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Potential and challenges of using Bio-Innovation in a sustainable economy

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(20 minutes)

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SCOPE

Bio-Innovation is very broad and inclusive;

Focus on bio-innovations in agri-food systems

- *What is a **Sustainable Economy** in the context of Sustainable Development?*
- *What are challenges within key SDGs to which bio-innovations can contribute*

•*What Bio-innovation technologies for a sustainable economy?*

•*Moving forward -- Ensuring Innovation success*

What are attributes of a Sustainable Economy?

- Brundtland Report -- Sustainable development is *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* -- World Commission on Environment and Development Report, Our Common Future 1987
- Features of a sustainable economy:
  - Regenerative and circular economy (agri, Aqua, livestock, novel food)
  - Meets the needs for Food, health, water, transport, housing for ALL
  - Equality and equity in economic opportunities.
  - Adequate Human capital — High employment and meaningful regular job creation
  - Minimal to no negative externalities from human activities
  - Meets EES or ESG rubrics


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Outcomes from Bio-Innovation to support sustainable development

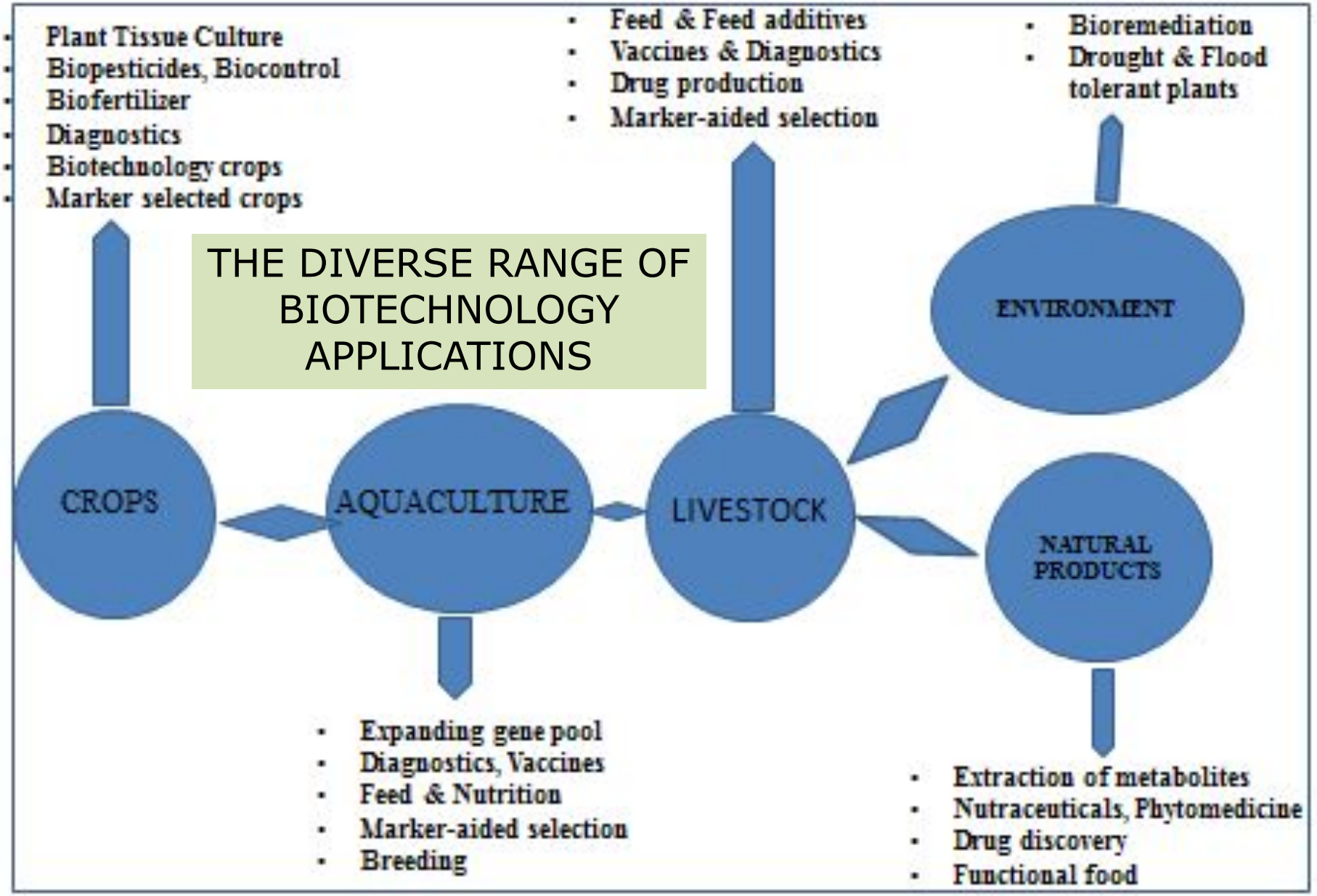
- ✔ SDG 1 NO POVERTY: Employment creation
- ✔ SDG 2 NO HUNGER: Food security
- ✔ SDG 3 GOOD HEALTH: Nutrition security
- ✔ SDG 7 RENEWABLE ENERGY: Bio (Green) Energy
- ✔ SDG 8 GOOD JOBS AND ECONOMIC GROWTH: Vibrant Food production and processing sector
- ✔ SDG 13 CLIMATE ACTION: Green Mitigation and adaptation technologies
- ✔ SDG 14 LIFE BELOW WATER: Conserving wild fisheries and advancing aquaculture
- ✔ SDG 15 LIFE ON LAND: Biotech crops
- ✔ SDG 16 PEACE AND JUSTICE: Ensuring food supplies
- ✔ SDG 17 PARTNERSHIPS: Cross-disciplinary initiatives for sustainable development

