RECENT ADVANCES IN AGRICULTURE

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INTRODUCTION

- Most challenging task for agricultural sciences today is to ensure for continuous and enough supply of food to growing human civilization.

- Increase in the productivity of agriculture by employing techniques of conventional (20th century) agriculture is posing a limitation.

- According to the estimates of UN population projection,
  - world population could reach 9.15 billion by 2050, thus the expected rate of increase in world population will be 2.25 percent over the next forty years [1] and thus provides for a potentially huge market for food grains and food production needs to be doubled to meet this demand.
  - It is projected that to feed the global population by 2050 require 70 percent increase in global food production with food production from developing countries needs to be doubled [2].

[1]: Alexandratos N, Bruinsma J (2012) World agriculture towards 2030/2050: the 2012 revision. ESA working paper No. 12-03. Rome, FAO.

[2]:http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

CONTD…

- Therefore, new innovations in agriculture are inevitably needed and these innovations should be integrated with the main stream agriculture (the big agriculture as we may call).
- Recent trend in agriculture has seen rise in vertical farming and G.M.O crops to accommodate the demands of increasing world population and address the rising concern for environmental issues.
  - Vertical farming shall help in meeting the food & other demands of the rapidly growing urban population.
  - On the other hand, genetic engineering in agriculture, increases crop yields, reduces costs for food or drug production, reduces need for pesticides, enhanced nutrient composition and food quality, resistance to pests and disease, greater food security, and medical benefits to the world's growing population.
  - Advances have also been made in developing crops that mature faster and tolerate aluminum, boron, salt, drought, frost, and other environmental stressors, allowing plants to grow in conditions where they might not otherwise flourish

VERTICAL FARMING

- Vertical farming is cultivating plant life within a skyscraper greenhouse, used warehouse, or shipping container or on vertically inclined surface.
- The modern ideas of vertical farming use indoor farming techniques and controlled-environment agriculture (CEA) technology, where all environmental factors can be controlled.
  - These facilities utilize artificial control of light, environmental control (humidity, temperature, gases...) and fertigation. Some vertical farms use techniques similar to greenhouses, where natural sunlight can be augmented with artificial lighting and metal reflectors.

HISTORY

- Vertical farming is not a new idea. Indigenous people in South America have long used vertically layered food growing techniques, and the rice terraces of East Asia follow a similar principle.
- One of the earliest drawings of a tall building that cultivates food for the purposes of consumption was published as early as Life Magazine 1909.
- This proposal can be seen in Rem Koolhaas's Delirious New York. Koolhaas wrote that this 1909 theorem is

“'The Skyscraper as Utopian device for the production of unlimited numbers of virgin sites on a metropolitan location' (1994, 82).”

CONTD…

- **1915 -** American geologist Gilbert Ellis Bailey coined the term “vertical farming” in his book, “Vertical Farming,”
- **1937 -** In a scientific journal article, William Frederick Gericke coined the term “hydroponics,”
- **1975 –** Allan Cooperman introduced the nutrient film technique
- **1989 –** Architect Kenneth Yeang envisioned mixed-use buildings, known as vegetated architecture
- **1999 –** American ecologist Dr. Dickson Despommier reinvented vertical farming, as it emerged at Columbia University.

CONTD…

By 2001 the first outline of a vertical farm was introduced and today scientists, architects, and investors worldwide are working together to make the concept of vertical farming a reality.

- **2009 –** Sky Green Farms built a vertical farm which is the the world's first water-driven, tropical vegetable urban vertical farm consisting of over 100 nine-meter tall towers in Singapore
- **2011 –** Dutch agricultural company, PlantLab uses red and blue LEDs instead of sunlight in their vertical farms.
- **2012 –** Farmed Here, a sustainable indoor vertical farming facility opened in a 90,000 square foot post-industrial building in Bedford Park, IL.
- **2012 –** Local Garden, North America's first ever VertiCrop farm, was constructed in Vancouver, Canada

Types

- Mixed-use skyscrapers

- Despommier skyscrapers

MIXED-USE SKYSCRAPERS

- It was proposed and built by architect Ken Yeang.
- He proposes that instead of hermetically sealed mass-produced agriculture that plant life should be cultivated within open air, mixed-use skyscrapers for climate control and consumption

DESPOMMIER SKYSCRAPERS

- Despommier proposed that plant life is mass produced within hermetically sealed, artificial environments that have little to do with the outside world. In this sense, they could be built anywhere regardless of the context.
- Despommier's concept of "The Vertical Farm" emerged in 1999 at Columbia University.

