NOKIA

# Smartening the farm-to-table supply chain

A SmartAg Workbook for **Real Action**

The Team

All boards

Favourite boards

Templates

**Projects** + New

Smart agriculture

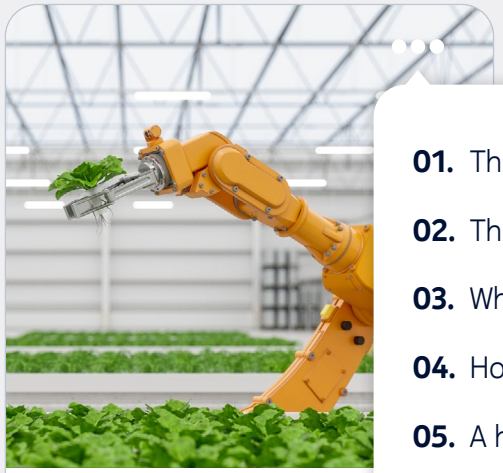
Season 2 ideas...

Trash

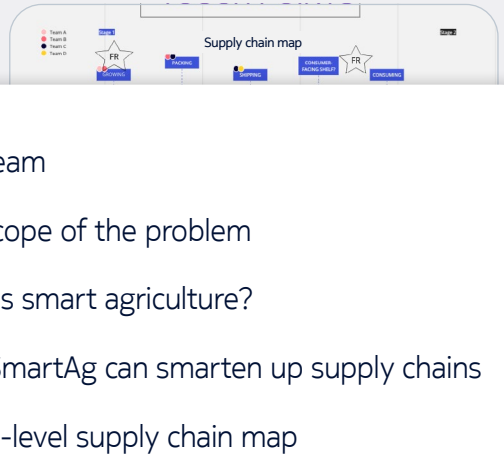
Support

Sign out

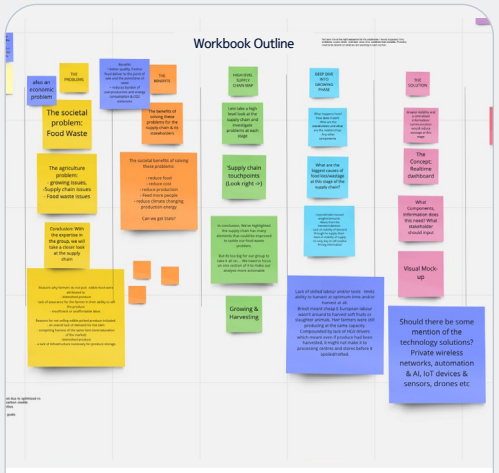
# Table of Contents



Smart agriculture






Workbook Outline

**Navigation**

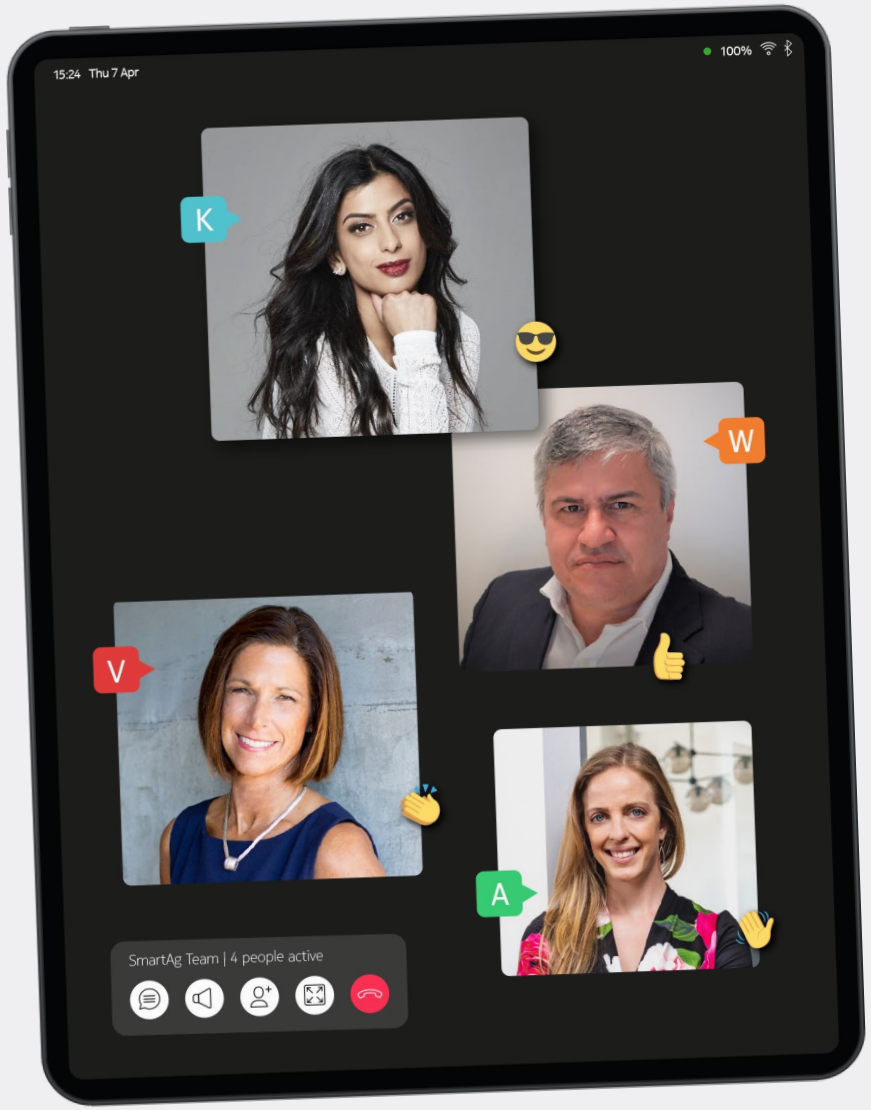
Use the contents page to quickly move between sections

