COMMENTARY

FOOD, INC:

Making the Coming Agricultural Revolution Work For You

2021

Marakon
Management Consulting at
Charles River Associates

EXECUTIVE SUMMARY

A new era of transformation in agriculture will make production more reliable, efficient, and sustainable. The need for this change is well understood—food insecurity, and the twin plagues of malnourishment and obesity mean that the current system is woeful at addressing the health and nutrition requirements of the majority of consumers. Additionally, climate change had already begun to pressurise the international food system even before COVID-19 shook the foundations of globalised supply chains and of international trade.

Many large food and drink players may still underestimate the scale of change and the pace at which it is arriving. In the past five years alone, investors have bet over $26.3 billion that substantial change will occur before 2030. Whilst it may be tempting for food and drink manufacturers to regard these shifts as simply evidence of "innovation on the fringes", the wise foresee substantial disruption looming within their own industry. New technologies, production practices, and changing consumer sensibilities will fundamentally alter how value is created in the industry by changing the shape and nature of demand, while heralding competition to own new types of intellectual property.

Now is the time for all significant participants in the food value chain to prepare for the next iteration of the agricultural revolution

WHY AN AGRICULTURAL REVOLUTION NOW?

Fundamentally, the food value chain does not universally and effectively deliver on several significant human needs, while it also creates, and is victim to, significant environmental externalities.

Food availability is not universally enjoyed. Almost a billion people globally still face food insecurity, whilst 2.5 billion people are overweight or obese, and even more consume the correct level of calories but with the incorrect mix of nutrients. Altogether, one third of the world's population maintains an inadequate diet with significant global and national inequalities in food consumption. Poor nutrition places burdens on economic development and public health resulting in $3.5 trillion in global costs. Linked to these issues is the price of food. Price represents around 10% of all household expenditure in developed countries such as the United States and up to 57% of household expenditure in developing countries such as Nigeria. Several factors drive these disparities in food availability.

Agricultural Unpredictability: The nature of current agricultural production methods leaves them open to substantial externalities including the impact of land characteristics, weather, infestations, diseases, wildfires, and human conflict. Natural disasters collectively cost the agricultural sectors of developing economies $96 billion in lost produce in 2005–2015, and such costs will escalate because of climate change. The Syrian conflict alone cost $16 billion. However, these extreme events represent a fraction of the real impact of externalities. The very location and nature of all agricultural production is tied up in the circumstances of the land on which it occurs, reinforcing supply chain vulnerability. Many previously mitigating activities, such as widescale herbicide and pesticide use, carry undesirable side effects.

Resource Inefficiency: The labour intensity of agriculture remains demonstrably high: current food production requires 40% of the world's workforce. Additionally, other input costs remain substantial too, with 43% of global land, excluding desert and tundra, being required, as well as freshwater amounting to 70% of all withdrawals globally. Substantial upfront capital investment costs have inhibited mechanisation of agriculture in countries such as Bangladesh well into the 21st century. Food waste is substantial—over 30% of all food produced globally is lost or wasted, and in Europe over half of these losses can occur before processing.

Creation of Environmental Externalities: It is a well-known fact that agriculture currently accounts for 26% of all man-made greenhouse gases, 32% of all land acidification, and 78% of eutrophication, or damage to aquatic ecosystems due to nutrient runoff. These externalities further increase unpredictability

and inefficiencies in agriculture, creating a vicious circle. For example, up to 16% of all farmland in China is now contaminated, with remediation costs reaching hundreds of billions of dollars and further diminishing production yields. Thus, it's no surprise that 72% of all signatories to the Paris Agreement on climate change have chosen agriculture as a priority sector for action.

Whilst the challenges facing agricultural production remain real and the crises of 2020–2021 are salient, an understanding of the past suggests that catastrophe is not inevitable. Much as the Green Revolution helped prevent widespread food shortages and starvation, once again it will fall to innovation to transform where, how, and at what cost our food is produced.