Skyscraper farming

A futuristic concept converts skyscrapers into crop farms that could help reduce global warming, improve the urban environment, and help feed the world's growing population. How it would work:

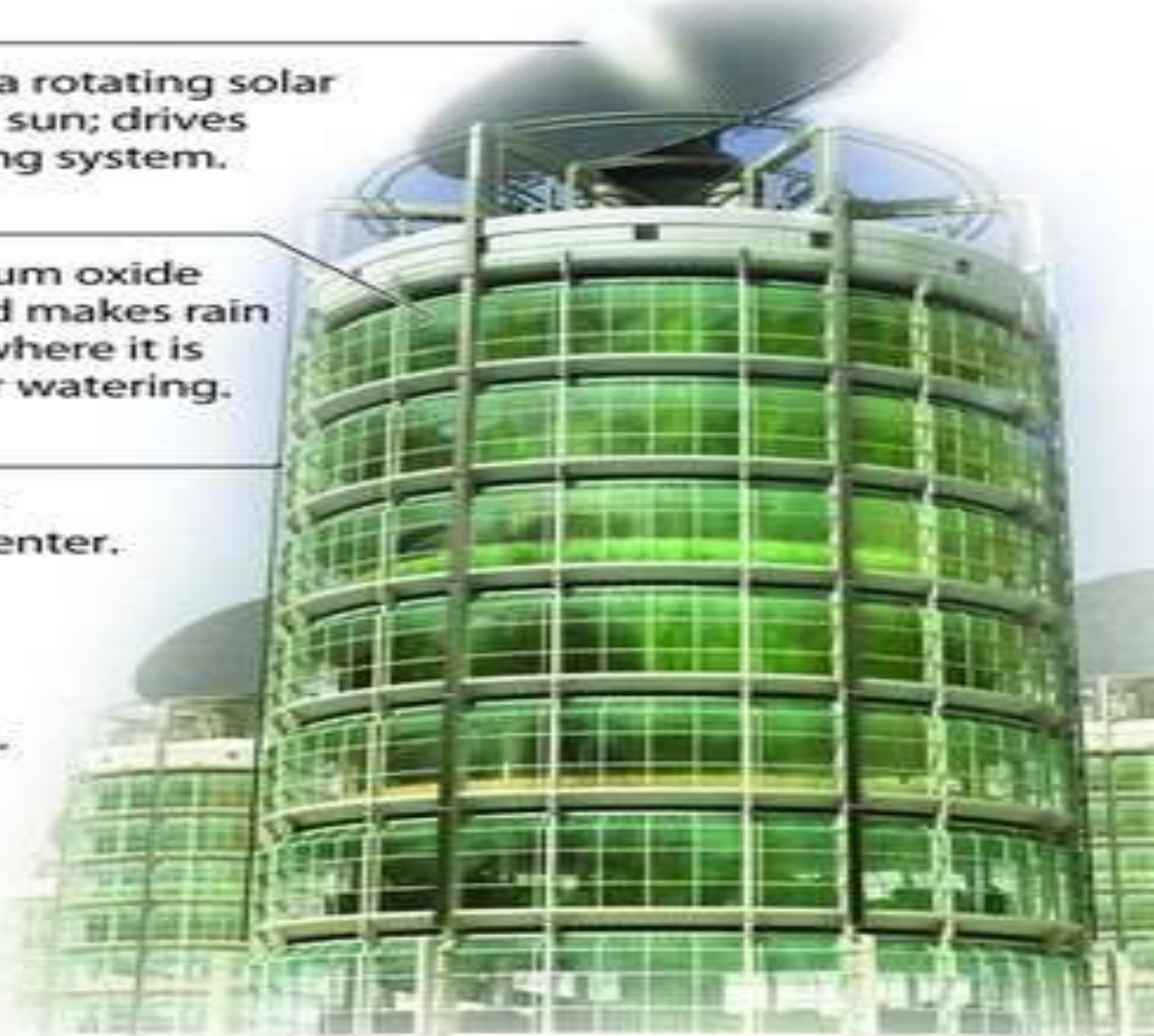
SOLAR PANEL
Energy is supplied by a rotating solar panel that follows the sun; drives interior cooling/heating system.

