SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

"THE FUTURE OF FOOD PRODUCTION: A POST-PANDEMIC INSIGHT ON CHALLENGES AND INNOVATIONS IN FOOD TECHNOLOGY AND ALTERNATIVE FOOD SYSTEMS TOWARDS 2050"

By

Flavia Falcone

UNISE1858IT

Supervised by

Salvatore Fava

Faculty of Business and Media

In fulfillment of the requirements for the degree of

Bachelor of Science in International Business

Year 2022

DECLARATION

I do hereby attest and confirm that I am the sole author of this project/dissertation titled "THE FUTURE OF FOOD PRODUCTION: A POST-PANDEMIC INSIGHT ON CHALLENGES AND INNOVATIONS IN FOOD TECHNOLOGY AND ALTERNATIVE FOOD SYSTEMS TOWARDS 2050*", submitted for the Award of Bachelor of Science of International Business (B.Sc.), Faculty of Business and Media, Selinus University of Sciences and Literature.*

The contents are only the result of the readings and research I have done. I hereby declare that all the information in this research was obtained and presented in accordance with academic rules and ethical conduct.

DATE: September 23rd, 2022

STUDENT SIGNATURE:

STUDENT NAME: FLAVIA FALCONE

STUDENT ID: UNISE1858IT

DEDICATION

This final dissertation is dedicated to my Grandparents, who have guided me untiredly with love and spiritual enlightenment in the darkest times of my life, relentlessly believing in me and supporting me.

Thank you.

SYNOPSIS

Chapter one presents the latest market trends resulting from the socio-economic changes inducted by the COVID-19 pandemic, around: online grocery, boosted food delivery apps and the rise of a new type of consumer with brand new values.

Chapter two focuses on the ways to achieve digitalization and innovations in the food and beverage industry, to optimize business processes understanding the consumer needs, producing efficiently while keeping a mind-set of change to operate adaptively and flexibly according to market demands and challenges.

Finally, **Chapter three**, shares trends in agriculture and food production towards 2050, when global population will reach 9.1 billion. Possible scenarios and challenges in increasing the volume of production in response to higher demand, changes in diets and kcal per capita/daily, prerequisites - technologic, politic and economic - to ensure global food security and achieve a true sustainable development by 2050 while trying to solve problems to date (hunger), are the main topics of the last section of this thesis.

TABLE OF CONTENT

CHAPTER ONE: “POST PANDEMIC MARKET TRENDS IN THE FOOD TECH INDUSTRY”

CHAPTER TWO: “DIGITAL TRANSFORMATION & SMART INDUSTRY IN FOOD AND BEVERAGE COMPANIES”

CHAPTER THREE: "THE FUTURE OF FOOD PRODUCTION TOWARDS 2050"

THE FUTURE OF FOOD PRODUCTION: A POST-PANDEMIC INSIGHT ON CHALLENGES AND INNOVATIONS IN FOOD TECHNOLOGY AND ALTERNATIVE FOOD SYSTEMS TOWARDS 2050

BY

FLAVIA FALCONE

UNISE1858IT

CHAPTER ONE (1)

"POST PANDEMIC MARKET TRENDS IN THE FOOD TECH INDUSTRY"

CHAPTER ONE

1.0 How Coronavirus outbreak changes online groceries services and food industry globally (US and Europe)

Despite severe economic and geo-political disruptions inducted by COVID-19 Pandemic, the food-tech industry looks, in fact, thriving and to be born to adapt to the rapid changes in customer preferences.

While tourism and global travel, on one hand, have been knocked out by Coronavirus, online grocery sales, on the other, have been and are booming in North America and Western Europe.

B**ig data analytics** affords the food industry deep **insights into shopping trends and the ability to predict** (*rather than react to*) **customer needs**. There's an increased demand for variety in food & beverage products; smart factories enable greater, cheaper customization than has ever been possible.

Undeniably, the travel industry was severely affected by social distancing policies in defeating the rapid spread of coronavirus pandemic. Even travel technology companies could not escape the crisis: the global industry has faced a loss of over 75 million jobs and US$ 2.1 trillion in value. In fact, tourism does require authentic experiences and interactions, which induce rapid infection via direct person-to-person contact.

On the other hand, online grocery delivery involved no human contact at all, and the business model appeared to be, in fact, a winner.

According to American professionals, **this trend can be a permanent shift worldwide**. RBC Capital claims that **Amazon** only will expectedly generate gross revenue of US$ 70 billion in 2023 for online groceries segment, which is three-time higher than that data in 2019.

And this is still the beginning.

1.1 Supply chain disruption globally: Boosted Food Delivery and Surge of Food Delivery Apps

Since international transportations were restricted due to the order of several countries to slow down or stop the spread of covid-19 infection, many retailers faced the threat of food shortage.

In several parts of the world, the restriction of public movement posed a challenge to the food supply chains, which raised doubt about the price spikes due to global shortages. In fact, millions of farmers couldn't harvest and plant due to the social distancing policy.

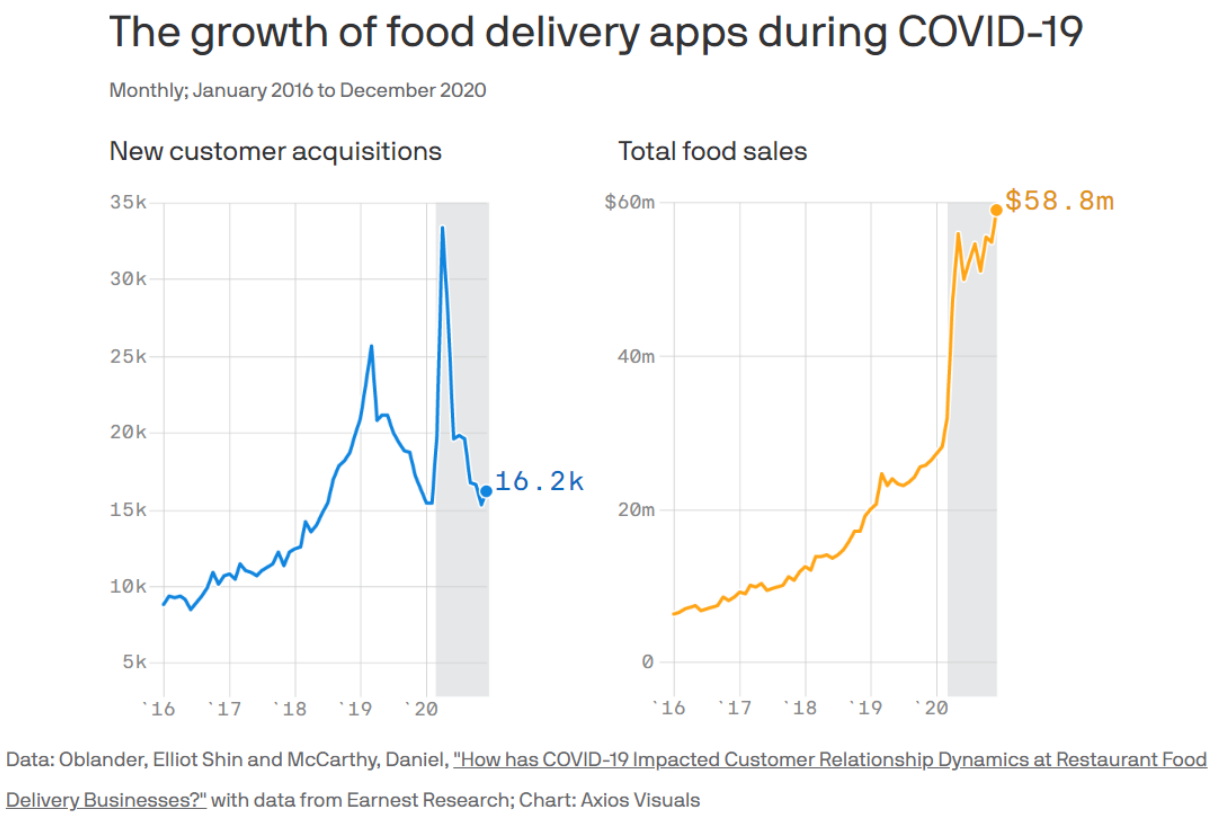
Up to April 2020, trade cargo transported by air travel significantly decreased by 55% compared with this volume before the pandemic. In this dramatic fall, China as a holder of mighty power in the global supply chain industry played a relevant role: by hosting in fact major manufacturing and airport hubs, the several lockdowns perpetrated not only in Wuhan but all around the Country, dramatically impacted the global economy.

Consider also, that food can be seen as short shelf-life products that need proper inventory control. Many companies said that their current storage is at capacity, leading to a limitation of storage availability. Since the import demand decreased due to Supply chain disruption, businesses were seemingly struggling with storing input materials for the continuous plant operation. Food and beverage companies' owners confirmed the need for robust inventory management solutions in order to optimizing the capacity of warehouses.

Not only disruption of the Supply chain along with shortage of primary goods and fresh products, but also the global run for purchasing more tinned and frozen food, have determined the rehabilitation *(rise?)* of delivery business in both grocery services and the Food industry.

Food delivery apps have reinvented the way we eat, with just one-click we get to have any special dish we crave on our very step door. No point to say that, during imposed lockdowns, while people had to stay at home (remote workers, students learning online...), affluence to supermarkets decreased, as a major reflection of the no-physical contact sanctions imposed by many governments.

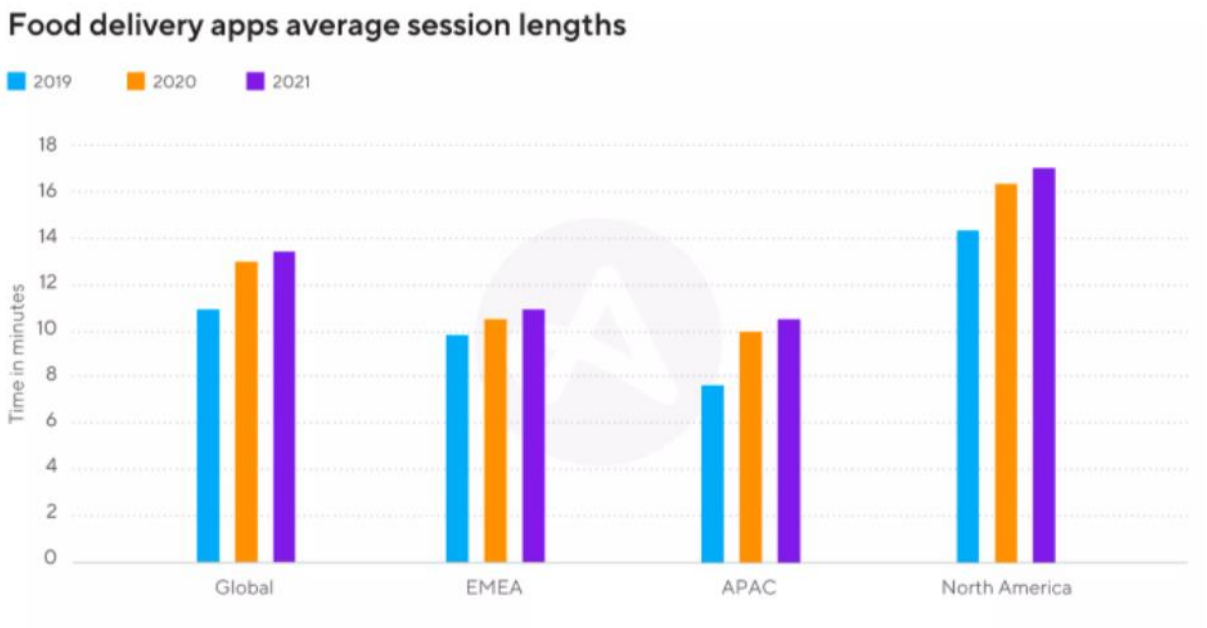
Top 3 US grocery delivery apps, namely **Walmart, Instacart, and Shipt**, whereas in Europe **JustEat, UberEats, Deliveroo, Glovo** have witnessed a dramatic increase in the number of downloads with the growth rate up to 160%, in both Google Play Store and Apple App Store.



