time locational tracing, automated alerts on route/load alterations ▪ Geo-fencing to check fraud				

Sources: NASSCOM research

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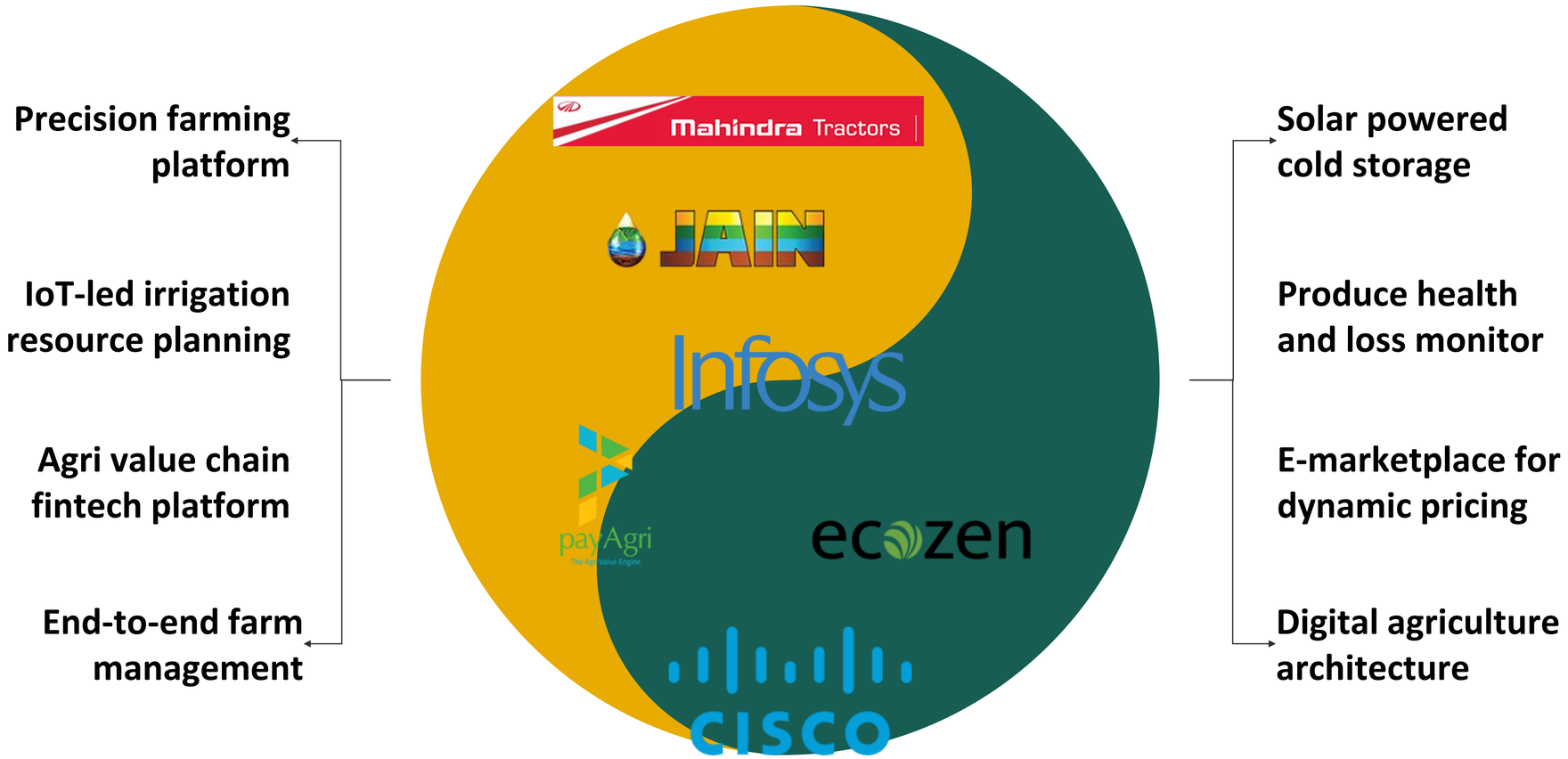
Adoption roadblocks aside, more evolved IoT solutions, from single-stage applications to integrated platforms, are mainstream

Select IoT Solution Providers in the Agri Value Chain



Sources: Company websites, NASSCOM research

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Rana, a small-time farmer from Haryana, has delf-deployed IoT sensors and devices to optimize water productivity in his fields

Pre-Harvest Stages

Land Tilling	Seeding/ Sowing	Irrigation	Fertilizer/ Pest Monitoring	Harvest/ Yield Monitoring

Problem Statement

Erratic and uneven rainfall across India increases the challenges for small and marginal farmers with limited ground water access to manage water efficiently, while also managing the mix of crops based on water constraints.

