Growing pains: new methods of food production to feed the planet in an age of climate breakdown

Evolving climate and geopolitical crises will make it harder to produce food using conventional methods leading to new scientific developments in molecular biology and the engineering of food production

Authors: Sam Stephenson; Charlotte Guffick

Subjects: Political Science; Pharmacology

Depts: Engineering; Pharmacology

	Low — High
Impact	●●●●○
Likelihood	●●●●●
Controversy	●●●○○
Where	Global
When	5-10 years
How fast	Years

We are entering a world of compounding crises. The climate crisis intersects with domestic and international issues, directly and indirectly increasingly geo-political conflict. Climate related disasters are already negatively impacting crop yields (up to a 10% reduction in European crop yields is forecast for this year [(1)]) while global conflict affects supply chains causing food prices to increase (up 12% globally this year and over 70% in some developing countries [(2)]).

These intersecting trends, of increased global warming and global instability will produce major disruptions to global food supply. In light of this, we anticipate significant scientific developments (within the next 10 years) in the methods used to produce food synthetically, including breakthroughs in single cell protein production and novel ways of making carbohydrates; alongside technical advancements that allow for the continued production of food sources in areas impacted by the climate crisis, particularly in the global south.

Early indicators of a food crisis are already starting to emerge, seen in the war in Ukraine and its impact on global food staples, alongside combined heatwaves in Europe, North America, North Africa, the Middle East and Asia affecting crop yields. The impact of these emerging crisis, both independently and compounded are only expected to increase in the coming decades as we race to curb our emissions and find new food sources to feed a growing world.

Summary

Scenario

By 2030 crop yield failures are expected to be up to 4.5x higher and potentially 25x higher by 2050 due to warmer climates and water scarcity (3). The effects of compounding crises are under analysed (4) but increased conflict stemming from the climate crisis is likely to exacerbate these challenges (5).

The effects of these crises will be felt most acutely in the global south with rising food prices and failing crops both impacting the world's poorest communities the most. This will necessitate scientific and technological developments in both the creation of food by novel methods (i.e., cell free starch and single cell protein production) and the challenges of food production in the climate-affected global south (i.e., GMOs and drought resistant crops).

Drivers & Inhibitors

Drivers: the UN expects the global population to grow by 2 billion by 2050 and 170 million people enter the middle class every year increasing global protein and dairy consumption (6). Combined with reduced production of corn, wheat, rice and potatoes.

Inhibitors: Regulatory and political barriers (and lobbying) will slow the scalability of new food sources. Existing debates over the labelling of meat and dairy alternatives are likely to continue and grow (7).

Early indicators: Sudden spikes in food prices; mass crop failure; anticipatory regulatory changes.

Advancements in Molecular biology

Approaches to advance and innovate protein, sugar and fat production have been demonstrated at the laboratory and low industrial scale e.g. production of starch from CO_2 through cell-free enzyme reactions (8,9); and the introduction of drought resistant genes to test plants to improve survival (10); We anticipate advancements in efficient DNA delivery methods (e.g. nanoparticles and microfluidics) (11), growth environments (e.g. bioreactors and feedstocks) for single cell protein production (12) and enzyme engineering for improved biocatalysts (13) for the required industrial scale yields.

Advancements in Engineering

The requirement for scalable technology in the global south will drive cost-effective development eliminating bottlenecks and increasing the rate of global viability; as has been seen in brewing and cellular therapy industries. We expect the rapid scaling of high-throughput platforms for molecular biology e.g. plant phenotyping, from academia to industry over the next 10 years and improvements to enzyme efficiency in the production of complex carbohydrates which can learn from machine learning to increase enzyme activity (14).

References

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