A giant technology company- **Uber** –launched a new food delivery service (**UberEats**) and started to provide on-demand grocery home delivery by a partnership within roundly 30 mins, especially for food products such as meat, fruit, and vegetables.

In various countries in the EU and America, where most people are living alone, the demand for meal prep for self-isolated consumers is on the rise. Several industry experts believe that it will not be a temporary trend.

With a surge of JustEat and UberEats application downloads, came also a significant increase in order volumes since the covid-19 pandemic started. Users have shown indeed a great appetite for takeaway during the lockdowns, which led only JustEat to more than doubling in orders.



Customers stuck at home across Europe placed 200m orders on JustEat with the company between January and March. Orders were up 79% compared with the same period a year earlier. The UK accounted for most of that total, with the number of orders increasing 96% to 64m, followed by Germany and the Netherlands, where delivery orders grew by 77% and 63% respectively.

According to consumer-sentiment surveys conducted by McKinsey & Co from March through September 2020 in the EU-5 (France, Germany, Italy, Spain, and United Kingdom), it appears that the new grocery-shopping behaviors will stick around and become more pervasive. Behavioral science tells us that it takes an **average of two months to form a new habit**, which will endure only if reinforced through routines and rewards. And we all know lockdowns lasted *way* longer than two months.

As lockdowns went into effect across markets in the spring of 2020 because of the COVID-19 pandemic, EU-5 consumers shifted to online grocery shopping due to restrictions on movements and concerns about exposure to other people in indoor public spaces.

Online sales of groceries dramatically escalated.

In the United Kingdom, for example, **Tesco**'s online-grocery business went up to 16 percent of total country sales in the first quarter of 2020, from about 9 percent.

Online supermarket **Ocado Retail** reported in April a tenfold increase in demand and web traffic up to 100 times higher than pre-pandemic levels.

Throughout the pandemic, about 15 percent of surveyed EU-5 consumers have shopped for groceries on a website that they had never used before. Among those consumers, more than 50 percent say they intend to continue shopping at their newfound site for at least some part of their grocery needs. Additionally, 12 percent of them have also switched to different grocery stores to take advantage of home delivery or click-and-collect services, both accessible via online ordering.

But not everyone has liked their online grocery-shopping experience.

UK respondents have had the most positive experiences with online grocery ordering and delivery, with 33 percent of home-delivery users saying they are “very satisfied” and just 5 percent saying they are “strongly dissatisfied”.

The United Kingdom has the most developed online-grocery market in Europe, with 6.5 to 6.9 percent overall penetration in 2020 (compared with 5.0 percent in France, 1.7 percent in Spain, 1.5 percent in Germany, and 0.7 percent in Italy),5 so it isn’t surprising that UK grocers were better placed to respond to surges in online demand.

Other grocers simply didn’t have the infrastructure to serve the surge of online consumers, and our research reflects the correlation between customer satisfaction and the ability to keep up with demand.

In Italy, France, and Germany, only 13 to 16 percent of respondents feel very satisfied with their online grocery.

Source: McKinsey & Company COVID-19 EU-5 Consumer Pulse Surveys across France, Germany, Italy, Spain, and United Kingdom, sampled and weighted to match Europe's general population: 18+ years. Survey dates: 6/18–6/21/2020; n = 1,000 per country, 5,000 total. Note that the 1,000 respondents did not always answer all questions

McKinsey & Company

Although some customers who are very satisfied with their online-shopping experiences say they view online grocery shopping as a temporary measure and plan to return to physical stores.

Indeed, according to McKinsey's September survey across EU-5 consumers, the only country where consumers expect to increase their online grocery shopping is the United Kingdom, with a net intent of +5 percent.

Other consumers expect to reduce their online grocery shopping, with net intent of –1 percent reported in France, –10 percent in Germany, –12 percent in Spain, and –14 percent in Italy.

That said, online sales are still higher than they were before the pandemic. A new subset of people who tried online grocery shopping during the pandemic have found that they enjoy it and will continue to use it. It is therefore to be expected the share of online sales to continue growing at a faster rate than it did prior to the COVID-19 crisis.

1.2 Post pandemic grocery landscape: a renewed focus on health and the arise of brand-new values

In the current extraordinary times, consumer behaviors continue to change: CPG **companies and retailers must closely monitor such changes**.
Their strategy, category-management, innovation, and consumer-insights teams should closely collaborate to develop price-point, brand, and category offers that address consumer needs in both online and offline channels.

And finally, as the world works through the unprecedented humanitarian and economic crisis related to the COVID-19 pandemic, companies should reassess and strengthen their corporate purposes—and bring them to the forefront.
The positive impact of purpose-led actions could last long after the pandemic ends.

As the world begins its slow pivot from managing the COVID-19 crisis to recovery and the reopening of economies, it's clear that the lockdown has had a profound impact on how people live. The period of contagion, self-isolation, and economic uncertainty has dramatically changed the way consumers behave, most likely for years to come.

These rapid shifts have important implications for any consumer-facing company. Because many of the longer-term changes are still being formed, companies have an opportunity, if they act now, to help shape the next normal.

Three takeaways are emerging from the initial efforts of sociologists, psychologists, and economists to form a holistic view of the **new post-COVID-19 consumer**:

1. *COVID-19 is changing how consumers behave across every aspect of their lives.* As consumers sheltered at home, adoption of new digital services took place at a blistering pace. In addition to growing health and hygiene concerns, economic recession, and the related decline in consumption, the scope of the change to people's lives is staggering.

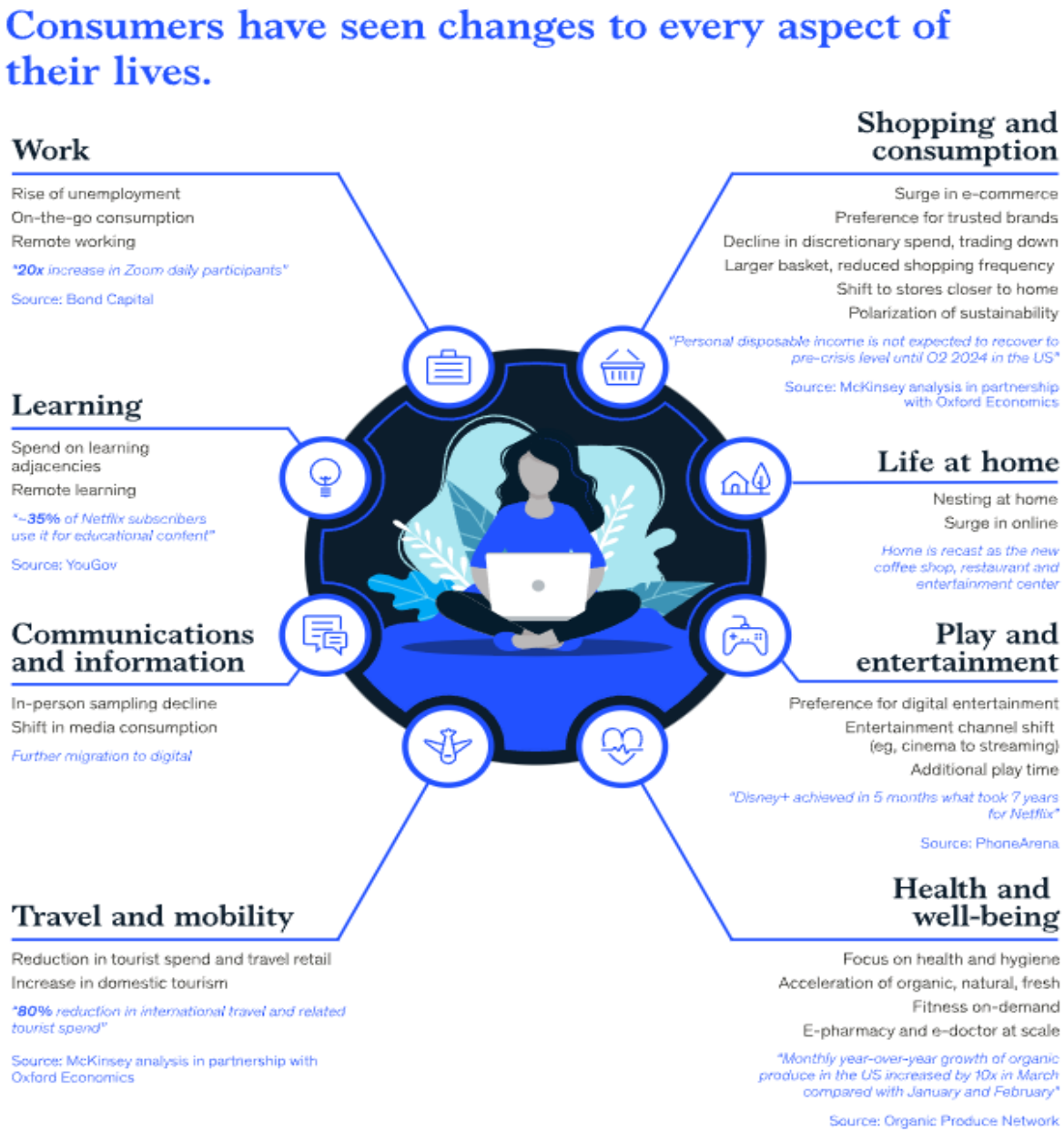
2. *Broad shifts to new behaviors hide significant variations.* Consumer behaviors likely fluctuate until we reach the next normal. How long they stick will depend on a range of factors including satisfaction with new experiences, demographics, infrastructure, and the severity of the recession.

3. *Companies must rethink how and where they connect with consumers.* They should expect to encounter structural challenges and upheaval across multiple dimensions. Overall consumption is shrinking, the shopping basket is undergoing a significant change in mix, and consumers are changing the ways they get their information.

1. *COVID-19 is changing how consumers behave across* every aspect *of their lives.*

COVID-19 has had a devastating effect on people's health and well-being on a global scale. One of the most striking features of the pandemic is how broad its impact on consumers' lives has been.

To get a better understanding of how consumer habits and preferences are changing, it's good to analyze and take a closer look at what that means in eight areas.



Life at home

During lockdown, the home has become a multiverse. It's where we work, eat, play, and connect with our families and friends.

Even as overall consumption has declined, the portion allocated for at-home categories has climbed. Over the months of social isolation, consumers' net intent to take part in a variety of activities in the home has shifted, with an increase of 54 percentage points for cooking, 30 to 40 percentage points for at-home entertainment, and 22 percentage points for home improvement. Similar shifts were seen across the globe.

Shopping

Overall, consumption will continue to decline—a 12 percent drop in private consumption is anticipated in the United States over the next two years, with recovery to pre-crisis levels only by 2023–24.

What we buy has changed across categories. Think fewer cosmetics and more flour.

The explosion of small brands, underway before the pandemic, has given way to a strong preference for global A-brands. After years of growth, out-of-home consumption has almost disappeared; many of us have stopped going to stores entirely. In many markets the surge in e-commerce has compressed the equivalent of several years of growth into just a few months.

Work

For many workers, the office is now in the living room.

For the cohort still able to work during the pandemic, work has turned largely remote and digital, with a sharp uptick in the use of digital collaboration tools. Zoom's daily user base grew from ten million people to 200 million in three months, and Slack's paying customers have doubled.

At the same time, there has been an enormous rise in unemployment, which is expected to reach approximately 15 percent when 2020's third-quarter results for the United States are complete.

Between February and October 2020, the unemployment rate in the euro area increased by only 1.2 percentage points to 8.4%, despite the large fall in

employment. The unemployment rate reached 8.7% in July and thereafter declined.

The limited increase in the unemployment rate in the euro area during the first months after the onset of the COVID-19 pandemic was in sharp contrast to developments in the United States, where part of the adjustment occurred via the temporary laying off of workers.

These are considered unemployed in the United States, whereas in the euro area those affected by short-time work schemes or temporary lay-offs remain, in most cases, on the payroll and are thus not considered unemployed (Job Retention Strategies).