A farmer, named Rana, in the Nandana village near Karnal district in Haryana devised an IoT-enabled solution to this problem.

Solutions and Impact

Solution

- Installed telemetry devices along with panels mounted onto poles on the road adjoining his fields
- Buried all the sensors / IoT enabled devices under the ground which helped him to check the moisture level in the soil
- Both devices and sensors are low cost from domestic providers which helped him adopt for a small 5 acre land

Impact

- 30% water use reduction, thereby lowering the dependence on rainfall or ground water
- 8% to 12% reduction in COC (input cost) and harvesting costs, net of technology investment
- Rana's 5-acre land is able to generate higher yield and income, thus creating an easy-to-replicate model farm example for the district

Sources: Company website, NASSCOM research

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Cisco's Connected Agriculture IoT deployment for livestock tracking and water management

Pre-Harvest Stages

Land Tilling	Seeding/ Sowing	Irrigation/ livestock	Fertilizer/ Pest Monitoring	Harvest/ Yield Monitoring

Problem Statement

Llanelli faced two main challenges in the daily management of their business; livestock tracking and water management.
Every single animal needed to be counted and managed manually once a month; a lengthy and tedious process prone to human error. Additionally, with eleven dams and three water tanks spread across a 1,300 mountainous land, Llanelli's staff lost a sizable amount of time travelling to each dam and tank to verify water levels and action the appropriate measures. And, they had to perform that task daily, and multiple times a day during draughts.

Llanelli is a 1,300 acres family farm located in Bathurst, NSW.

Solutions and Impact

Through a solution combining Cisco IoT and Enterprise Networking products, third party sensors, and Farmdeck, an in-house analytics platform, Outcomex enabled Llanelli to track and identify livestock, manage water tanks and dams' levels, and surveillance the perimeter of the property.

Solution: The solution consists of:
- Cisco Solution for LoRaWAN, Cisco Camera
- Semtech Sensors, Custom High Frequency RFID sheep tags, Outcomex online platform

Impact: By providing access to data and analytics for water (levels, leaks, volumes and usage) and livestock (track, count and identification), Outcomex has enabled the Bathurst farm to more proactively address their many challenges, such as drought preparation, tank damage, stray livestock, and budget constraints.

Sources: Cisco Case Study

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Ecozen's solar-powered portable cold rooms improve self-life and minimize the biggest challenge of 40% post-harvest produce loss

Post-Harvest Stages

Agri Ware-housing	Agri-Processing	Agri-Supply Chain	Agri-Distribution	Agri Retail

Problem Statement

Ecozen Solutions is an Agri-Tech company manufacturing cold storages rooms & solar water pump controllers in India. Approximately 25,000 farmers in India use Ecozen's products.

Employees: 70+
Industry: Agri-Tech
Corporate Office: Pune
Website: www.ecozensolutions.com

Solutions and Impact

Ecozen Solutions offers Ecofrost, a solar-powered, portable cold room based on thermal energy storage for on-farm cooling and storage of perishable produce immediately after harvest.

Solution

- Ecofrost uses in-built IoT sensors to control temperatures
- Mobile unit for remote rural areas and small farms
- Farmer-controlled mobile App for remote control
- Automatic battery mode switchover during cloudy conditions or lower solar panel output
- Innovative 'Lease-a-Cold-Room' model for cyclical or unplanned needs or to manage high-perishability conditions

Impact

- Shelf life of highly perishable crops, such as Spinach, Capsicum, Tomatoes went up from 24-72 hours to 21 days
- Profit margins on exotic vegetables, such as Broccoli, went by 20-30% with a 2-day shelf-life improvement
- Remote farmers able to access Tier-I/Tier-II cities located ~1000 kms away with better produce shelf-life, resulting in more sales