WHAT THE FUTURE MIGHT LOOK LIKE

Agriculture is witnessing an unprecedented phase of development of technologies and agricultural practices. Each of these innovations in isolation is either targeted at one or more of the drivers of transformation detailed above, or it acts to enable other technologies. However, taken collectively, these innovations herald the rise of intelligent agriculture and the transition of primary production from the industrial age into the information age.

Agricultural Predictability: Entrepreneurs are developing new approaches to monitor and ameliorate some of the externalities that are hindering predictability in agriculture. For example, insect-sensing technologies promise to reduce losses from infestation and to improve yields through enhanced pollination and reduced use of pesticides. Trapview is a Slovenian start-up that combines trap automation and artificial intelligence to allow farmers to monitor and respond to pests, whilst Delaware-based OSBeehives pre-empts health issues in apiaries. Field-sensing technologies expand the scope of externalities including disease, nutritional variance, and environmental factors. Aker uses drones to collect data, advanced analytics tools and agronomists to review it, and digital decision-support tools to enable farmers to act upon recommendations. Hydroponics and aeroponics allow for plants to be grown in water and in mist, respectively, instead of in soil, thereby reducing the risk of crop failure whilst also working to enhance yields.

Resource Efficiency: Other technologies are more focused on improving the efficiency of key inputs including water, labour, and equipment. Waterbit is a precision irrigation technology, which monitors irrigation, provides analytics, and allows for remote control of watering systems—thereby promising water efficiency, improved yields, and higher quality crops. Picktrace, on the other hand, uses in-field mobile barcode scanning software to provide real-time operational efficiency and workforce management insights. A new generation of agricultural equipment is emerging that incorporates the latest in robotics and artificial intelligence technologies. Harvest Croo and Agrobot promise to automate the highly manual task of strawberry picking and thereby address the threat of fruit-cost inflation linked to labour shortages. Thorvald promises to automate UV-treatment, picking, phenotyping, in-field transportation, grass cutting, and spraying.

Sustainable Food: Innovation is driving changes to the sustainability profile of the food we eat. Regenerative farming incorporates practices such as no-till, crop rotation, and use of cover crops to revitalise soil, increase biodiversity, and sequester carbon where soil quality, local economics, and population density allow. Such process changes could or could not be accompanied by technological interventions which can monitor and even reward carbon offset. Other technologies might improve sustainability by reducing the substantial waste generated in agriculture or in transit. Full Harvest, Spoiler Alert, and Imperfect Foods are just some of the start-ups that are aiming to create marketplaces for produce that might otherwise fail to find a buyer. Freshness control interventions such as Hazel Technologies might improve shelf-life and thereby further reduce food waste in transit, whereas Baramoda aims to process waste from the field into organic fertilizer.