The left/right arrows can be used to move between pages

Use the home icon to return to the contents page

# 01. The team

Return to contents




## Meet Komal
## Founder at Copia

Komal

Komal Ahmad is recognized globally as an award-winning changemaker, humanitarian, and entrepreneur. As a UC Berkeley student, Komal discovered that Hunger is not a scarcity problem; it's a logistics problem.™ This led to her founding Copia, a Y-Combinator-backed for-profit food redistribution and waste reduction technology company. Copia has successfully diverted over 5 million pounds of food from landfills.

## Meet Wilson
## CTO at Nokia Latin America

With more than three decades of experience, Wilson Cardoso is the Chief Technology Officer for Nokia Latin America.

Passionate about sustainability, he believes that 5G technology in the region can be used to increase productivity via crop science.

Wilson

## Meet Vonnie
## VP of Innovation at IFPA

Vonnie

Vonnie Estes currently serves as the Vice President of Innovation for the International Fresh Produce Association (IFPA).

During her storied career, she has focused on developing the supply chain connections necessary to take innovations from the inception to the farm.

**Vonnie:** Hi, nice to meet you all!
Really excited to kick this project off

## Meet Allison
## CMO / Head of Data Products at IUNU

Allison Kopf is working on closing the autonomous growing gap for greenhouse and indoor growers as the Chief Marketing Officer and Head of Data Products at IUNU.

Previously Allison founded Artemis, a leading Cultivation Management Platform in the horticulture industry, which was acquired by IUNU in 2021.

Allison

# 02. The scope of the problem

If you wanted to choose a way to save the world, smart agriculture would be a good place to start.

The **total land surface area of the Earth is 57 million square miles.** About three-quarters of that firm matter beneath our feet is habitable. And of all the habitable land, about **half is devoted to agriculture.**

Even though half of the world is used to produce food, a 2020 UN report found that nearly **690 million people are hungry, up by nearly 60 million in five years.**

And these figures are only projected to further swell in the wake of the COVID-19 pandemic.

But the problem is not that we don't produce enough food to feed everyone. We do. In fact, **we waste 931 million tons of edible food each year.** *

In consideration of these figures, a disturbing picture begins to emerge. **We disposed of enough food last year to feed every single one of the 690 million who went hungry.**

A Change to 931 million tons

**Komal:** It's not a lack of food that's the issue, rather an ineffective distribution of that food.

**Allison:** We need to drive the future of how we produce food in a more sustainable way.

*How can we visualize this?


Food waste impact

Hungry people @ approx. 690m

Wasted food @ 931m tons p.a.

Let's use a food source to visualize

Part of the problem with understanding (and solving) a problem like this is coming to grips with its scale.

**How much is 931 million tons?** We have few, if any, accessible references for comparison.

Let's think about something smaller.

How about a peach? The average peach weighs about **0.25 pounds.** So: there's roughly **8,000 peaches in one ton.** If we extend this frame of reference to the amount of food wasted each year, **931 million tons**, then that means we annually throw away the equivalent of **7,448,000,000,000 peaches**.

**You could feed a lot of people with 7.5 trillion peaches.**

Food waste also squanders other resources such as fresh water, land, energy, labor and money – and these are precious/limited resources too.

Zooming in on irrigation alone, **agriculture accounts for 70% of our fresh water usage.** But we're **wasting 25% because of the food we waste.**

Shows the scale of the problem


**Reasons why farmers do not pick edible food:**

- Blemished produce
- Insufficient or unaffordable labor
- Farmer deems produce otherwise unsellable

**Reasons for not selling edible picked produce:**

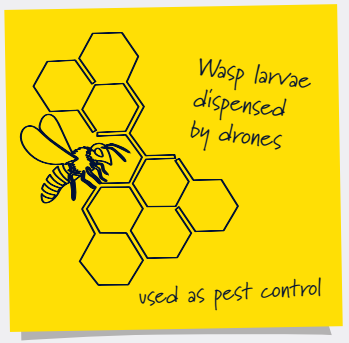
- An overall lack of demand for the item
- Competing harvest of the same item (oversaturation of the market)
- Produce spoiled in transit

We need to get smarter.

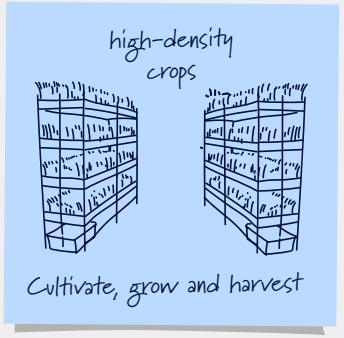
# 03. What is smart agriculture?