Sources: Company website, NASSCOM research

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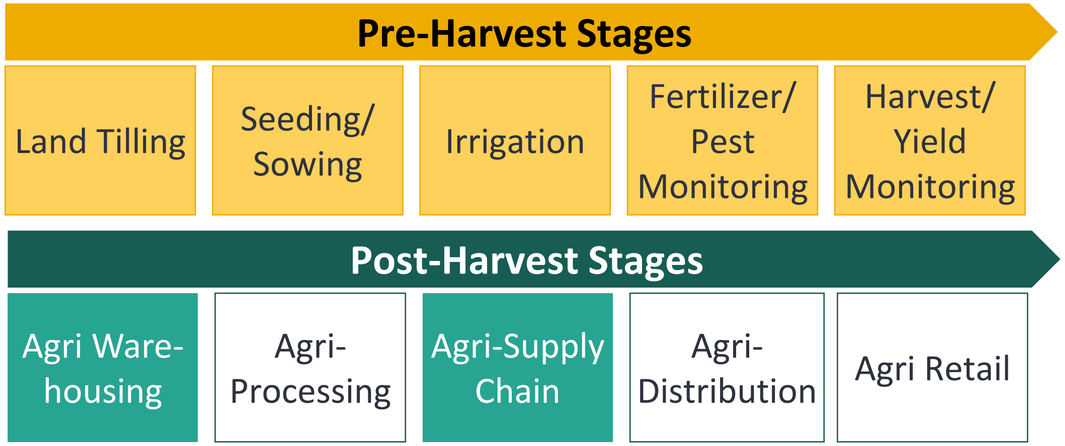
Infosys's IoT and AI/ML based agri-information platform enables farmers to make "environment- and market-linked" crop selections



Company Overview

Infosys has developed a platform leveraging IoT, Big Data & Analytics, Mobility and Cloud, combined with customizable algorithms, business logic, and strong agriculture domain expertise through collaboration with agricultural universities and research institutes.

Employees: 2.2 Lakh+
Industry: IT services
Corporate Office: Bengaluru
Website: www.infosys.com

Solutions and Impact

Infosys has deployed IoT-enabled devices for crop production at one of its campuses in Hyderabad.

Solution: The IoT-enabled farming platform has been built as an end-to-end solution that integrates domain expertise, market intelligence, and big data analytics to draw relevant and actionable insights for a farmer/cultivator or a crop advisor.

The platform has been used over seven crop seasons. The platform intakes data from a wide variety of field sensors and devices, such as field wireless sensors, drone and satellite images, actuators, wireless communication gateways, third party services such as weather data and market price exchanges or sources, and applies a host of open source built multiple simulation models using AI/ML techniques such as CNN. The platform is hosted on cloud and can be accessed through multiple channels, such as the Web, a mobile device, etc.

Impact: Infosys has observed significant improvement in overall cultivation cost reduction and increase in water productivity.

Sources: Company website, NASSCOM research

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Cisco aims to digitally strengthen the farming system in Kerala using digital technologies and IoT-enabled integrated farm management

1. Sensors in field

II. Data collection, Analytics, collaboration with experts

- Remote Sensing
- Sensor Set-up
- Data Centre
- Web portal
- Mobile App
- Agri Platform & Monitoring

III. Setting up of a Village Knowledge Centre with customized dashboards for farmers, VKCs and govts.

Objectives

- Leveraged power of Technology and Data in Agriculture
- Implemented precision agriculture solutions and remote sensing for real time status for monitoring, control.
- Deployed Agri Platform with Agri Digital Infrastructure and Mobile App for insights & outcomes.
- Built Village Knowledge Centres (VKCs) for enablement & skill development of farmers.

Outcomes

- Real-time information on farm water level, temperature, pH, etc. to plan and execute the farming activities.
- Alerts and predictions on weather hazards, pest infestations for better planning and preventive measures.
- Region wise crop health, harvest progression and readiness data for better department planning at district/ state level.
- Collaboration between Farmers- FPO's-Krishi Panchayat- Agri Dept.- Industry