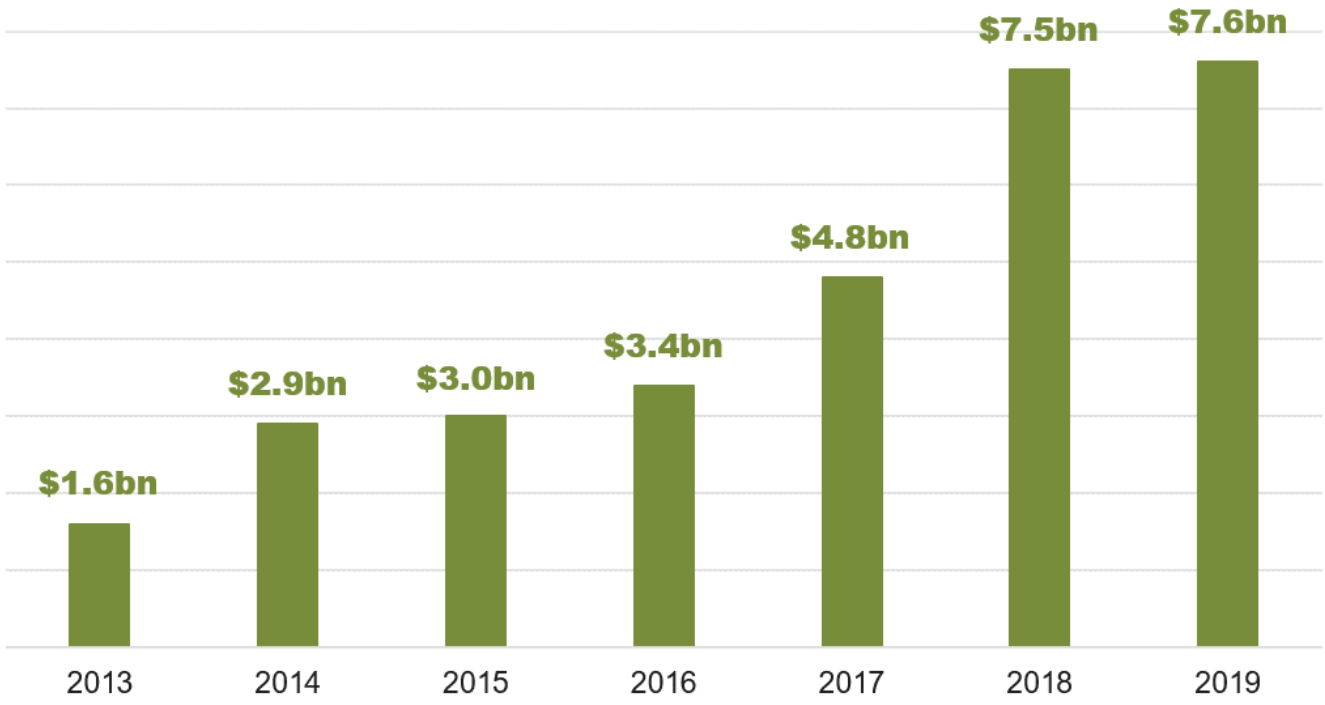
Enabler Technologies: These include a range of interventions that capture, transmit, integrate, and analyse data. These often build on existing Enterprise Resource Management systems to enhance data integration, utilise cryptographic techniques—such as blockchain—to provide decentralisation and data security, and use a range of structured and unstructured data analysis techniques. DeHaat integrates a range of data to facilitate procurement of inputs, soil testing, disease detection, farmer education, pricing, and selling. Other enabler technologies might help fund agricultural producers, including those such as Agvesto that facilitates agricultural insurance.

Effect of These Innovations in Combination: The integration of many of these new technologies could drive the transition into intelligent agriculture. The combination of monitoring, controlling, and optimizing technologies allows for more autonomous operations, greater co-ordination across the value chain, self-service, and continuous improvement. It can address questions around agricultural predictability, efficiency, and sustainability in tandem. One such example might be the vertical farm. These are highly automated internal growing spaces that monitor and control species, temperature, light, humidity, and nutrients to avoid agricultural externalities, boost yields, and reduce negative environmental impacts. Should such a future be successful, it would have profound implications for agriculture: moving from a highly manual pursuit which is subject to the vagaries of the outside environment to a highly capitalised learning process that could close the loop between food demand and supply and can be located almost wherever required.

HOW QUICKLY THE FUTURE MIGHT ARRIVE

Substantial capital has already flowed into agricultural technology investments. Indeed, venture capital funding expanded from $1.6 billion in 2013 to $7.5 billion in 2018 and grew in 2019, despite all-industry global venture capital deals diminishing by 13% in that year. Deal sizes have increased, demonstrating the growing maturity of the start-ups being funded.