Health and well-being

Public health and uncertainty about the length of the pandemic became the primary consumer concerns during the lockdown, with 68 percent saying they were very or extremely concerned. Self-care has climbed up the priority list for most consumers. Here, too, digital is playing a larger role as the use of e-pharmacy and e-medicine accelerates. Of consumers who had to cancel medical appointments during the lockdown, 44 percent accessed telehealth options, and online searches for telemedicine increased more than ninefold.

COVID-19 Pandemic has stroke further attention on the Work Life Balance topic.

As hybrid models and WFH becomes the new normality, concerns and challenges arise daily.

Many workers now work from their “workspace” of choice which includes home, office, and co-working spaces (depending on the work tasks they are entrusted with). Workers may thereby see better outcomes for their health, family, and overall well-being.

While many have adjusted to and enjoyed this change, others have had challenges in drawing a line between working and non-working hours.

The likelihood is high for several employees to experience increased working hours, as well as increased work-life conflict. For example, in today’s hyper-connected world, many remote working employees are expected to respond to urgent tasks as well as after-work emails, resulting in a blur between work and leisure. A recent study revealed that employees WFH during the pandemic experienced an increase in work-related fatigue and overlap between work and non-work life (Palumbo, 2020)

Studies conducted in UK, revealed that HR support models and managerial support during coronavirus disease helped employees enhance their living quality.

Alternatively, governments are discussing the option to implement specific policies in this regard. One notable example would be to adopt the "***right-to-disconnect***" law similar to that which is enforced in the Philippines and France, where employees have the right not to respond to work-related engagements and demands during nonworking hours (Broom, 2021; Department of Labor and Employment, Philippines, 2017; Eurofound, 2019).

Encouraging healthy work practices such as working within regular hours and taking regular breaks will help employees to draw a firm line between work and nonwork activities (Adamovic, 2018; Chen & Fulmer, 2018). Optimizing personal and work life is not easy when adopting a "new normal" working model. Employees need to be disciplined and well-organized in their work and personal life management.

This global health crisis has made people pay more attention to health and hygiene, which has also driven up the demand for healthy workplace cultures.

However, to attain a WLB in the post-coronavirus disease world, employers may need to consider and plan a way forward such as providing clarity to employees and a variety of programs to support employees in their well-being as well as fostering a "trust- and outcome-based working culture" (Sarin, 2020; Wolor et al., 2020). Employers' attention to employees' WLB will assist in keeping employees motivated and maintaining their performance. Therefore, WLB in the post-pandemic times should be brought to both employers' and employees' attention and should be considered when developing a plan for policy changes that would benefit both companies and employees.

Learning

By necessity, learning and studying went virtual, driving adoption of new tools. The user base for remote learning services grew by 120 percent. The shift of learning from outside the home to inside has blurred the lines between learning and leisure.

Entertainment

Consumers stuck at home are spending more time but likely less money on their entertainment, as the trend toward digital options accelerates.

Downloads of gaming apps increased more than 30 percent, year over year, while 45 percent of consumers report using more online streaming services at home.

Netflix added 16 million subscribers in five months while Disney+ nearly doubled its subscriber base to about 50 million—a feat that took Netflix seven years. Popular out-of-home activities are trying to adjust to this new reality, with Nascar and the NBA launching online product offerings, the J. Paul Getty Museum creating virtual tours, and the Metropolitan Opera streaming performances.

Travel and mobility

Consumers are staying home in droves. Tourism has been almost entirely grounded, with airline travel declining 90 percent overall. At the same time, there is an emerging preference for avoiding public transport and high-density transit hubs, which has decreased demand for on-the-go consumption. While it might take years for international travel to recover to pre-crisis levels of demand and supply, domestic travel could rise much sooner as consumers start summer vacations.

Communication and information: the Digital Shift

Overall, media consumption has increased in almost all channels. Forty-three percent of consumers are watching more television, 40 percent are using more social media, and 28 percent are listening to more radio. Readership of online news has risen 39 percent.

What’s not gaining? Print media, where the ongoing decline has worsened with a 33 percent drop in readership.

2. *Broad shifts to new behaviors hide significant variations (Consumer segment)*

While many consumers overall have been adopting new behaviors, there are significant generational and cohort differences.

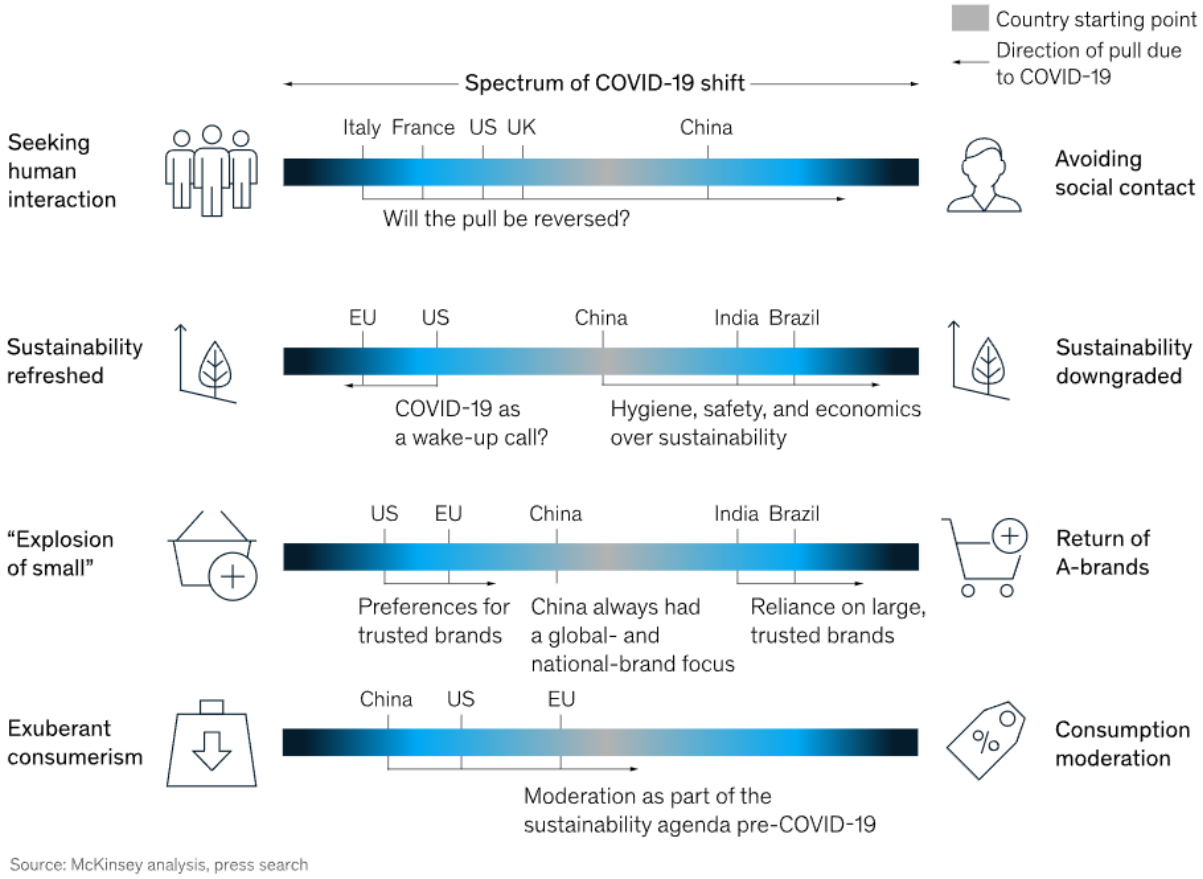
Gen Z, for example, which had a high degree of digital adoption pre-COVID-19, is unlikely to exhibit a significant increase, but the survey indicates that they are much more likely to be economically impacted by the crisis due to their disproportionate exposure to self-employment and, in particular, to the sharing economy.

Income disparities also seem to be driving pronounced behavioral differences across consumer segments. The more affluent have not been feeling the economic impact as much as other cohorts and will have more means for digital acceleration compared with people living paycheck to paycheck.
Segments will not be the same in every country. The consumer-sentiment data shows, for example, that retirees in the United States are not expected to feel the economic pinch as much as retirees in China.

Behaviors that are driven by personal values, such as sustainability or the desire for personal interaction, are apt to vary in their long-term adoption rates across countries and regions, depending on local infrastructure and other conditions. Some behaviors that look deeply embedded now could regress, or not.

The emphasis on health and hygiene that has led to an increase in single-use plastic reversed some of the preexisting focus on sustainability. Will that last or will consumers come to see COVID-19 as a wake-up call, a glimpse of the potentially catastrophic consequences of climate change?

Value-driven behavior changes occur on a spectrum, and their pull and magnitude depend on each country's starting point.



Source: McKinsey analysis, press search

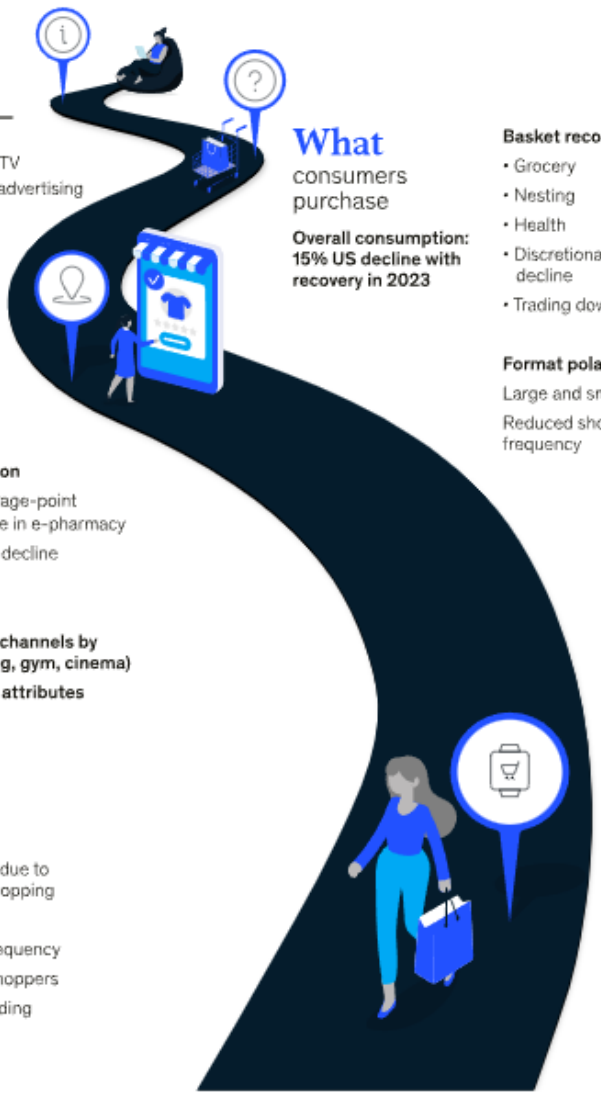
McKinsey & Company

3. *<u>Companies must rethink how and where they engage with consumers.</u>*

With the World Health Organization (WHO) stating that COVID-19 will be with us for some time, companies must prepare for a rapidly changing environment that may bounce between periods of lockdown and transition.

As consumers go in and out of these cycles, the new trends may wax and wane, but they will mostly persist until we move past the transition phase for good.

Companies will need to adjust quickly to changing consumer behavior until COVID-19 is under control.



How
consumers
get information

Shake-up of media mix—further shift to digital

Temporary comeback of TV

Decline in out-of-home-advertising

Decline of in-person engagement

What
consumers
purchase

Overall consumption: 15% US decline with recovery in 2023

Basket recomposition

- Grocery
- Nesting
- Health
- Discretionary-spend decline
- Trading down

Format polarization

Large and small packs

Reduced shopping frequency

Shake-up in hierarchy of needs

Health and hygiene rises

Polarization of sustainability

Brand-preference evaluation

Turning to A-brands for trust

Where
consumers
purchase

Channel-mix reevaluation

E-commerce: 17-percentage-point increase in grocery, surge in e-pharmacy

On-the-go consumption decline

Decrease in travel retail

Replacement of offline channels by at-home alternatives (eg, gym, cinema)

New channel-selection attributes

Proximity to home

Hygiene

No queue/room in store

New shopping reality

Decrease in satisfaction due to inconvenience of safe shopping

Increase in basket size

Decrease in shopping frequency

Decrease in density of shoppers

Decrease in tourist spending

How
consumers
experience

Shake-up in what consumers value

Loyalty shake-up, as consumers are forced to try new things

1.3 Meet the new customer 2.0

Cooking from scratch and buying fresh products have been prevalent behaviors during the COVID-19 pandemic.

