Walmart

THE FUTURE OF FOOD

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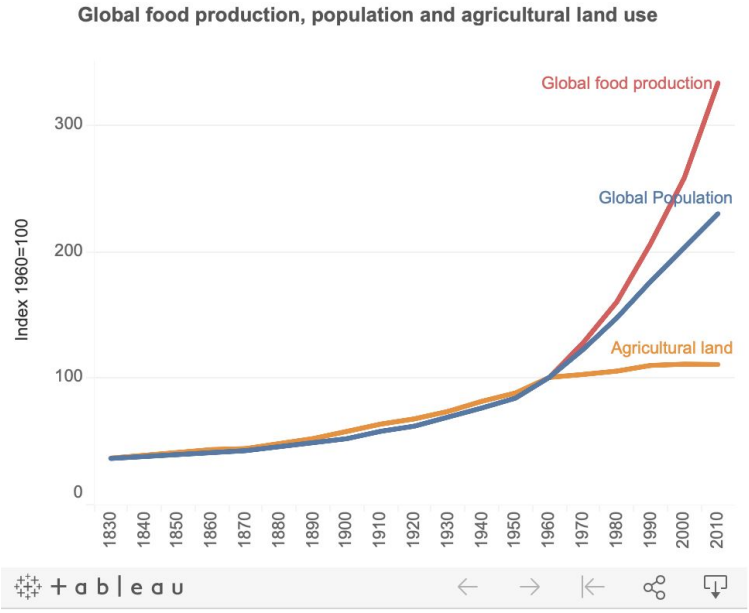
Contents

1. The Future of Food

1.1 - Overview

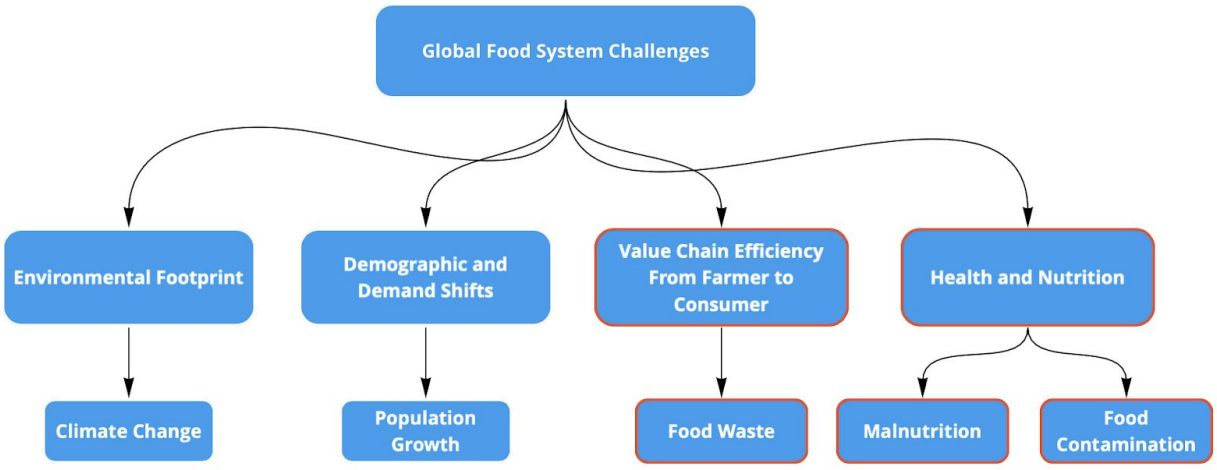
According to the WWF, 33% of the planet's surface is used to produce food and the demand for food will double by 2050. (1) With a growing population that will reach almost 10 billion in 2050, the global food system needs to adapt towards social, economic and environmental sustainability to ensure an affordable food supply for all.



(OECD report)

The New Vision for Agriculture (NVA) holds that, to meet the world's needs, sustainable agriculture must simultaneously deliver food security, environmental sustainability and economic opportunity. Achieving those goals requires a transformation of the agriculture sector as well as leveraging market-based approaches through a coordinated effort by all stakeholders, including farmers, government, civil society and the private sector. (2)

1.2 - Breakdown of the challenges



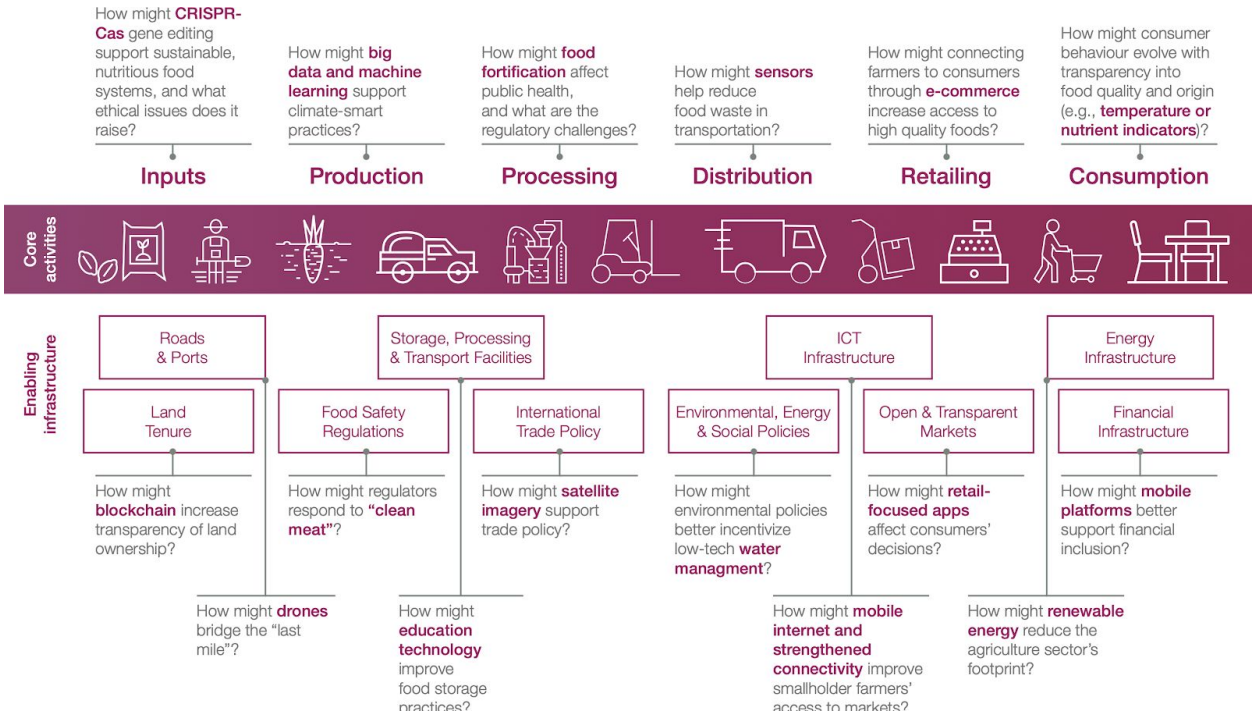
Analyzing WEF's Dynamic Briefing Report on the Future of Food, four major global food system challenges arose, as showcased in the diagram above. (3) (for the first two, see Appendix 6.1.2)

Value Chain Efficiency

Multinational retailers are increasingly relying on smallholder value chains to satisfy growing global food demand. Many are supplying technical assistance to support productivity, creating more awareness of the environmental and social dimensions of food loss and waste. A report published in 2013 found that roughly one-third of food produced for consumption is lost or wasted along the value chain, which cost 1.3 billion tons of food. (6)

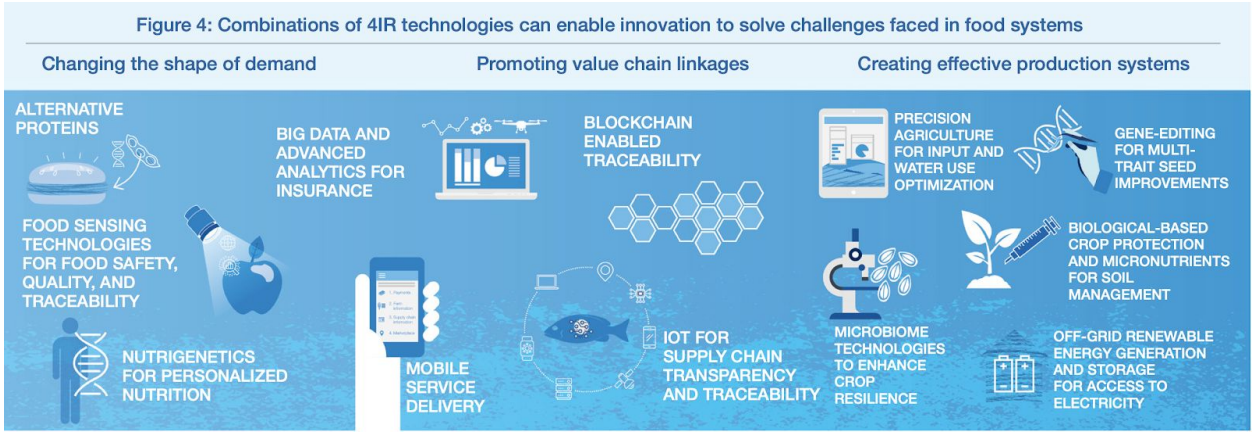
Health and Nutrition

Health and nutrition poses a challenge for the global food industry, especially the development of sustainable products and the safety of food. Around 12% of adults are obesed, according to the 2018 report called State of Food Insecurity and Nutrition in the World. (7) Meanwhile, in 2017, the number of undernourished people in the world grew to 821 million. This, coupled with severe food insecurity, appears to be increasing in nearly all subregions of Africa as well as in South America.



(WEF Innovation with a Purpose, 2016)

Yet, technologies and innovation can help tackle these global food system challenges. WEF's 2016 Innovation with a Purpose project proposes two phases: (8)



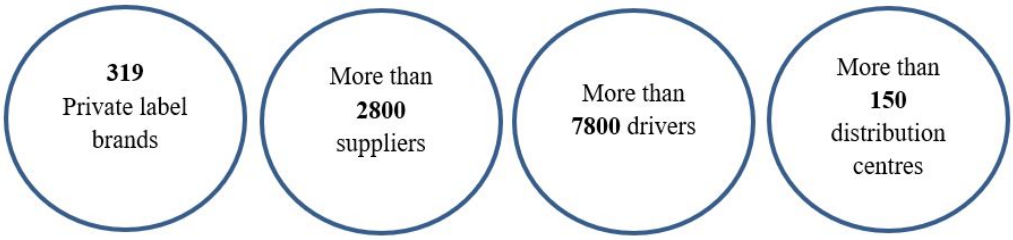
The 2018 WEF Innovation with a Purpose Report identified twelve disrupting technologies from which the global food system could benefit from called “The Transformative Twelve”. (9) These 12 technologies have the potential to:

- Materially impact food systems outcomes across various countries/regions, promoting inclusivity, sustainability, nutrition and health
- Deliver impact to stakeholders across food systems, including input manufacturers, farmers, consumers, distributors and the enabling environment

2. Walmart

2.1 - The company

Walmart Inc. is an american multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores in 27 countries, with 11,400 stores worldwide. It boasts the highest revenue - roughly $524 billion and the largest private employer with almost 2.3 million employees. 56% of its total revenue is generated by groceries. (10)



2.1.1 Business Model Canvas

(11)