Figure 1: Global Investment Flows into Agricultural Technology



Source: Ag Funder Investing Report 2019

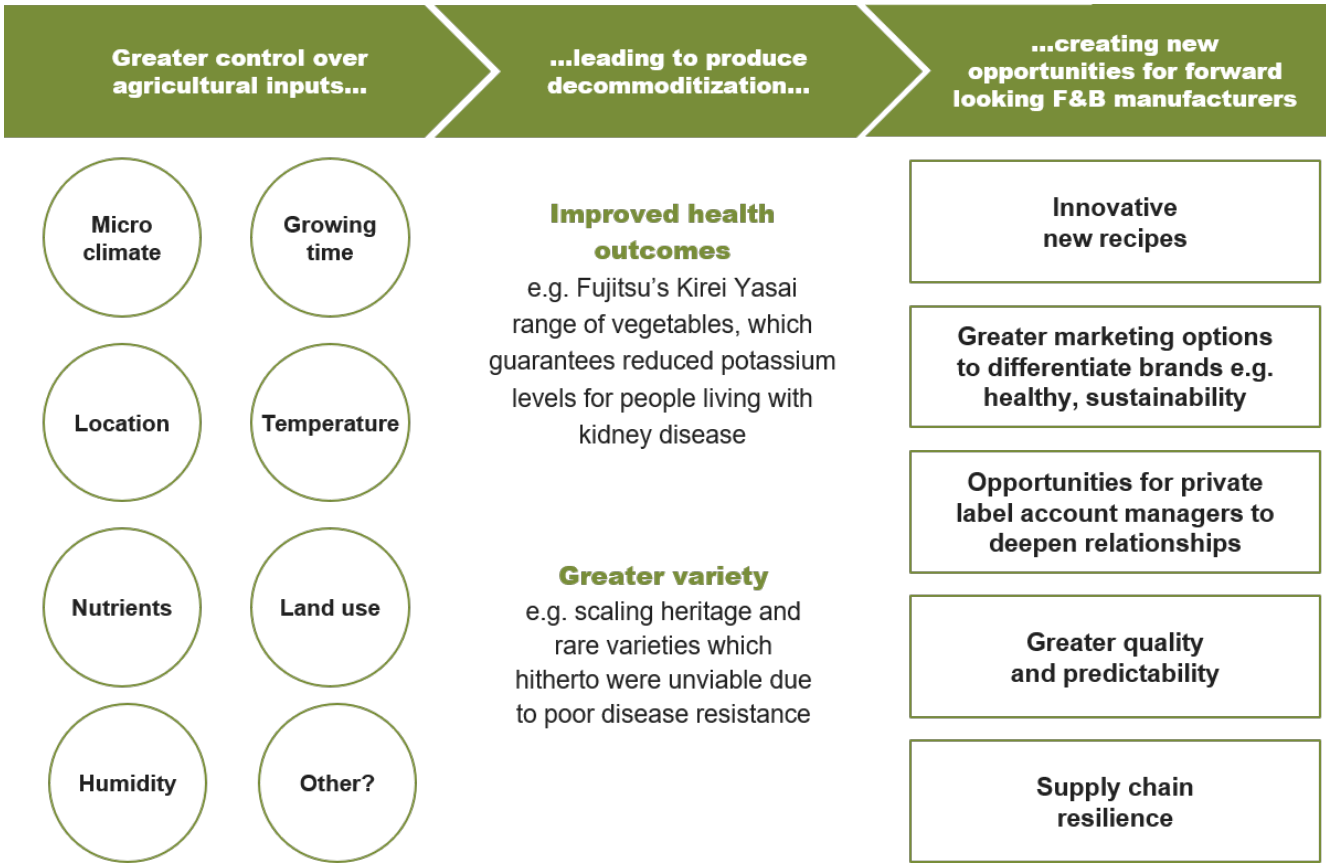
Furthermore, the first round of "unicorns", with valuations in excess of $1 billion, has already emerged: Europe's Ingigo Ag achieved a $3.5 billion valuation in 2018 despite being founded only in 2016. Whilst individual venture capital funds vary in terms of holding-time horizons, exit timelines from prior venture capital investments in internet digital technologies were typically between eight to 10 years. From this perspective, investors are betting substantial money on commercialisation of information age innovations before 2030.