More than half of EU-5 McKinsey's survey respondents—and up to 85 percent in some countries—report that a **focus on healthy foods** is a "very important" consideration in their weekly grocery shopping.

The behavioral shift is particularly pronounced among (but not limited to) younger consumers. Among both Generation Z and millennial consumers, approximately 35 percent cook meals from scratch more often than they did prior to the COVID-19 crisis, as do 23 percent of Gen Xers and 17 percent of baby boomers.

EU-5 consumers were already conscious of their food choices before the pandemic, with 25 to 30 percent of UK consumers reporting in January 2020 that they had "very active" food goals or followed specific diets.

During the pandemic, food has become even more central to consumers' lives.

Home has been recast as the new restaurant, with heightened health consciousness (though with some allowances, since home is also the new pub and new center of entertainment, reflected in skyrocketing sales of baking products, alcohol, and snacks).

As consumer needs and preferences continue to change, the offerings from retailers and CPG companies will need to evolve as well. In times of economic and public-health distress, that might mean helping customers find inspiration for healthy, fun, and affordable meals that they can make from scratch.

About 25 percent of survey respondents reported that their personal finances have been negatively affected by the COVID-19 crisis.

At the beginning of 2020, medium-term forecasts indicated a recessionary environment, even as the overall macroeconomic forecasts show a vaguely U-shape recovery. Based on previous recessions, it is expected that price sensitivity will continue to affect retail.

The current recession, however, has the added element of an increased amount of time spent at home, which has led to higher grocery sales.

Market research shows that at the end of June 2020, consumers further reduced their spending on all categories except groceries, where instead they expected to spend more, with a net intent of +4 percent.

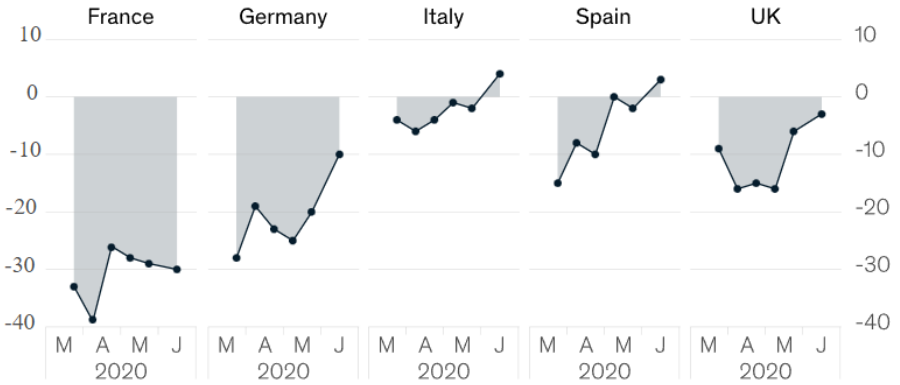
The **increased use of shopping lists to reduce impulse buying**, reflects the rise in price sensitivity: only in UK, 29 percent of UK respondents were shopping based on a list versus 21 percent in April; in Germany, the shares were 16 percent in June versus 6 percent in April.

In addition, across Europe (namely United Kingdom, Germany, Italy and Spain) a phenomenon of **down trading** has spread, and majority of consumers have switched to cheaper versions of the products they usually buy and declared they will continue to do so.

It's likely that price pressure will intensify further, particularly on discretionary products (such as alcohol and premium fresh produce).

More consumers in Italy and Spain bought cheaper versions of products than didn't.

Shift toward cheaper versions of products compared with prior to the COVID-19 crisis,[1] net sentiment[2]



[1]Question: Thinking about your grocery purchases last week compared with prior to the COVID-19 crisis, to what extent do you agree with the statement "I have bought cheaper versions of the products I normally buy"?
[2]Net sentiment is the % of respondents who answered "strongly agree" or "agree" minus the % of respondents who answered "strongly disagree" or "disagree."
Source: McKinsey & Company COVID-19 EU-5 Consumer Pulse Surveys across France, Germany, Italy, Spain, and United Kingdom, sampled and weighted to match Europe's general population: 18+ years. Survey dates: 6/18–6/21/2020, 5/21–5/24/2020, 4/30–5/03/2020, 4/16–4/19/2020, 4/2–4/5/2020, 3/27–3/29/2020; n = 1,000 per country, 5,000 total. Note that the 1,000 respondents did not always answer all questions

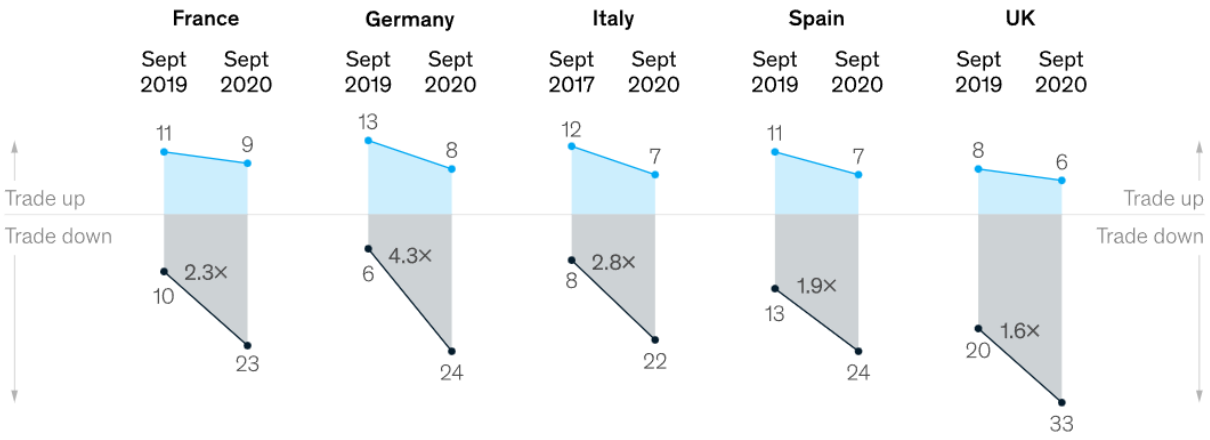
McKinsey & Company

According to McKinsey's September 2020 survey, UK consumers have traded down the most, with 33 percent of those who have changed their shopping behaviors reporting that they have switched to less expensive brands or stores or started buying items on sale. And 20 percent of UK respondents were already doing so before the pandemic.

The most profound behavior changes occurred in Germany, where just 6 percent of consumers were trading down in 2019 but 24 percent have done so in 2020.

Consumers who changed brands were more likely to trade down, compared to last year.

Trade-off behavior,[1] % of purchases



[1]Question: Please indicate how your buying behavior has changed in a standard shopping basket for the items shown in the past 12 months. Possible mutually exclusive answers: "Switching to less expensive brands"; "Buying the same brand as I bought 12 months ago, but at stores with lower prices"; "Buying only when on sale or with coupon"; "Buying less frequently of lower quantity of the same brand"; "Switching to more expensive/premium brands"; "Have made some other change in how I buy these products"; "Have not made changes in how I buy these products"; Base for trade-off behavior is consumers who have changed behavior.
Source: McKinsey 2018, 2020, and 2021 Global Sentiment Survey

McKinsey & Company

In June 2020, a few of the surveyed EU-5 consumers (22 percent in Italy, 19 percent in the United Kingdom, 13 percent in France, 13 percent in Spain, and 7 percent in Germany) who had shopped at brick-and-mortar stores during the crisis, had switched to a different primary grocer. And they did so mainly based on convenience, with 33 percent of consumers who had changed stores citing proximity as the main reason for doing so.

The survey results also suggested that consumers could stay with their new stores if the price was right: 25 percent of those who had switched stores affirmed they did so because of lower prices.

In September, the surveyed consumers were continuing to try out new retailers, with similar shares (19 percent in Italy, 17 percent in the United Kingdom, 13 percent in France, 11 percent in Spain, and 5 percent in Germany) reporting a primary-grocer switch.

Consumers' motivations, however, had changed, with **price as the primary drive**r: 28 percent of respondents who had changed stores cited better value as the reason, and 27 percent cited better prices and promotions.

But **location remains important**, with 26 percent of respondents who had switched moving to a store closer to their homes. And the shares of respondents who are looking for more ways to save money when shopping than they did before the crisis are approximately 44 percent in Spain, 36 percent in both Italy and the United Kingdom, 27 percent in France, and 23 percent in Germany.

The **availability of delivery slots**—so that consumers can order and receive groceries when they need them—is critical to staying competitive.

Grocers with an **in-store picking model**—in which online orders are fulfilled in the store for delivery or pickup—have found it easier than those without one to meet online demand and ramp up deliveries because the model's limited capital expenditures and shorter drive times allow for more flexibility. Online-only retailers, with no stores to deliver from, found it more difficult to meet the demand surge, although there are some exceptions (such as Italy's Cortilia, a food retailer that has continued to grow its fresh-food-delivery service).

It is thus evident a shake-up among grocery players as they battle for consumer loyalty. For retailers, that means that now is a critical time to invest in retaining their newly gained customers.

Within the CPG industry, small brands have had the lion's share of growth in recent years. Only in the United States, small brands accounted for 50 percent of value growth between 2017 and 2019, although they contributed just 11 percent of revenues in 2016. That growth was fueled largely by consumer preference **for small brands' authenticity and uniqueness**, with the help of investments from the venture-capital industry. In efforts to capitalize on the trend, large CPG companies have devoted significant attention and effort into building, acquiring, and incubating small brands—and have been increasingly successful in doing so.

But the COVID-19 pandemic has revived some large brands too.

In the first months of lockdowns, surveyed consumers in most EU-5 countries said they preferred well-known brands versus trying new, smaller brands. Availability was clearly a major reason: during full lockdowns in March and April 2020, large CPG companies were able to keep up with demand, while smaller players struggled to make products available because of supply-chain challenges and retailers cutting down SKUs.

The big-brand revival, however, might be short lived. Early signs suggest that consumers' interest in small brands is returning. Across EU-5 markets, the net

purchase intent of smaller or lesser-known brands was –9 percent in June, compared with –15 percent in March.

Over time, small brands are expected to return to their previous growth trajectory. McKinsey's survey results show that brand authenticity and provenance are increasingly important to consumers, and that will likely benefit the small brands that are resilient enough to weather the crisis. Some small brands won't recover, but others will continue to grow, and new ones will enter the market. Some large brands will also improve their growth profiles for the long term, in part by acquiring small brands.

Consumers increasingly value retailers and brands with a purpose. While healthy food is still the main priority for surveyed consumers' weekly grocery shopping, consumers are also conscious of the values and purpose of the brands they are buying.

An increase in overall net sentiment across environmental and ethical product attributes has been registered: consumers have more choices about where to shop and what to buy. In Italy, **net sentiment toward brands with strong values** and purpose reached 49 percent in June 2020. And across France, Germany, Spain, and the United Kingdom, about one-fourth of respondents see brands' values as important. That sentiment has remained true through September, with 18 percent of respondents buying more sustainable and eco-friendly products, and 12 percent report buying more from brands based on their purpose than they did at the beginning of the COVID-19 pandemic.

During and after the 2008–09 recession, it was important for consumers that large companies **prioritize social responsibility**. A few years later, 70 to 90 percent of consumers in various countries said they expected corporations to operate in ways that align with society's interests, even if it meant sacrificing shareholder value.

In the current crisis, early evidence suggests that the importance of social responsibility has accelerated for consumers. EU-5 survey respondents report strong intent to support local stores and brands that demonstrate care and concern for their staff and that use and promote sustainable solutions.