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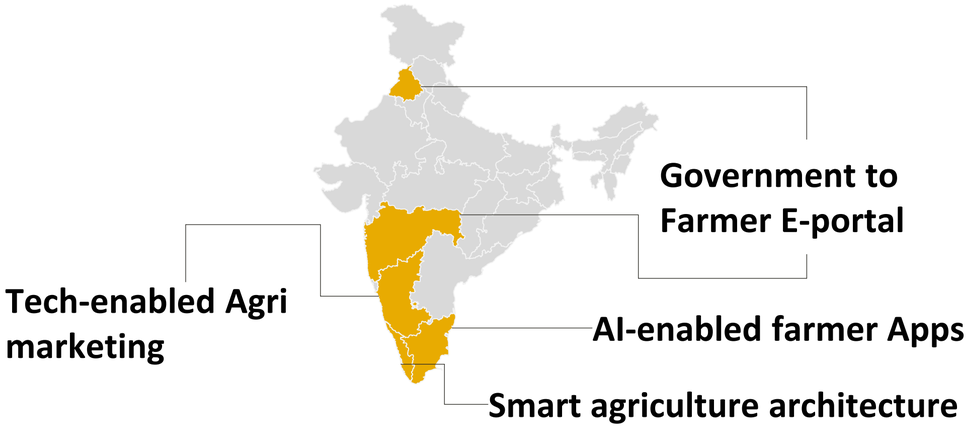
State governments are building support portfolios, enterprises are dedicating CSR funds, and AgriTech startups are innovating rapidly

Emerging Ecosystem Support, Programs, and Innovations to Drive Tech Adoption in Agriculture

State Governments With Active AgriTech Initiatives



Rapidly Growing AgriTech Startups

1. **80-90% of AgriTech startups focused on pre-harvest digitization** using low-cost sensors and devices
2. **Post-harvest - higher adoption in close-to-retail stages** with focus on more advanced communication tech

Enterprise CSR Funding into AgriTech Programs

CSR Allocation	▪ **$17.8 Million or 0.3%** of $10 bn. "utilized" CSR funds by 7,300+ Indian enterprises during 2014-2019

Funds Distribution	▪ **~95% or $17 mn. in pre-harvest stages**
	  ▪ Irrigation techniques
	  ▪ Crop efficiency and pest monitoring
	▪ <5% is directed to post-harvest stages

Mode of Engagement	▪ **Direct-to-farmer** (D2C or B2C) models via not-for-profit (NGOs) or self-help groups (SHGs) at the village level
Key Support Areas	▪ **Infrastructure support** in drip irrigation, solar energy powered farm equipment ▪ **Digital Tech support** through real-time alert Apps, farm management portals, and e-agri marketing platforms

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Karnataka has adopted one of the most effective technology interventions in agriculture marketing of farming equipment

Karnataka has adopted a market-driven approach to bringing innovations in farming, equipping farmers with the right balance of equipment, information, and market access to enable higher profits from shrinking agri output and cultivable land

Quick State Stats in Agriculture *2019*	
Agri-to-GSDP*1 ratio	**10%**
Cultivable land per capita*2	**0.4 acre**
Average annual farmer income	**$2,602**
Average annual AgriTech funding	**$46 mn.**
Number of AgriTech Startups	**27%** of total 450

AgriTech Initiatives and Objectives

- **IoT-enabled drip and sprinkler irrigation** using rainwater harvesting innovations
- Partnerships with AgriTech startups to provide farmers access to **farm mechanization**
- 92 Custom Hire Service Centres (CHSC) in nine districts for **direct-to-farmer market facilitation**
- Innovative pay-per-use models for farmers
- **Rashtriya eMarket Services (ReMS)** in a JV with NCDEX for e-agricultural marketing through a unified market platform (UMP)
- Crop advisory and **market pricing Apps**

*1 – GSDP is Gross State Domestic Product

*2 – Cultivable land per capita is calculated as the ratio of Net Sown Area/Total Population; numbers may vary since data has been sourced from 2015-2019