What are challenges within key SDGs to which bio-innovations can contribute?

- Addresses All dimensions of food security (Food availability, accessibility, stability)
- Reduces GHGs (climate mitigation and adapta5ion)
- Maintains farming livelihoods (productivity)
- Feeds a growing urban population (Maintaining or increasing production)

21st C as Biology Century

(plus digital sensu 3IR, 4IR)


Plant Tissue Culture
Biopesticides, Biocontrol
Biofertilizer
Diagnostics
Biotechnology crops
Marker selected crops
Feed & Feed additives
Vaccines & Diagnostics
Drug production
Marker-aided selection
Bioremediation
Drought & Flood tolerant plants
THE DIVERSE RANGE OF BIOTECHNOLOGY APPLICATIONS
CROPS
AQUACULTURE
LIVESTOCK
ENVIRONMENT
NATURAL PRODUCTS
Expanding gene pool
Diagnostics, Vaccines
Feed & Nutrition
Marker-aided selection
Breeding
Extraction of metabolites
Nutraceuticals, Phytomedicine
Drug discovery
Functional food

What Bio-innovation technologies for a sustainable (rural) economy?

Benchmark against features of a sustainable economy.

- ✔ New crop varieties and fish/animal breeds using GM, gene editing and gene editing ++
- ✔ Production of inputs (biofertilisers)
- ✔ Fish and animal health (vaccines, epigenetics)
- ✔ Bio-energy via microbial digestion
- ✔ Enzymes and food ingredients
- ✔ Food loss reduction and waste valorisation
- ✔ Circularity in sectors

Synergy with other disruptive technologies like digital

Biotechnology as a Disruptive Innovation for crop agriculture

Niche or mainstream contributor to improving nutrition?

Biotech crops: fastest adopted crop technology in modern agriculture

Genetically Modified (GMOs)

B.t. Brinjal

Two varieties of papaya resistant to papaya ringspot virus have been developed using biotechnology: SunUp, *left*, and Rainbow, *right*. They have performed well for Hawaiian growers, even under prolonged and heavy disease pressure.