Against this backdrop, retailers and CPG manufacturers should be ever-more mindful of their roles in society as responsible and purpose-led employers, providers of essential goods and services, and pillars of their communities.

As these new behaviors solidify, companies will need to adapt to fundamentally different consumer preferences and behaviors regarding how consumers get their information, what and where they buy, and how they experience the product or

service. Many companies will need to increase their investment in insights and plan to stay on top of the changes.

Consumer behavior has changed radically in response to the COVID-19 lockdown. Understanding which changes are likely to stick will help companies plan for the recovery.

THE FUTURE OF FOOD PRODUCTION: A POST-PANDEMIC INSIGHT ON CHALLENGES AND INNOVATIONS IN FOOD TECHNOLOGY AND ALTERNATIVE FOOD SYSTEMS TOWARDS 2050

BY

FLAVIA FALCONE

UNISE1858IT

CHAPTER TWO (2)

"DIGITAL TRANSFORMATION & SMART INDUSTRY IN FOOD AND BEVERAGE COMPANIES"

CHAPTER TWO

2.0 Digital transformation: the driving force of the food tech industry

The digitalization in the food industry has begun for over 30 years with the support of technology innovation. In which digital transformation contributed to **cost reduction** and **food production optimization** due to the emerging of mobile app development**,** automated processing, robots, and big data.

Along with the growth in the modern lifestyle, people are getting busier, especially in cities or suburban. Living in a fast-paced World, we can have access to any amenity with just *one click*, including food and beverages on our very step door.

Digitalization changed and still changes all areas of life: the way we stay informed, the way we travel, the way we buy things, and the way we manufacture products from cars to cookies to cream.

The massive power of digitalization—the great opportunities and great risks—is changing business models daily. As such, the pace of an **enterprise's innovation and the willingness and ability to change** are key success factors in global competition

Digitalization means optimizing business processes through the adoption of a host of new digital technologies—**big data analytics, IT/OT convergence, Digital Twin, Artificial Intelligence**, even **3D printing** and **robotics**.

Elements of digitalization (or digital transformation or Industrie 4.0) are applicable across industry and manufacturing, including food & beverage.

Food & beverage companies must be open to leverage digitalization advantages in everything, from **restructuring the value chain to embracing virtualization to capitalizing on the full breadth and power of the IoT**.

Capturing the need of the market, major companies have invested more effort to accelerate their software development projects, which support online services. In particular, the need for developing restaurant ordering software, grocery delivery software and on-demand delivery is on the rise.

In this decade, the term artificial intelligence (AI), the Internet of Things (IoT), and machine communication formed another norm in the food tech industry, which is claimed as the typical representative of digital transformation.

Recently, global food production and services stepped out of times of traditional processing to turn on the concept of intelligence.

In the current world, data is put into the central role, enabling the key to optimize the entire phase of development. Instead of production, digitalization creates a new order in distribution, which enhances the inter-connection. In which, from the collected data, it came up with a better and accurate understanding regarding customers and the market. Whereby several custom mobile or web applications are born in favor of accelerating the innovation of the food and beverage industry.

Digital transformation seemingly contributed to every corner in life, which affect the entire players, including food distributions, retailers, productions, and restaurants.

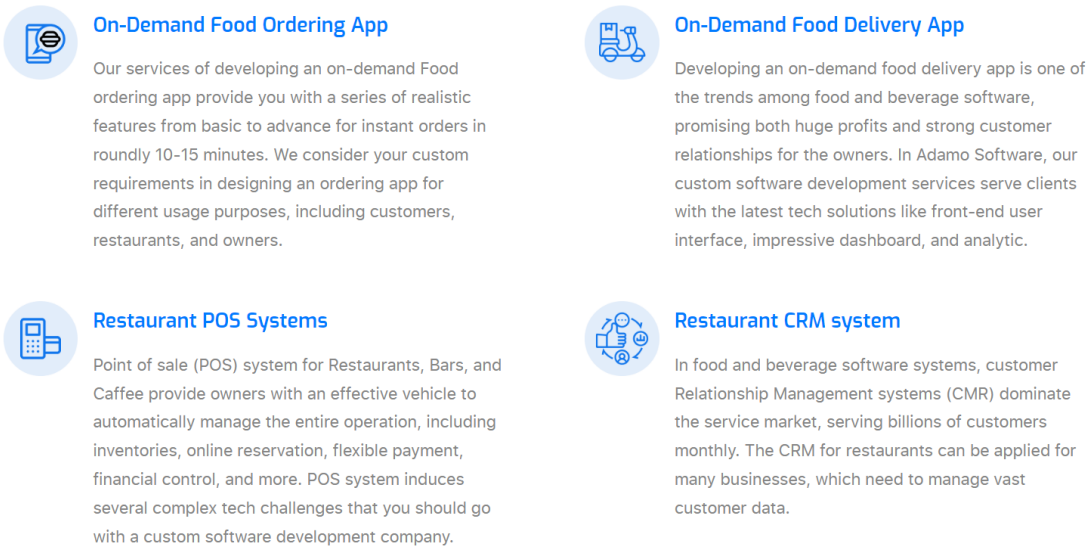
Accordingly, it allows businesses to turn challenges into opportunities.

From time to time, the food tech industry involves revolution coming, benefits most players in the market. Evidently, the innovation in the food industry would benefit software development companies with massive projects to build hi-tech solutions for food and beverage businesses.

Research and investigations prove that food and beverages services as restaurants, meal prep business, online distributions lean of software development enjoy significantly high proficiency and less cost than others. For more specific, food tech seemingly brings more benefits to several corners of the food industry.

Generally, food tech covers four centered concepts, including the online ordering system, food delivery system, inventory management software, and restaurant POS system.

The market for applying technology in the food industry is predicted to reach over US$ 250 billion at the end of 2022.



Many experts explained this lucrative standing depended on four driving forces:

1. **Demand for more healthy and nutrient products**: the healthcare concern is listed on the top of customers' desires. According to an investigation involved by over 40,000 participants pointed out that roundly 43% of respondents concern the term healthier when consuming foods. It forces the food business to several problems of ingredient contribution, which contributed to nutrient-related problems. Expressly, food products desiring to be commerce need to be both healthy and tasty, which contain fewer baddies and more goodies.
2. **Demand for better efficiency in food production:** with the need for more food volume, food producers are currently seeking digitalization and automation in reducing cost while remain output and quality. Accordingly, they are leveraging the innovation of automated machines, hardware, and software development to replace manual tasks. Whereas the value of software and date per employee in food manufacturing had increased by over 35% from 2016 to 2020.
3. **The impact of environmental and political sectors:** animal welfare and food safety remain debated among communities, leading to new regulations and legislation imposed on the food and beverage industry. Besides, the threat of climate change induces the need of reducing energy and food waste. It directly affects the direction of the digital transformation process.
4. **Reality and perception gap**: mass production imposes a heavy burden in Food retail network, which demands applied human intervention solutions

in every food process. For increasing the accuracy rate in every task applying technology in both production and distribution tend to be the norm.

2.1 The power of change: how a change mind set can drive success by adopting digital tech (Smart Industry)

"Doing the right thing is more important than doing the thing right."

Peter F. Drucker

A **mindset of change**—a willingness to reimagine longstanding approaches to business—must be adopted across the enterprise, from the decision-makers in the C-suite to the machine operators on the floor. Specifically in the food & beverage field, approaches to adopting digitalization play particularly important roles in a program's success.

First, the digitalization program must be implemented in a strategic, holistic manner, supported by properly trained, fully engaged stakeholders with **business driven KPIs for success**. All parties should recognize that in digitalization, process and organizational change are equal parts of the transformation. Recognizing this is critical for companies looking **to drive best practices and minimize customization**.

A key play role is here played by **Data Analytics**, to steer value in the mountains of new data Companies are producing and so to position themselves to properly analyze this data to drive faster, more-informed business decisions.

The most advanced companies will drive competition with prescriptive analytics and **Artificial Intelligence**, while smaller ones might still analyze the data through a rearview mirror.

Next is prioritizing which parts of the enterprise to go after first. No one can do this all at once.

Enterprises must determine **where value will be delivered first**, which is dictated by clear business imperatives and KPIs that engage all stakeholders who drive this vision.

Stages are prioritized and sequenced to build a foundation onto which additional capabilities can be layered.

A **time-to-value mindset** should inform these strategic decisions. Constant engagement with stakeholders must be maintained by frequent communication and collaboration. It is critical to **partner and communicate with everyone**

throughout every step (though consensus, which can paralyze progress, isn't always the goal).

In a world of smart, connected products, where entire markets can vanish with a single innovation, food & beverage manufacturers must take a new approach to business.

Some companies closely watch how products are being used, and feed data back from product utilization into product ideation and development in order to anticipate trends. But even if you know what to make, you still have to make it. That's why **manufacturing**—the realization phase of innovation—is vital in this new era too.

Food & beverage manufacturers must **weave a digital thread through Ideation, Realization and Utilization**. It's not enough to *digitize*: that just mimics processes digitally for incremental improvement. For companies is now needed to *digitalize*. Digitalization makes the digital thread of knowledge a proactive agent in driving business. With a fully optimized "Digital Enterprise," enterprises will be better equipped to initiate or respond to disruptive innovation.

To activate digitalization, a good "Smart Innovation Portfolio" (offered for instance by Siemens) should include and make sure to deliver:

- **Engaged users** who receive the right information at the right time—by transforming information so that only what's relevant is delivered in a context suited to each person's role.
- **Intelligent models** that evolve throughout the process with the information necessary to optimize themselves for how they need to be built and how they should perform.
- **Realized products** that achieve business goals through the integration of virtual-product definition and real production execution.
- **An adaptive system** that helps to efficiently deploy solutions in food & beverage segment in the era of smart innovation.

2.2 Digitalization in Consumer Product Companies

Increased challenges in the consumer products industry are creating dramatic shifts in what companies need to do to stay competitive in the marketplace. The growing demands of globalization are adding complexity to all parts of the supply chain, including ensuring a product's quality and timely delivery.

Increased demands of consumers for personalization and one-day delivery are requiring companies to operate in new and innovative ways, and at warp speed.

Consumer products companies must work on a global scale, while maintaining flexibility, speed, quality and innovation within their businesses.

The most innovative of these companies are using the power of digitalization—i.e. the integration and information sharing among multiple digital technologies—to transform their businesses and better connect to consumers to drive innovation.

Leveraging IT software technologies that have been boosting productivity for discrete manufacturers for years — such as product lifecycle management (PLM), advanced simulation and bigdata analytics — these companies are beginning to reap the same benefits.

Digitalization can unlock unlimited potential for consumer products companies by enabling them to deliver consumer preferred innovation, at a speed they never thought possible, with productivity and profit that deliver top and bottom-line results.

In this, external forces are able to create and induce challenges and opportunities as well.

The consumer products industry is going through more change than it has seen in the last 50 years.
From food to cosmetics to household cleaners, there are 30 times as many new product lines launched each year as there were in the 1960s, with the numbers rising sharply since 2000.

Whether these new companies are growing to support Asia's increasing population or introducing new products to satisfy the personalized demands of consumers and retailers, there are more consumer-packaged goods than ever before. As an example, Mintel adds 33,000 new products each month to its global database. Companies must manufacture billions of each new product, in

hundreds of different manufacturing environments around the world, and for thousands of global customers.

This level of scale and complexity is exacting a toll.

Many consumer products companies are seeing the complex needs for supporting current business drain the innovation capacity of research and development organizations, just at the time when consumer demand for innovation is increasing.
Today's consumers demand more of brands, including integrity and authenticity.

The rapidly growing millennial generation looks beyond obvious features and benefits of a product, and is now looking for ethically sourced ingredients, formulas that aren't tested on animals, sustainable manufacturing that doesn't involve child labor, and recycled or recyclable materials. To get a product into consumers' shopping baskets, companies must pay strict attention to everything from the recipes for their products and where materials are sourced, to working conditions and purpose-driven marketing, all while introducing new consumer-preferred products to the market faster than ever before.

And it's not only consumers who are paying attention to ingredients.

Over the last five years, regulatory agencies have been demanding more and more product documentation. Companies must ensure they meet the ever-increasing regulatory demands, such as the new Food Safety Modernization Act.