Business Model Canvas

Designed for: Wal-Mart

Designed by: Team 10

Key Partners

- 2.3 millions associates
- 2800 suppliers worldwide alimented through connected platform Retail Link (sales data)
- 319 private label brands
- logistic partners: Bringg, DoorDash, PostMates
- distribution: Sam's club distribution centers
- 1.4 small and medium farmers
- providers: top-notch support & range of eCommerce services
- Acquisitions of online commerces to drive customer experience
- collaboration with NGOs and government leaders
- financial institutions

Key Activities

- procurement
- logistics
- Distribution
- Supply chain practices
- Pricing
- Negotiation with vendors
- Customer Service
- Customer Data processing
- E-commerce operation
- Marketing

Key Resources

- supply chain and logistics infrastructure (more than 150 distribution centers + a fleet of 6100 tractors, 61,000 trailers and more than 7800 drivers)
- online and mobile platforms and IT infrastructure (e-commerce websites in 11 countries)
- its international chain of physical retail stores (11,695 stores under 59 banners operating in 28 countries)
- 2.3 million employees worldwide
- About 40% of products sold in Wal-Mart are private label store brands
- partnerships and alliances
- Walmart Labs

Value Propositions

- provide low priced products to its customer everyday
- one stop shopping (provide a wide range of products and services in one place)
- online product recommendation and personalisation

Customer Relationships

- online shopping
- self-service
- Automation (pick up machine)
- No membership fees
- benefits for members
- Different shipping options
- Customer service
- Rewards
- Campaigns

Channels

- for customer buying markets:

physical:
Supercenter
Discount Store
Neighbourhood market
Sam's Club
Online :
Online shop - Walmart.com
Mobile apps

- Customer digital solutions :

Pickup machines
Wal-Mart pay

- For suppliers :

Online fulfillment

- Advertising and promotions :

Media / Social networks/ Newsroom / Events & Webcasts/Blog/ Walmart community/ Affiliate program/ Walmart Museum/ Credit cards / Gift cards

Customer Segments

personal (Walmart):

- Low to medium income consumers
- Hispanic customers
- African American customers
- Empty Nesters
- Suburbanites
- Rural area customers

Business (Sam's club)

- small business owners
- entrepreneurs

Cost Structure

Operating expenses as a percentage of net sales fell from 21.5% of net sales in 2018 to 20.9% of net sales in 2020, with net sales increasing thus showing an excellent effort in controlling expenses.

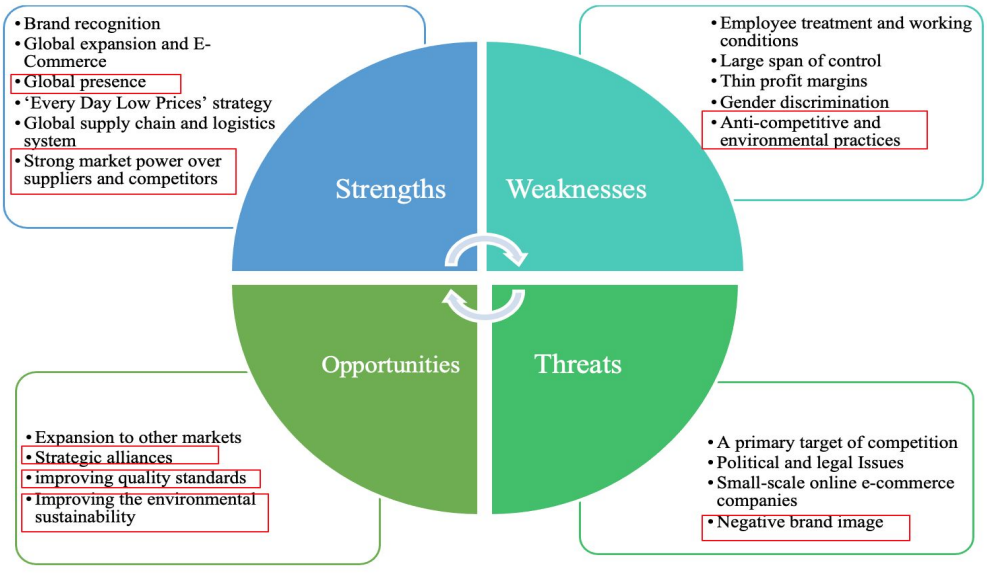
Capital expenditure on Ecommerce, technology and improving supply chain in 2020 = 5.6billion USD
Capital expenditure on store remodels in 2020 = 2.2billion USD

Revenue Streams

Revenue in 2019 : 524billion USD, increase continuously from the last 5 years at 482billion USD
Gross margin maintained between 24-25% since 2016
Net profit in 2019: 14.9billion USD
Walmart US segment contributed 65% of revenue
Walmart International segment sales fell in 2019 due to a lower stake in Walmart Brazil.
Walmart International's biggest revenue contributor is Mexico and Central America, followed by the UK and then Canada.

2.1.2 Swot Analysis

Walmart's global presence justifies its strong market power over suppliers and competitors, therefore its actions are impactful and could drive real positive change in the food system. These include expanding and improving healthy food offerings, being environmentally sustainable or avoiding anti-competitive practices. (12)



2.1.3 Walmart's impact on the Food System

Industry impact

Walmart provides suppliers with exposure to 200 million customers weekly in more than 10,000 retail units in 27 countries. Due to its influence, Walmart may require its suppliers to comply with food legislation and make profound changes and improvements in the Food system. (13)

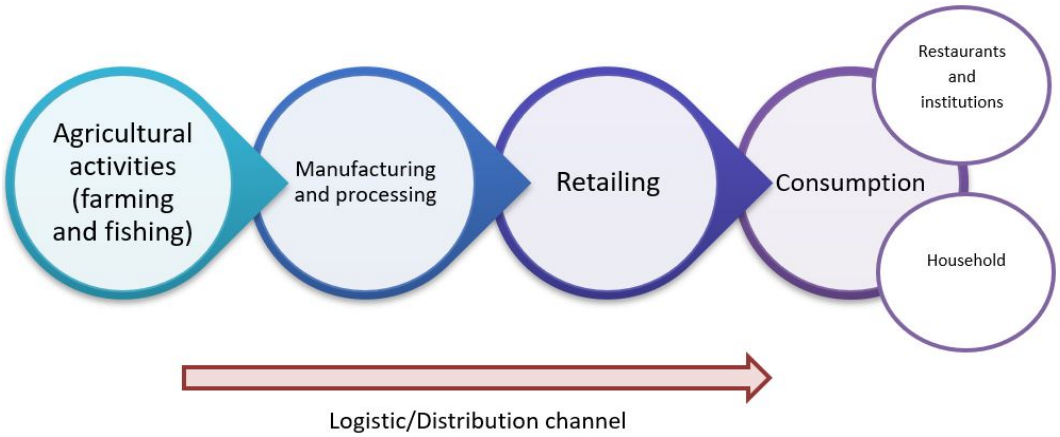
Environmental impact

According to Statista, in 2018, Walmart was responsible for 18.1 metric tons of green gas emissions. These are mostly the result of **electricity supply** (69%). (14)

In regard to renewable energy, Walmart has set a target of 10% reduction of its chemical footprint by 2022. It used renewable energy to run 29% of its facilities in 2019, securing more wind and solar compared to other United States companies. It aims to power its operations using 100% renewable energy by 2035. (15)

2.2 - Challenges of food system faced by Walmart

2.2.1 Efficiency in food system: Food Waste



The diagram above shows the 5 key activities in the food supply chain. For Walmart to improve the operation efficiency in retailing, it must understand and cooperate with other partners in the supply chain.

2.2.1.1 The scale of food waste in each activity in the supply chain

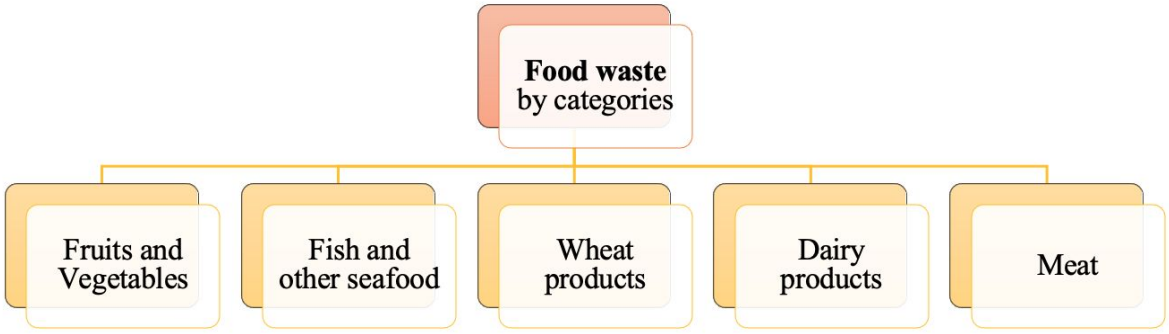
Agricultual activities	Manufacturing and processing	Retailing	Consumption	Logistic / Distribution Channel
•Waste from farming actitivies are often caused by two main factors, namely **Pest Infestation** and **Extreme Weather**, according to the Natutal Resources Defense Council •In US farming, between **3 - 10 million tonnes of crops were wasted annually.** • In fishing, the Food and Agricultural Organisation (FAO) estimates that 8% of fish caught in the world were discarded, representing nearly 80 million tonnes per year •In US fishing, **16 -32% of fish caught was discarded**, which is at least twice of the global average	•Waste from manufacturing and processing are the least among the supply chain, reasons including selling surplus of waste to another party. For example, excessive corns used in processing will be sold to make fertilisers or other uses. •It is estimated that around **2 million tonnes of waste is generated from manufacturing and proecessing**	•Is the **2nd largest contributor** of food waste in the supply chain in many countries, including the US. •It is estimated between **20 -30 million tonnes of food waste came from the retailing in the US**. •USDA found waste from unsold fruits and vegetables cost retailers $15billion annually. From the $15billion, $6 billion came from disposing fruits and vegetables with imperfect apperance Walmart Save money. Live better.	•Food waste from **household is the largest contributor in food waste** in most countries, incldluing the US. •In the US, around 40 -50% of food waste came from household, as estimated by ReFED. That is **nearly 50 million tonnes of food waste in a year**. •Average American spent $500 in contributing food waste annually. •Restaurants and instituitions such as schools caused more than **10 million tonnes of food waste annually**.	•As food move along the supply chain, food waste is accumulating from the very first place to the end consumers. •Although this area is more difficult to measure, the Commission for Environment Cooperation (CEC) estimates that **logistic caused 9% (or 9 million tonnes) of total food waste in the US**, more than Mexico (5%) and Canada (1%). •Recently, due to the Covid-19 pandemic and Brexit deal, more food were wasted in logistic as borders were closed and shipping of food became harder, which cause more food being rotten in containers.

(16) (17) (18)

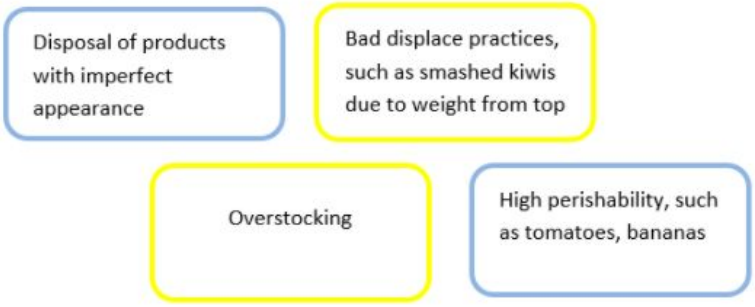
2.2.1.2 Share of US food waste in the supply chain

The diagram above depicts the share of food waste in the US food supply chain. Specifically, the household comprises 50% of food waste, followed by retailers with 20% and restaurants and institutions with 10%. As a result, a conclusion suggesting the closer towards the consumer ends, the more waste is generated. As retail is the one of the most important means for consumers to purchase food, actions from retailers like Walmart can have a significant impact on the industry.