Virus-prote ed papaya

Vitamin A-enhanced "Golden" Rice

Source: www.isaaa.org

Gene-Editing biotechnologies (CRISPR, etc)

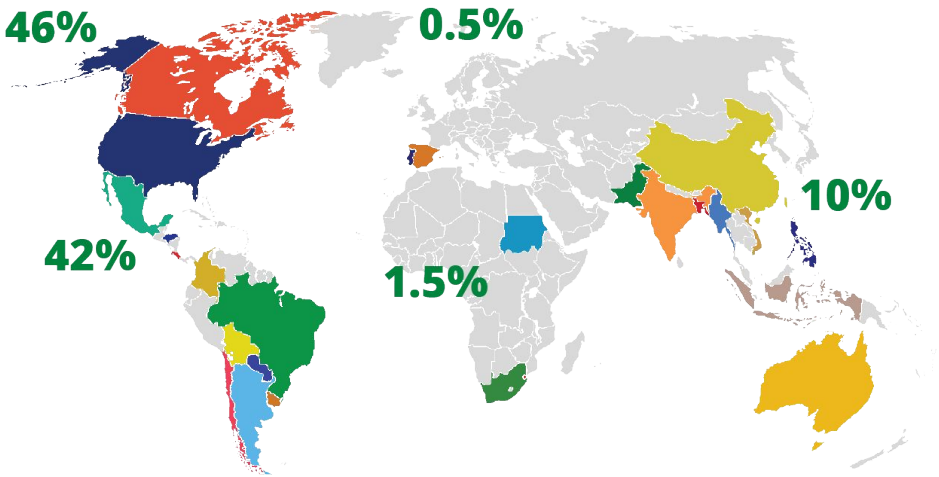
Non-browning potato

Flood-tolerant rice

in 2018,191.7 Million hectares grown in 26 countries (10 Latin American, 9 Asia Pacific, 2 North American, 2 EU, and 3 African countries)/ 70 Countries approved GMOs for Food, Feed and Processing

Next Generation: Genome Editing Induced Gene Silencing (GEiGS)

Global Area of Biotech Crops, 2018: Regional Proportions and Country Areas



26 countries which have adopted biotech crops

1.1%
Increase from 2017

In 2018, global area of biotech crops was 191.7 million hectares, representing an increase of 1.1% from 2017, equivalent to 1.9 million hectares.

Source: ISAAA, 2018

50,000 hectares, or more

1.	*USA*	75.0 million
2.	Brazil*	51.3 million
3.	Argentina*	23.9 million
4.	*Canada*	12.7 million
5.	India*	11.6 million
6.	Paraguay*	3.8 million
7.	China*	2.9 million
8	Pakistan*	2.8 million
9.	South Africa*	2.7 million
10.	Uruguay*	1.3 million
11.	Bolivia*	1.3 million
12.	*Australia*	0.8 million
13.	Philippines*	0.6 million
14.	Myanmar*	0.3 million
15.	Sudan*	0.2 million
16.	Mexico*	0.2 million
17.	*Spain*	0.1 million
18.	Colombia*	0.1 million

Less than 50,000 hectares

Vietnam*	Bangladesh*
Honduras*	Costa Rica*
Chile*	Indonesia*
Portugal	eSwatini*

** Developing countries*

10 Latin American, 9 Asia Pacific, 2 North American, 2 EU, and 3 African countries

Contributions of Biotech Crops to sustainability

- 49% productivity gain at 328 MT (1996-2011) and 78% or 50.2 MT (2011) from biotech soybean, maize, cotton and canola
- 51% (1996-2011) and 22% (2011) reduced cost of production in ploughing, fewer pesticides, less labor
- Economic benefits of US$98.2 B (1996-2011) and US$19.75 B (2011)
- Savings of CO_2 emissions: reduced use of fossil fuel in insecticide and herbicide applications = 1.9 B kg of CO2 or 0.8 M cars off the road
- Reduction of CO_2 emissions from conservation tillage = 21.1 B kg CO_2 or 9.4 M cars off the road

Brookes and Barfoot, 2013

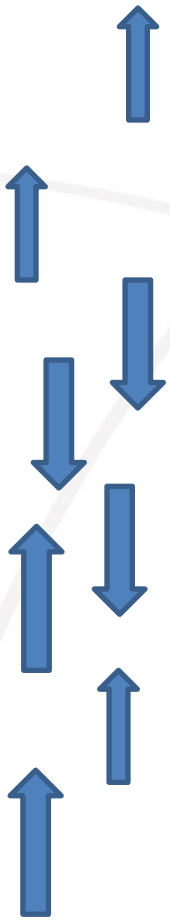
Source: ISAAA 2022

Courtesy: ISAAA

RSIS

Food security is essential for a sustainable economy

What are the issues in food production which biotechnology can address?