Companies must be responsive enough to quickly bring new products to market to win consumers, but precise enough and with the high quality necessary to satisfy regulators. And they must do this on a global scale. Global multi-location operations mean original product formulas and their manufacturing processes must be adapted for the materials and equipment available, in compliance with local regulations, all while maintaining the consistent product quality consumer's demand.

Controlling product quality is essential to maintaining brand integrity, which is more and more important to today's buyers.

But what's the concrete step to move from digital do digitalization?

Good news: all the needed data to supercharge productivity, enhance customer value and unleash innovation is probably already available inside each company, and already digital.

What's needed is a common software platform that turns all that data into useful information that is not only secure, but also **easy to find, understand, act on and re-use**.

And that is the ultimate essence of digitalization.

An advanced **PLM system** creates a broad, transparent view across all the stages of a product lifecycle, making business planning much easier. It can help consumer products companies make smart decisions and respond to change more quickly. Having transparency of data allows for both descriptive and prescriptive analytics, bringing insight to issues, and helping determine what the impact of a decision can be and how to optimize the solution.

Over time, PLM systems that are initially adopted for efficiency can generate new levels of insight, helping turn existing assets, processes and products into an effective innovation portfolio driving growth.

Digitalization can create the 'agility with precision' needed to win market share in this dynamic and demanding environment.

Consumer products companies can digitalize their entire product line and processes into a single collaborative environment. Instead of relying upon data silos or employees' hard drives, companies can now connect their systems via a single platform.

This '**digital thread'** can run from the consumer trend that sparks an idea, through recipe formulation, batch and filling instructions, lab tests and results, supplier networking, quality control inspections and even the labeling, packaging and artwork design used to launch the product.

Modern PLM software solutions allow companies to optimize their innovation process, entering information once and enabling it to automatically flow throughout the entire company, the supply chain, and distribution facilities.

Using a digital thread of information enables companies to track projects from research and development to production, optimize the process and design of products and improve the re-use of knowledge and assets far more efficiently. Take the overall packaging process as an example; if a department wants to utilize the same artwork in multiple markets, the marketing team in each country can leverage the original artwork design file and the data from the formulation and product definition. Instead of needing to design and approve new artwork, they can access the original art file and begin adapting it to the needs of their specific market. More than 75% of transactional work can be eliminated by re-

using data, automating tasks and maintaining the relationships of the data across the portfolio of relevant products.

The ability to automate insight from product and production data to create actionable plans closes the loop between design, production, and actual product performance.

As companies mature in their use of big data analytics, processes and insights gleaned will mature as well. Insights move from being descriptive, to diagnostic, to predictive, to prescriptive.

Predictive analytics based on big data collected externally, from the market and social media, as well as internally, covering product performance from different teams and divisions, help identify which projects should be fast-tracked, which ones require more resources or testing, and when it is time to involve the senior management team to avoid missing the window of opportunity.

Prescriptive analytics are all about taking action.

Companies are driving both top-line revenue growth and operational cost savings with analytics. Consumer products companies have leveraged analytics in the market measurement space for years. The difference now is the ability to search

and analyze contextualized big data from multiple data sources, in seconds— from a cloud based, software-as-a-service solution.

If all this sounds a world away from the ad hoc systems and processes most businesses use now, remember that there's no need to change everything all at once.

Digitalization using a product lifecycle management system to deliver an integrated, single source of truth isn't reserved for large companies; it is something every business needs to consider and put in place.

Digitalization, supported by digital thread, Digital Twins, simulation and analytics, can reinvigorate companies whose growth has been lagging.

A seamless digital thread benefits every department, leading every part of the organization to the key information they need to bring the right products to the right market at the right time.

In conclusion, Digitalization is not all about technology; it is a strategy to grow business. It can free up capacity to allow innovators to innovate again— leading to the next breakthrough product that the world is waiting for.

THE FUTURE OF FOOD PRODUCTION: A POST-PANDEMIC INSIGHT ON CHALLENGES AND INNOVATIONS IN FOOD TECHNOLOGY AND ALTERNATIVE FOOD SYSTEMS TOWARDS 2050

BY

FLAVIA FALCONE

UNISE1858IT

CHAPTER THREE (3)

"THE FUTURE OF FOOD PRODUCTION TOWARDS 2050"

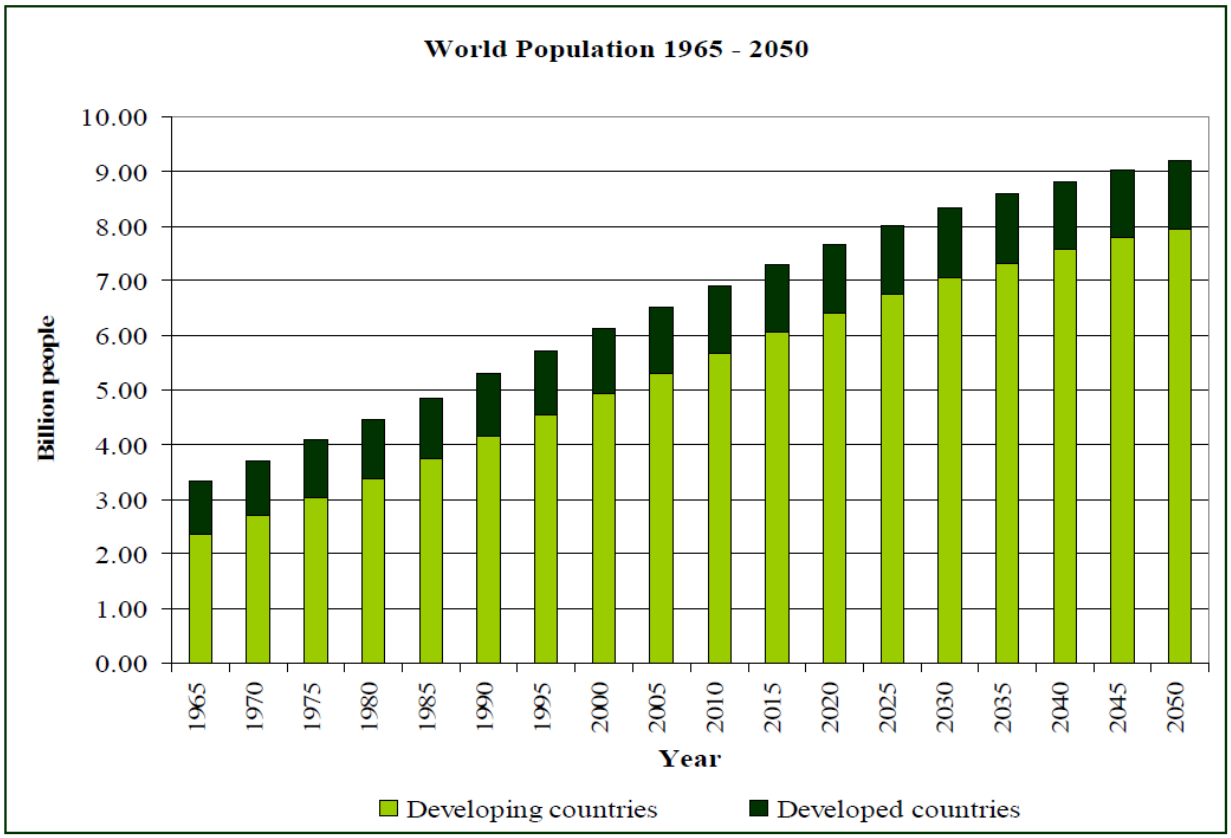
CHAPTER THREE

3.0 Future Trends in Agriculture and Production

By 2050 world's population will reach **9.1 billion**, 34 percent higher than today. Nearly all of this population increase will occur in developing countries. **Urbanization** will continue at an accelerated pace, and about 70 percent of the world's population will be urban (compared to 49 percent today).

Income levels will be many multiples of what they are now.

In order to feed this larger, more urban and richer population, **food production** (net of food used for biofuels) **must increase by 70 percent by 2050**. Annual cereal production will need to rise to about 3 billion tons from 2.1 billion today and annual meat production will need to rise by over 200 million tons to reach 470 million tons.



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2007)

Satisfying this demand for more food – and, most likely, more meat – presents a huge challenge for our already struggling planet, especially when you consider that the food system accounts for 26 percent of total global greenhouse gas emissions. (Agriculture, forestry, and land use make up 18.4 percent of this, while the rest is down to things like packaging, refrigeration, and transport.)

The obvious, and arguably the simplest, solution is for us all **to adopt a plant-based diet.** In fact, research shows that excluding meat and dairy is the single most effective way for people to reduce their environmental impact.

But, if we're honest, getting billions of people to switch overnight to a fully vegan diet is, at best, unlikely. After all, meat is deeply ingrained in many cultures, as is dairy.

With all this in mind, it's clear that we need urgent new innovations in agriculture and food production.

Today, two broad trends are making their way and might revolutionize our food system.

Trend 1: Reimagining farming methods

Embracing new farming methods could help the agriculture industry reduce its environmental impact while still increasing productivity. While previous evolutions in farming have largely been driven by mechanical improvements (namely, bigger, better machinery) or genetic advances (better seed, more effective fertilizers, etc.), the next big **transformation** is being **driven by digital tools**. For example, we have:

- **Automation** – including the use of robots, drones, and autonomous tractors to make farming more efficient.
- **Precision farming** – which involves applying irrigation, fertilizers, and pesticides at variable rates, depending on the needs of crops, rather than uniformly applying them at set times, quantities, and frequencies.

A good example of precision farming comes from a collaboration between Israeli company Phytech and Swiss agrichemical company Syngenta. Together, they have developed a monitoring system that includes plant growth sensors and soil moisture sensors to help farmers continually monitor crop growth and soil health and take action when and where it's needed.

Other key trends to watch in farming methods include:

- More localized, **urban farming** – i.e., producing food closer to the people who need it, thereby reducing food miles. “Intuitive farming”, to coin a new expression, is what is happening across many dumps in India, where abandoned cars are now finding a new purpose and becoming tanks to host plantations of veggies and flowers.

- **Vertical farming**, the practice of growing crops in vertical layers and **hydroponics**, meaning growing plants in nutrient-rich water, – are both methods that generally use less water, soil, and space than traditional field farming methods. The world’s largest vertical farm, located in Newark, New Jersey, shows that vertical farming can be done on a huge scale and with impressive results. Creators AeroFarm say the vertical farm is **390 times more productive per square foot than a field farm**.

Trend 2: Finding new ways to create food (especially meat)

One-third of croplands are used to grow feed for livestock rather than humans. It’s an astonishing statistic. Finding innovative new ways to create meat, would allow more of that land to be given over to growing crops for humans – something that will surely become more pressing as the global population grows.

This is where cultured (lab-grown) and **plant-based meats** come into play. Starting with plant-based meats, it’s clear that the market for meat alternatives is thriving. Chains like Burger King are routinely stocking plant-based burgers, and plant-based pioneers Beyond Meat became one of the most successful IPOs in history after going public at $1.5 billion and being valued at $13 billion less than three months later. In fact, estimates suggest meat alternatives could account for 10 percent of the global meat industry by 2029.

For those who don’t want to make the switch to plant-based meats, **cultured meat** – which is genetically the same as real meat but is produced from animal cells – could prove to be a viable alternative.

Real meat without the factory farms and animal slaughter? Sounds pretty good.

It's early days for cultured meat, but there are signs that the market – and regulators – are coming around to the idea. In 2020, Singapore became the first nation to approve cultured meat for sale.

There's also the potential for **3D printing** to play a role in food production. Barcelona-based startup NovaMeat is leading the way in 3D printing plant-based food and has already successfully created the world's first 3D printed piece of "meat" that apparently mimics the fibrous nature of real meat.

3.1 The Future of Food: how food technology can help sustainable development

Researchers from the University of Copenhagen, among others, have now created an overview of solutions that include a number of **new technologies (75 to be precise)** that can collectively address this global challenge. The results are published in *Nature Food*.