Sources: Government of Karnataka, YourStory

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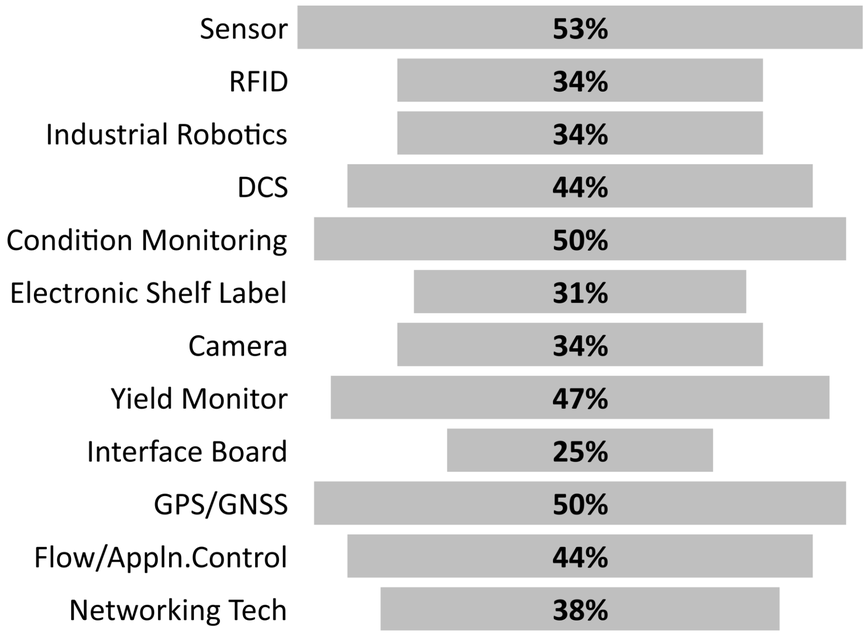
In AgriTech startups, 80% surveyed offer pre-harvest solutions, but full-spectrum solutions need stronger farm-side interest and usage

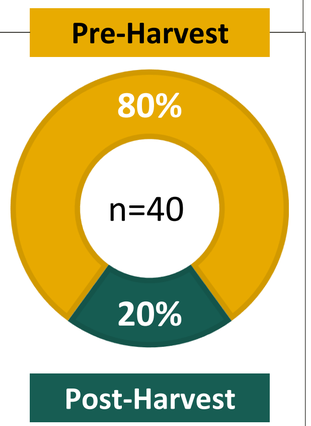
AgriTech Startups in the Pre-Harvest Stages, *80% of the total respondents*

I.

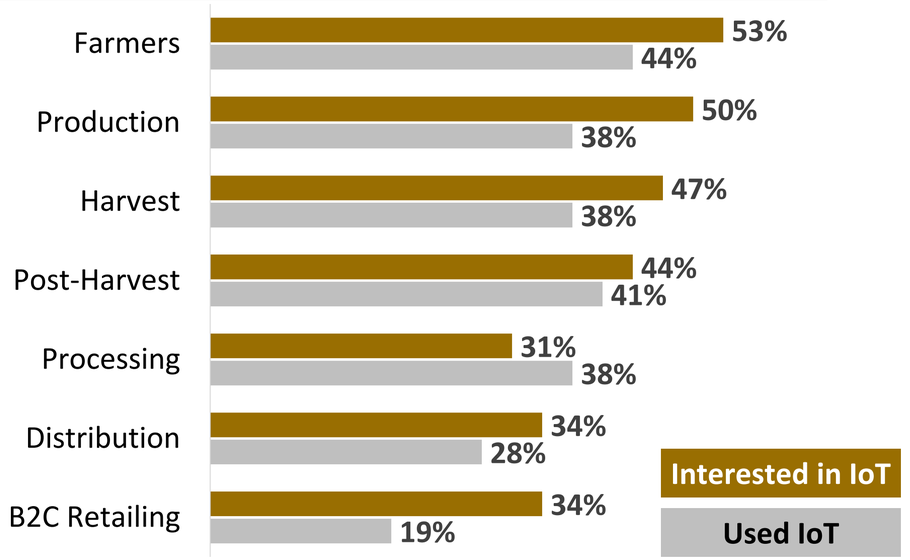
- 50% operate in B2C or hybrid model
- 66% generate revenue

II. IoT technologies adopted





III. % Startups securing >50% interest & usage



IV. Key Observations

1. Usage is limited to simpler IoT Tech
2. Interest from end users, i.e. farmers, is unpredictable and dependent of investible surplus

Sources: NASSCOM IoT Adoption Index survey analysis

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For post-harvest AgriTech startups, low-cost, scalable, and replicable IoT solutions are key to commercial success