The capability and economics of future technologies are inherently uncertain. For example, in 2018 vertical farm-grown vegetables were between 40% and 180% more expensive than their equivalent organic local produce on the East Coast of the United States. Capital investment drove much of the price differential, with the $4 million start-up costs of a large vertical farm likely to have diminished if industry scale drove competitiveness and repeatability in construction. Energy efficiency and water usage were factors too—though advances in aeroponics, which improve yield and diminish water use, and LED lighting technology promised to reduce these direct input costs. Whilst Moore's Law predicted rapid processor performance gains in the computing sector, it is too early to rule definitively on the end-state economics of agricultural technology. Researchers in economics, such as Wageningen University's Luuk Graamans, are hopeful and foresee the biggest initial applications in locations with the most extreme climate conditions.

WHAT EXECUTIVES IN FOOD AND DRINK CORPORATES SHOULD DO

Whilst many food and drink executives will immediately recognise the procurement implications of agricultural transformation, the wisest will recognise the potential for significant disruption in their own industry. As Michael Porter observes, smart connected technologies transform competition, alter industry structure, and blur not only value chain boundaries, but also industry boundaries.

Figure 2: How the F&B Industry Could Look in 2030



A comprehensive response to the challenges and opportunities posed to food and drink manufacturers will need to be multi-faceted. The shifting location and magnitude of consumer demand might lead some executives to question the shape of their company's geographic portfolio and its exposure to emerging markets. Others might be keen to re-evaluate their competitive strategy in light of the shifting basis of advantage, for example defining new sources of differentiation based upon fundamental ingredient differences that are enabled by emerging technology. Still others will be concerned about adapting their own operations to leverage data, embedding new quantitative approaches to sustainability, and avoiding substantial reputational risk. The best leaders will seek to develop options that coherently integrate actions across each of these dimensions and even more.

Our experience supporting clients as they address potential technological disruption suggests three components at a minimum:

1. **Build Information Advantage.** At the most basic level, food and drink manufacturers should continue to deepen their understanding of the transformation sweeping through agriculture. Given the uncertainty inherent in technological developments, scenario planning is a tool that can challenge the executive team's assumptions about the future and test the enterprise's robustness. Building clarity on early indicators upfront can also provide the business leadership with vital information about the speed and nature of change. Many of the most forward-thinking companies will seek to engage early pilots, partnerships, or even minority investments to ensure they have asymmetric insight into how this sector is developing

2. **Design and Execute an Integrated Response.** Given the broad-ranging implications of agricultural transformation, food and drink manufacturers should develop a deep understanding of how the most likely market development scenarios might impact upon their prior strategic choices. As outlined above, challenges and opportunities might require adjustments to geographic and category participation choices. They might change the basis of competitive advantage and shift market pricing and/or demand new capabilities from the organisation. Any such response requires a robust understanding of both financial and sustainability implications to ensure that the enterprise continues to be valued and valuable. Furthermore, they should be accompanied by a full implementation plan, for example one which includes a perspective on changes required to core production technologies to capitalise on the opportunities of supply-chain data integration

3. **Embed Strategic Agility.** Leadership teams should consider whether their enterprise is sufficiently agile to adapt to rapid and significant shifts in market ahead of competitors, particularly given the unprecedented levels of uncertainty that they might face. In addition to injecting dynamism in setting strategic direction, we also usually suggest companies reassess their execution enablers, embed agile working practices, and drive a shift in ethos.

Whilst many enterprises may choose to embark on this journey alone, our clients have sought support from an external advisor. They believe this can accelerate change by providing an objective viewpoint on the business, bringing to bear deep experience and capability in facilitating the integrated response outlined above, and offering access to an ecosystem of subject-matter experts and potential partners.

SOURCES

Anthem, P., "Risk of Hunger Pandemic as Coronavirus Set to Almost Double Acute Hunger by End of 2020," United Nations World Food Programme, 16 April 2020, https://insight.wfp.org/covid-19-will-almost-double-people-in-acute-hunger-by-end-of-2020-59df0c4a8072.

Burwood-Taylor, L., "AgFunder Agri-Food Tech Investing Report," AgFunder, 2019, https://research.agfunder.com/2019/AgFunder-Agrifood-Tech-Investing-Report-2019.pdf.