As addressed by Svend Christensen, University Professor and Head of Department of Plant and Environmental Science at the University of Copenhagen, the identified 75 new technologies combined, **can transform the entire food chain**: from production and processing to consumption and waste management. This will eventually help to meet the demands of the future for significantly greater food production, while protecting the environment and being resilient to climate change.

Together with an array of leading researchers from the 'Commonwealth Scientific and Industrial Research Organization' and the CGIAR Research Program on Climate Change, Agriculture and Food Security, Professor Christensen has identified a number of new and upcoming technologies that together, and each with their own approach, will be able to solve the global challenge for society. Most of these technologies are fully developed, while others are just a few steps away.

Some of the more well-known technologies **include artificial intelligence, robotics, genetic engineering, micro-algae production and vertical farming**.

Others include nitrogen-fixating cereals that do not require artificial fertilizers, biodegradable polymers and the breeding of insects for animal feed and foodstuffs.

While each of these technologies are distinguished by their **ability to reduce the climate footprint**, there are tradeoffs that public authorities and decision makers must take a stand on. Among other things, the researchers cite the use of GMOs, as well as varying levels of access to new technologies from country to country.

There is no doubt that this will require the **support of, and large investments from, politicians**, so that technologies and know-how are available in as many countries as possible.

At the same time, there is a **need to test and adapt these technologies** in order for them to be used across the food chain, from farm to fork. This requires considerable investment and an acceptance of some of the technologies that need to be developed and adapted over many years.

Some of the new technologies may seem controversial to consumers.

Therefore - in terms of generating **public support and acceptance** -, transparency, clear information and open dialogue will be necessary so that consumers can become comfortable with the new ways of producing food.

The **suite of technological options should be as broad as possible**, ranging from new plant varieties and animal breeds better adapted to changing conditions; to farming systems with improved water- and labor-saving technologies; reduction of losses and waste; and natural resource management.

Technological advances are particularly needed in the staple crop sector. Preference should be given to technologies promising **win-win combinations** of enhancing productivity and sustainability managing natural resources, for example conservation farming approaches based on no tillage.
It is not enough to ensure that future yields are high in some high-potential countries which can export surpluses to deficit countries. Rather, improvement of productivity and resilience of production systems is of particular importance in **countries with limited import capacity** and, within countries, in those areas where productivity growth in agriculture is essential for raising rural incomes, improving access to food for the poor and enabling local agriculture to compete better with low-price food imports.

Even at current levels of technology**, large and economically exploitable yield gaps** remain in many places. In sub-Saharan Africa, in particular, there are indications of yield gaps which could be exploited with given varieties and with known practices. Cereal yields in Africa have grown little and are still at around 1.2 tons per hectare, compared to an average yield of some 3 tons per hectare in the developing world as a whole. Fertilizer consumption was only 13 kg per ha in sub-Saharan Africa in 2002, compared to 73 kg in the Middle East and
North Africa and 190 kg in East Asia and the Pacific.

There are many **reasons why yield gaps exist**.

One is that farmers do not have sufficient economic incentives to adopt yield enhancing seeds or cropping techniques. This may be explained by numerous factors, including lack of access to information, extension services and technical skills. Poor infrastructure, weak institutions and discouraging farm policies can also create huge obstacles to the adoption of improved technologies at farm-level. Other factors can be that available technologies have not been adapted to local conditions.
Solutions lie with public sector investments in infrastructure and institutions, and sound policies to stimulate adoption of technologies that reduce costs as well as improving productivity, thus increasing agricultural incomes. Changes in crop

management techniques can also help closing yield gaps. Plant breeding plays an important role in closing yield gaps by adapting varieties to local conditions and by making them more resilient to biotic (e.g. insects, diseases, viruses) and abiotic stresses (e.g. droughts, floods).
Studies estimated that the global yield loss due to biotic stresses averages over 23 percent of the estimated attainable yield across major cereals.

The technology challenge also extends to the **up- and downstream sectors**. Transforming developing economies in particular need research and extension services to ensure that traders, processors and distributors have access to a broad choice of technologies that are competitive and comply with food safety and quality standards.

In 2008, genetically modified crops were cultivated on 800 million hectares in 25 countries (15 developing and 10 developed countries). Herbicide tolerant soybeans are the major genetically modified crop, occupying 53 percent of the totally area under genetically modified crops, followed by maize (30 percent), cotton (12 percent) and canola (5 percent). So far, the acceptability of transgenic crops continues to be controversial in many societies, including those of developing countries. In others, the related trade risks are considered too high. To date, many developing countries do not have the technical and regulatory capacity to assess the benefits and costs of modern biotechnology in their domestic agriculture and eventually to monitor the inclusion of transgenic crops in their agriculture. However, some major developing countries (China, Brazil, India) have been making great strides in agricultural R&D.

Spreading knowledge, skills and technology is a major challenge.

Agricultural extension programmes are meant to ensure that information on new technologies, plant varieties and cultural practices reaches farmers.
In many regions of the developing world, **women form the majority of farmers**, which means particular efforts need to be made to factor the needs of women into dissemination and capacity development programmes.
However, in the developing world it is common practice to direct extension and training services primarily toward men. A recent FAO survey showed that female farmers receive only five percent of all agricultural extension services worldwide and that only 15 percent of the world's extension agents are women.
Policies have been based on the assumption - proved wrong by studies - that information conveyed to the male head of a household would be passed on to its female members.
Apart from extension services, Farmer Field Schools are proving an effective means to spread knowledge, while information and communication technologies (ICTs) also look very promising tools for information dissemination.

3.2 The Agrimonde Platform: Analysis of food and agricultural challenges by 2050

Agrimonde was established as a collective instrument - led by the French Initiative for International Agricultural Research on behalf of the Institut National de la Recherche Agronomique and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) - for **analyzing global food and agricultural issues under the scenario of feeding 9 billion people by 2050, while preserving agro-ecosystems** from which other services and products are expected (including climate change, carbon storage, biodiversity, bio-energy, or bio-materials).

Agrimonde considers the following steps: choosing the scenarios and their underlying building principles, developing quantitative scenarios, and **building complete scenarios by combining quantitative scenarios with qualitative hypotheses**.

Between 2006 and 2008, the Agrimonde Expert Panel focused on building two scenarios.

In the first, "**Agrimonde GO" (AGO),** the second scenario, is more trend-based. It consists of an application of the **Millennium Ecosystem Assessment (MA) Global Orchestration scenario** into a food and agriculture scenario.
Global Orchestration is the MEA scenario with the largest reduction of poverty and malnutrition. It is based on both the liberalization of trade and on major technical advances in terms of agricultural yields. The priority given to economic development in this scenario, nevertheless, results in an exclusively reactive management of ecosystems and environmental problems.
This scenario was called Agrimonde GO because it was reconstructed on the basis of the quantification method adopted in Agrimonde, and because the population hypotheses chosen for this scenario are not precisely those used in the MEA. The MEA scenarios are exploratory because they explore the consequences of changing trends by starting with the present situation.

Some experts, including those involved in the MEA, indicated the need for a desirable scenario on the future of ecosystems.
As a result, a new scenario, Agrimonde 1, was developed.

In **"Agrimonde 1" (AG1)** scientists imagined a food and agricultural system designed to be sustainable by 2050 and is therefore **regarded as a normative**

forecasting scenario because it aims to explore the meaning and conditions of existence of a scenario on the development of a sustainable food and agricultural system. The idea was to better understand the meaning of such development, with the dilemmas and the main challenges that this type of scenario entail, and through the changes and discontinuities that it implies.

The hypothesis of **Agrimonde 1** uses as reference points a combination of the MEA scenario and the one proposed by Griff in 2006, who describes agriculture considering all characteristics of sustainability and the potential and conditions of a “doubly green revolution”.

This type of agriculture would be characterized by **agricultural production technologies that both preserve ecosystems and allow for development** through agriculture in countries lacking capital, where the implementation of production systems requiring intensive use of equipment, pesticides, and fertilizers is limited.

Both scenarios, Agrimonde GO and Agrimonde 1, indicate that global economic growth and ecological intensification remain as main challenges for feeding the earth’s growing population toward the mid-21st century.

The World in 2050, as described in Agrimonde 1, is based above all on **sustainable food conditions, allowing for the reduction of inequalities in food and health through a drastic reduction of both undernourishment and excessive food intake.**

By that time, it is **required to implement a set of actions to intensify productive systems and to increase production** in most regions.
These actions will meet the following three objectives:

- Satisfy the growing demand
- Allow for the development of income from agriculture in rural areas of the Global South
- Develop environmentally friendly agricultural practices.

Two underlying principles constitute the Agrimonde 1 and Agrimonde GO scenarios:

1. **Assessing the capacity** for each large region of the world **to satisfy its food needs in 2050,** thereby implying that interregional trade would be considered only after evaluating the extent to which agricultural production in each region covered local needs.
2. **Identifying the effects of future population trends** independently of the large international migratory flows, so that the implications of expected

population explosions could be examined fully with regard to each region's capacity to feed its own population.

3.3 Food Consumption in 2050

In the Agrimonde scenarios, as in the MEA scenarios, **"food availability" serves as an approximation of food consumption**. It is calculated as the balance between the calorie equivalent of quantities of available foodstuffs to feed the human population in a region (i.e., excluding animal feed, non–food uses, seeds, and postharvest losses), and the number of inhabitants of that region.

It reflects the quantity of calories available to consumers, at home and through other channels, and includes calories that will be lost between the purchase of the products and their ingestion. It should not be confused with the quantity of calories actually ingested, (around 2000 to 3000 kcal daily).

Food consumption trends are very different between Agrimonde GO and Agrimonde 1.

Agrimonde GO uses the hypotheses from the MEA Global Orchestration scenario in which economic growth largely explains consumption levels. Agrimonde GO qualifies as a trend scenario in terms of the evolution of the total food calorie consumption, where economic growth boosts consumption in all regions to reach a mean global availability of **3590 kcal per capita daily and substantially reducing undernourishment**.

The **Agrimonde 1** scenario stances in a whole different way and is clearly distinguished from the Agrimonde GO trend scenario.
Here, the income–food consumption nexus is not the main determinant because of great concerns for health, equity, and the environment.

The hypothesis of food availability that the Agrimonde expert panel selected for 2050 is 3000 kcal (818 more than today) per capita daily in all regions, remarking a significant change in trends observed between 1961 and the beginning of the 21st century: it corresponds to a slow **growth of food availability per capita** in most regions up to 2050, except in sub-Saharan Africa, where the per capita food availability will increase by 20% in 50 years, and the Organisation for Economic Co-operation and Development (OECD)–1990 region, where it will decrease by one-fourth.
The 3000 kcal are broken into 2500 kcal of plant products and 500 kcal of animal products.

Trends in relation to population increases in each region were thereafter calculated. The set of hypotheses on food consumption assumes that people's diets will depart from current tendencies as they take into account the objectives

of **sustainable development, which will ensue from the mounting pressure on resources and public health problems associated with human diets**.
It is a very strong set of hypotheses, as it implies that consumers, producers, and public policymakers will take into account the global and local impacts of modes of food production and consumption on health and the environment.
This set of hypotheses corresponds to four challenges:

1. **The wide gap between the observed availability and the necessary availability for food security**.
   The actual mean daily availability in 2000 was close to 4000 kcal per capita daily in the OECD-1990 zone and just under 4500 kcal per capita daily in the United States, whereas the Food and Agriculture Organization (FAO) of the United Nations deems satisfactory a mean daily per capita availability of 3000 kcal to guarantee that each individual has sufficient healthy food (FAO, 2002). These gaps can be explained by the distribution of diets within the population, by the fact that in rich countries the 3000-kcal threshold may be simply exceeded, and by a great proportion of loss between the available food and actual consumption, linked to consumption habits.

2. **The importance of equity in a sustainable development scenario**.
   Instead of using the assumption suggested by Collomb (1999) that each region attains at least 3000-kcal per capita daily threshold, with some countries exceeding that level, Agrimonde chose to test a stronger hypothesis that there will be a convergence of average availabilities of food worldwide.

