

# AGRICULTURAL AND NATURAL MANUFACTURING TECHNO



The near future of technology promises change at an ever-increasing pace while rapidly transforming business models, governments and institutions worldwide. In order to help us make sense of our uncertain future, Policy Horizons Canada engaged Michell Zappa of Envisioning Technology to explore key technologies that are likely to have a profound effect on humanity on a global level and generational timeframe. This report is structured around six key areas of technological research: digital and communications, neuro and cognitive, health, agricultural and natural manufacturing, nano and material science, and finally energy. It provides a sense of how broad and far-reaching our future technologies might be. Digital currencies, hydrogen energy storage, brain-to-brain interfaces, and robotic farms are all likely to be common before 2030. Each of the six key areas indicates the dozen or so interdependent technologies that are most likely to have a high impact on society and the economy. The six images provide the reader with maps of how the technologies portrayed in each area are likely to mature over the next 15 years; that is, our best estimate of the point at which a technology matures so that it can be used.

Agricultural and natural manufacturing technologies are the focus of the diagram below. It identifies four key areas of accelerating change: Sensors, Food, Automation and Engineering, Sensors help agriculture by enabling real-time traceability and diagnosis of crop, livestock and farm machine states. Food may benefit directly from genetic tailoring and potentially from producing meat directly in a lab. Automation will help agriculture via large-scale robotic and microrobots to check and maintain crops at the plant level. Engineering involves technologies that extend the reach of agriculture to new means, new places and new areas of the economy. Of particular interest will be synthetic biology, which allows efficiently reprogramming unicellular life to make fuels, bioproducts accessible from organic chemistry and smart devices.









## FOOD

### Infrastructural health sensors

Can be used for monitoring vibrations and material conditions in buildings, bridges, factories, farms and other infrastructure. Coupled with an intelligent network, such sensors could feed crucial information back to maintenance crews or robots.

## In vitro meat

Also known as cultured meat or tubesteak, it is a flesh product that has never been part of a complete, living animal. Several current research projects are growing in vitro meat experimentally, although no meat has yet been produced for public consumption.

## Genetically desianed food

The creation of entitlely new strains of food animals and plants in order to better address biological and physiological needs. A departure from genetically modified food, genetically designed food would be engineered from the ground up.

Collars with GPS, RFID and biometrics can automatically identify and relay vital informa-tion about the livestock in real time.

#### Crop sensors

Instead of prescribing field fertilization before application, high-resolution crop sensors inform application equipment of correct amounts needed. Optical sensors or drones are able to identify crop health across the field (for example, by using infra-red light).

### **Equipment telematics**

Allows mechanical devices such as tractors to warn mechanics that a failure is likely to occur soon. Intra-tractor communication can be used as a rudimentary "farm swarm" platform.

Fundamental additions to the automated farm, these sensors would enable a real time understanding of current farm, forest or body of water conditions.

#### Robotic farm swarms

**AUTOMATION** 

The hypothetical combination of dozens or hundreds of agricultural robots with thousands of microscopic sensors, which together would monitor, predict, cultivate and extract crops from the land with practically no human intervention. Small-scale implementations are already on the horizon.

#### Precision agriculture

Farming management based on observing (and responding to) intra-field variations. With satellite imagery and advanced sensors, farmers can optimize returns on inputs while preserving resources at ever larger scales. Further understanding of crop variability, geolocated weather data and precise sensors should allow improved automated decision-making and complementary planting techniques.

#### Agricultural robots /

Also known as agbots, these are used to automate agricultura usea to dutomate agricultura processes, such as harvesting, fruit picking, ploughing, soil mainte-nance, weeding, planting, irrigation, etc.

#### Rapid iteration selective breeding

The next generation of selective breeding where the end-result is analyzed quantitatively and improvements are suggested algorithmically.

#### Variable rate swath control

Building on existing geolocation technologies, future swath control could save on seed, minerals, fertilizer and herbicides by reducing overlapping inputs. By pre-computing the shape of the field where the inputs are to be used, and by understanding the relative productivity of different areas of the field, tractors or agbots can procedurally apply inputs at variable rates throughout the field.

## ENGINEERING

#### Vertical farming

A natural extension of urban agriculture, vertical farms would cultivate plant or animal life within dedicated or mixed-use skyscrapers in urban settings. Using techniques similar to glass houses, vertical farms could augment natural light using energy-efficient lighting. The advantages are numerous, including year-round crop production, protection from weather, support urban food autonomy and reduced transport costs.

#### Synthetic biology

Synthetic biology is about programming biolog Synthetic biology is about programming biolog using standardized parts as one programs computers using standardized libraries today. Includes the broad redefinition and expansion of biotechnology, with the ultimate goals of being able to design, build and remediate engineered biological systems that process information, manipulate chemicals, fabricate materials and structures, produce program would food and maintain and applications. energy, provide food, and maintain and enhance human health and the environment

#### **Closed ecological systems**

Ecosystems that do not rely on matter exchang outside the system. Such closed ecosystems would theoretically transform waste products into oxygen, food and water in order to support life-forms inhabiting the system. Such systems already exist in small scales, but existing technological limitations prevent them from scaling.

**NEUROTECHNOLOGY** AND **COGNITIVE TECHNOLOGIES** 

#### AGRICULTURAL AND NATURAL MANUFACTURING **TECHNOLOGIES** is one segment

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Government of Canada Policy Horizons Canada

Best estimate of technology maturation

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Gouvernement Horizons de politiques

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