**Reply :**Re: Zero Hunger - Food security, nutrition, agriculture
**From :** [redacted]
**Date :** 20-Jan-2018 10:59 PM

Grp 2 Member A

How can we harness Earth's microbiomes to achieve "zero hunger"?

Zero Hunger

- Sufficient food supply
- Sufficient nutrients

How?

- Synthetic biology:
  - o Genetically engineering microbes; Man-made micro-organisms

Synthetic biology – Food producing microbes

- Capable of producing nutritional compounds/supplements
  - o Comparing to synthetic methods – safer, less waste/toxic by-product
  - o Lower cost of production? Higher yield?
- Personalise diet
  - o Every individuals will have specific diets/nutritional demands specially cater for them
  - o Optimising nutrient consumption
- Food producing microbes
  - o Synthetic proteins; lab-grown foods

Synthetic biology – Agricultural microbes

- Microbes that secrete chemicals to increase growth/yield
  - o Eg. plant hormones
  - o Probiotics for plants
- Microbes that protect plants from pests/diseases
  - o Cross-talking with existing plant microbiome to improve their health
  - o Bio-pesticides? To help kill pests? Kill weeds?
    - § Able to use less chemical pesticides/herbicides

Synthetic biology – Livestock farming microbes

§ Probiotics for animals

o Improve health; less disease prone; disease free

**Topic :**Roles of microbiome in food sustainability
**From :** [redacted]
**Date :** 16-Jan-2018 01:24 AM

Grp 2 Member B

I picked up several ways in which microbiomes may have a role in working towards "Zero Hunger":

**1) Improving land fertility by nitrogen fixation thereby improving agricultural yield:**

Generally, there are about 50 billion microbes in one spoonful of soil. The microorganisms' primary role is to break down organic matter to obtain energy. Microorganisms help release essential nutrients and carbon dioxide and perform key roles in nitrogen fixation, the nitrogen and phosphorus cycles, denitrification, immobilization, and mineralization. Microbes must have a constant supply of organic matter, or their numbers will decline. Conditions that favor soil life also promote plant growth.

- Immobilization (assimilation) – uptake of inorganic-N from soil and incorporation into organic-N compounds in microbes (N becomes unavailable to plants)
- N-Fixation – conversion of N-gas in the air to organic-N that becomes available to plants (performed by bacteria associated with roots of legumes and other plants, and some free-living soil microbes

**2) Improving crops' uptake of crucial nutrients from soil hence its eventual quality and nutritional value:**

Three mechanisms are usually put forward to explain how microbial activity can boost plant growth: (1) manipulating the hormonal signaling of plants; (2) repelling or outcompeting pathogenic microbial strains; and (3) increasing the bioavailability of soil-borne nutrients.

In natural ecosystems, most nutrients such as N, P, and S are bound in organic molecules and are therefore minimally bioavailable for plants. To access these nutrients, plants are dependent on the growth of soil microbes such as bacteria and fungi, which possess the metabolic machinery to depolymerize and mineralize organic forms of N, P, and S. The contents of these microbial cells are subsequently released, either through turnover and cell lysis, or via protozoic predation. This liberates inorganic N, P, and S forms into the soil, including ionic species such as ammonium, nitrate, phosphate, and sulfate that are the preferred nutrient forms for plants.

Also, providing agriculture systems with macronutrients through the application of mineral fertilizers is an unsustainable fertilization practices due to rapidly diminishing phosphate rocks and the greatly energy-intersive Haber– Bosch process. One possibility is to replace mineral fertilizers by organic inputs, and to supplement plants with specific root-associated microbes that are able to break the organic matters down. Since organic inputs are comparatively much more sustainable than mineral fertilizers (due to myriad agricultural, industrial and municipal processes producing huge volumes of nutrient-rich "waste"). Another factor is that organically bound nutrients are more stable in the soil compared to mineral fertilizers, and therefore less prone to leaching and volatilization.