AgriTech Startups in the Post-Harvest Stages, *20% of the total respondents*

I. IoT technologies adopted

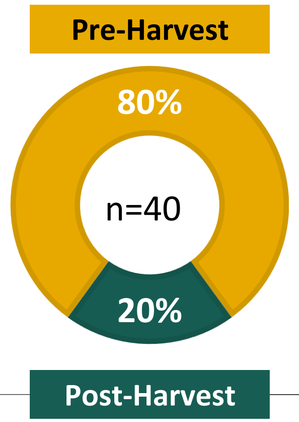
50% use simpler IoT tech – sensors, RFID, and flow/application control

50% offer yield and condition monitoring solutions to help farmers manage real-time field conditions

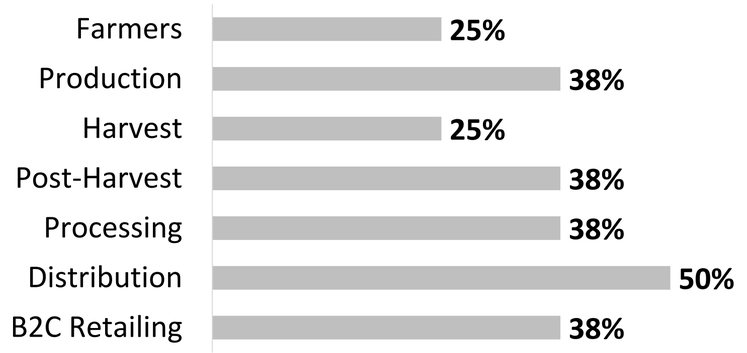
50% offer GPS/ GNSS solutions to track crops to warehouses, processing units, and retail ends

3% providers find networking tech solutions profitable after heavy upfront capex

2% providers offer DeepTech solutions with IoT / AI sub technologies



II. Segments served



III. % Startups securing >50% interest & usage

25% end-users expressed interest and used IoT solutions in the processing, distribution and retailing segments

Sources: NASSCOM IoT Adoption Index survey analysis

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AgriTech contribution by enterprises, at 0.3% of CSR budgets, lags as enterprises assess right partnerships, models and tech solutions

Pre-Harvest Stages

$17 mn. or 95% of CSR Funding in AgriTech has been in pre-harvest

Irrigation	vedanta transforming elements	476 rainwater channels, 60,000 horticultural crop areas covered with drip irrigation, 681 small rain-water harvesting and 14 ponds to improve soil quality implemented in Rajasthan
	HDFC BANK	36,000 farmers across 11,000 villages impacted by implementation of solar Irrigation pump sets and integrated farming models
	कॉनकॉर CONCOR	CCI CSR initiatives impacted 4,500 apple growing farmers who were able to increase their income
	BHEL	Pro-bono installation of solar water pump sets impacting 100+ farmers
Crop Efficiency	Reliance Foundation	Reliance Foundation Information Services (RFIS) provides information, such as, tackling pest attacks on crops, cyclone alerts for fishermen, or preventive measures against livestock diseases, thereby having impacted 2 mn. farmers
	TATA CONSULTANCY SERVICES	mKrishi, mobile agri advisory system giving information in local languages on agriculture related advice, has been used by more than 1 mn. farmers across 10 states. Aim is to reach 100 mn. farmers
	Mahindra Rise.	50,000 farmers have benefited from “Krishi Mitra” & “ Seed the Rise” CSR initiatives

Post-Harvest Stages

5% of CSR funding in AgriTech

ITC Limited

- Total Farmland size of more than **4.15 lakh** acres impacted
- E-Choupal Agri business platform & advice has been beneficial to lakhs of farmers
- Deployed across Uttar Pradesh, Bihar, West Bengal, Rajasthan, Madhya Pradesh, Andhra Pradesh & many more states

