FRONTIER TECH HUB

UKaid from the British people

5 Speculative Scenarios for the Future of Frontier Tech in Development

What are the frontier technologies showing the most promise for impact in international development?

Time Horizon • 2030

Contents

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Executive Summary

In this short report, we share the 5 speculative scenarios that were developed as part of the 2023 Futures Exploration into the future of frontier tech for development.

The scenarios are designed to spark curiosity, catalyse conversation, and help you to imagine potential futures, so you can make more informed decisions in the present.

They are not a prediction of the world in 2030.

Below each scenario, we explore three things:

1. *The data.* Based on the data available now, what is the current context for this scenario?
2. *The risks.* We've been generally optimistic in the scenarios, but there are, of course, key risks that will need to be mitigated to realise the benefits.
3. *Recommendations.* We've explored some suggestions for what organisations like the FCDO might do now to act on the opportunities and challenges that the scenario presents.

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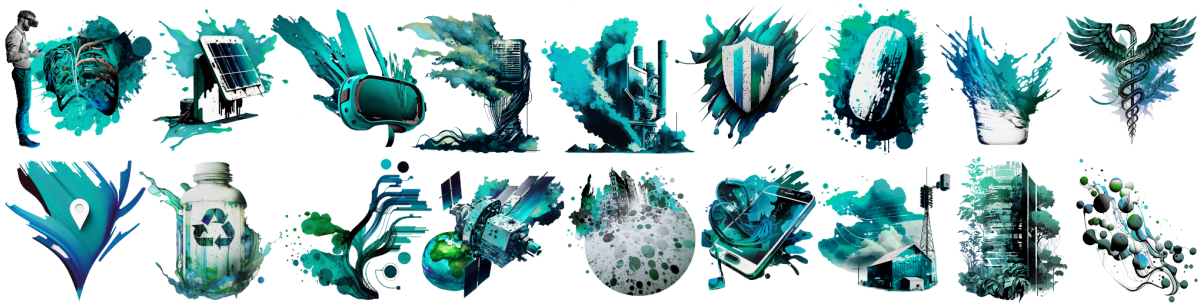

SKETCHES OF POTENTIAL EMERGING USE CASES FOR FRONTIER TECH IN DEVELOPMENT

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Scenario 1 • EdTech

Adaptive AI is closing the gender gap in developing countries

THE SCENARIO

It's 2030. AI's rapid ascent in education has birthed the concept of Learning Support Networks (LeSuNs), which blend dialogue-based tutoring with personalised learning. Think ChatGPT for learning that knows all about you and your learning needs.

As the earliest and best-funded players in the AI space, major cloud providers like Amazon and Google still dominate most AI computing, but cost-effective, privacy-centric open-source AI models are pulling ahead across the global south, built by a dedicated global community of philanthropic developers.

This democratisation of AI, supported by enhanced connectivity in rural areas, is revolutionising education globally. It's especially transformative for girls in developing regions, encouraging gender-responsive education and reducing skills gaps in STEM particularly.

Collective investments from the development community have fostered innovation and collaboration, making education across the global south more inclusive and equitable.

What does the data tell us about this scenario?

In 2019, there were 58.4 million children of primary school age not in school, 33.8 million of these children live in Sub-Saharan Africa, where populations are expected to double by 2050 (Our World in Data, 2021).

Access to education is especially challenging for girls. 63% of girls globally complete primary school (compared to 67% of boys), and only 21% of young women complete secondary school (compared to 26% of young men) (World Bank, 2022).

According to the 2020 Future of Jobs report, skill gaps are a key barrier to increasing employment within emerging in-demand roles, such as data analytics, process automation specialists, and information security analysts.

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The report notes that analytical thinking and innovation, active learning and learning strategies, and complex problem-solving are the top skills for 2025 (Future of Jobs report, 2020).

Personalised learning journeys could support people to build these core competencies and access emerging job markets.

What are the key risks that need to be mitigated in this scenario?

An over-reliance on AI as an educational tool may lead to students losing out on human interaction, that is essential to support learning and build social skills.

As such, students who are able to access both in-person and automated learning may have a more fulfilling education than students who only have access to automated learning tools.