Smart agriculture applies cutting-edge technologies, such as connectivity, IoT, AI, Big Data, drones, sensors and robotics, to food production. Also known as SmartAg, this field leverages data to optimize food production systems. The potential of using these technologies in agriculture is huge.

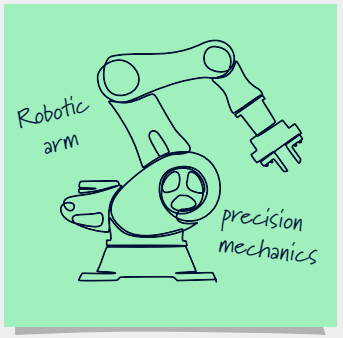
## SmartAg Examples




Researchers in Canada, for example, published a paper about using drones to aerially dispense wasp larvae as a non-chemical pest control. These predatory bugs eat the crop-gnawing insects, preventing blight and improving yields at once.




Vertical farming takes the idea of high-density human habitation and uses the concept to cultivate, grow and harvest crops all year round. AeroFarms, which is located in New Jersey, is working with Nokia Bell Labs on a proof of concept for an integrated system that tests technologies such as AI/ML, wireless networking and drone orchestration to monitor for abnormalities at the individual plant level. This system can image every plant every day.




There are also robotic arms that tend to seedlings with syncopated precision, and greenhouses that autonomously tweak the humidity (usingpredictive analytics to forecast conditions and climate-monitoring IoT) to maximize plant growth.

This technology shows the power of automation for SmartAg

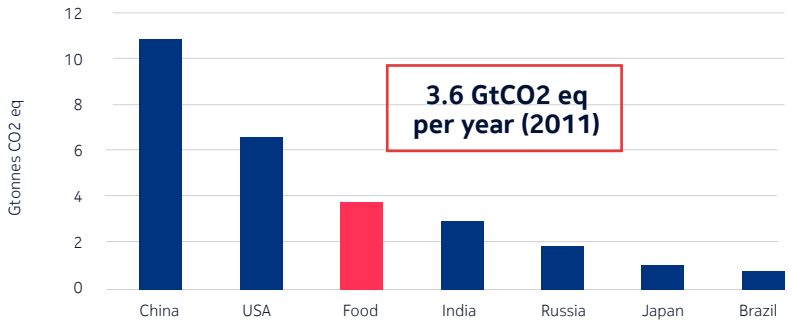
World's 3rd largest CO2 emitter after China and the US.

Lets show this stat in a graph?

But, there are other reasons for new efficiencies, too. The carbon footprint of food waste is **3.3 billion tons of CO2 annually.**

As noted in FAO's 'Food wastage footprint and Climate Change' report, if we counted 'food waste' as a country, in terms of its carbon output, then **"it would be the world's 3rd largest emitter of CO2 after China and the US."**

**Total GHGs emissions excluding Land, Use, Land-Use Change and Forestry Top 7 countries (year 2011) vs. Food wastage**




Source: WRI's Climate Data Explorer (4)

An increase from 3.3 in 2007

Fortunately, by allowing farmers to grow more food in less space and with fewer resources, SmartAg is also poised to create cleaner crop science.

Here is one paper, for example, that found an autonomous greenhouse system **reduced energy consumption by up to 27%** and **shrank costs by 27.76%.** Another report found that cucumber yields **improved by 6% using a similar system.**

Indeed, there is a wealth of opportunity here. The global smart agriculture market, **now valued at around $6 billion, is projected to triple in size by 2026 to $30bn.**

Current market value = $6 billion

We have the tools in our hands to revolutionize the way we farm, ship and store food.

Our ambition here is to show how SmartAg solutions could be blended into the entire length of this supply chain to reduce food waste.

# 04. How SmartAg can smarten up supply chains

To reduce food waste, we first need to identify when food waste happens.

For example, if we provide farmers with real-time data on their crops' condition, then farmers are better able to intervene when necessary. Better still if an autonomous system can make these adjustments – on a watering schedule, for example -this allows the farmer to focus on other tasks.

IoT sensors can even alert farmers that the harvest is ripe. To gather this data, the sensors record temperature and soil moisture, along with camera-based drones used to provide visual inspection of crop growth. Then, they track the location of packed perishables to optimize the journey and reduce spoilage.

**Vonnie:** If farmers can keep their crop healthier, then they will lose fewer to blemishes or rot.

Add examples as sticky notes below...

## What causes food waste?

**75%**

of food waste happens at the growing, packaging and storing phases[1]

**500m tonnes**

in the U.S. is lost due to pest infestation, improper irrigation and untimely harvest[1]

**350m tonnes**

in the U.S. are also lost during the packaging and storing phase[1]

**40%**

of food produced in the U.S. is never eaten[2]

**35%**

of food waste comes from supermarkets, shops and households[1]

**20%**

of fruit and vegetable supply is lost during production[2]

1. United States Department of Agriculture 2. https://www.nrdc.org/resources/left-out-investigation-fruit-and-vegetable-losses-farm

For example, a paper called Predictive Modeling of Microbial Behavior in Food, published in 2019, found predictive modelling to be an effective tool for preventing food spoilage. To build such an algorithmic scaffolding, the conditions of storage – pH, temperature, and humidity, among others – must be carefully considered, and then monitored. When done well, this area of research, dubbed 'predictive microbiology,' can accurately assess when food will rot based on its surrounding conditions.