GLASS PANELS
Clear coating of titanium oxide collects pollutants and makes rain slide down the glass where it is collected and used for watering.

ARCHITECTURE
Circular design allows maximum light into center.

ECONOMY
The plan combines farming with office and residential stories.

IRRIGATION
Filtered, sterilized wastewater from sewage system can be used for irrigation.



TECHNOLOGIES AND DEVICES

- Greenhouse
- The Folkewall and other vertical growing architectures
- Flowerpot
- Aeroponics / Hydroponics / Aquaponics
- Composting
- Grow light
- Phytoremediation
- Skyscraper
- Controlled-environment agriculture
- Precision agriculture
- Agricultural robot

GREENHOUSE

- A greenhouse (also called a glasshouse, or, if with sufficient heating, a hothouse) is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown.

FOLKEWALL

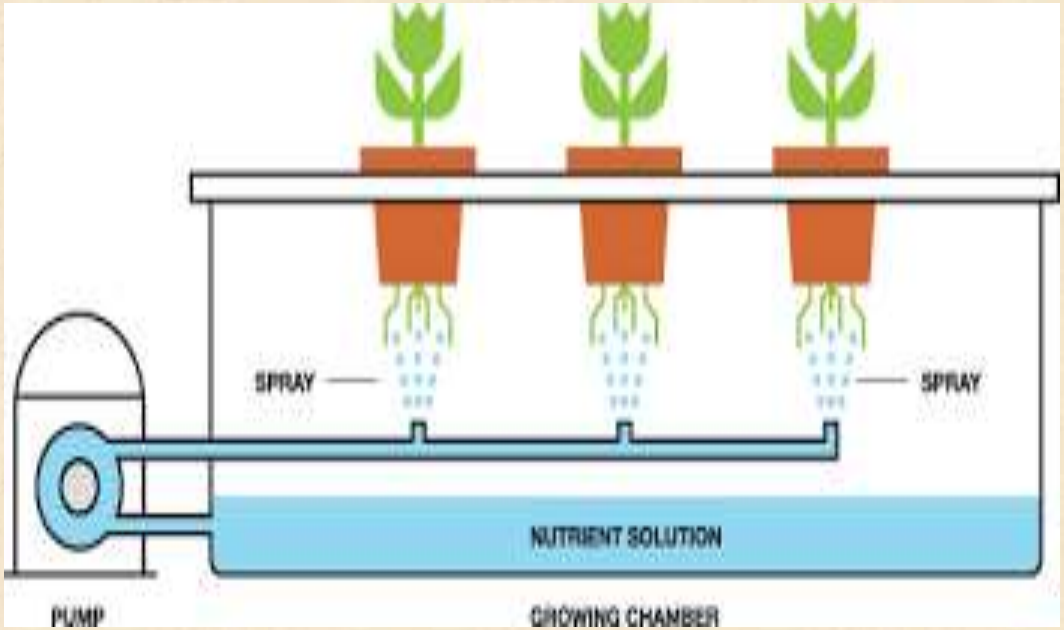
- The Folkewall is a construction with the dual functions of growing plants and purifying waste water. It was designed by Folke Gunther in Sweden.

Flowerpot

- A flowerpot, flower pot, or plant pot is a container in which flowers and other plants are cultivated and displayed

AEROPONICS

- Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium (known as geoponics)