CGIAR Research Program on Climate Change, Agriculture and Food Security, "Agriculture is Integrated into the Paris Agreement [Case Study]," 2016, https://ccafs.cgiar.org/publications/agriculture-integrated-paris-agreement#.Xw9AgihKg2x.

Chartzoulakis, K. & Bertaki, M., "Sustainable Water Management in Agriculture under Climate Change," *Agriculture and Agricultural Sciences Procedia*, 4, 88-98, 2015.

Cremades, A., "How Venture Capital Works," *Forbes*, 2 August 2018, https://www.forbes.com/sites/alejandrocremades/2018/08/02/how-venture-capital-works/#7b680cfb1b14.

Day, S., "AgTech Landscape 2019: 1,600+ Startups Innovating on the Farm and in the 'Messy Middle'," *AgFunder News*, 4 June 2019, https://agfundernews.com/2019-06-04-agtech-landscape-2019-1600-startups.html.

Day, S., "AgTech Landscape 2020: Farm Tech Market Map: Why it's time to distinguish farm tech from the messy supply chain," *AgFunder News*, 9 June 2020, https://agfundernews.com/farm-tech-market-map-why-its-time-to-distinguish-farm-tech-from-the-messy-supply-chain.html.

Ehrlich, P. R. *The Population Bomb*. Rivercity Press. 1975.

Eisenstein, C., "We Need Regenerative Farming, Not Geoengineering," *The Guardian*, 9 March 2019, https://www.theguardian.com/sustainable-business/2015/mar/09/we-need-regenerative-farming-not-geoengineering.

Evelyn, K., "Major US Meat Producer Warns 'Food Supply Chain is Breaking'," *The Guardian*, 27 April 2020, https://www.theguardian.com/us-news/2020/apr/27/tyson-foods-coronavirus-food-supply-chain.

Food and Agriculture Organisation of the United Nations, "Malnutrition in the Crosshairs," press release, 1 December 2016, http://www.fao.org/news/story/en/item/455867/icode/.

Food and Agriculture Organisation of the United Nations, "Water for Sustainable Food and Agriculture," 2017, http://www.fao.org/3/a-i7959e.pdf.

Food and Agriculture Organisation of the United Nations, "2017: The Impact of Disasters and Crises on Agriculture and Food Security," 2018, http://www.fao.org/3/I8656EN/i8656en.pdf.

Food and Agriculture Organisation of the United Nations, "The State of Food Security and Nutrition in the World 2019," 2019, http://www.fao.org/3/ca5162en/ca5162en.pdf.

Godin, M., "Swarms of up to 80 Million Locusts Decimating Crops In East Africa, Threatening Food Security For 13 Million People," *Time*, 14 April 2020, https://time.com/5784323/un-locust-east-africa/.

Gollin, D. et al., "Two Blades of Grass: The Impact of the Green Revolution," National Bureau of Economic Research, 2018, https://www.nber.org/papers/w24744.pdf.

Harvey, F., "Dust Bowl Conditions of 1930s US Now More Than Twice as Likely to Reoccur," *The Guardian*, 18 May 2020, https://www.theguardian.com/environment/2020/may/18/us-dust-bowl-conditions-likely-to-reoccur-great-plains.

Houwat, I., "Here's How Climate Change Could Cause Insects to Destroy Our Crops," World Economic Forum, 7 February 2020, https://www.weforum.org/agenda/2020/02/insects-global-warming-damage-crops-rising-temperatures/.

Malthus, T. R. (1878). *An Essay on the Principle of Populatio*n. Reeves and Turner.

Matsutani, M., "Fujitsu Harvests Low-Potassium Lettuce Grown in Semiconductor Plant," *The Japan Times*, 13 May 2014, https://www.japantimes.co.jp/news/2014/05/13/national/science-health/fujitsu-harvests-low-potassium-lettuce-grown-plant-clean-room/#.XtDOMTpKg2w.