By using other tools, such as Machine Vision, we can use AI to identify individual fruits. In principle then, equipment that monitors the condition of food could be used along every part of the supply chain, from seed to sale, so that it can be put on a plate before it decays.

To this end, we've endeavored to map out each stage of the supply chain, so that we can determine where better data-monitoring tools can be put in place to reduce food waste. This data could be reflected in a real-time dashboard, a concept for which we've applied a mock-up.

W Can we take this type of innovation into our thinking?


V The supply chain and dashboard mock-ups are set out below!

# 05. A high-level supply chain map

**Allison:** Let's concentrate on finding a solution for growing and packaging phases.


**Solution:**
We need ~~an end-to-end~~ a holistic dashboard.

Would love to see this problem with end-to-end info; manage transport conditions. etc.

Research this further

V

This is a really good starting point for mapping out the supply chain

Return to contents

# 06. Our Solution

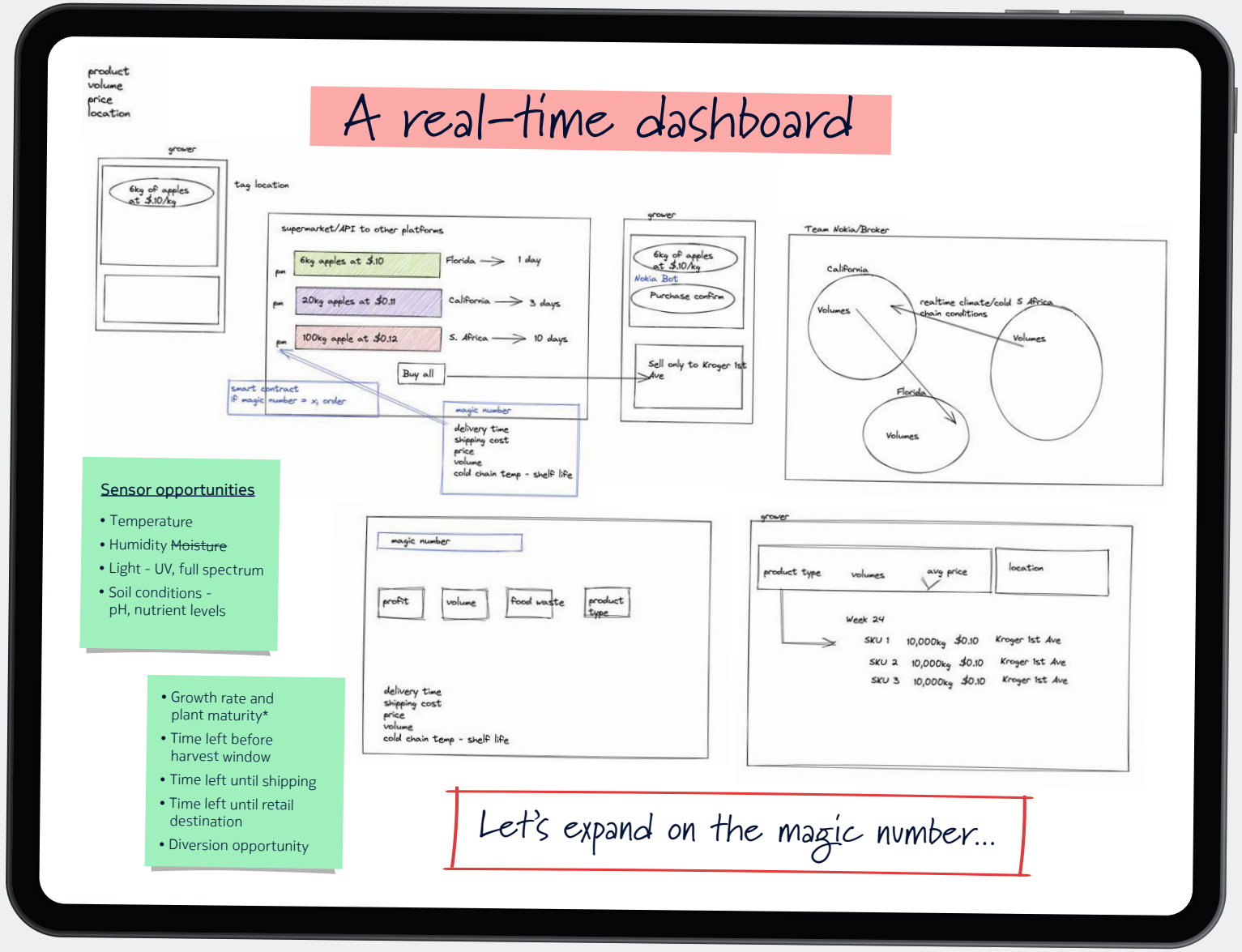
Sensors capture information on the relevant conditions, such as temperature, humidity, pH level, and UV light. This information is used to generate predictive models using AI.