- Surplus food production: More with less, price stability; New crop varieties; Resilience
- Labor saving production technology
- Negative externalities, e.g. pesticide pollution
- Environmental stress (drought, floods)
- Biotic stress (pests, diseases)
- Nutrition and safety
- Trade in food
- Reduce GHG

Moving forward – Challenges to ensure (Bio) Innovation success

IMPERATIVES

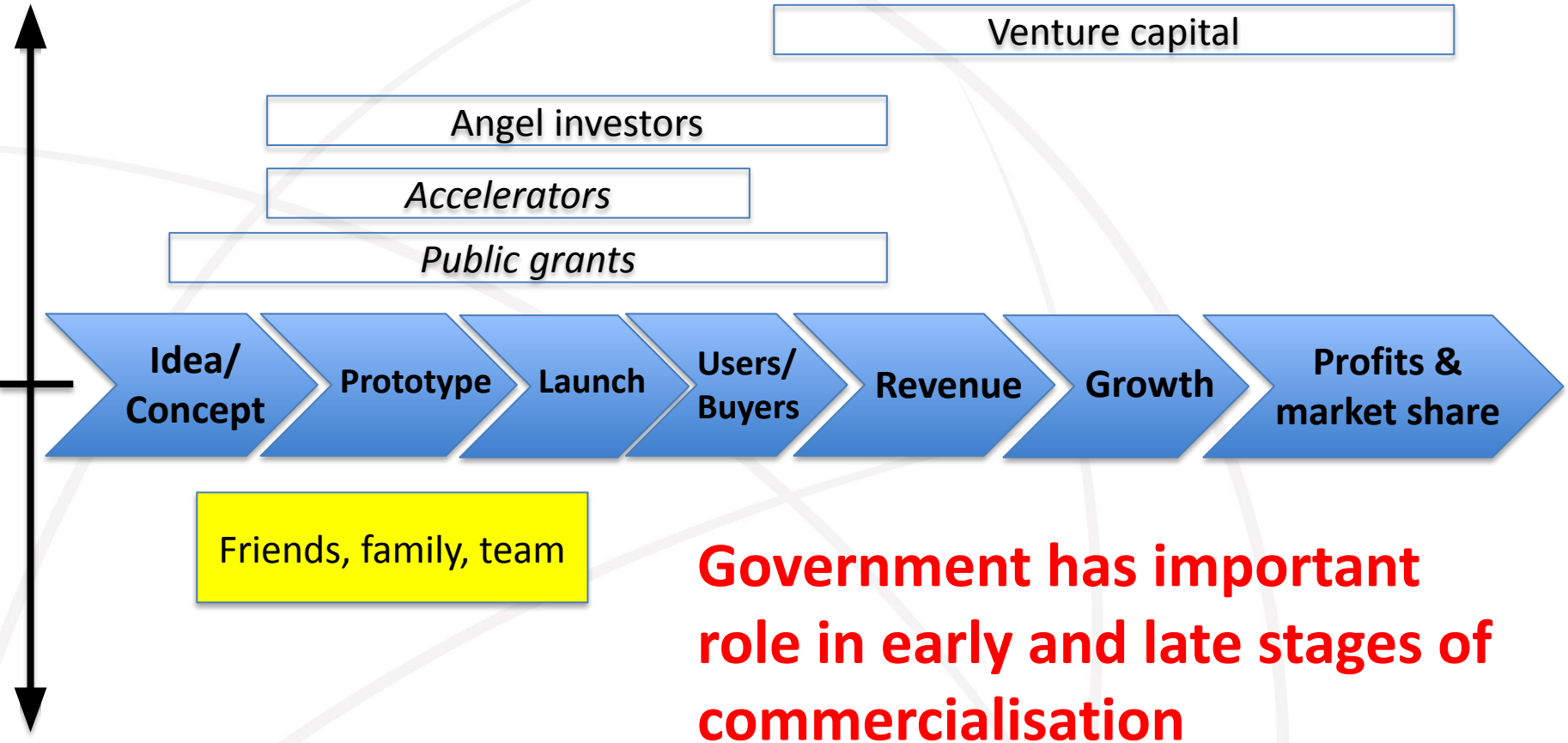
- Commercialization pathway
- Valley of Death
- Innovation ecosystem