EdTech companies would be able to gather a significant amount of data on young people, which, without proper protection, could lead to children being exploited for economic incentives.

If the cost of the core technologies remains high, then a digital divide may emerge between those who are able to pay and those who aren't. This could perpetuate existing inequalities.

What can development organisations do to realise the potential impact and mitigate the risks presented in this scenario?

Take advantage of the potential for AI to reduce barriers to the job market:
The potential learning models that could be developed with AI may allow people to access a wider range of jobs. The cost of completing a degree and its requirement for access to certain jobs can create a barrier to entering certain sectors in many parts of the world.

Through the use of AI, people can be equipped with skills and knowledge usually disseminated through a tailored university education at a much lower cost, enabling them to access new job markets.

By testing the potential of these solutions, development organisations could help build an evidence base to support partner countries to improve access to global job markets.

Horizon scanning to prepare for the future:
There is a tendency to get excited about the next big thing without a clear vision of what the future holds. Through the use of horizon scanning, development organisations can better predict the future and so can more proactively shape programming around upcoming developments and ensure that they are focused on cost-effective innovations that are likely to see sustained impact in the future of education.

More user research into key innovations:
The best way to understand the potential impact of technologies, and de-risk investments, is through user research. With technologies like AI, more research and due diligence are needed to determine whether it is more cost-effective than existing solutions before investing. This would allow development organisations to invest resources in developing AI systems that have proven impact and cost-effectiveness.

Use Big Data and AI to target resources efficiently:
Development organisations can leverage existing datasets of things like classroom conditions to support partner countries to allocate resources efficiently through the use of AI. AI could be used

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to model how climate change might affect classroom conditions to make proactive resource allocations to improve them.

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Scenario 2 • DemTech

Democracy is more transparent and participatory

THE SCENARIO

It's 2030. Governments across the world are using a range of technologies to operate with more transparency. This, coupled with the rise of tech-enabled citizen investigative journalism, puts pressure on governments to implement citizen-centric policies.

Blockchain helps to run secure voting systems, and Web3 tech enables a new kind of 'semi-liquid' democracy (read more on this at a16zcrypto), where digital identities enable cheap and quick referenda on a range of topics, which allows for regular community input into local and national government decision-making.

Machine learning helps predict the effects of complex policy-making, including with real-time data. But, accountability varies in AI-driven decisions, and some citizens are calling for more transparency and auditing of these processes.

Digital identities allow for better targeting of humanitarian aid across the world, but in other areas, they have given rise to a host of dangerous deep fakes.

What does the data tell us about this scenario?

According to the *Rest of World* classification, between 2016 and 2022, the number of democratic countries has fallen from 96 to 90, with a corresponding decrease from 3.9 to 2.3 billion people living in democracies (Our World in Data, 2022).

Without intervention now, we might see these trends continue.

What are the key risks that need to be mitigated in this scenario?

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Using social media data for sentiment analysis may allow false content to influence government decision-making - either through bad actors purposefully creating fake content for the sake of influence or models using fake content as a basis for decisions.

Similarly, e-petitions could be skewed by input from bots, allowing external actors to influence governmental decision-making.

Data-driven decision-making for complex public issues requires encoding values into the AI models analysing datasets. Whoever has the power to set which values the model should aim to maximise will have significant power over the recommendations output by the model.

There may be a lack of accountability if AI 'black-box' models guide government decision-making.

There is potentially an auditing issue, with AI models being fed the same prompt and producing different results each time. As such, some recommendations may not be recoverable, limiting the government's ability to demonstrate its decision-making process.

Digital identity infrastructure could be taken advantage of by autocratic states to monitor and control citizens' behaviour.

What can development organisations do to realise the potential impact and mitigate the risks presented in this scenario?

Addressing information scarcity:
In information-scarce environments, AI could be used to help people access information about different government policies and explain complex issues. This could help people across the world make more informed voting decisions.

A key issue here is neutrality. Development organisations can explore the complexity of building AI models that are capable of providing recommendations which aren't biased.

Development organisations can also begin to test public trust in these kinds of systems, to better understand how to build a model that the public would be willing to adopt.

Proactive humanitarian action through AI modelling:

Development organisations can use and gather data on various metrics affecting the stability of countries to identify where future security issues may arise and prepare for them.