2.2.1.3 Scale of food waste by food categories



According to the Food Loss and Waste report from the Food and Agriculture Organisation (FAO), fruits and vegetables was ranked top, which made up 45% of waste, followed by fish and other seafood, which made up 35% of waste. (19) The common reasons of high waste in fruits and vegetables category includes:

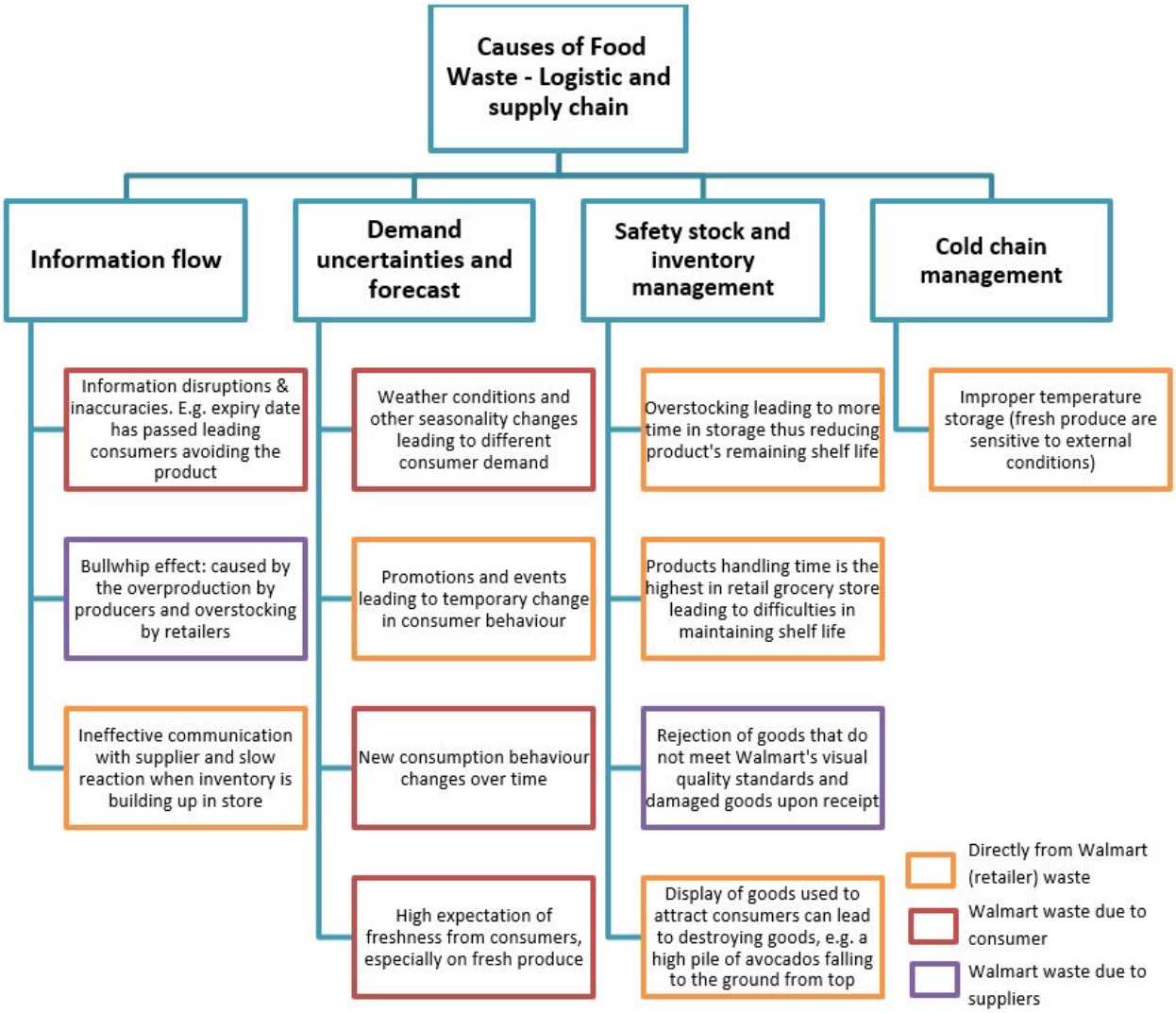


For fish and other seafood, the most crucial reason is the high-level of expectation of freshness from consumers. Fish kept in supermarkets' fridges often has a shelf life of less than 5 days, as

only frozen fish is better in keeping freshness. Besides, the temperature of storing fish should be maintained at a suitable level, as bad storing practices will cause the whole batch of fish to be disposed of.

2.2.1.4 Root causes and challenges of food waste in Walmart

According to the Global Business Management Review report, we identified the root causes of food waste in Walmart. (20)

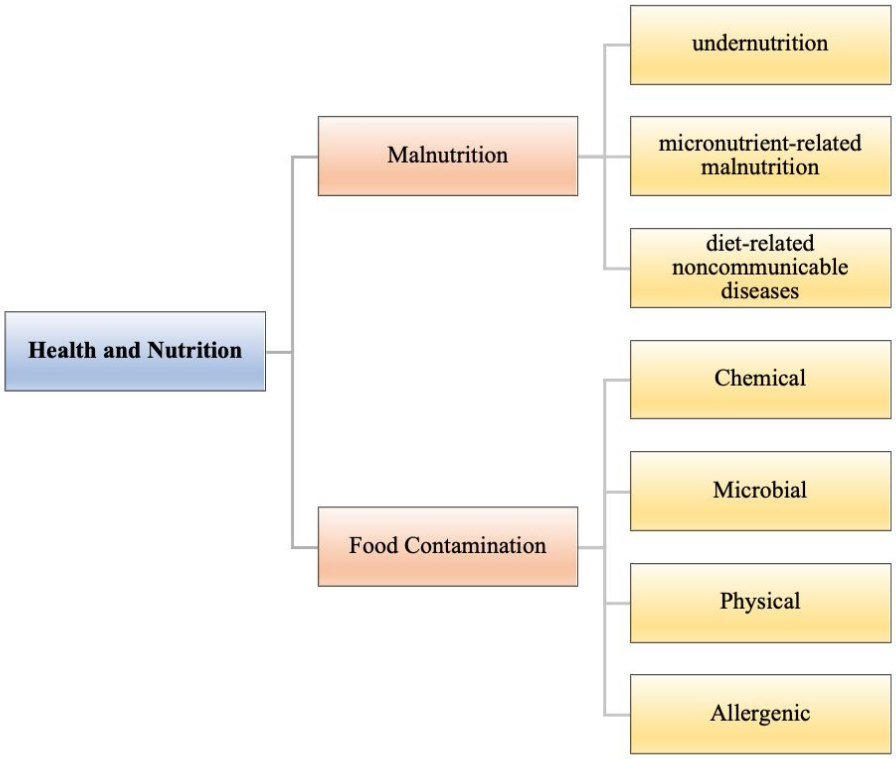


Information inaccuracies can mislead consumers' buying decisions. A major problem arises when consumers interpret the **Best before date** by thinking the product is no longer consumable

when it exceeds the Best before date and the similar problem goes for **Minimum durability date**. In fact, both Best before date and Minimum durability means the product may gradually lose its nutritious value and taste, instead of unfit for human consumption. The Best before date is just a former name for Minimum durability date. Published by Carrefour, having poor understanding on Minimum durability date is accountable for 20% of all food waste in France. (21)

2.2.2 Health and nutrition: Malnutrition and Food Contamination

Profound changes in our current food systems and consumption patterns are needed to combat nutrition problems that afflict more than 2 billion people. Regarding Health and Nutrition, we have mainly identified two challenges in Walmart: *Malnutrition* and *Food Contamination.* Malnutrition costs the world's economies trillions of dollars due to higher healthcare costs and loss of productivity. Food Contamination leads to foodborne illness that has been estimated to be as high as $90 billion annually. (22)



2.2.2.1 Scale of Malnutrition

Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. The term malnutrition addresses 3 broad groups of conditions: (23)

Undernutrition

- includes wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age)

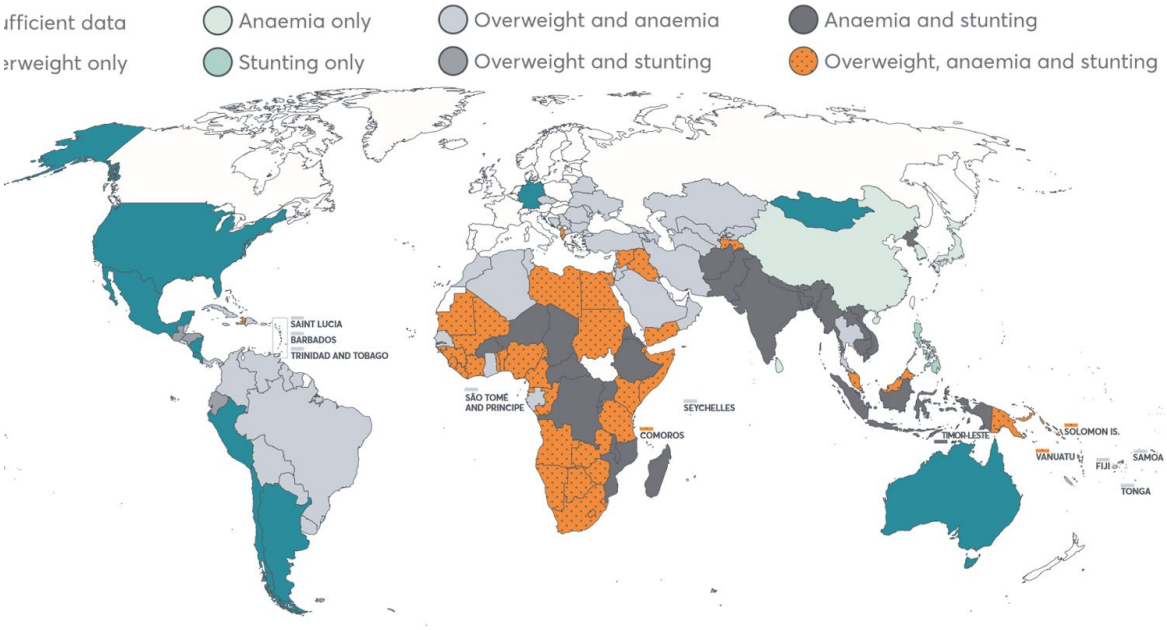
Micronutrient-related malnutrition

- includes micronutrient deficiencies (lack of important vitamins and minerals) or micronutrient excess

Overweight, obesity and diet-related noncommunicable diseases

- such as heart disease, stroke, diabetes and etc.