Sources: Company websites, NASSCOM research

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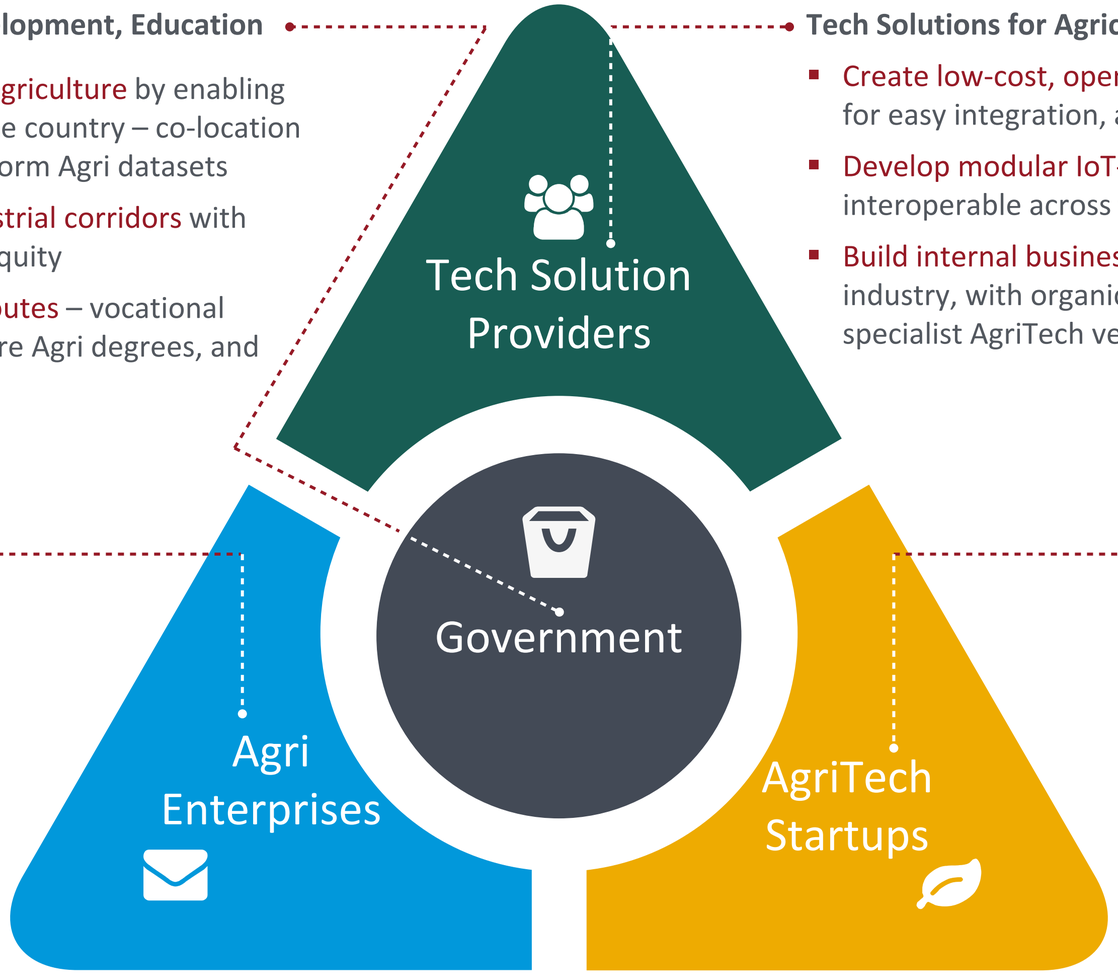
Recommendations for technology infusion in Indian Agri to enable a systemic shift to self-sustainable value creations

Access to Cutting-Edge R&D, Cluster Development, Education

- Institutionalize R&D and innovation in agriculture by enabling access to top Tech capabilities within the country – co-location within STPIs or startup hubs, open platform Agri datasets
- Build Agri corridors on the lines of industrial corridors with PPP-mode development and farmers' equity
- Formalize Agri education via multiple routes – vocational training at primary farming schools, more Agri degrees, and Agri MBAs

Tech Solutions for Agriculture as an Industry

- Create low-cost, open source, cloud-based platform solutions for easy integration, access, and device support
- Develop modular IoT-integrating applications that are interoperable across various farmer information portals
- Build internal business case and CoEs to serve Agriculture as an industry, with organic/inorganic approach to incubating specialist AgriTech ventures



Connected Agriculture Foundation

- Establish global standards in Agri containerization, storage, distribution
- Invest in low-cost high-speed wireless infrastructure and satellite connectivity for real-time data use
- Mobilize CSR and digital tech funds to adopt, and innovate with, AgriTech startups

Pivot and Collaborate

- Establish local presence along Agri clusters for ecosystem integration and access to government, industry, local NGOs, and FPOs
- Pivot to either a verticalized solution for the broader market, or an end-to-end horizontal solution for a cluster of farms

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