By synthesising complex datasets, development organisations can identify key at-risk areas without having to invest in more manpower on the ground.

This will allow development organisations to cut through complexity and gain a better understanding of countries' security risks during peacetime before emergencies arise.

As humanitarian action becomes more proactive and security issues more complex, AI tools can be used to make effective long-term decisions based on evidence.

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Scenario 3 • AgriTech

Synthetic biology is revolutionising agriculture

THE SCENARIO

It's 2030. Regulations around gene editing have been relaxed for 4 years, and the use of the tech has surged. The agricultural benefits now extend beyond big agribusinesses and are impacting the work of smaller farmers across the world.

Gene-edited crops with directly enhanced DNA have been developed to withstand extreme conditions to mitigate the increasingly devastating effects of climate change. Partnerships between biologists and smallholder farmers have led to the dawn of a new age of self-sustained agriculture.

This has had a secondary benefit of reducing deforestation. Increased crop yields have meant that farmers now have less need to expand, and some biodiversity loss has actually been reversed.

Synthetic biology is complemented by other tech. Access to low-cost 3D printing, sensors, drones, and AI systems empowers farmers with monitoring soil, crop health, and precision application of pesticides and fertilisers, even in low-connectivity and resource-poor regions.

What does the data tell us about this scenario?

In 2021 the number of people affected by hunger was 848 million, an increase of 48 million from the previous year.

According to the Food and Agriculture Organization of the United Nations, 20-40% of crops are currently lost to disease, which corresponds to a $220 billion loss to the world economy (FAO, 2019).

What are the key risks that need to be mitigated in this scenario?

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Gene-edited crops outcompete and replace native plant species leading to the destabilisation of the local ecosystem.

A digital divide is created between farmers who have access to the technology and those that don't, leading to some communities being better placed to adapt to climate change than others. As such, unequal access to technology may perpetuate other inequalities.

Even if AI models are open source, other synthetic biology products may still be owned by big pharmaceutical companies who are only willing to share the technology at costs prohibiting access in poorer contexts.

Global companies and NGOs exploit Indigenous and local communities. Large-scale monoculture operations replace traditional farming practices, and value is extracted from local economies.

What can development organisations do to realise the potential impact and mitigate the risks presented in this scenario?

Tailor solutions to smallholder farmers:
Smallholder farmers are a prominent part of the agriculture system envisioned in this scenario. They face unique challenges which affect their ability to make use of innovations, such as a lack of capital to purchase technologies and competing demands from different stakeholders in the ecosystem.

Development organisations can play a role in balancing the different interests of stakeholders (from smallholder farmers to multinational agribusinesses) in the ecosystem to ensure fair prices and control over production. They can also help identify the best partners to support capacity-building initiatives that will allow farmers to improve innovation and allow them to tailor solutions to the needs of their context.

Regulation:
Effective regulation can encourage the proliferation of new and effective innovations while protecting people from the key risks that they present. This is especially important with the adaptation of food crops, where people's lives are directly at risk.

Development organisations can support regulation in a number of ways:

- Ensure that regulations are aligned between different countries to overcome challenges related to a fragmented regulatory ecosystem
- Showcase the positive impacts of innovation through rigorous research into the risks of specific technologies to present governments with a clear, evidence base to make decisions.
- Offer a model for and promote best practices for regulation within Agtech.

Knowledge Sharing:
As implementers generate evidence on what works within the sector, development organisations can gather and disseminate that evidence to relevant parts of the ecosystem, such as in the FCDO UK-India Smart Farm Club, where innovators share lessons learned and challenges within a Network of implementers. Development organisations can also share this information internally with relevant teams.

Development organisations can also focus on building a strong evidence base for different innovations, which can be showcased to a broader audience of other actors in the global development community to influence funding and decision-making.

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Manage the connection between agriculture and sustainability:
There's a complex relationship between the goals of improved food security and climate change. The agricultural intensification needed for more food often involves heavy use of fertiliser and pesticides, mass deforestation, increased water use, and food waste, all of which can contribute to increased levels of greenhouse gases and environmental degradation.