**3) Microorganisms may aid in reducing susceptibility of crops to diseases and pathogens thereby increasing overall yield:**

A number of soil factors and management practices affect root growth, distribution, and health. Cultural practices that promote soil biodiversity help maintain healthy root systems, because an active and diverse microbial population competes with root pathogens and can reduce root disease. Research into soil microbiota has shown how some species can enhance plant defences against infection. However, other species can cause problems. For instance, Rothamsted Research found one strain of bacteria that removed nitrogen from the soil. This depleted the nutrients needed for plant growth and created greenhouse gases.

Examples:
*Trichoderma* spp.: These species are attributed to a variety of physiological, antifungal and insecticidal effects. It acts against a broad spectrum of plant pathogens. These fungi increase plant growth and development, but also development of root system. It has also been observed that selected *Trichoderma* strains can improve plant nutrients' uptake. Increased growth occurs due to its strong anti-pathogenic activity, biosynthesis of hormones, improving nutrient uptake from the soil, root development by increasing metabolism rate of carbohydrates and increased photosynthesis.

*B. amyloliquefaciens* is gram-positive,aerobic, and endospore-forming bacteria, beneficial agents for plant growth promotion and suppression of soil-borne diseases in agriculture. *B. amyloliquefaciens*produces many metabolites such as e.g. enzymes, and many types of antibiotics, which inhibit growth of fungal pathogens.

**4) Improve individual's microbiota hence their ability to absorb nutrients more efficiently from the food consumed:**

Billions of friendly bacteria are living in our digestive tract, the most commonly commercialised ones include *Lactobacillus* and *Bifidobacterium*. In our gut, good bacteria can displace bad bacteria and influence our overall health, metabolism, digestion, and body composition. Gut bacteria also help to synthesize Vitamins B and K and enhance digestion and nutrient absorption while controlling the growth of other pathogens

The stomach and proximal small intestine are responsible for most nutrient digestion and absorption in humans. In an healthy individual, the indigestible carbohydrates and proteins that the colon receives represent from 10%–30% of the total ingested energy. Without the activity of the colonic microbiota, these nutrients would generally been eliminated as stool without further absorption because the human large intestine has limited digestive capability. Hence, modifying the gut microbiota may be one of the possible strategies to counter undernutrition.

**Reply :** Re: PLACEMAT DIAGRAM
**From :** [redacted]
**Date :** 21-Jan-2018 10:12 AM
[redacted]

**Grp 2 Member C**

A. **Need for a global microbiome effort via standardize interdisciplinary administration**[1]
- **Resolving global hunger requires multidisciplinary collaborative groups with a standardize administrative framework**
  - Holistic understanding of the role of Earth's microbiome
  - Common goal: Using Earth's microbiome to resolve global hunger
- **Unified Microbiome Initiative (UMI) and International Microbiome Initiative (IMI)**
  - Collaborative effort among top scientists from public and private agencies and foundations to research and develop technical solutions
  - Develop a framework that standardize the sharing of technical expertise, research information and funding across borders and disciplines
  - Bring cohesion to the multitude of microbiome initiatives
- **Rationale behind the UMI and possible IMI effort**
  - Overcoming disciplinary silos – Individual compartmentalization of scientific information within the discipline field.
    - Fragmentation of life-sciences field
    - Lack of coordination efforts among various microbiome research endeavours
    - Current global initiatives generate vast amount of data that are not easily comparable and lack consistency in methodologies to comprehend.
- **Some possible ways:**
  - Develop an organization - Monitor developments and implement guidelines for the study of microbiomes.
    - The established standards ➔ Facilitate data sharing, analysis of crucial data and intellectual property.
  - Prioritize and develop unified research agenda
    - The goal of enabling comparative analyses that starts from local geographically areas to global scales worldwide.
  - Develop new research tools and methodologies
    - Facilitate and identify new cross-disciplinary ways for microbiome studies.
    - In-depth access to the availability of research data and chart possible new directions, which can be a potential solution in the future.
  - Establish platforms for proper discussion and exchange of research information within and between countries.
  - Conferences and research seminary meetings
  - Development scholarly programmes
    - Training the next generation of microbiome researchers, and the establishment of outreach projects to educate and engage the general public.