These models can then be used to predict different scenarios and suggest or execute interventions. The idea here is that we house all of the technology under one digital roof, and then reflect the insights the IoT gleans on an attractive dashboard for the end user.

For example, produce is more likely to rot in the presence of moisture and heat. IoT sensors, if placed in packaging, could detect if the fruit were likely to rot ahead of delivery, and then suggest a potential nearby diversion – so that the food does not go to waste. Similar sensors could monitor the tree from which the fruit was picked, ensuring its conditions are optimal.

Our dashboard would incorporate sensors along the entire journey of produce, from seed to sale, so that we can grow more and waste less.

Here's how our real-time dashboard works:




* Also called Yield Monitoring

**Komal:** As an example,the scale could be zero to four

# 07. The idea for a 'magic number'

## What could you use a real-time dashboard for?

Imagine there is a 'magic number.' A number that presents a value for dynamically matching producers/ sellers and buyers, based on predictive modelling fed by a range of climate, logistical and commercial data points.

For example, the magic number knows how much produce a farmer currently has, but also the likely to yield this year, based on weather patterns, current growth trajectories, previous harvests, and other inputs.

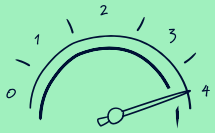
And the magic number also knows who needs the produce, where they need it and how much they need.

To help illustrate this point, imagine you own an apple orchard in Maine and you ship your apples all over the country

**Stage 1**

A request for produce reaches the farmer digitally

**Stage 2**




The dashboard ranks the request on a scale of 0-4

**Stage 3**


The request is ranked as '4', meaning fruit is available and the buyer is a smart match.

**Stage 4**

The ordering happens automatically and the request is fulfilled.

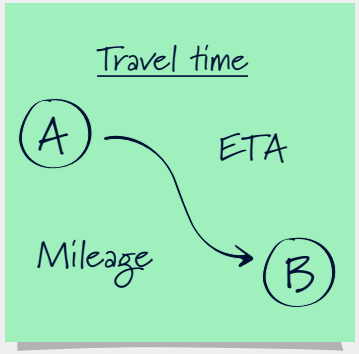
Let's say that, when this magic number reaches a certain threshold (for the purposes of an example, let's say it's 4, on a scale of 0-4) the ordering happens automatically, and is fully tracked, and in exactly the right amount; whenever your inventory as a farmer and a buyer are a smart match, the dashboard ranks the purchase numerically.

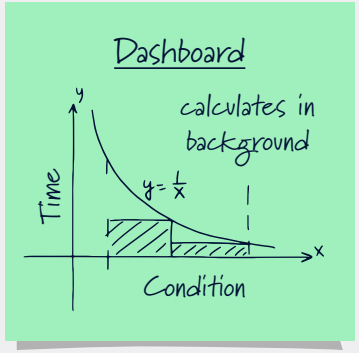
K

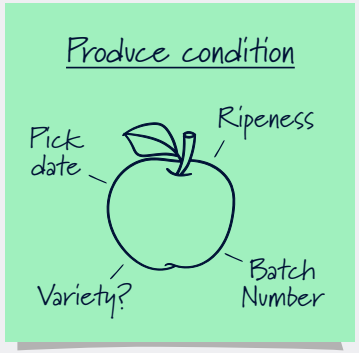
This level of automation is helping the farmer make faster and more intelligent decisions

Can we think of another example to demonstrate this?

The dashboard would also account for the distance of travel and sell-by date.




Now, to help us visualize this, let's say there is a buyer in California who needs apples. But the real-time dashboard rates this match as a 2. No sale is generated.

The low rating is the result of too much time traveling combined with unseasonably warm temperatures. This rejection is logged in the system, but the farmer needn't lift a finger.

Another request for apples. This time, it's local, and you have enough ripe stock to meet the order. You, the farmer, do nothing, while the paperwork is signed, sealed, and delivered. And you never have to worry about the program selling more apples than you have. (AI can identify types of fruit from pictures with 98% accuracy.)

Were a person to receive the order for apples in California, without the help of predictive analytics, AI, IoT, and other technologies, they would have to manually make this decision. Not only is this time-consuming, but as we have demonstrated, it is extremely wasteful.

Whenever your inventory as a farmer and a buyer are a smart match, the dashboard reaches the number 4, and a purchase order is automatically triggered, tracked, and delivered. (All this automated functionality would be supported by blockchain to be secure.)

**Wilson:** This solution demonstrates how AI can revolutionize the supply chain process.

The magic number would simplify all the complex parameters into a single digit that is easy for anyone to use.

Add any tech examples here

# 08. Tech for a real-time dashboard

Smart agriculture needs many different technologies to work together. This is why a real-time dashboard, which is easy for a farmer to monitor what they need to know, would be such a game-changer.

The real-time dashboard would collect all of the metrics for these variables and crunch the numbers to make intelligent predictions, take crop-saving interventions, and even organize sustainable sales at scale.

The tech all needs the correct interfaces, and the real-time dashboard essentially summarises the conversation for the farmer.