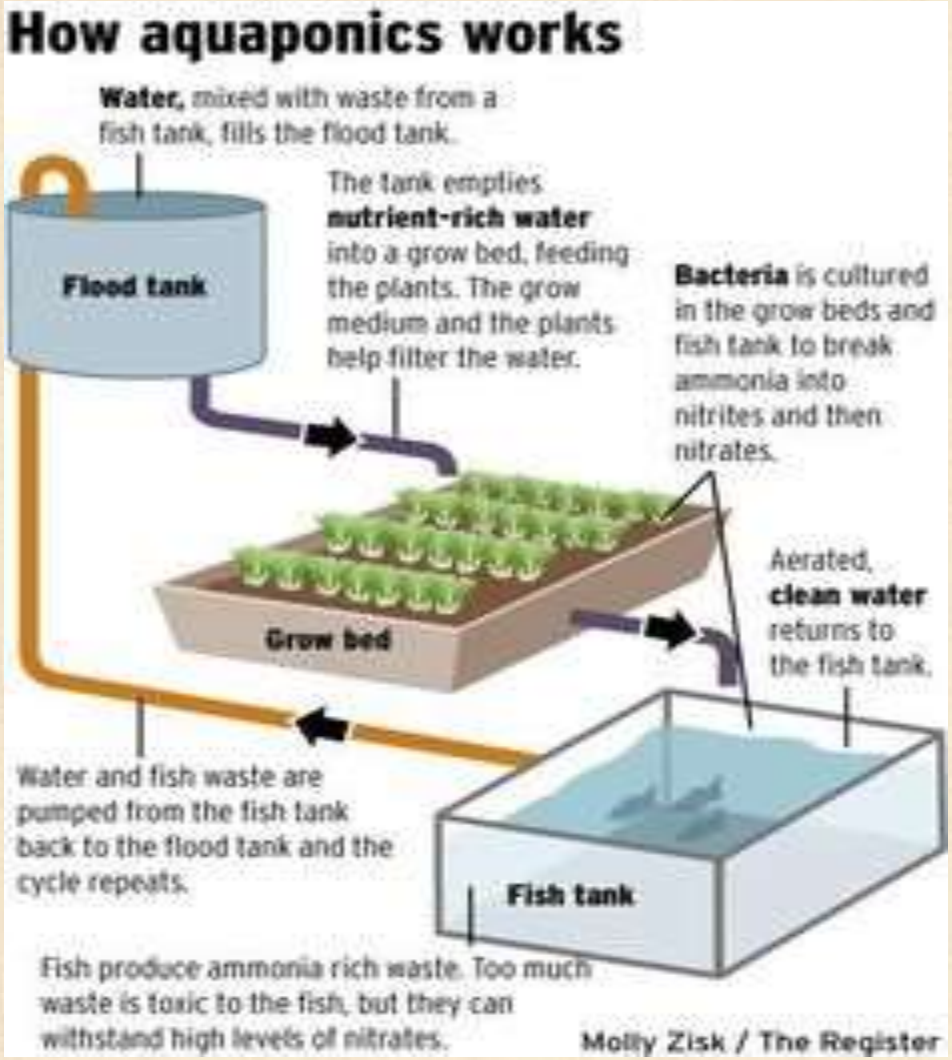


HYDROPONICS

- Hydroponics is a subset of hydroculture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent.
- Terrestrial plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel.
- The nutrients in hydroponics can be from fish waste, duck manure, or normal nutrients.

AQUAPONICS

- Aquaponics refers to any system that combines conventional aquaculture (raising aquatic animals such as snails, fish, crayfish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment.



COMPOSTING & GROW LIGHT

- Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment.
- A grow light or plant light is an artificial light source, generally an electric light, designed to stimulate plant growth by emitting an electromagnetic spectrum appropriate for photosynthesis.

PHYTOREMEDIATION & SKYSCRAPER

- Phytoremediation (from Ancient Greek (phyto), meaning 'plant', and Latin remedium, meaning 'restoring balance') refers to the technologies that use living plants to clean up soil, air, and water contaminated with hazardous chemicals.

- A skyscraper is a tall, continuously habitable building having multiple floors of vertical farm. It is the structure where will be the farm set up.

CONTROLLED-ENVIRONMENT AGRICULTURE

- Controlled-environment agriculture (CEA) is a technology-based approach toward food production.
- The aim of CEA is to provide protection and maintain optimal growing conditions throughout the development of the crop.
- Production takes place within an enclosed growing structure such as a greenhouse or building.
- Plants are often grown using hydroponic methods in order to supply the proper amounts of water and nutrients to the root zone.
- CEA optimizes the use of resources such as water, energy, space, capital and labour.