Scale of the Problem (24)



(25)

2.2.2.2 Scale of Food Contamination in Supermarkets by types

Type	Chemical	Microbial	Physical	Allergenic
Definition	Food becomes contaminated by some chemical substance. This may occur from preparing food on a surface that still has chemical residue on it or if someone sprays cleaning chemicals close to uncovered food.	Food has been contaminated by microorganisms, including bacteria, viruses, mould, fungi, and toxins.	Happens when a food has been contaminated by a foreign object. Types of physical contaminants that can be found in food include jewellery, hair, plastic, bones, stones, pest bodies, and cloth.	Allergenic contamination occurs when a food that causes an allergic reaction comes into contact with another food. For someone with a food allergy, consuming even a tiny amount of that food is enough to cause a fatal reaction.
Scale	California supermarkets knowingly and intentionally sold products that exposed California consumers to lead or cadmium without providing a clear and reasonable warning that the products contained these toxic chemicals. (26)	In 2020, at least 6 types of Walmart products have been recalled due to microbial diseases found in these. They include almost only fruits & vegetables but raw beef as well. Most of the products had already been dispatched through dozens of states resulting in several cases of foodborne illness. In 2020, there was concert that it is possible that supermarket products are contaminated with COVID-19. (27)	in 2020, metal needles were located in a punnet of strawberries and in an avocado, and thumb tacks were located in a loaf of bread by supermarket customers. It was reported that someone also discovered a needle in a mandarin. (28)	At Walmart, Spaghetti Marinara was recently recalled and removed for sale due to several units with incorrect packaging resulting in undeclared milk and sulphites. (29)

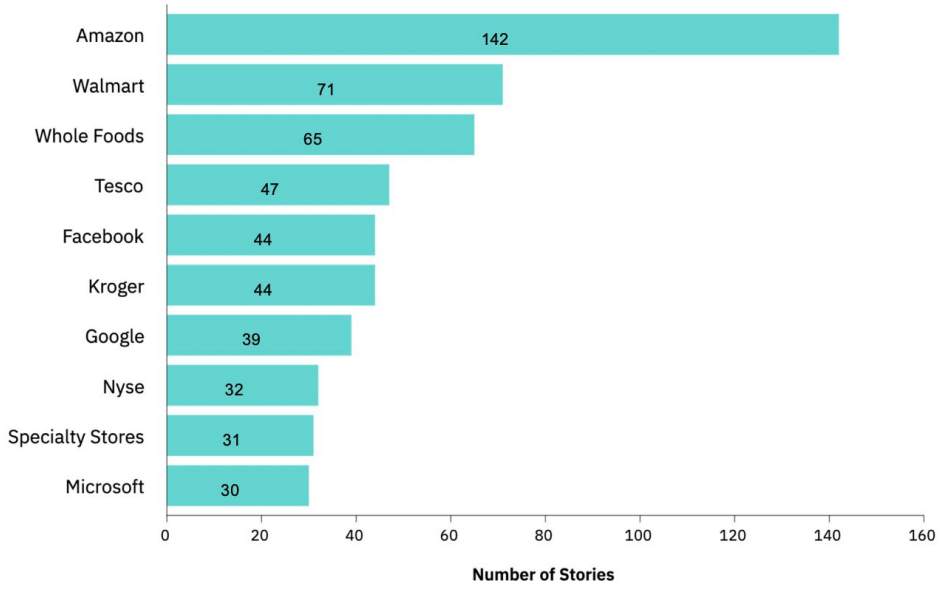
3. Transformative Innovations Applications

3.1 - Extensive research using Quid

All the bellow graphs are explained in the appendix section:

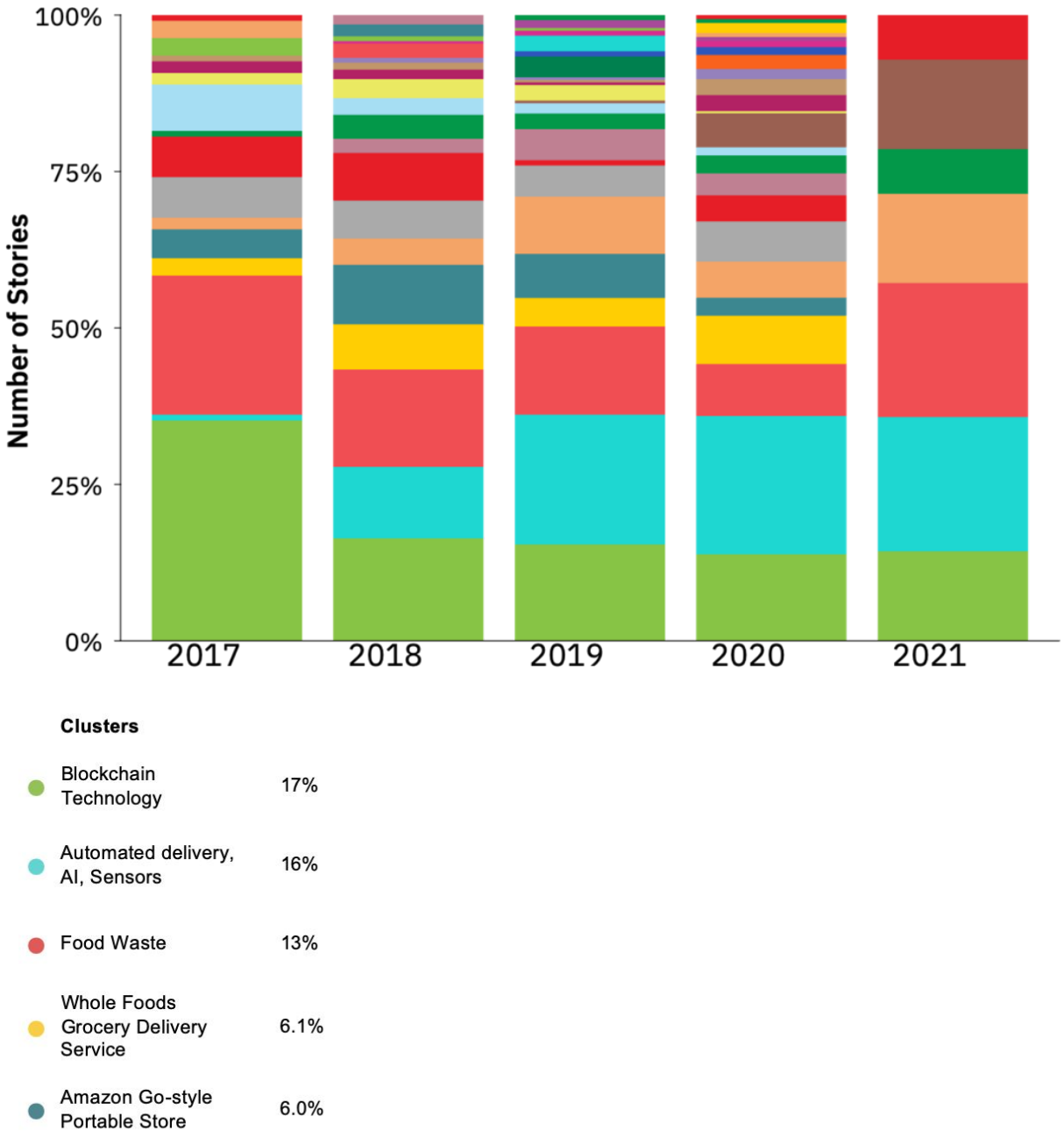
2017-2021 Top companies supermarket food technology

News article bar chart with 350 stories. Colored by uniform.



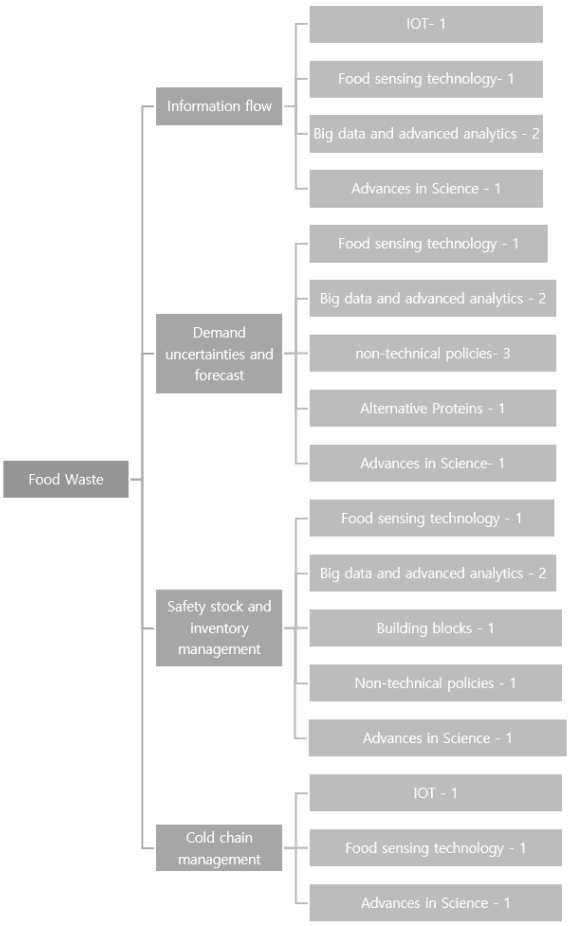
Timeline - food trends

News article timeline with 938 stories. Colored by clusters.