**Vonnie:** The opportunities this technology provides for the future of SmartAg are huge!

## In the context of SmartAg...

### The Cloud

An abstract term, the 'cloud' is not a physical entity.

Rather, this vast network of remote servers is linked together, designed to operate as a single compute platform.

### 5G

This 'fifth generation' connectivity will change what is possible. 5G networks will be up to 100x faster than 4G with much lower network delay and very high reliability

### Internet of Things

The Internet of Things, or IoT, refers to the litany of devices that are connectivity enabled to improve performance. In SmartAg, IoT and the connected devices or sensors are used mainly to monitor the plants and the conditions they grow, ship and are stored in.

In SmartAg, IoT and the connected devices or sensors are mainly used to monitor the plants and the conditions they grow, ship and are stored in.

### Artificial Intelligence

Artificial intelligence (AI) is most often known for its predictive prowess in Smart Agriculture. Algorithmic models have already been developed to predict many outcomes, such as crop yield.

In predictive models, the AI crunches the numbers on many factors, from the average number of sunny days in a region to average yield per sq.-mile of comparable soil.

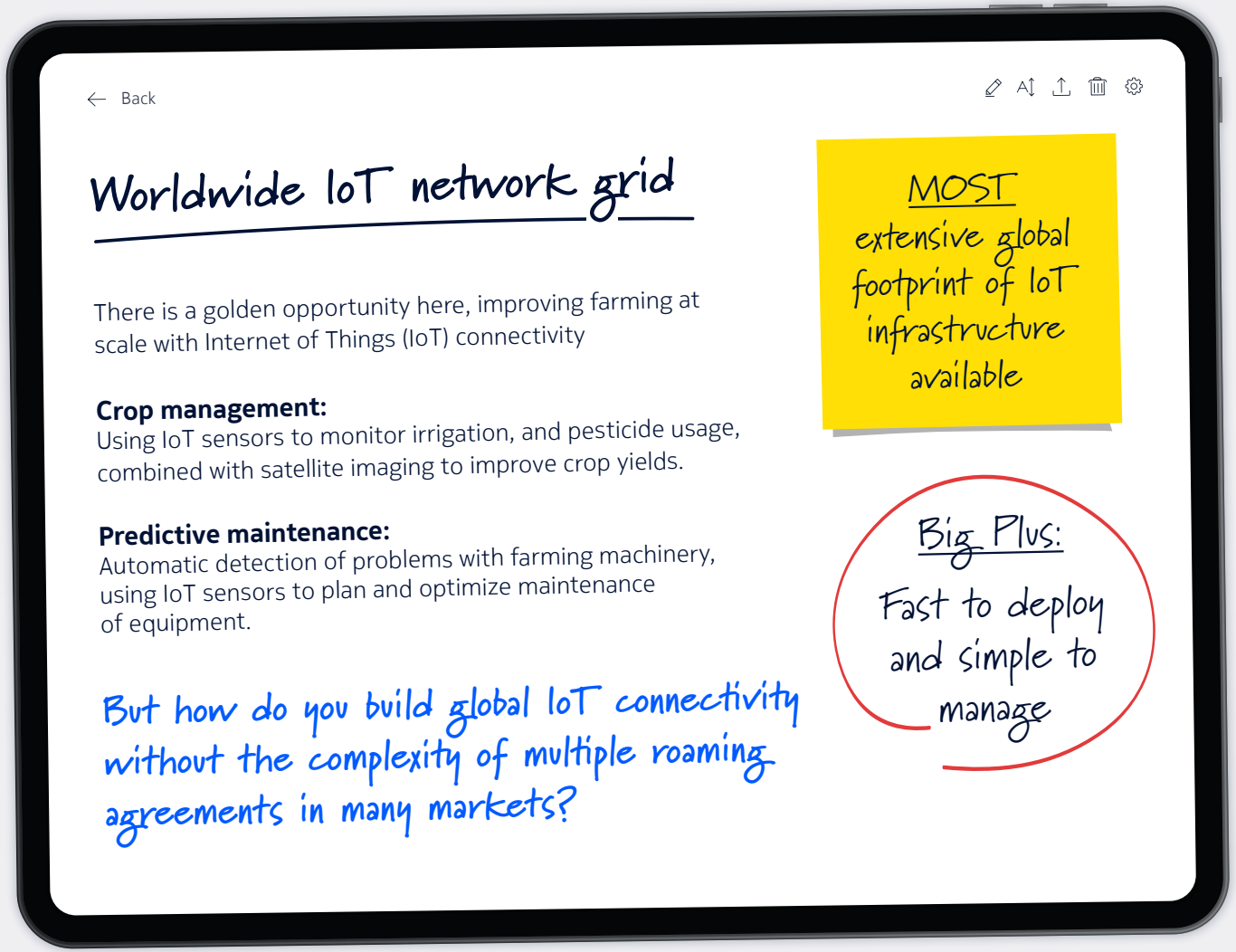
## What can this provide to agribusiness?