PRECISION AGRICULTURE

- Precision agriculture (PA) or satellite farming or site specific crop management (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops.
- The goal of precision agriculture research is to define a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources.

AGRICULTURAL ROBOTS

- Agricultural robots or agbot is a robot deployed for agricultural purposes. The main area of application of robots in agriculture today is at the harvesting stage. A possible emerging application of robots or drones is for weed control.
- Fruit picking robots, driverless tractor / sprayer, and sheep shearing robots are designed to replace human labor

ADVANTAGES OF VERTICAL FARMING

- Increase in production and availability in crops
- Production of organic crops
- Conservation and recycling of natural resources
- Environment friendly
- Sustainable urban growth

KEY ISSUES CHALLENGING THE ADOPTION OF VERTICAL FARMING

- Uniform practices cannot be adopted for vertical farming
- Lack of crop varieties suitable for the vertical farming.
- Lack of knowledge and skills required for farming practices in urban populations.

GM CROPS

- In agriculture, genetically engineered crops are created to possess several desirable traits, such as resistance to pests, herbicides, or harsh environmental conditions, improved product shelf life, increased nutritional value, or production of valuable goods such as drugs (pharming).
- Plants, including algae, jatropha, maize, and other plants have been genetically modified for use in producing fuel, known as biofuel.

HISTORY

- **The first genetically modified crop plant was produced in 1982, an antibiotic-resistant tobacco plant**. In 1987, Plant Genetic Systems (Ghent, Belgium), founded by Marc Van Montagu and Jeff Schell, was the first company to genetically engineer insect-resistant (tobacco) plants .

- The People's Republic of China was the first country to allow commercialized transgenic plants, introducing a virus-resistant tobacco in 1992.

- **The first genetically modified crop approved for sale in the U.S., in 1994, was the Flavr Savr tomato.**

- In 1995, Bt Potato was approved by the US Environmental Protection Agency, making it the country's first pesticide producing crop.

- In 2000, Vitamin A-enriched golden rice was developed, though as of 2016 it was not yet in commercial production.

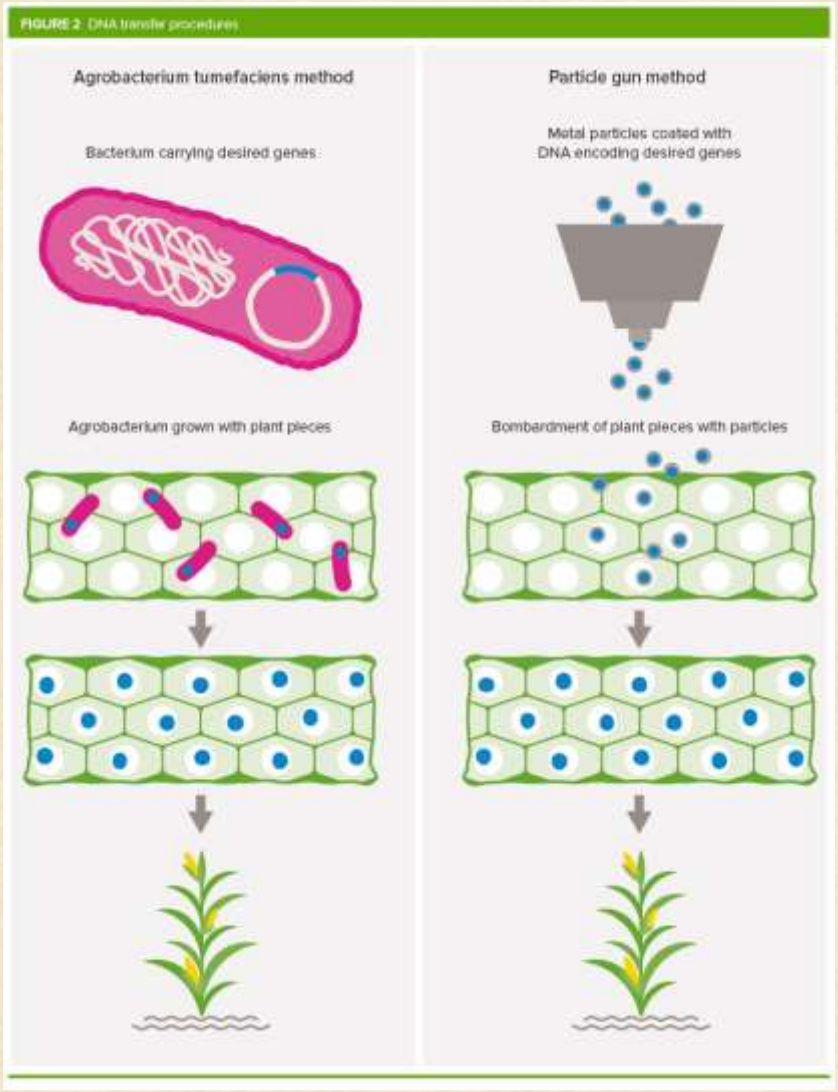
- In 2013 the leaders of the three research teams that first applied genetic engineering to crops, Robert Fraley, Marc Van Montagu and Mary-Dell Chilton were awarded the World Food Prize for improving the "quality, quantity or availability" of food in the world.