There needs to be more work done to manage trade-offs between the two goals. In an ideal world, farmers will be able to tap into multiple revenue streams and have a positive impact on both goals, e.g. by attaining climate credits through developing solar irrigation systems.

Development organisations could help build a taxonomy to prioritise each focus in different contexts to prevent slowing down the rollout of innovations which involve trade-offs.

Development organisations can also support innovators to access multiple revenue streams and remove barriers to doing so, such as costly verification processes in the carbon credit markets.

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Scenario 4 • MedTech

IoT advances are improving health outcomes

THE SCENARIO

It's 2030. Advancements in connected devices have transformed healthcare and improved health outcomes on a wider scale.

Pioneering hospitals remotely monitor patients using electrocardiogram (ECG) heart monitors and physiological sensors, whilst AI diagnostic tools automate patient screening.

Remote consultations and auto-personalised treatments benefit patients in inaccessible areas. And drones and UAVs efficiently manage medical supplies and delivery in these regions.

IoT similarly plays a pivotal role in disaster management, enabling emergency services to track personnel and deploy resources (people, medicines, food) effectively through geolocation and smart clothing with embedded sensors.

The rich data streams provided by these now-ubiquitous devices are instrumental in predicting and controlling infectious diseases through monitoring and accurate forecasting, improving humanitarian efforts.

What does the data tell us about this scenario?

According to WHO, in 2017, at least half of the world's population lacked access to healthcare, with 100 million people being pushed into extreme poverty from healthcare expenses. (WHO, 2017)

Over the past 20 years, life expectancy has increased by 6 years, from 66.8 to 73.4 years (WHO, 2022). Improvements in healthcare globally could ensure that all countries see an equitable share in improved healthcare delivery.

What are the key risks that need to be mitigated in this scenario?

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In the healthcare sector, the accountability issue with AI is particularly pronounced. If an AI model were to make life-or-death decisions, there would need to be a clear model of accountability for decisions which factor in machine reasoning and human error.

There is bias in almost all data that AI models are trained on; these biases could be perpetuated in the models' recommendations and would need to be accounted for. In addition to this, advice would need to be sufficiently tailored to local contexts to be useful for people in different communities.

Data generated from an increasingly ambient array of sensors would create an enormous amount of sensitive data, which would need to be sufficiently protected to prevent bad actors from using the data to manipulate people.

What can development organisations do to realise the potential impact and mitigate the risks presented in this scenario?

N/A

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Scenario 5 • GovTech

AI is speeding up government processes

THE SCENARIO

It's 2030. The hype has long since diminished, and AI has changed how governments run services and operations in many countries.

Large Language Models streamline tasks like compliance and document processing. They automate routine work, saving time and resources while empowering civil servants to focus on high-priority issues.

Generative AI enhances research and data analysis, helping governments understand constituents more deeply, and enhanced AI communication tools enable richer citizen engagement.

Public data security is fortified with AI cybersec that detects breaches swiftly and resolves them even faster.

It touches every aspect of government operations. Even maintenance, resource allocation and trade negotiations are optimised through predictive algorithms and shared datasets, improving international cooperation and boosting global GDP.

What does the data tell us about this scenario?

By 2020 around 15% of UK businesses had adopted at least one AI technology in their work, with the proportion expected to rise to 22% by 2025. (DCMS, 2020) Though it's important to note that this prediction was in a pre-ChatGPT world, so it may already be much higher.

Further, 68% of large companies have adopted AI technology into their work (Ibid). With a significant proportion of large organisations using AI to improve the efficiency of their work, development organisations will need to explore how these technologies could be implemented to ensure their systems are integrated with other departments or actors.

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What are the key risks that need to be mitigated in this scenario?

There are a range of risks relating to both accountability and auditing in this scenario.

Citizens who are affected by decisions guided by AI models will be reluctant to accept them without sufficient trust in the AI system. This could corrode public trust in government processes and the work of development organisations.

If civil servants or staff are not sufficiently trained to understand the limitations of AI systems, they may use them for tasks they are not designed for. Further, if they are using AI without sufficient training on the key risks present in AI systems, they may fail to mitigate those risks in their work.

What can development organisations do to realise the potential impact and mitigate the risks presented in this scenario?