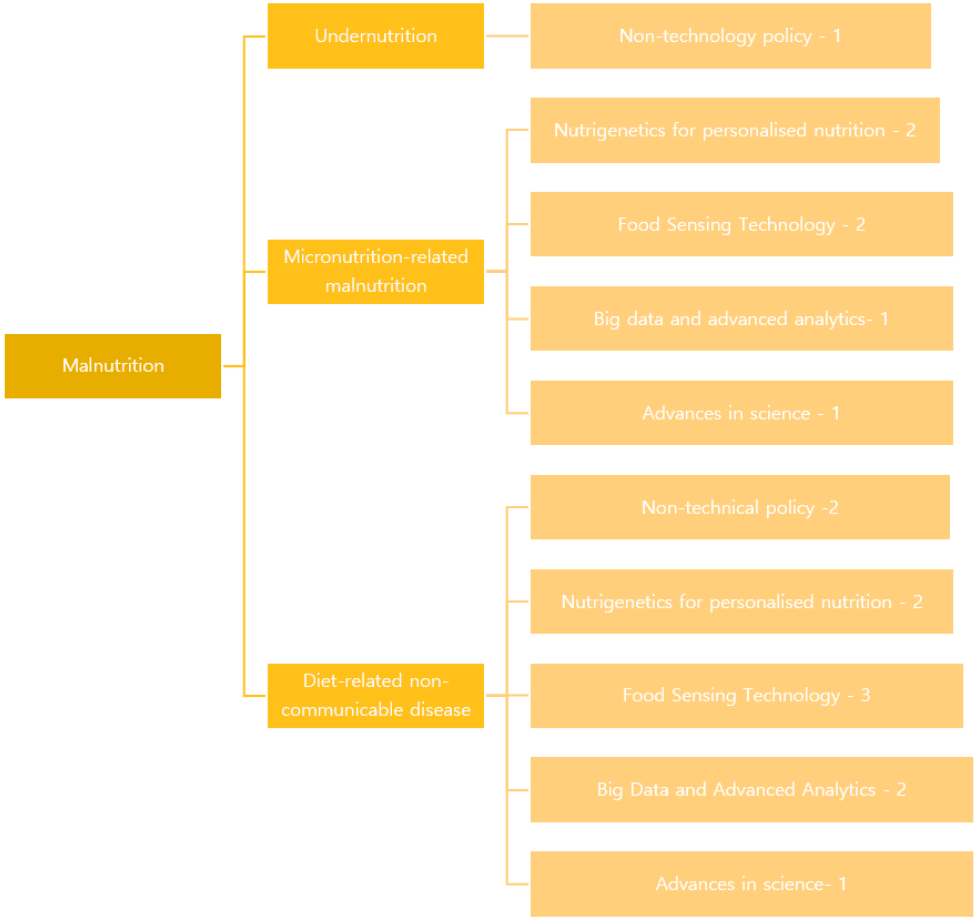


3.2 -Number of innovative technology applications for each problem

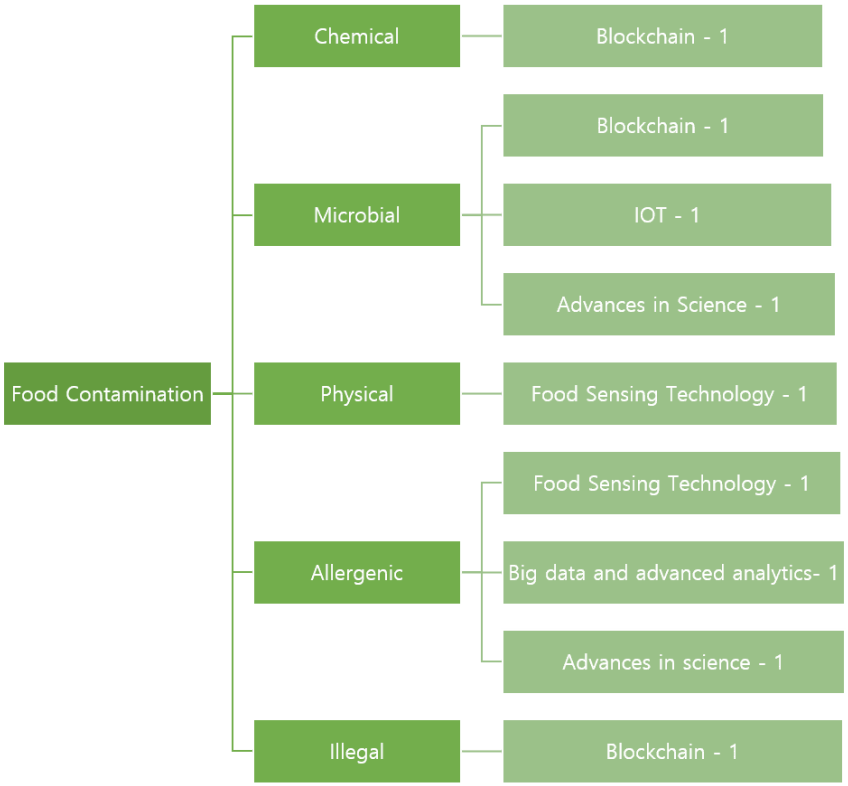
Food Waste



Malnutrition



Food Contamination



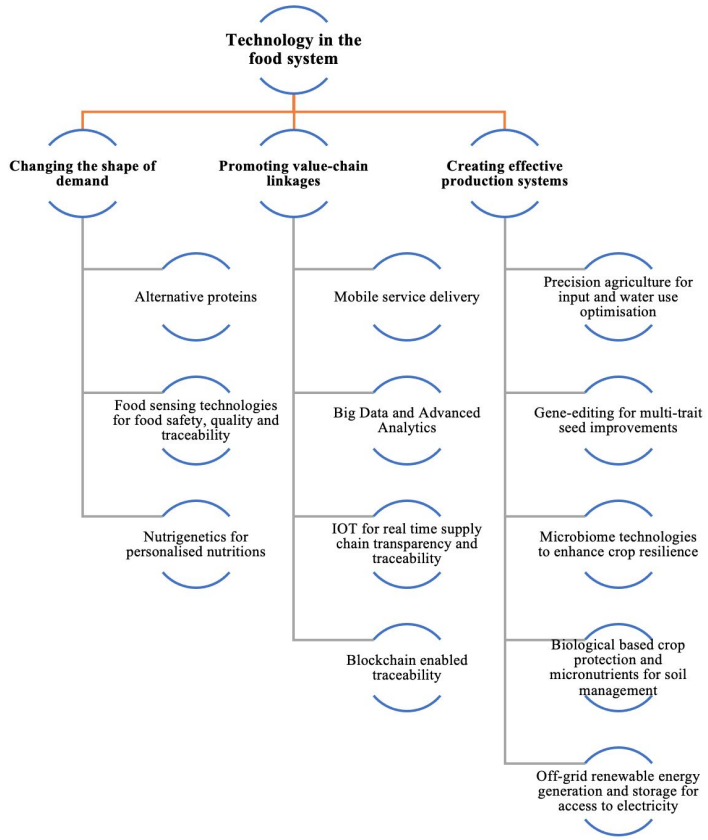
Total Examples: 48

See appendix for detailed technology innovation applications explanations

4. Transformative Innovations Map

4.1 - Existing Classifications

World Economic Forum - The Transformative Twelve (30)

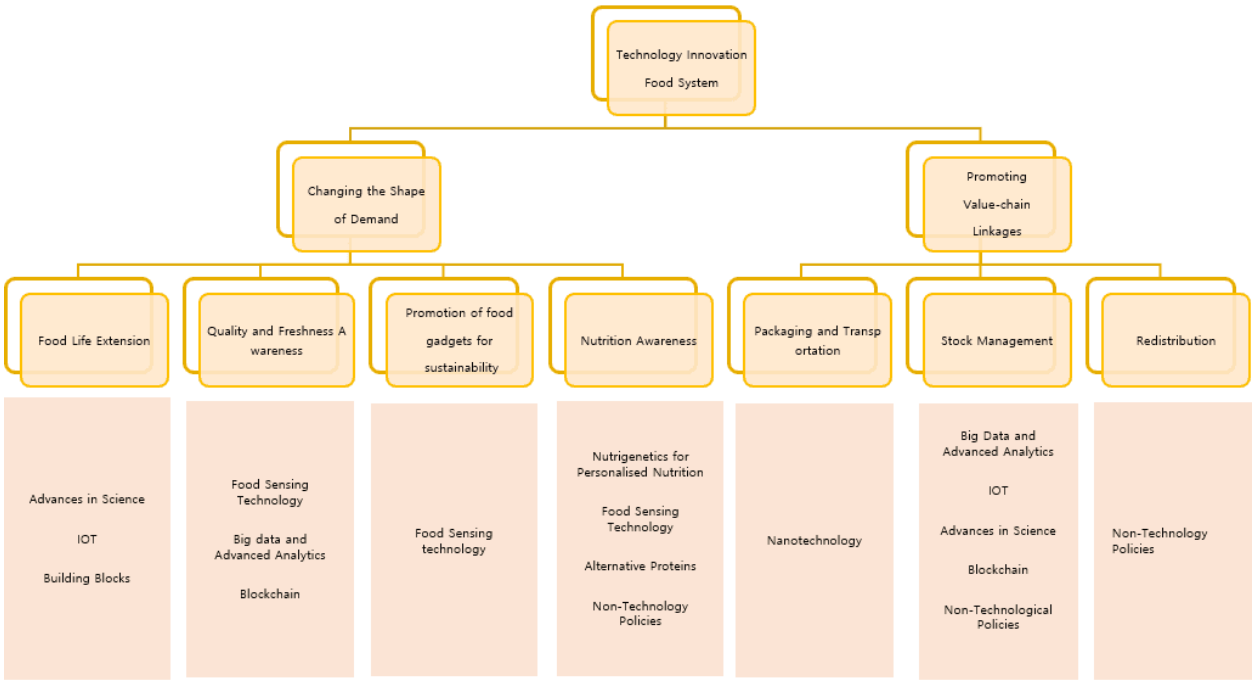


The 2018 WEF Innovation With a Purpose report outlined twelve innovation technologies for the food system (30). This provided a starting point of understanding how different technologies should be categorised.

BRC - Reducing food waste from farm to fork (31)

BRC's The Retail Industry's Contribution to Reducing Food Waste report categorised possible solutions for farm/suppliers, retailers and consumers/community. This provided insights of bringing in solutions as sub-categories for our map

4.2 - Our transformative innovation map for Walmart



(30) (31)

Using existing classifications above, a new transformative innovations map has been created. Creating effective production systems was not taken as it only relates to the agriculture industry. Using the insights from the BRC report, changing the shape of demand and promoting value-chain linkages have been divided further into sub-categories depending on possible solutions retailers could implement. Some ideas were taken from “in-store” and “influence the home/community” in the BRC report. Others were created by looking at Walmart’s current situations and global food system problems.

5. Impact of Specific transformative innovations

5.1 Impact Vision - food sensing technology

Impact Vision, a technology start-up, develops a system that collects hyperspectral images of food from a camera mounted above a conveyor belt when processing food (32).
Machine learning models process these images to detect patterns of chemical composition reflecting the food's quality. Measures of freshness such as pH or dryness gives real time insights enabling an optimal sorting & packing infrastructure. This innovation is particularly interesting. It does not only detect unfresh food to reduce food waste, but also the presence of foreign objects, increasing food safety conditions. The technology has been selected by the WEF forum as one of the 56 most promising Technology Pioneers of 2019 (33).

Performance and feasibility

For fruits and vegetables, a previous study has shown that HSI classification can reach up to 94% accuracy rate (34). The widespread adoption of this technology however would require some improvement. First, hyperspectral imaging has been developed mainly for laboratory use with slow moving trays. It makes it more difficult for food companies who are constantly trying to increase the speed of the food processing. The hypercube (3D) image acquisition of a product can take 2 to 4 minutes. However, it is expected that future development in system components make it a matter of seconds to enable real-time HSI quality monitoring systems (35).

Food system impact

Food contamination

The Study "Multimode Hyperspectral Imaging for Food Quality and Safety" determines that hyperspectral imaging (HSI) can quantify and visualize E.coli loads rapidly (36). This is beneficial to Walmart as the same bacteria was the subject of a food contamination outbreak in August 2020 leading to eighteen sickened people in six states with five further cases of hospitalizations (37). The product was displayed in more than 1100 US Walmart stores: a number that can drastically reduced by implementing correctly the technology in the Walmart supply chain.

Food waste

Using hyperspectral imaging in the supply chain, 100% of products could be tested instead of the 2 to 4% today (38). This technology could determine acceptance factors such as tenderness and ripeness accurately avoiding simple judgment which leads to unnecessary waste . Knowing the quality of all processed products has an indirect anti-food-waste effect as it could help make decisions about the ultimate use of the products (e.g., potatoes can be used for bashing), thus improving the supply chain efficiency.

5.2 TellSpec - Food Sensing Technologies, Big Data and Advanced Analytics, Advances in Science

TellSpec can be used by scanning a food item (the actual food, not the barcode) with its scanner and it will report on a mobile app the item's characteristics such as calories, fats, proteins, carbs, allergens.

Key technology elements - Performance and costs

TellSpec is made out of 3 elements:

Tellspec's NIR sensor (the food scanner)	A cloud-based patented analysis engine	Mobile app
• Light reflected from the sample is collected through the front window. The light is measured by a detection system, which produces a digital electronic signal (spectrum) - characteristics of the composition of the analysed material. • Tellspec's Enterprise sensor uses Texas Instruments' DLP technology. This technology allows the scanner to have an excellent performance due to higher signal to noise ratio as well as a more accurate spectrum acquisition. Moreover, in the past, this type of analysis had to be performed with large and expensive equipment. This sensor's dimensions are 82.2mm (L) x 66mm (W) x 45mm (H) and Texas instruments claim it is cost-effective. However, even if the cost is much smaller than before, the price of a sensor is $1999. (40)	• The spectrum provided by the scanner is sent to the cloud platform and analysed with ML techniques. These are then shown on the mobile app. The analysis takes 3 seconds per item. The algorithm improves with every scan because it enlarges its database : for example, after 300 people scanned an item, a 3 seconds scan will have the efficiency of a 900 seconds scan (3x300). (41)	• The app is free for purchase in AppStore or GooglePlay. Apart from providing a scanned item's composition, it can be used for adding up the total calories, carbs (or other substances) of all the scanned items in order to show the user his total intake.

Feasibility

It is feasible to use in supermarkets, as a scan of a product takes 3 seconds and the size of a sensor is similar to an apple. However, the product is not feasible yet from an economic perspective. The price of a sensor is $1999, which is at least 20 times more than the revenue generated from a customer's shopping list. The solutions for this include Walmart making deals for bulk-buying to get a discounted price.