Nelson, M., "U.S. Food Expenditures at Home and Abroad," The American Farm Bureau Federation, 2019, https://www.fb.org/market-intel/u.s.-food-expenditures-at-home-and-abroad.

Porter, M. & Heppelmann, J., "How Smart, Connected Products Are Transforming Competition," *Harvard Business Review*, 92(11), 64-88, 2014.

Plumer, B., "Map: Here's How Much Each Country Spends on Food," *Vox*, 15 August 2015, https://www.vox.com/2014/ 7/6/5874499/map-heres-how-much-every-country-spends-on-food.

Poore, J. & Nemecek, T., "Reducing Food's Environmental Impacts Through Producers and Consumers," *Science*, 360(6392), 987-992, 2018.

Primack, D., "Indigo Ag Raises $250 million at $3.5 Billion Valuation," *Axios*, 18 September 2018, https://www.axios.com/indigo-ag-crop-yield-farming-raise-valuation-285f7c4e-2b60-49a0-95f6-d4c38ddedff6.html.

Rezaei, M., & Liu, B. (2017). Food Loss and Waste in the Food Supply Chain. International Nut and Dried Fruit Council: Reus, Spain, 26-27, 2017 http://www.fao.org/3/a-bt300e.pdf.

Ronte, H. & Foxcroft, R., "Real World Evidence: Enabling the Life Sciences Industry to Transform Patient Care," Deloitte, 2015, https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/life-sciences-health-care/ch-rwe-enabling-the-life-sciences-industry-to-transform-patient-care.pdf.

Southey, F., " 'Are Vertical Farms Even Remotely Efficient?' Putting a Figure on Plant Factories," *Food Navigator*, 15 May 2019, https://www.foodnavigator.com/Article/2019/05/15/Are-vertical-farms-even-remotely-efficient-Putting-a-figure-on-plant-factories.

Sundaram, J. K. & Elver, H.,"The World Produces Enough Food to Feed Everyone. So Why Do People Go Hungry?," World Economic Forum in collaboration with Project Syndicate, 11 July 2016, https://www.weforum.org/agenda/2016/07/the-world-produces-enough-food-to-feed-everyone-so-why-do-people-go-hungry.

Steingoltz, M. et al., "Consumer Health Claims 3.0: The Next Generation of Mindful Food Consumption," LEK, 2018, https://www.lek.com/sites/default/files/insights/pdf-attachments/2051-Healthy-Food-Claims.pdf.

Traitler, H. et al., *Megatrends in Food and Agriculture: Technology, Water Use and Nutrition*. John Wiley & Sons, 2017.

"Agriculture to be Mechanised to Cut Production Cost: Minister," 1 May 2020, *United News of Bangladesh*, https://unb.com.bd/category/Bangladesh/agriculture-to-be-mechanised-to-cut-production-cost-minister/50915.

World Health Organisation, "Malnutrition [Fact sheet]," 2020, https://www.who.int/news-room/fact-sheets/detail/malnutrition.

Christine Delivanis
Vice President, London
cdelivanis@marakon.com
+44-20-7664-3737

With a significant debt of gratitude to: **Roland Foxcroft**

ABOUT MARAKON

Marakon is a strategy and organizational advisory firm with the experience and track record of helping CEOs and their leadership teams deliver sustainable profitable growth. We get hired when our client's ambitions are high, the path to get there is not clear (or taking too long) and lasting capabilities are as important as immediate impact.

We help clients achieve their ambitions for sustainable profitable growth through:

- Stronger strategies and advantaged execution based on:
  a. A better understanding of what drives client economics and value
  b. Insight into changing industry dynamics and the context in which clients need to succeed
- A stronger management framework to generate better ideas and link decisions and actions to value
- A stronger organization with a more focused top management agenda and well-aligned resources
- A more confident and effective leadership team that's focused, decisive, and strategic

We have a joint team delivery approach where client ownership and engagement is paramount. Partners are highly engaged in the work product and supported by strong analytical and industry relevant capability. We work as advisers and catalysts in close, trust-based relationships with top management teams.