Make use of existing datasets:
Development organisations often have extensive archives of data that could be drawn on to improve operational efficiency but given their size and geographical spread it is often a challenge to consolidate this information.

Through the use of emerging technologies, development organisations can focus on how to manage these barriers to allow employees or civil servants to better leverage the data they already have, such as by managing complex security issues.

Explore the potential to do things differently by leveraging emerging technology:
To stay competitive and manage emerging risks, development organisations must actively explore and test the use of emerging technologies to improve operations.

Address key questions around data governance and ownership:
If data is going to be leveraged to improve operational efficiency, key questions around its ownership and governance need to be addressed.
Without understanding who owns the data and its governance, there can be confusion over what data can and can't be shared without that owner's permission and how the data can be used. Exploration of these issues would provide staff with guardrails when using data in their work.

Explore inter-departmental data sharing and interoperability:
Within government departments or organisational hierarchies, it can be bureaucratic and complicated to share data between departments. To overcome some of these challenges, development organisations can begin to explore what data can be shared and work out ways of doing so which are efficient while maintaining the security of the data shared.

Address ethical questions about applying AI:
AI systems must be explainable. Given the need for public trust in government and organisational decisions, exploring ways to create AI systems

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that are explainable offers a way to establish accountability.

Users must be able to use the system. By sufficiently supporting staff to both understand and apply AI responsibly, development organisations can mitigate the risk of it being misapplied.

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Appendix • Full Scenarios

Scenario 1 • EdTech • Adaptive AI is closing the gender gap in developing countries

In the last seven years, the use of AI in learning environments has grown exponentially, fuelled both by the school closures following the COVID-19 pandemic and the Beijing Consensus on Artificial Intelligence and Education (UNESCO, 2019),

Student-facing innovations such as dialogue-based tutoring and personalised 'exploratory learning environments' have evolved and combined to drive high levels of investment and widespread adoption. These high-quality Learning Support Networks (or LeSuNs for short) benefit students and feed into broader learning management systems and delivery models that allow educational institutions and organisations to tap into valuable 'learning analytics'. While the ambition here is to develop a global data set that educators can tap into and learn from, concerns over student privacy and potentially invasive AI tools such as facial recognition means that things are progressing slowly.

While the largest cloud-service providers (Amazon, Microsoft and Google) dominate the 'back end' of AI - allowing developers to plug into the powerful computing power required to develop and train models - they have not succeeded in monopolising the most valuable part of the AI ecosystem. Instead, the open-source community has stayed one step ahead of the tech giants, with open-source models offering faster, more customisable and more privacy-focused solutions at a fraction of the cost. Right now, we are seeing companies like Google starting to embrace open-source collaboration in what seems to be an 'If you can't beat 'em...' strategy.

While the Open Source community's role in AI development has created wider access to knowledge and personalised learning for a much broader group of people, it would be impossible for these models to be fully introduced into rural communities in developing countries without improved connectivity and upgraded equipment. But significant investment in these critical enablers in recent years has paid off in multiple ways - not least in the widespread adoption of teaching practices that are more accessible to girls and women.

The injection of AI into learning environments has helped create more equitable and inclusive education systems, helping to power gender-responsive digital learning policies and programmes that are free of negative gender norms, as well as delivering accessible learning tools that are affordable, safe and secure. STEM education and digital skills development, in particular, have benefited from the removal of gender bias and stereotypes from learning materials.

Girls' completion rates for higher levels of schooling in both Sub-Saharan Africa and South Asia are now closer to those for primary schools (around 90%), and 55% of countries have achieved gender parity in primary education (up from 49% in 2023). We are also starting to see reversals in patterns around early marriage, young pregnancy and poverty as a result.

Without the introduction of AI into this environment, those public and private sector partnerships looking to match curriculums with the emerging needs of businesses would have struggled to reach their targets. With the economies of South Asia and Africa now supplying almost 60% of the world's new workers, the skills gap that has only widened in the past decade has become a huge challenge that educators, social entrepreneurs and progressive governments have come together to begin solving. This has created fertile

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ground for accelerated innovation in education and training, something which has been made far easier as affordable, accessible education opportunities for women and girls in developing countries have become the norm rather than the exception.