Food system impact - Health and nutrition

<u>Malnutrition - Micronutrient related malnutrition & Diet-related noncommunicable diseases</u>

The scale of malnutrition is explained in section 2.2.2.1. Over 1.9 billion adults are obese and 1 of 6 women in the US is iron-deficient during pregnancy (39). The implementation of this device into Walmart stores could significantly reduce these numbers - the people that are using it can buy items with fewer calories or use more micronutrients for the people who are deficient.

<u>Food contamination - Allergenic</u>

Section 2.2.2.2. explains that Walmart had a problem with allergens present in Spaghetti Marinara and that allergenic contamination can cause a fatal reaction for someone with food allergy. By solving, Walmart may avoid bad publicity - people may test the products to see if they contain an allergen to avoid those products.

6. Appendix

6.1 - The Future of Food

6.1.1 Breakdown of the Challenges

The Environmental Footprint

The Environmental Footprint through climate change, which increasingly affects food systems. Rising temperatures and shifting rainfall patterns will put crop production at risk, leading to yield losses and higher food prices. A 2013 World Bank report (4) argued that 2°C of global warming above pre-industrial levels could reduce total crop production by 10%.

Demographic and Demand Shifts

Demographic shifts are having a dramatic impact on global demand for food. According to the UN's World Urbanization Prospects report, the percentage of people living in urban areas will increase from 55% in 2018 to 68% by 2050. In the United Nations' paper, World Agriculture Towards 2030/2050,(5) the authors argued that the combined impacts of a growing population and an exploding middle class could increase world food demand by 60% by 2050, compared with 2005/2007 levels.

6.2 - Walmart

6.2.1.Pestle analysis

Full analysis: (42)

- **Political factors**: Walmart is a globally recognized department store. As it operate
  all over the world, Walmart has many policies it must follow. These can be policies which influence Walmart' manufactures and suppliers or bills that threaten the revenue of the company (i.e. raise the minimum wage of workers).

- **Economic factors**: Walmart, like any other corporation, is affected by economic stability. Walmart is known for low prices of goods. However, if the economy hits, it may require production to go up. If it does, Walmart will have to raise the price of goods. Since the economy can change based on the country, Walmart needs to be aware of the economic landscape in each location where stores

operate. Some locations may have higher interest rates or taxes, which will also affect potential revenue.

- **Sociocultural factors**: Despite Walmart's global recognition, it's not necessarily a
popular place to shop. For instance, Germany's lack of interest cost Walmart over $1 billion. This was more an issue from Walmart, as they failed to properly market to the German audience. Walmart is an American brand, but by not adjusting its marketing to fit the German market, it led to heavy revenue loss.

- **Technological factors**: For more efficiency behind the scenes, Walmart has adopted automation and robotics. The technology can fulfill orders, streamline production, and help with keeping the store clean. Adopting automation is a form of digital transformation, which uses automated technology to create more efficient business processes. With a brand as big as Walmart, automation is an expected step for the business to take. By allowing robots to handle menial tasks, employees can focus on selling products without distraction.

- **Legal factors**: Walmart must abide by the laws and regulations of the world. The most common of these laws include employment regulations, data protection laws, labor laws, and health and safety laws.

- **Environmental factors**: Walmart receives backlash for improperly dumping pesticide and hazardous fertilizers, which found itself into the sewage pipes.

6.2.2.Walmart's current actions to tackle these challenges compared to other competitors in the USA

	Walmart	Kroger	TARGET	COSTCO WHOLESALE	WHOLE FOODS MARKET
Redistribution of food waste	Diverted **81%** of unsold products and 1.6 billion pounds of food waste from landfills Donated 640 million pounds of food in the US	Diverted **27%** of food waste from landfills Donated **101** million pounds of food in the US	Diverted **> 77%** of operational waste from landfills Donated **105** million pounds of food in the US	Diverted nearly **76%** of food waste from landfills Donated **67**million pounds of food in the US	Donated **218** million pounds of food in the US
Existing policies and actions	**Standardise date labels** to prevent information inaccuracies - 92% of private brands using "Best If Used By" date currently Walmart Foundation works with organisations such as WWF in **conducting research to analyse policies** to reduce food waste	Leverage existing technology in California and Indiana to **convert food waste into renewable energy** through anaerobic digestion	Improving **prediction accuracy** through forecasting tools and offers discount on food close to expiration	Turning unsold goods to new products, e.g. unsold chickens are made into deli entrees Waste Management Programme including **composting and turn food waste into energy**	**Partnership** with Food Donation Connection to donate food to local food banks **Food waste diversion into renewable energy** through anaerobic digestion
Future policies, actions and targets	**Achieve zero food waste** from operations in the US, UK, Japan and Canada by 2025 Embrace technologies in reducing food waste by tackling root causes	Kroger's Zero Hunger aims to achieve **zero food waste** by 2025 Expand processes to allow more donations of nutritious food scraps to animals	Reduce food waste from operations by **50%** in 2025 Create pilots for better transition timing and store volumes	Divert **80%** of food waste from landfills Expanding Waste to Energy to generate more renewable energy from food waste	Setting **sustainability standards** on all food sourced, e.g., it developed a set of standards for different type of seafood activities

(43) (44) (45) (46) (47) (48)

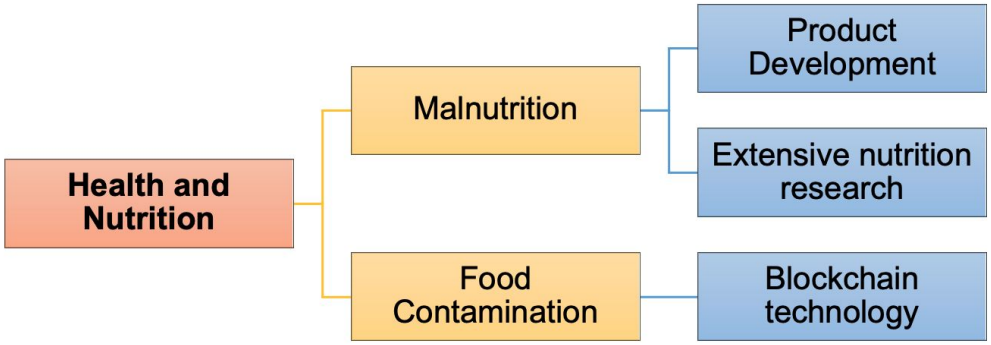
The table above compares some of Walmart's actions, both current and future, in reducing food waste with its main competitors. In general, the US retailers are committed to search for a more sustainable food supply chain and reducing food waste. The table below shows the ranking of top 10 US retailers' report cards in the path towards Zero Food Waste, an analysis carried out by the Centre for Biological Diversity. Notably, Walmart has room for improvement in the Tracking/ Transparency section. (49)

SLOW ROAD TO ZERO:

A Report Card on U.S.Supermarkets' Path to Zero Food Waste

RANK	COMPANY	COMMITMENTS	TRACKING/ TRANSPARENCY	PREVENTION	TOTAL	GRADE
1	KROGER	5	5	5	15	A
2	AD USA	5	5	5	15	A
3	WALMART	5	4	5	14	A
4	WHOLE FOODS	3	3	4	10	B
5	TARGET	4	3	3	10	B
6	ALDI	4	3	3	10	B
7	ALBERTSONS	3	3	3	9	C
8	TRADER JOE'S	2	1	2	5	D
9	COSTCO	2	1	2	5	D
10	PUBLIX	1	1	2	4	D

6.3 - Health and nutrition: Malnutrition and Food Contamination



6.3.1 Malnutrition: Walmart vs. competitors actions

To tackle Malnutrition, Walmart has been putting enormous efforts to develop deep understandings about food nutrition and product development. The company has been redesigning their products to make them healthier, in particular, by reducing sodium, sugar and additives. (50)

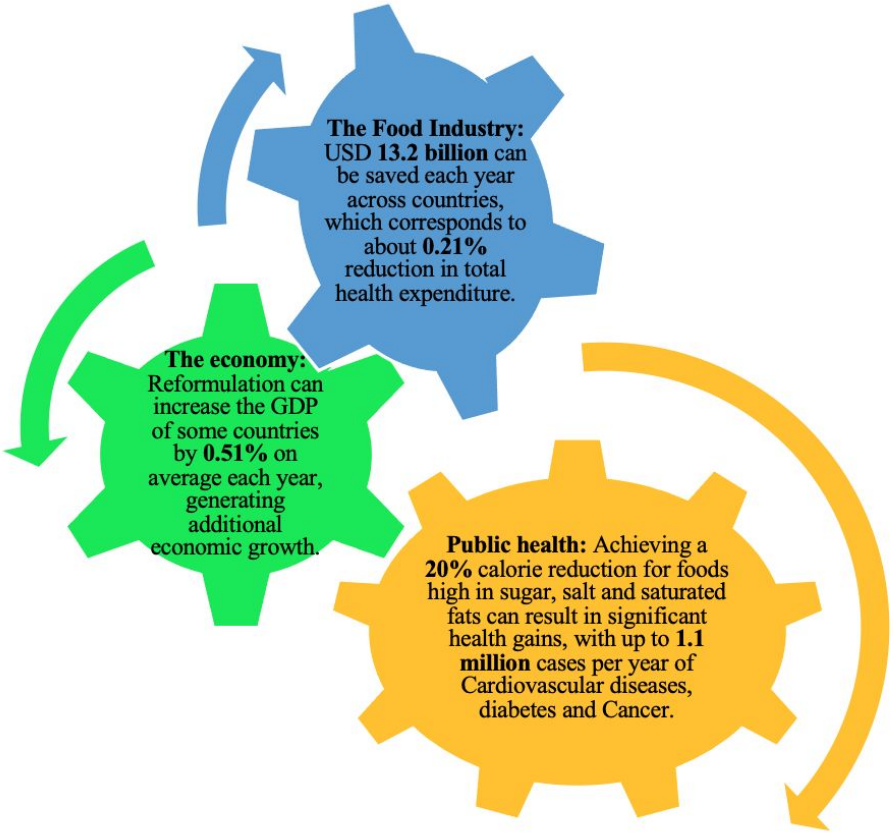
WALMART ACTION (51)

Extensive nutrition research
Walmart has conducted extensive studies to identify more nutritions options. For instance, it launched the "Great for you" products which meet rigorous nutrition criteria informed by the latest science developed in consultation with food and nutrition experts.

Product development
Walmart performed product redesign to satisfy different tastes demanded by consumers It is working on:

- Reducing sodium, sugars and fat: Since 2011, Walmart reduced sodium by 18 percent, added-sugar by 10 percent and removed all industrial-produced trans-fats in private brands
- Reducing additives: Walmart aims to remove certified synthetic colors and artificial flavors in products.

The impact of food reformulation (52)



The diagram below show the competitors actions (53):

Healthier food options

Olive Garden (Darden)

- Reduced "calorie footprint" by 12.8%
- Reduced sodium footprint by 22.6%

Sodexo

- Implemented 9 (of 18) smarter lunchroom tactics in 100% of 3,523 elementary, middle, and high school accounts

Subway

- Now includes graphic depictions of kids' meals which include vegetables, fruit, and low-fat milk

Walgreen's

- Made 32% progress toward goal of expanding access to fruits and vegetables in at least 1,000 stores in or near food deserts.

Dannon

- Cut the sugar content in 78% of its products – including all products intended for children – to less than 23 grams of total sugar per six ounces.

Sugar reduction by companies around the world

The United Kingdom

- Tesco supermarkets cut the sugar in their own-brand soft drinks in order to avoid the soda tax which went into effect on April 6, 2018.
- Supermarket operators cut sugar by an average of 13% across 80 of its breakfast cereal lines.