3. **The food/health nexus**.
   A daily per capita availability of 3000 kcal may have positive consequences in terms of public health by (i) maintaining the proportion of undernourished people at a relatively low level, thus reducing the risks of malnutrition in developing countries; and (ii) limiting overconsumption, a source of nontransmissible food-related diseases such as obesity. Public actions aimed at changing food-related behaviors are a response to the current increase in obesity.

4. **The relationship between diet and the pressure on natural resources**.
   The aim of adequately feeding 9 billion people in 2050 implies that, irrespective of the production methods, there will be considerable pressure on natural resources that will increase along with the growing proportion of animal products in people's diets.
   The production of animal calories requires a substantial volume of plant calories, water, and energy. In addition, breeding ruminants generates

greenhouse gases directly or indirectly (e.g., through animal fodder, processing, and transport).
This last component is increasing with the intensification of production.
Caution is nevertheless required, considering the environmental impact of animal production.
One can also consider that there is an advantage in producing animals that optimize the use of plant resources (e.g., grazing on pastures, which humans cannot digest).
Systems have, however, been intensified over the past 40 years, which has resulted in shrinking pastures and concentrates, especially for grains. Producing ruminants still has the advantage of using land that is often unfit for crops (e.g., high altitudes, slopes, or semiarid areas), and of storing carbon on such lands. Furthermore, ruminants also have various uses because they represent a form of capital for their owner, provide organic fertilizer, are often used as draft animals, and are sources of food and regular income for populations often among the poorest in the world.

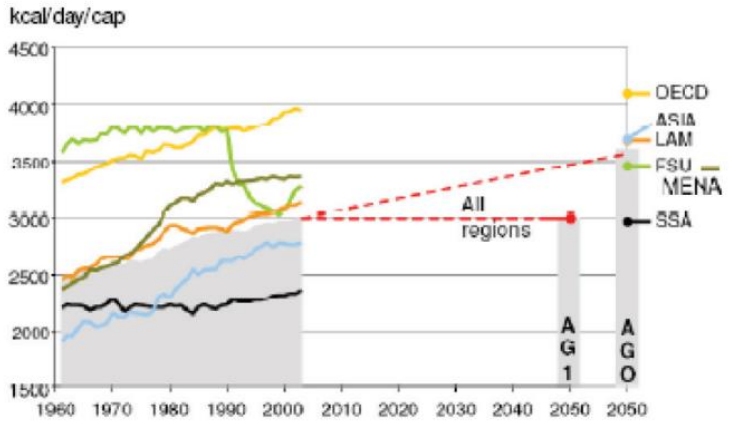


Figure 1. Mean regional food availability (daily kcal per capita) trends in *Agrimonde* Global Orchestration (AGO) and *Agrimonde* 1 (AG1) scenarios. The data used for this figure (1961–2003) ensued by reprocessing data from the Food and Agriculture Organization (FAO) of the United Nations. FSU: former Soviet Union States, LAM: Latin America, OECD: Organisation for Economic Co-operation and Development (or so-called developed world), MENA: Middle East and North Africa, SSA: sub-Saharan Africa.

The projections for the future socio-economic environment and the assessment of the situation and prospects of the natural resource base raise the question as to whether and under what conditions the estimated future food demand can be met and how food security can be achieved.
Based on the projected growth of population and incomes and expected changes in consumption patterns, the FAO estimates future consumption levels for various commodities country by country.
Taking into account countries' known resource capacities and projected development of yields, input use and technologies, and making assumptions

about their future trading capacity, estimates are also made of future production levels, land use and trade.
At the same time, on the basis of available information concerning the distribution of incomes and access to food within countries, the future prevalence of hunger is estimated in terms of the proportion of populations not having access to an adequate level of food energy.

FAO's long-term perspective studies thus seek to assess the implications of the projected socio-economic and demographic environment for future demand growth and to ascertain the extent to which individual countries and the world as a whole can meet this demand through production and trade and improve food security, based on reasonable assumptions about resource and productivity growth potentials.

According to **FAO's baseline projections, it should be possible to meet the future food and feed demand of the projected world population in 2050** within realistic rates for land and water use expansion and yield development.

However, achieving this will not at all be automatic and several significant challenges will have to be met.

In conclusion, under the assumptions made for the baseline modelling of the outlook towards 2050, food security for all could be within reach.

The conditions under which this can be achieved are **strong economic growth**, **global expansion of food supplies** by about 70 percent, relatively **high production growth** in many developing countries achievable through growing capital stock, higher productivity and global trade helping the low-income food deficit countries to close their import gaps for cereals and other food products at affordable prices.

3.4 The World in 2050 in the Agrimonde Scenarios

The analysis of scenarios, in terms of coherence and action levels, and their comparison, enabled the identification of certain qualitative hypotheses in the Agrimonde 1 scenario.
On this basis, the factors that had not yet been considered in the analysis, but that were likely to have a decisive impact on the world's food and agriculture during the period leading up to 2050, were sought.
These factors have been grouped into seven main themes:

1. the global context
2. international regulations
3. the dynamics of agricultural production
4. the dynamics of biomass consumption
5. the actors' strategies
6. knowledge and technologies in the field of food and agriculture
7. sustainable development.

According **Agrimonde GO** scenarios, by 2050, pushed by rapid economic growth and intense urbanization, diets will be based on a **richer protein content** as people consume more meat and fish. It will ultimately result in the **growth of obesity** in many regions (Asia, Africa), where new nutrition policies need to be implemented.

Technological development will allow for more intensive farming, as well as for an extensive use of fertilizers and genetically modified crops.
The vast majority of farms, both small and large, will become highly mechanized and industrial, replacing standardized industrial methods and the variety of agricultural species will be reduced. Multinational firms are a predominant feature of this scenario, as they will increase their share of plant and animal production, primarily through the development of new genetic strains and increase of the cultivated areas by 18%.

On the other hand, **Agrimonde 1** scenarios present a different panorama: while the main goal is to feed the world by preserving ecosystems, in 2050, diets in the various regions of the world will converge regarding calorie intake and on average about **3000 kcal per capita daily should be available worldwide.**
Cultural particularities would nevertheless maintain some diversity in the distribution of the various food sources.

From 2000 to 2050, the **agri-industrial model**, initially clearly dominant, should merge increasingly **with the local food and agricultural systems** based on

short circuits and on the diversity of small and medium-sized farms and processing enterprises, especially in the developing world.
The tendency toward standardization, internationalization, and concentration around a limited number of multinational firms declines. This change is facilitated by **national and regional strategies to ensure food security**, and by the considerable **impact of corporate social responsibility (CSR)** on large firms' strategies.
The agri-food sector is strongly affected by CSR as consumers in the rich countries prove to be more and more concerned about food issues, due to the spread of the sustainable food concept and following the "**hunger riots**."
They pressure agri-food firms, often via nongovernmental and consumer organizations, to take on their particular role in economic development and the reduction of malnutrition, as well as in the struggle against obesity.

According to AG1, the increase of cropping area needed is almost 39% more than the current state, with yields varying from 20,000 to 30,000 kcal ha−1 daily.
In this case, there is a huge need for new models of agricultural activities facing new ways of **combining the ecological and productive functions of agroecosystems** in the same area corresponding to a **model** that can be qualified as "**integrationist**."
It is based on the combination of different types of productive systems in a given territory, adapted to the local ecosystems in such a way as to maintain it in the form of a mosaic of ecosystems producing a diversity of services (e.g., purifying and regulating water resources, soil conservation, maintenance of landscape structures and biodiversity, or carbon fixation).
This model involves different types of farming (such as livestock, forestry, or crops) in the same territory, on the same farm or on different farms, overlapping to differing degrees (see the mode of ecological intensification in the Agrimonde 1 scenario for the North Africa–Middle East, sub-Saharan Africa, Latin America, and Asia regions).

Not only enhancing investments in sustainable agricultural production capacity and rural development, but also promoting technology change and productivity growth: these are the main streams to focus on as prerequisites for global food security.

CONCLUSIONS

Despite the consistent progress of technology that humankind has invested into and conquered, not exclusively in food and beverage industry, the new business strategies applied to meet the arising customer needs in a fast-evolving world, with increasing urban population estimated to reach 9.1 billion by 2050, this thesis argues that there is still a long road ahead for progress and room for change and shows various possible scenarios and challenges that *will* arise by 2050.

Primarily, the need to feed billions of people while trying to fight the secular problem of hunger and poverty. The required increase in food production is not sufficient per se to achieve such food security: facing and possibly solving existing hunger issues and future ones can be achieved only if all necessary **investments** are undertaken and **policies** conducive to agricultural production are put in place. Therefore, a strong and decisive political will and campaign must be set in place and focus on global awareness must be catalyzed now more than ever.

First, a key role will surely be played by **investments (public and private) and donor programs**: it has been calculated that, total average annual net investment in developing country agriculture required to deliver the necessary production increases would amount to USD **83 billion**, meaning a spike of investment about 50 percent.

In help of monetary strategies, **political and governmental decisions, local and international policies must be issued and adopted to guarantee greater market access** to developing country farmers so that they can compete on a more equal footing and encourage them (and other private participants) in agriculture to increase their investment.

Estimation says, in developing countries, 80 percent of the necessary production increases would come from increases in yields and cropping intensity and only 20 percent from expansion of arable land.
But the fact is that globally **the rate of growth in yields of the major cereal crops has been steadily declining**, dropping from 3.2 percent per year in 1960 to 1.5 percent in 2000.
The challenge for technology is today and in the near Future to reverse this decline, since a continuous linear increase in yields at a global level following the

pattern established over the past five decades will not be sufficient to meet food needs and **discover and implement alternative and sustainable ways** to produce food while respecting the ecosystems.

From a social and international perspective, countries also need to consider **joint measures to be better prepared for future shocks to the global system,** through coordinated action in case of food crises, reform of trade rules, and **joint finance** to assist people affected by a new price spike or localized disasters.

Climate change and increased biofuel production represent major risks for long-term food security. Although countries in the Southern hemisphere are not the main originators of climate change, they may suffer the greatest share of damage in the form of declining yields and greater frequency of extreme weather events.

Agriculture will have to adapt to climate change, but it can also help **mitigate the effects of climate change**, as useful synergies exist between adaptation and mitigation.

The world has the resources and technology to eradicate hunger and ensure long-term food security for all, in the light of sustainable development and reverse the climate change, in spite of many challenges and risks.
It needs to mobilize political will and build the necessary institutions to ensure that key decisions on investment and policies are taken and implemented effectively.

The time to act is now.

Bibliography and Research

CHAPTER ONE

https://adamosoft.com/blog/technology-in-the-food-industry-the-impact-of-digital-transformation/#:~:text=The%20digitalization%20in%20the%20food,%2C%20robots%2C%20and%20big%20data.

Health and Well-Being contributions
Broom, 2021; Department of Labor and Employment, Philippines, 2017; Eurofound, 2019

Adamovic, 2018; Chen & Fulmer, 2018

Sarin, 2020; Wolor et al., 2020

https://academic.oup.com/policyandsociety/article/41/1/155/6512154

CHAPTER TWO

Siemens PLM offer and debriefing
https://www.plm.automation.siemens.com/media/global/en/DE4FB-Industry-Briefing-Digitalization-In-Food-And-Beverage-66023_tcm27-17780.pdf

McKinsey
https://www.mckinsey.com/industries/retail/our-insights/how-european-shoppers-will-buy-groceries-in-the-next-normal?msclkid=ba25bd51d04911ecb5c7c2bbb3572e27

https://www.mckinsey.com/business-functions/growth-marketing-and-sales/our-insights/meet-the-next-normal-consumer

CHAPTER THREE

Bernard Marr – Forbes

University of Copenhagen; Bernard Hubert, Mark Rosegrant, Martinus A. J. S. van Boekel, and Rodomiro Ortiz

Deloitte
https://www2.deloitte.com/ch/en/pages/consumer-business/articles/future-of-food-responsible-production.html

FAO Researches & Documentation
https://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

AGRIMONDE Materials
https://acsess.onlinelibrary.wiley.com/doi/pdfdirect/10.2135/cropsci2009.09.0530