Scenario 2 • DemTech • Democracy is more transparent and participatory

Over the last 7 years, government attitudes, processes and powers have transformed as emerging technologies have been adopted with an openness that had never been seen before.

Open-source journalism is now standard newsroom practice thanks to the increase in publicly available data (and black data markets) that includes increasing amounts of transparent political records. This has put governments under increased pressure to listen to citizens and shape policies around their concerns. Many governments now use sentiment analysis across huge social media data sets to understand those concerns and create policies and programs to address them.

The accountability loop is closed through blockchain-enabled, secure, verifiable voting data, which aims to eliminate the idea of contested elections. The introduction of Web3 technologies into the voting system has also had implications outside of elections. The rise of a 'semi-liquid democracy' movement (a hybrid of direct and delegative voting systems) is slowly introducing decentralised decision-making processes into broader aspects of society while still retaining a level of governmental oversight. Sometimes referred to as 'e-petitions on steroids' these new forms of civic participation are allowing more and more people to be increasingly involved in forming the laws that govern them. At the same time, generative AI is being used more and more to communicate policies and deliver information to electorates in personalised and exploratory formats.

This increasingly complex and fast-moving democratic landscape has meant that governments are increasingly turning to machine learning in order to better predict and understand the ramifications of complex and far-reaching decisions, adopting a big data approach to policy making and planning. Predictive analysis has become a vital tool for governments around the world in the facilitation of such areas as disaster planning, asset management and urban planning. Millions of scenario simulations are undertaken every day around the world, fed by data such as consumer spending patterns, building occupancy, water levels, traffic flows, temperature changes etc.

In the most successful implementations, real-time, highly accurate data sets are used to inform impact evaluation studies and support key decisions on investing, budgeting and planning. In these instances, skilled and knowledgeable 'human agents' retain full moral and causal responsibility for the final actions based on the input of 'artificial agents'. In too many instances, though, complex organisational structures create a system of distributed responsibility, so any delegation to AI tools is executed without meaningful knowledge or control or the transparency and accountability necessary for successful auditing.

Decentralised voting systems and predictive policymaking have both been made possible by new digital identity schemes, which have had the additional benefit of allowing displaced individuals to verify their identities and access public services. With these new digital identities, direct financial support has become much more targeted, reducing overheads and corruption.

The rise in digital voting systems and AI-enabled policymaking has, almost inevitably, led to an increase in the number of DemTech Deepfakes to enable activities such as identity theft, the spread of state

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propaganda and election interference. This is being countered through the practice of embedding cryptographically-secured metadata into documents and images as a form of authenticity.

Longstanding privacy concerns mean that unique personal identifiers are not compulsory in the UK, as increasing numbers of people adopt tools such as 'digital wallets' into their daily lives, the convenience created by digital ID services and the levels of privacy, control and ownership afforded by these 'self-sovereign identity schemes' has made them increasingly attractive to a greater proportion of the population.

Scenario 3 • AgriTech • Synthetic biology is revolutionising agriculture

Over the last seven years, the relaxing of regulations surrounding gene-edited crops has allowed for a significant leap forward in the space. Genome-editing technologies are now widely accessible and relatively inexpensive to implement, and as a result, the democratisation of the benefits is becoming more and more prevalent.

The technology is being used to diversify agricultural systems and improve major and minor crops, including so-called 'orphan crops', which are typically not traded internationally but can play an important role in regional food security in LMICs. The widespread accessibility of genome-editing technologies has allowed UK biologists to partner with smallholder farmers to foster self-sustained, technologically empowered agriculture that improves agronomy and food and feed quality, as well as resistance to abiotic stresses such as extreme temperatures and drought.

Previously, with crops that were not adaptable to climate change, yields would decrease, and farms would be forced to expand in order to produce the same amount of food. This led to deforestation, plant biodiversity loss and the destruction of wildlife habitat destruction. This trend has now been largely reversed, a crucial achievement given that the world's population reached 8.5 billion in 2030 and is set to increase further to 9.7 billion in 2050, while 1.5 million hectares of land is rendered useless every year through land degradation and climate change.