The Netherlands

- Albert Heijn supermarkets cut the sugar in its own-brand products by 10-40%.

Ireland

- Nestle now sells a chocolate candy bar with 30% less sugar.

Singapore

- In 2017, seven beverage companies agreed to reduce their sugar content to 12% by 2020.

India

- PepsiCo brand introduced lower-sugar (along with salt and fat) breakfast items in 2017.

6.3.2 Food Contamination: Walmart vs. Competitors actions

Walmart treats food safety as a part of its culture and is committed to sell products that meet high safety standards. Besides, Walmart also decided to use Blockchain technology to prevent food contamination in the supply chain. According to the World Health Organisation, 10% of people fall ill due to food poisoning annually, while 400,000 across the globe die from contamination.
These figures can be prevented with more information and traceability of food products in the supply chain as currently, it takes weeks to identify a point of contamination, which leads to further illness, loss of sales and food waste. Hence, by using the application all participants in the supply chain can access information regarding the origin of the food. (54)

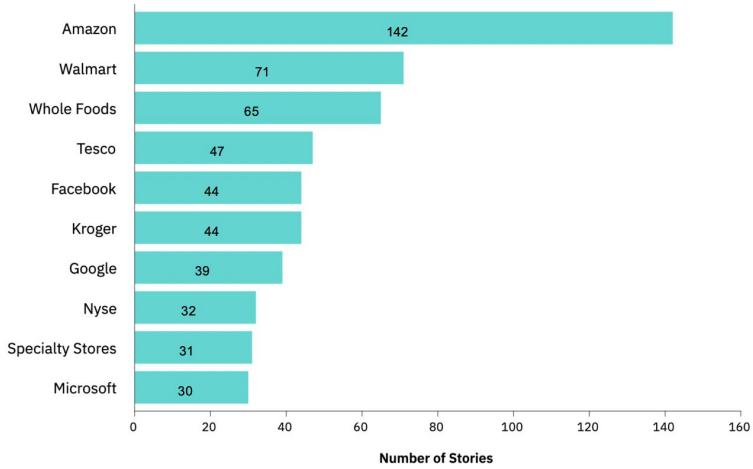
Furthermore, rising food recalls are costing the food industry billions of dollars annually in waste and lost inventory. Blockchain could reduce the losses by increasing transparency and making it easier to trace the source of contaminated food items. This technology is also actively used by competitors like Dole and Kroger. (55)

6.4 - Quid graph explanations

The following query helped us identify technology trends in the food industry in supermarkets. We included the proximity operator to make sure the technology is related to food. (10 words proximity in articles)

Query (news & blogs 2017-2021):
"food technology supermarket" ~ 10 OR "food industry innovation supermarket" ~ 10

2017-2021 top companies supermarket food technology
News article bar chart with 350 stories. Colored by uniform.

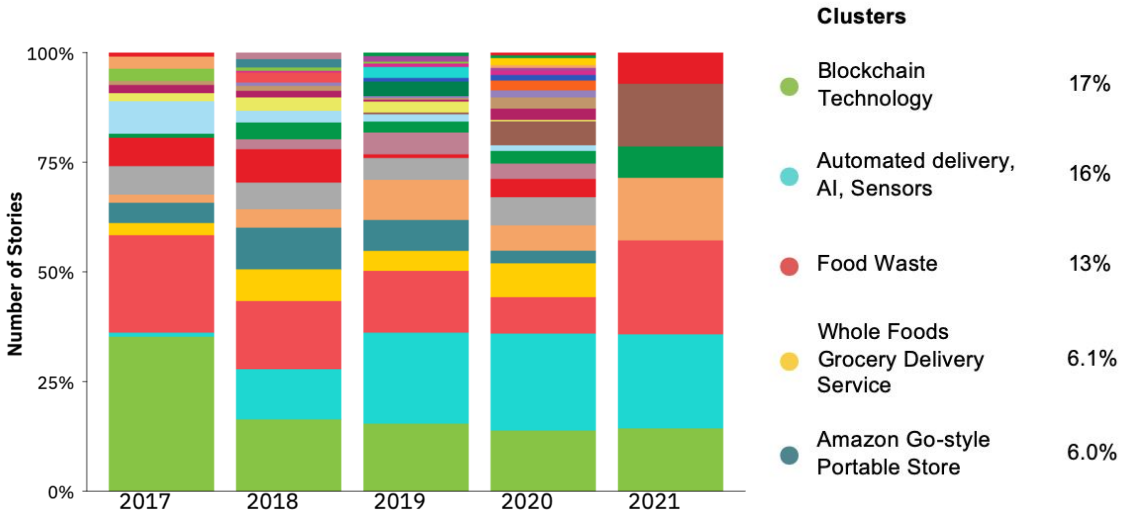


We used the companies view in order to identify the main technology users and suppliers. Many of our technology solutions in the examples table are implemented by Walmart and Tesco and we started our research with articles found in the clusters here.

Timeline - food trends

News article timeline with 938 stories. Colored by clusters.

We used the timeline barplot in order to visualise the different categories of food technologies, their importance, and how they changed in the last 5 years.



For preparation, we added a filter to exclude the stories that were not allocated to any cluster.

Then, we merged 2 clusters - Blockchain Technology and Blockchain Programme - so we formed the biggest cluster with 153 stories. We found blockchain technologies for supply chain visibility applied into the food contamination problem. We renamed the second cluster after reading more news from it. From this cluster, we found one big data and advanced analytics technology applied for food waste, one food sensing technology applied for malnutrition, 3 non-technical solutions applied for food waste. From the third biggest cluster, food waste, we found 12 examples of food waste technologies.

6.5 Transformative Innovations Application

Food Waste

Name of the innovation	Category of problem	Sub-category	Technology	Technology category	user/customer	Supplier	link
Ovie smarterware	Food waste - Waste due to consumers	Information disruptions & inaccuracies	smart food storage system tags food to remind the consumer to eat what is left	IOT	Individuals	Ovie	(56)
Food for the future	Food Waste - Waste due to consumers	New consumption behaviors over time	Providing food businesses with complete solutions for processing alternative proteins into high quality meat or fish substitutes	Alternative proteins	Food businesses	Buhler	(57)
Winnow vision	Food Waste - Waste due to consumers	High expectations on freshness	Electronic scale that weighs waste as it is thrown away, making it easier to keep track of the volume involved. It can help sensitize customers by weighting expectations against reality	Food sensing technology	commercial kitchens	Winnow	(58])

Impact Vision	Food waste - Waste due to suppliers	Rejection of food that do not meet quality standards	determine quality content in real-time and sort products accordingly at the production line. (Avocado & meat)	Food sensing technology	Tesco	ImpactVision	(59)
SAS AI	Food waste - Waste due to suppliers	Bullwhip effect: Caused by overproduction of suppliers and overstocking of retailers	Analysis of the data improves downstream forecasting and upstream ordering with suppliers – reducing waste and overstocks.	Big data and advanced analytics	Carrefour	SAS Viya	(60)
Ocado Smart Platform	Food waste - Waste due to suppliers	Bullwhip effect: Caused by overproduction of suppliers and overstocking of retailers	Assess 20 million forecasts of what customers want and need and adjust orders from suppliers accordingly.	Big data and advanced analytics	Ocado	Ocado	(61)
Captain Peter visibility tool	Food waste - Waste due to suppliers	Rejection of food that do not meet quality standards (sea food, fruits and vegetables)	Remote Container Management platform identifies container temperature, humidity, and CO2 levels configured to the customer's specific needs	Big data and advanced analytics	Wiskerke Onions	Maersk	(62)
Mimica Touch	Food waste - Directly from Walmart (retailer waste)	Improper temperature storage (fresh produce are sensitive to external conditions)	Mimica Touch is a label or cap that indicates the temperature to make sure food is kept at the correct temperature	IOT		Mimica	(63)
Alsense Food Retail	Food Waste	Improper temperature	The platform monitors	Food sensing technologies		Microsoft Danfoss	(64)

	- Directly from Walmart (retailer waste)	storage (fresh produce are sensitive to external conditions)	temperatures with sensors across the grocery supply chain. The technology leads to an estimated 40% decrease in food waste				
Advanced sous-vide aseptic packaging (ASAP)	Food waste - Directly from Walmart (retailer waste)	Improper temperature storage (fresh produce are sensitive to external conditions)	Sterilises food at low temperature (60 to 80 celcius) using Microwave-assisted thermal sterilisation (MATS) technology, allowing food to be stored at the room temperature	Advances in Science		Ixon Food Technology	(65)
Wasteless Pricing engine	Food waste - Directly from Walmart (retailer waste)	Promotions and events leading to temporary change in consumer behaviour	An artificial intelligence price tag that uses reinforcement learning to find the best price for customers depending on the date and the amount of stock available	Big data and advanced analytics		Wasteless	(66)
Barcodiscount	Food Waste - Directly from Walmart (retailer waste)	Promotions and events leading to temporary change in consumer behaviour	The price label on the food products changes its colour and the discount percentage according to the expired date	Advances in Science		Dyson Award project	(67)

Neurolabs	Food Waste - Directly from Walmart (retailer waste)	Overstocking leading to more time in storage thus reducing product's remaining shelf life	A platform that uses artificial intelligence to foresee the demand required in retailers	Big data and Advanced analytics	Grupo Uvesco	Neurolabs	(68)
Eden	Food waste - Directly from Walmart (retailer waste)	Ineffective communication with supplier and slow reaction when inventory is building up in store	An app that uses algorithm to check the flow and quality of food production at any supply chain stages	Food sensing technologies	Walmart	Walmart	(69)
Enterprise Resource Planning software	Food waste - Waste due to suppliers	Bullwhip effect: Caused by overproduction of suppliers and overstocking of retailers	ERP software predicts the production amount depending on the storage available and also foresees the expected sales	Advances in Science			(70)
Hazel®	Food waste - Directly from Walmart (retailer waste)	Product handling time is the highest in retail grocery store leading to difficulties in maintaining shelf life	A safe chemical 1-MCP is released to the fruit to reduce the time of the fruit ripening	Advances in Science	PureFresh Sales, WP Produce, Sacia Orchards	Hazel Technologies	(71)
Apeel	Food waste - Directly from Walmart (retailer	Product handling time is the highest in retail grocery store leading	A plant extracted peel that covers vegetables and fruits to delay the rotting process	Building blocks	Costco	Apeel Science	(72)

	waste)	to difficulties in maintaining shelf life					
Iri cpg demand index	Food waste - consumer	new consumption behaviour changes over time	Shows insights into demand by week and product and forecasts food demand	Big data and advanced analytics			(73)
	Food waste - consumer	High expectations on freshness from consumers	Offering “ugly” food at discount	non-technical			(74)
	Food waste - consumer	High expectations on freshness from consumers	Making fresh juices and soups for purchase out of “ugly” food	non-technical			(75)
	Food waste - consumer	High expectations on freshness from consumers	"testing tables" set up to encourage shoppers to try ugly fruit or produce	non-technical			(76)

