Nanotech and AI could hold key to unlocking global food security challenge
24 June 2021

"Precision agriculture' where farmers respond in real time to changes in crop growth using nanotechnology and artificial intelligence (AI) could offer a practical solution to the challenges threatening global food security, a new study reveals.

Climate change, increasing populations, competing demands on land for production of biofuels and declining soil quality mean it is becoming increasingly difficult to feed the world's populations.

The United Nations (UN) estimates that 840 million people will be affected by hunger by 2030, but researchers have developed a roadmap combining smart and nano-enabled agriculture with AI and machine learning capabilities that could help to reduce this number.

Publishing their findings today in Nature Plants, an international team of researchers led by the University of Birmingham sets out the following steps needed to use AI to harness the power of nanomaterials safely, sustainably and responsibly:

- Understand the long-term fate of nanomaterials in agricultural environments—how nanomaterials can interact with roots, leaves and soil;
- Assess the long-term life cycle impact of nanomaterials in the agricultural ecosystem such as how how repeated application of nanomaterials will affect soils;
- Take a systems-level approach to nano-enabled agriculture—use existing data on soil quality, crop yield and nutrient-use efficiency (NUE) to predict how nanomaterials will behave in the environment; and
- Use AI and machine learning to identify key properties that will control the behavior of nanomaterials in agricultural settings.

Study co-author Iseult Lynch, Professor of Environmental Nanosciences at the University of Birmingham, commented: "Current estimates show nearly 690 million people are hungry—almost nine percent of the planet's population. Finding sustainable agricultural solutions to this problem requires us to take bold new approaches and integrate knowledge from diverse fields, such as materials science and informatics.

"Precision agriculture, using nanotechnology and artificial intelligence, offers exciting opportunities for sustainable food production. We can link existing models for nutrient cycling and crop productivity with nanoinformatics approaches to help both crops and soil perform better—safely, sustainably and responsibly."

The main driver for innovation in agritech is the need to feed the increasing global population with a decreasing agricultural land area, whilst conserving soil health and protecting environmental quality.

Intensification of agriculture has resulted in extremely poor global NUE, which poses a serious threat to environmental quality as large amounts of...
nutrients are lost to water and air—warming the
planet, with nearly 11% of global greenhouse gas
emissions coming from agriculture.

Of particular concern is the emission of the
'laughing gas' nitrous oxide as a result of excessive
nitrogen fertilization of land, which is 300 times
more potent than carbon dioxide in inducing global
warming. Some 70% of the anthropogenic source
nitrous oxide emissions into air are contributed from
the agricultural sector.

Nano fertilizers offers the potential to target crop
fertility, enhance NUE and reduce nitrous oxide
emission, which can thus help support the net zero
greenhouse gas emission by 2050 targets under
the UK Climate Change Act.

The research team, which includes experts from
the Hellenic Military Academy, in Vari, Greece and
Novamechanics Ltd, in Nicosia, Cyprus, note that
nanotechnology offers great potential to enhance
agriculture in four key ways:

- Improving production rates and crop yields;
- Boosting soil health and plant resilience;
- Improving the efficiency of resources, such
  as fertilizer, and reducing pollution; and
- Developing smart sensor plants that can
  alert farmers to environmental stresses.

Co-author Dr. Peng Zhang, a Marie Sklodowska-
Curie Research Fellow at the University of
Birmingham, commented: "Computational
approaches including AI and machine learning will
have a critical role in driving the progress of nano-
enabled agriculture. Such approaches are already
starting to gain regulatory acceptance for safety
assessment of nanomaterials, allowing the
development of safe-by-design nanomaterials for
consumer products and medicine.

"Integrating AI and nanotechnology into precision
agriculture will play a vital role in probing the design
parameters of nanomaterials for use in fertilizer and
pesticide delivery to ensure minimal impacts on soil
health coupled with minimal nanomaterial residues
remaining in the edible tissue portions—helping to
ensure safe and sustainable agriculture."

More information: Nanotechnology and artificial
intelligence to enable sustainable and precision
agriculture, Nature Plants (2021). DOI:
10.1038/s41477-021-00946-6,
www.nature.com/articles/s41477-021-00946-6

Provided by University of Birmingham