**Comments**

**Wilson** updated content

**Vonnie** posted a comment

View all




## Data marketplace

**Supply chain automation:**
Optimize logistics network performance, reduce delays by automating settlements between the stakeholders

**Federated intelligence:**
Improve intelligence exchange between government agencies for faster action

**Environmental data monetization:**
Increase yield, minimize herbicides, and optimize the use of fertilizers depending on actual (non-uniform) soil conditions by algorithm-driven control of farm equipment.

## Digital Automation Cloud (DAC)

End-to-end private wireless networking and edge computing platform.

We need reliable high-bandwidth, low latency 4G/5G connectivity with local edge computing capabilities and a catalog of click & deploy applications.

# 09. Five key takeaways

Return to contents

## Takeaway #1

**Smart farming is new, and growing**

Drones have been around for a while. But it is only recently they've been scanning crops for pests, and then dropping all-natural pesticides, such as wasp larvae, or snapping pictures of miles worth of fields and producing an accurate count of down to the last strawberry.

Complete | April 4

Research current agricultural IoT market trends and solutions

Complete | April 2

W

This research is complete now

## Takeaway #2

**We make more food than we need, yet millions go hungry**

In the words of Komal, "we don't have a food scarcity problem; we have a food distribution problem." If we could reduce the amount of food we waste by half and get it to people in need rather than throwing it away, then we could reduce human suffering. At the same time we improve farming and making it a more sustainable industry.

Complete | April 2

Finalize supply chain map

Complete | March 30

Email team for final amends

## Takeaway #3

**By keeping track of food better, we can tackle food waste**

A lot of food spoils on the field or in transit. Most of this food loss happens because of poor planning – not accounting for when the food would spoil, or how long it would take in transit. A dashboard that presents the conditions of the produce, from seed to sale, would remedy this problem.

Complete | March 24

A

Decide upon structure for workbook content/copy

Complete | April 2

**Komal:** Are there any other tasks we need to complete before we wrap this project up?

## Takeaway #4

**If you care about climate change, you need to care about SmartAg**

Agriculture is to blame for up to 14%[1] of greenhouse gas emissions. But everything is connected. This figure does not consider the toll of clearing land (deforestation), or toxins from fertilizer and herbicides leaking in to groundwater. To reduce our use of limited resources, we should start with wasting less.

Complete | March 28

Update project plan & collate notes for magic number

Complete | March 29

## Takeaway #5

**Without connectivity, there is no smart agriculture**

The genius behind SmartAg is connectivity. The IoT sensors in the ground talk to the drones in the air, and so on, and this information is relayed in real-time to be presented to the farmer. None of this is possible without high speed broadband with lower latency and high reliability.

Complete | March 23

Arrange summary meeting

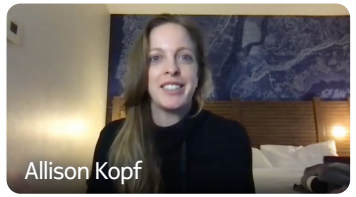
Complete | April 8

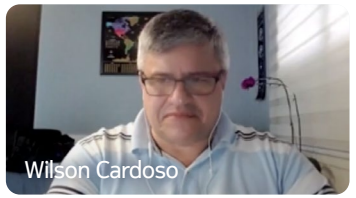
Check all sources for workbook

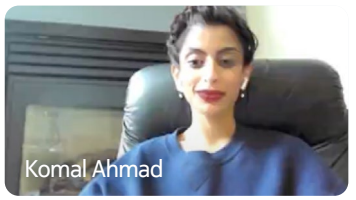
1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7116829/

**SmartAg Scrum:** Supply Chain

You are viewing Vonnie Este's screen


# 10. Next steps for smarter supply chains

## If you could see into the future, you could prepare for it better.

SmartAg allows us to reduce guesswork and become more predictable. AI models can, for example, predict demand for produce, shipping times, and make other relevant forecasts. Real-time monitoring equipment can ensure the conditions of food storage via a data management platform.

In this workbook, we've created a mockup of what a data management platform would look like.

This rough proof-of-concept would need to be bespoke to be effective. Information on the weather is only relevant if local; different crops would require different conditions for optimal growing and storage; shipping times vary by country.

The model we've provided is broadly applicable, provided the data inputs are relevant to your/local situation. As we've discussed, there are many disparate pieces of technology on the table that need to be put together to unleash their full potential.

Over time AI models can help by predicting demand for produce, with expected crop outputs, along with logistical requirements. Combined with real-time monitoring, farmers and distributors needs can be matched with greater monitoring.

What's needed now is an end-to-end solution, which monitors food every step of the way, and presents this data on a dashboard like the one we have provided.

**Notifications**

**Wilson** posted a comment

I've had the great opportunity to learn a lot from three smart agriculture experts. Adding the power of Nokia solutions, we believe that we can start to solve the food waste problem.

See 2 more

# 11. Brazil x ConectarAGRO

In May 2019, Nokia joined ConectarAGRO to empower Brazilian farmers.

**What is ConectarAGRO?**
This initiative promotes connectivity innovations for the Brazilian agribusiness.

**Who created it?**
The founding members of this organization include agribusiness leaders, such as CNH, AGCO, Bayer, Jacto, Solinftec and Trimble, and telecom leaders, such as Nokia and TIM.

Brazilian farming could really benefit from the use of this technology.