Other emerging technologies have contributed to this revolution in agricultural practices. By utilising open-source, locally 3D-printed smart sensors and drones, farmers are able to monitor crop health and livestock conditions. On-site data processing is made possible by reduced semiconductor costs following the end of the 'chip wars' in 2026, while AI 'chatbots' that do not require an Internet connection have allowed communities in areas with low connectivity to access highly targeted information using nothing but their smartphones.

Artificial Intelligence is, of course, making its mark in this area too. The 'protein prediction revolution', powered by Google's (open source) AlphaFold, has matured to the point where it can help generate 'made-to-order' proteins, including those with functions not present in nature. Current estimates say that, by 2050, almost half of drugs will be 'computationally designed proteins', and many of these will have catalytic functions for use in agriculture, materials and food science.

AI-enabled 'precision agriculture' has also evolved significantly in the last decade, with 'farm manager' algorithms making recommendations on elements such as irrigation schedules, pest control and fertilisation requirements based on the specific needs of each plot of land. AI also helps farmers better

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negotiate for the best possible price for their harvests through more accurate crop price forecasting based on yield rates.

They also make additional income by selling their data to foreign aid organisations, which now contributes to preemptive humanitarian support models.

Scenario 4 • MedTech • IoT advances are improving health outcomes

It's 2030. The enhanced accuracy, sensitivity and intelligence of connected devices has not only revolutionised the healthcare sector, it has also allowed for the preservation of life on a much broader scale.

In 2030, hospitals are able to remotely monitor potentially vulnerable patients securely and in real time through the use of remote ECG/EEG monitors and wearable or ingestible physiological sensors. Remote, proactive, preventative interventions are now commonplace (increasingly supported by programmable, connected inhalators that are capable of monitoring dosage), freeing up beds and creating a better quality of life for patients.

Blockchain technology has enabled secure data storage, and affordable, specialised AI diagnostic tools, leading to the widespread use of automated patient screening systems in the health systems of developed countries. This has cut down on the number of highly trained personnel required on the 'front line' without the expense of large-scale cloud processing services.

Patients in remote areas who previously may have difficulty reaching healthcare facilities use video conferencing to communicate with their doctors, saving them money and time. The treatment they receive is individualised thanks to the availability of personal data, improving patient outcomes while saving healthcare management costs.

In 2022 it was reported that 56% of rural residents globally lack access to essential healthcare services. This number has been reduced to under 50% in under a decade thanks to the introduction of remote consultancies and smart devices.

The monitoring and maintenance of medical supplies and devices in these remote areas is also increasingly automated and predictive, reducing long-term costs and maximising machine uptime. While delivery of supplies and devices in hard-to-reach or hazardous environments is now almost entirely achieved through autonomous drone technology.

One effect of the acceptance and prevalence of personal connected devices (and the biological data they emit) has been the increasingly vital role that IoT has played in disaster management and emergency planning over the last seven years.

IoT-enabled disaster response procedures are now commonplace in disaster hotspots around the globe. Emergency services are able to monitor the movements of key personnel through sensors and IoT-enabled cameras, as well as gain greater situational awareness through smart clothing and bio-sensors that broadcast vital signs and on-scene conditions and allow for the judicial deployment of autonomous drones and vehicles.

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On an even broader scale, IoT and AI tech is being deployed in order to predict, prevent and control emerging infectious diseases. Monitoring and forecasting disease outbreaks is now a much more accurate science thanks to lower-cost, highly accurate IoT devices, and this has led to many more predictive and preventive strategies, as AI is able to more confidently identify vulnerable regions and communities and countries and to suggest effective mitigation steps.

Scenario 5 • GovTech • AI is speeding up government processes

By 2030, AI has become an integral tool for the efficient and effective delivery of government services as well as for addressing challenges and accelerating the pace of change in the public sector more broadly.

AI systems have not replaced humans. Instead, they have supplemented and streamlined existing systems by introducing the ability to hypothesise, model, simulate and refine with a speed and accuracy that was previously unimaginable. Confidence and momentum have been built through careful auditing and iterative adoption of machine learning in key areas, and this has accelerated the rate of digital transformation in government agencies and public bodies that complex legacy systems may have previously hamstrung.