Malnutrition

Subcategory	Description	Solution/technology category	User	Supplier	Link
Undernutrition	Walmart partnered with Feeding America, a network that feeds more than 40 million people	Non-technical policies	Walmart		(77)
Diet related non-communicable diseases - overweight	hired dieticians to help shoppers select healthier foods	Non-technical policies	Kroger, Hannaford		(78)
Diet related non-communicable	The Dietary Guidelines	Non-technical policies			(79)

diseases - Overweight	for Americans implemented new labeling laws for informing customer about nutrition standards				
Micronutrient - related malnutrition Diet related non-communicable diseases	Habit - provides consumers with personalized food recommendations tailored to their unique DNA. Consumers collect bio-samples and send them to a processing facility. Habit uses the data to provide biology reports and a personalized eating plan via a mobile application - the test takes 2.5 hours - results come in 2 weeks	nutrigenetics for personalised nutrition	consumers		(80)
Micronutrient - related malnutrition Diet related non-communicable diseases	GenoPalate - nutrigenetics home test - analyses more than 100 genetic markers and determines a person's specific needs for 24 nutrients and a personalised list of 80+ foods	nutrigenetics for personalised nutrition	consumers		(81)
Diet related non-communicable diseases Micronutrient - related malnutrition	TellSpec - food scanner that offers insights into allergens, chemicals, nutrients, calories, and ingredients in food - reports them on a mobile app	Food sensing technologies Big data and advanced analytics Advanced in science			(82)

Diet related non-communicable diseases Micronutrient - related malnutrition	SCiO - absorbs light reflected from an object, breaks it down into a spectrum, and analyzes it to determine the object's chemical makeup	Food sensing technologies			(83)
Diet related non-communicable diseases ; groundnuts, rice, chillies , maize, tree nuts	predict the amount of harmful aflatoxin ; This device captures the fluorescence by cameras with filters. Images are processed and the fluorescence degree and pattern are fed into a learning model	Big data and advanced analytics		Pure Scan AI and ICRISAT	(84)
Diet related non-communicable diseases	Prototype of sensor activates food display panels -show nutrient, price, allergens	Food sensing technologies		MIT's Senseable City Lab	(85)

Food Contamination

Name of innovation	Category of contamination	Technology	Technology category	Technology (3 categories)	User	Supplier	Link
Allergy ATellSpec - food scanner that offers insights into allergens, chemicals, nutrients, calories, and ingredients in food - reports them on a mobile app mulet	allergenic	takes a sample of a food and tests it for the presence of target allergens - uses molecularly imprinted polymer (MIP) technology; can be used in the supermarket for users to test the products for allergens	Food sensing technology	Advances in science		Allergy Amulet	(86)

TellSpec	allergenic	food scanner that offers insights into allergens, chemicals, nutrients, calories, and ingredients in food - reports them on a mobile app	Food sensing technologies Big data and advanced analytics Advances in science				(87)
Impact Vision -meat, fish, fruits	physical	Collects images of food and uses ML to provide insights of quality of food - detects foreign objects; The system can be integrated with sorting, packing and rejection infrastructure to optimize processing, maximize product value	Food sensing technology	Digital building blocks		Impact Vision	(88)
Hyperledger	microbial	Data: food barcodes, labels to trace food expiration date, batch number, farm of origin ; Tracing mangoes manually 7 days vs tracing mangoes with Hyperledger 2.2 seconds	Blockchain	Digital building blocks	Walmart		(89)
	microbial	sensors with near field communication technology (NFC) allowing the company to track product and production attributes throughout the	IOT	Digital building blocks	Walmart	IBM	(90)

		supply chain - communication with other home sensors, Walmart can grant delivery drivers access to fill customer's refrigerator					
oneAgrix	Food imported illegally - meat	tracks halal produce, ingredients and the authenticity of a manufacturer's halal certificate to combat halal fraud	Blockchain	Digital building blocks		OneAgrix	(91)
	chemical	Tesco identified the need to identify and trace products which were contaminated with additive and reduce loss	Blockchain	Digital building blocks	Tesco		(92)
The BluApple	Microbial-fruits and vegetables	Fruits and vegetables produce Ethylene gas which shortens their life- the technology absorbs this	Chemical ingredients that absorb gases	Advances in science		Bluapple	(93)
	microbial	New materials that could be used for food packaging that has better barrier, thermal and flammability properties	Plymer/Inorganic nano-composites (PINCs)	nanotechnology			(94)

6.6 Definition of categories

Name of the category	Definition
Changing the shape of demand	Today, emerging technologies have the power to shape consumer behaviours. This starts by changing nutritional consumer diets, elevating them to certain health standards. But it is also about making them aware of the environmental implications of the production and consumption of certain foods.
Promoting value-chain linkages	Value-chains in the food industry are benefiting from the combination of different technologies such as big data and advanced analytics, blockchain and IOT. They benefit by improved collaboration, simplified efficient supply chains and transparency.

(95)

Name of the technology	Definition
Alternative proteins	Considering alternative proteins is becoming essential to reduce the large environmental impact traditional proteins generate (15% of greenhouse gas emission and 10% of fresh water globally). Allowing a shift in consumption behaviours such that it achieves a certain level of environmental impact requires efforts on many fronts. It starts by commercializing alternative proteins at equal or lower prices than traditional ones, with the same or better nutritional gains.
Food sensing technology	Using sensors or machine learning to analyse and collect information about freshness, safety, quality and authenticity of food. The proper use of these technologies could lead to reduction in food fraud and food

	contamination and food waste
Big data and advanced analytics for insurance	Data collection technologies are reducing the cost of collecting and processing data. Financial institutions get the opportunity to lower their transaction costs while mitigating agricultural specific risk at the same time. Big data can be used in improving modelling, reducing the risk of the insurance products provided to farmers.
Nutrigenetics for personalised nutrient	Nutrigenetics technology requires the use of one's DNA to gain personal dietary information which is then used to recommend individual's diets. This technology could lead to reduction in malnutrition problems
Nanotechnology	This technology is concerned with building materials using the scale of atoms and molecules. One nanometre equals to 1/10,000,000,000 of a metre. (96) New materials created using nanotechnology have different properties that could benefit in food packaging
Big data and advanced analytics	Data-collection technologies, computing power and algorithms are lowering the costs of collecting and processing data. Combined with blockchain and IOT, big data is used to offer transparency in the whole supply chain.
Blockchain	Blockchain is a distributed ledger technology that can serve roles in the food system such as reducing transaction costs or tracking land tenure. It monitors food through the whole supply chain offering transparency to manufacturers, retailers and households. As a result, there is more confidence about the quality of food.
IOT	The Internet of Things, which relies on sensors and actuators connected by networks

	to computing systems, makes it possible to track the trajectory of products through supply chains and control the transportation and storage environments (e.g. temperature, humidity, gas) in real time. These details are available for specific items, not only at a generic level.

(97)

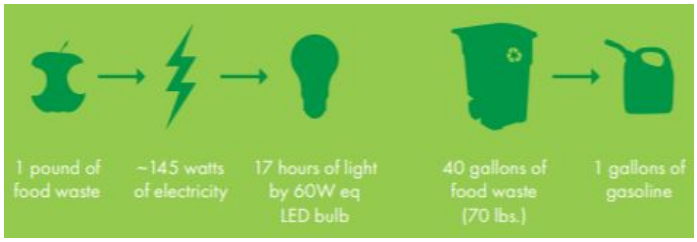
6.7. Impact of transformative innovations on Walmart food problems

6.7.1 Food Waste - Community behavioural change with Walmart

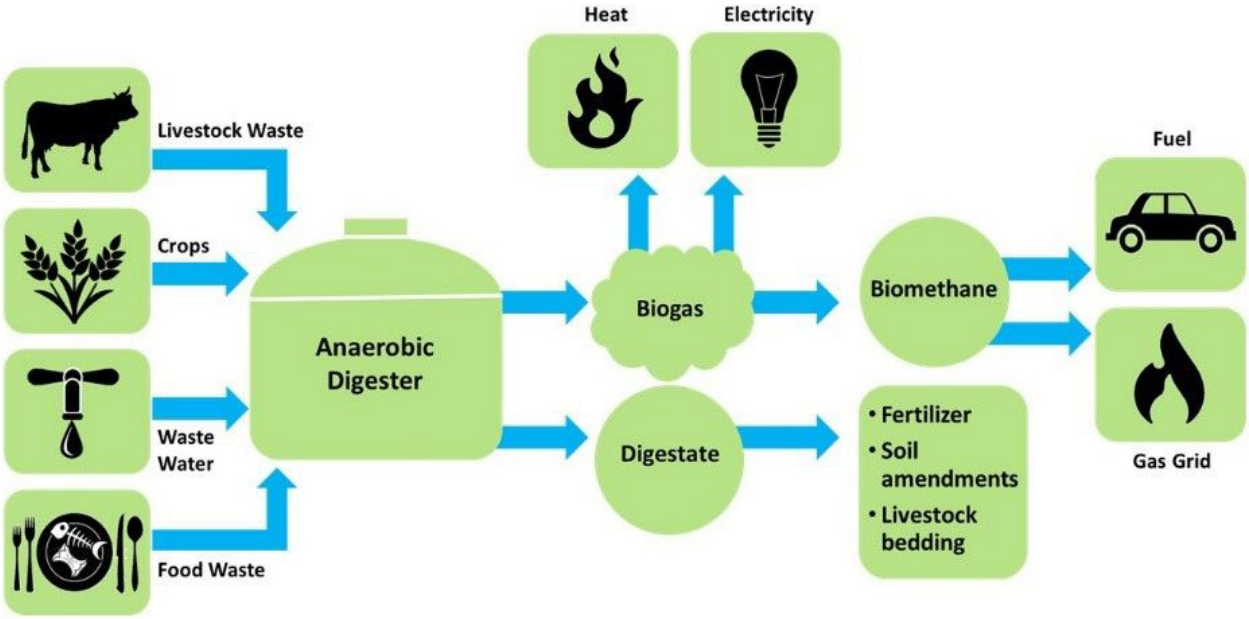
The French government launched the Biowaste Recycling Initiative in 2017, where it collects bio waste from households, restaurants and other institutions like schools, to convert the food waste into fertilisers and even heat and electricity, acting as a renewable energy. This leads to a question: Can Walmart lead a revolution in combating food waste in the US? (98)

Walmart has more than 5,000 stores and clubs in the US alone, and around 140 million people visit Walmart either physically or through online retail which represents 43% of the US total population. Given its sphere of influence, Walmart is very likely to possess the financial and technical ability to launch a bio-waste collection programme in order to maximise the value of food by not disposing them.

Impact Bioenergy Inc provides solutions to food waste by converting them into fertilisers and power to generate heat and electricity. Below is a diagram showing the quantity of food waste required to convert into a certain watts of electricity and gallons of fuel. (99)



The flow chart below shows how an anaerobic digestion process converts food and other waste into power to generate heat and fuel, together with fertilisers for farming activities.



6.8 Feedback

	Key feedback – interim presentations	**Key feedback – final presentations**	**Key feedback – other teams**
Key feedback received	-include supply chain in the categories for food waste -include different products in the categories	- for the food safety category the name is not suggestive enough (it does not include food reformulation subcategory) -3 subcategories we identified for food problems, including product development and extensive research, are solutions, not problems - break down waste into more than 5 subcategories	- team Tesco was told that the innovations they found are not feasible – and they need to think if it is convenient for a supermarket customer to use that product - while in our final presentation we clearly presented the problems for supermarkets, team McDonalds also related their problems to their company, not only to fast foods in general

Actions to incorporate this feedback	-for the final presentation, we split waste into 5 categories related to supply chain -in the report, we included the scale of food waste for 5 different product categories	- we renamed food safety into health and nutrition - we changed the names of the categories that sounded like solutions into actual problems such as undernutrition or micronutrient related-malnutrition -we further broke down waste, and found 12 subcategories for waste in the supply chain	- the technologies we explained in more depth are both convenient for supermarket customers – for example, one of them is a sensor of the size of an apple that scans food in 3 seconds to show calories - we related the problems more to Walmart: for example, for food contaminations with allergens, we identified that Walmart had this problem with Spaghetti Marinara, that contained allergens due

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