Why make GM crops?

- Traditionally, a plant breeder tries to exchange genes between two plants to produce offspring that have desired traits. This cross breeding, however, is limited to exchanges between the same or very closely related species. It can also take a long time to achieve desired results.
- GM technology enables plant breeders to bring together in one plant useful genes from a wide range of living sources, not just from within the crop species or from closely related plants. This powerful tool allows plant breeders to do faster what they have been doing for years.

How are GM Crops Made?

- GM crops are made through a process known as genetic engineering. Genes of commercial interest are transferred from one organism to another. Two primary methods currently exist for introducing transgenes into plant genomes.
  - The first involves a device called a ‘gene gun.’ The DNA to be introduced into the plant cells is coated onto tiny particles of gold or tungsten. These particles are then physically shot onto plant cells and incorporated into the genomic DNA of the recipient plant.
  - The second method uses a bacterium to introduce the gene(s) of interest into the plant DNA.



List of Genetically Modified Foods

GMO FOODS		DESCRIPTION
1.	Corn	Corn are altered with an insect killing gene so farmers will no longer spray pesticides around it.
2.	Soybean	85% of soybeans are altered that's why most soybeans are used for livestock.
3.	Sugar Beets	It is altered with a gene that would help it grow faster than it's usual.
4.	Potatoes	Potatoes that are genetically modified were created so it won't be affected by diseases, such as Phytophthora Infestans, that can spread quickly and kill entire fields of potatoes.
5.	Tomatoes	Tomatoes are genetically modified so it would last longer and can be transported to other places.
6.	Squash	Squash were modified to protect them since they are susceptible to some viral diseases.
7.	Oils	Oils are also genetically modified to lose its bitter taste and make it more resistant from herbicides.
8.	Golden Rice	Golden rice was chosen to be genetically altered to have vitamin A supplements added on it.
9.	Salmon	Salmons are altered to make it last longer, grow faster and produce more babies as well.
10.	Dairy Products	Dairy products are altered to contain growth hormones.

BENEFITS

- Benefits More economically friendly as pesticides do not go into the air, soil, and water .Their production hazards to the environment also decreases.
- Reduction of sicknesses and illnesses, as transgenic crops are more nutritious. Vitamins and minerals can be provided to children and to people, where they were inaccessible before.
- The most obvious benefit is yield increase. It could potentially solve hunger.
- We can begin to grow foods in different conditions. Other foods that grow in cold climates could be engineered to grow in hot climates.
- Enhancement of the taste and quality of food.

THE POTENTIAL RISKS OF GM CROPS

- The danger of unintentionally introducing allergens and other antinutrition factors in foods
- The likelihood of transgenes escaping from cultivated crops into wild relatives
- The potential for pests to evolve resistance to the toxins produced by GM crops
- The risk of these toxins affecting nontarget organisms.

CONCLUSION

- Thus, in conclusion changing demographic trends and technological advancements are delivering new innovations in the field of agriculture. These emerging technologies are required to be used judiciously to meet the growing demands from modern agriculture. Vertical farming and GM crops can be adopted as the viable alternatives for the conventional agriculture to meet the changing demands and needs of mankind. Further, constraints in adoption of such practices should be addressed and linkages between researchers and farmers should be created for suitable measures.