Large Language Models (LLMs) have been most effective in improving departmental effectiveness and overall efficiency. Tasks such as routine analysis and document processing are now almost fully automated, creating time and cost efficiencies as well as freeing up skilled personnel to focus on high-priority, high-impact jobs. Training and education of civil servants has also been boosted by customised learning materials, while AI-assisted compliance tools help officials digest and understand complex regulations, while translation and live interpretation has greatly improved international and multilingual communication.

Generative AI underpins the automated research and data analysis that helps government departments better understand and meet the needs of their constituents, and public servants are also able to act on those signals through the use of AI-enhanced communications to build relevant, up-to-date comms strategies that keep citizens informed and engaged on the issues which matter most to them. Similarly, many public queries are now handled through smart automated systems capable of using machine learning to recognize data patterns that help distinguish helpful answers from unhelpful ones

At the same time, public data is more secure than ever, as AI tools detect and report on data breaches and other incidents, identify affected systems and trigger alerts to relevant stakeholders to resolve situations quickly and effectively.

Maintenance of vital infrastructure is increasingly prioritised through predictive algorithms, and the optimisation of budgets and resources at both local and national levels is optimised thanks to the availability of vast shared data sets that facilitate increasingly intelligent forecasting and scenario modelling.

As we move into the 2030s, we are starting to see AI-augmented negotiation platforms being used to facilitate complex trade deal negotiations by removing the risk of misinterpretation and accelerating the time it takes to achieve a mutually-beneficial outcome.

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Glossary

Scenario 1 • EdTech

- **Dialogue-based tutoring:** This is an approach to education where AI systems provide personalised learning through a two-way exchange between the student and an AI tutor.
- **Learning Support Networks**: A group of people who come together for collaborative learning facilitated by technology which provides resources, tools and assistance.
- **Open Source**: Software that the owner makes freely available for others to use, modify and redistribute.

Scenario 2 • DemTech

- **Web3:** This is a decentralised, peer-to-peer phase of the web designed to give users control over the data and content they share.
- **Direct and delegative voting systems:** A direct voting system is one where citizens vote directly on policy issues. In a delegative voting system, citizens delegate their votes to specific people who represent their interests.
- **Generative AI:** An artificial intelligence which is capable of generating content (text, images, videos, etc.)
- **Decentralised voting systems:** Blockchain can be used to record votes on an immutable ledger without the need for a central authority controlling the system.
- **Predictive policymaking:** The use of technologies such as machine learning and data analysis to forecast the potential impact of policies using existing data sets.
- **Digital identities:** A digital representation of an individual, which includes personal information, credentials and attributes.
- **Deep fakes:** Synthetic media which re-create people's likenesses, depicting them doing and saying things that they never did.
- **Cryptographically secured meta-data:** Meta-data is data that provides information about other data, such as its structure or provenance. By cryptographically securing this data, individuals can check that the information about the data hasn't been tampered with.
- **Unique personal identifiers (UPIs):** These are codes attributed to individuals that allow them to be identified across systems while maintaining their privacy.

Scenario 3 • AgriTech

- **Genome-editing:** A technique to insert, delete or substitute genes in an organism's DNA to improve specific traits.
- **'Orphan crops':** Potentially valuable crops which aren't widely available.
- **AlphaFold:** An AI system developed by DeepMind, that can be used to predict the functionality of different proteins.
- **Computationally designed proteins:** The design of novel proteins which have specific functions.
- **Precision agriculture:** A farm management system where farmers use sensors and data analytics to gather real-time data and use that information to optimise production.

Scenario 4 • MedTech

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- **ECG/EEG monitors:** These are systems used to measure and record the activity of the heart (ECG) and the brain (EEG).
- **Physiological sensors:** Sensors used to monitor physiological features (heart rate, blood pressure, oxygen levels, etc.) of the human body, which can be used for remote monitoring.
- **Automated patient screening system:** A system which uses data analysis and AI to assess a patient's medical records and predict the likelihood of them developing specific conditions.
- **Smart Clothing:** Clothing that includes sensors to monitor people's vitals; they can then transfer this information to hospitals, allowing doctors to monitor patients and flag any concerns remotely.
- **Biosensors**: Devices which use biological molecules to detect the presence of different chemicals in our body or the environment.

Scenario 5 • GovTech

- **Large Language Models (LLMs):** AI models capable of generating human-like text based on patterns learned from large datasets.

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