**What is the goal of ConectarAGRO?**
93% of Brazilian farmers have no wireless access.

Nokia will address this by providing the necessary technology for 4G coverage today and 5G tomorrow.

**4G Coverage and SmartAg?**
4G coverage enables IoT and other precision agricultural technologies that will boost yields and help meet rising food demand.

**How many farms will be affected?**
The initiative will visit 500,000 Brazilian farms to employ a range of tech including robotics, scanning drones and temperature and moisture sensors to improve yields.

**Which crops will be impacted?**
The soybean, cotton, corn, and sugar cane crops are the most common large-scale produce grown by Brazilian farmers.

**How does this help?**
The agribusiness sector of the Brazilian economy is responsible for 80% of growth in the entire country.

Moreover, if the farmers have access to better technology, they will be more profitable as individuals.

But it is about more than money. SmartAg tech allows less land to yield more, and so less Amazonian land will need to be cleared, and less waste will occur.

**What is Nokia's role?**
Nokia will develop and provide solutions for the agribusiness sector. Nokia's wireless broadband solutions include 4G/LTE and 5G, as well as satellite and microwave technology.

This powerful connectivity platform is built to support advanced IoT solutions and new use cases that improve efficient use of resources and boost productivity for farmers.

**What is the response?**
"Nokia is currently the only connectivity technology vendor contributing to ConectarAGRO," **says Wilson Cardoso, CTO of Nokia LATAM.** But we have plans to expand our activities elsewhere in Latin America. It has so far been a huge success, and we have reached more than a million people already in just two years."

Insight

**93%**

of Brazilian farmers have no wireless access

Reach & Impact

**500k**

farmers will be visited to employ a range of tech solutions

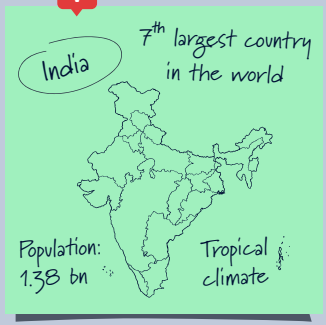
# 12. India x Nokia

*In December 2020, Nokia started working with 50,000 farmers in two Indian states to improve their food production technology with digital technology*

**What happened?**
In 2020, Nokia and partners deployed more than 400 sensors to collect data for analysis by the solution's cloud-based and localized smart agriculture app. The WING solution comprised soil probes, weather stations, insect traps and crop cameras.

**Who is involved?**
Following on the success of its efforts in Brazil, in 2021 Nokia and Vodafone India Foundation, the CSR arm of Vi, deployed a Smart Agriculture solution designed to improve the productivity of farmers in India.

V




*Reach & Impact*

400 sensors

100 locations in 2 states

100,000 hectres covered

50,000 farmers impacted

**Where did it happen?**
Nokia launched a pilot project in 100 locations in Madhya Pradesh and Maharashtra, two States in India, which will cover 100,000 hectares of farmland.

**Who will be affected?**
The effort will give 50,000 farmers access to new technology with the potential to boost their productivity, income and sustainability.

A

**How does it work?**
Let's unpack this with one example: soil health. IoT sensors are often used to monitor the soil for nutrients, moisture, and pH.

**Why does soil matter?**
Good soil is full of nutrients, the by-products of micro-organisms munching on rocks and other materials that contain atoms of iron, boron, phosphorus, calcium, and potassium, among others. These nutrients are essential not just for the plant growing in the soil, but for us. But the plant cannot access the nitrogen and nutrients in this soil if its pH level is too low or too high, indicating the soil is too basic or acidic (respectively).

**Why do we need to measure pH?**
The plant itself influences the acidity. The roots will secrete either acid or alkaline substances depending on the crop's stage of development, the food available, the differences in root temperature and light intensity.

So, pH is a good indicator of soil health and keeping the soil in an agreeable level of acidity is important.

**How does SmartAg help?**
IoT sensors connect to a private network or local mobile network to monitor the soil, test its nutrient levels, and report other metrics.

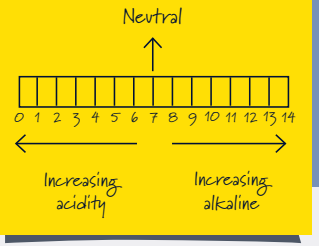
The presence of this technology also means that the farmer can take real action to rectify pH levels, ensuring that the soil produces the expected healthy yield.

*What is pH?*

Soil pH is an indication of the acidity or alkalinity of soil and is measured in pH units.

The pH scale goes from 0 to 14 with pH 7 as the neutral point of the relative amount of free hydrogen and hydroxyl ions in the water.

*The pH scale*




## Food waste impact

Hungry people @ approx. 690m

Wasted food @ 931m tons p.a.

Find out more about Nokia's Real Action series by clicking here

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We create the critical networks and technologies to bring together the world's intelligence, across businesses, cities, supply chains and societies. With our commitment to innovation and technology leadership, driven by the award-winning Nokia Bell Labs, we deliver networks at the limits of science across mobile, infrastructure, cloud, and enabling technologies. Adhering to the highest standards of integrity and security, we help build the capabilities we need for a more productive, sustainable and inclusive world.

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