"Innovation is a process of turning opportunity into new ideas and of putting these into widely used practice". Tidd et al. 2001

"Agricultural innovation is ***the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context.."*** FAO UN, 2018

It is important that the originators of ideas understand, at the outset, what is involved in moving from concept to product, and how enterprises are grown.

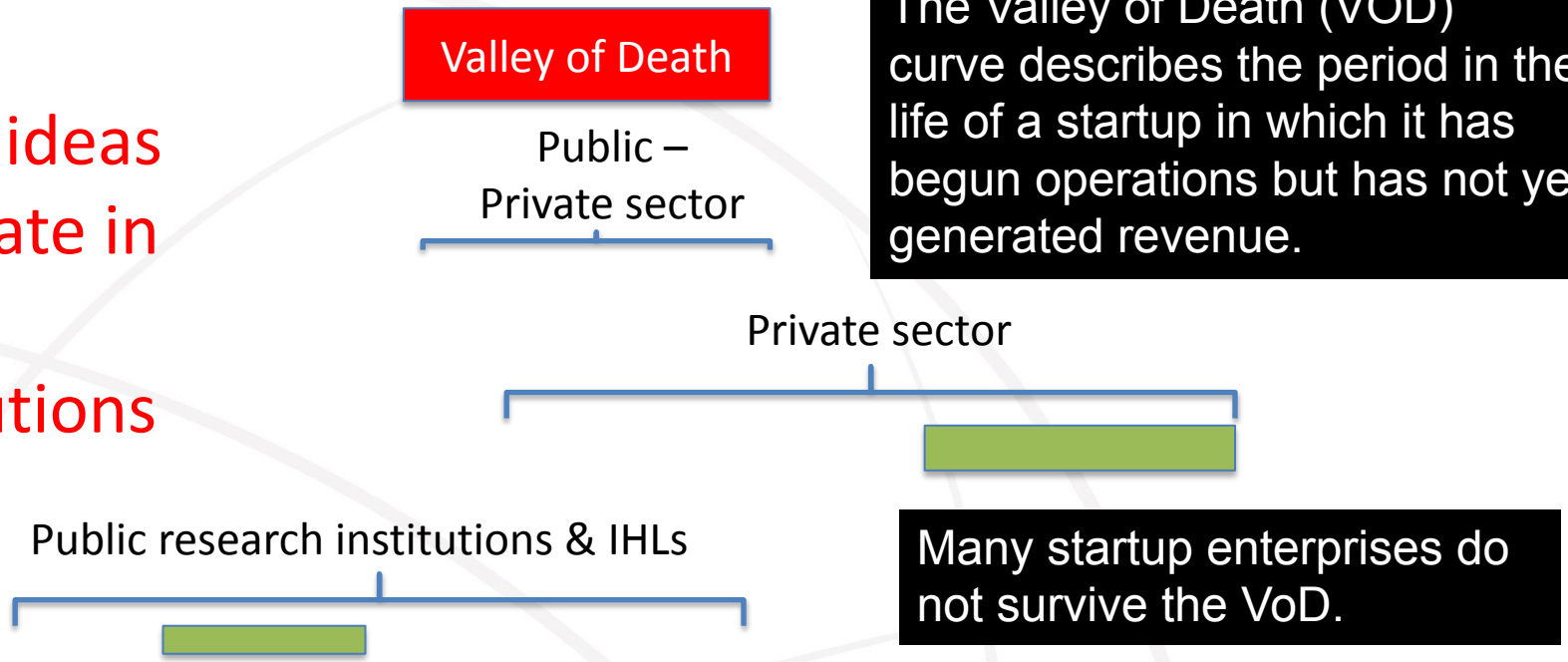
A simplified Commercialization pathway:
Converting concepts to products (enterprises)



Government has important role in early and late stages of commercialisation

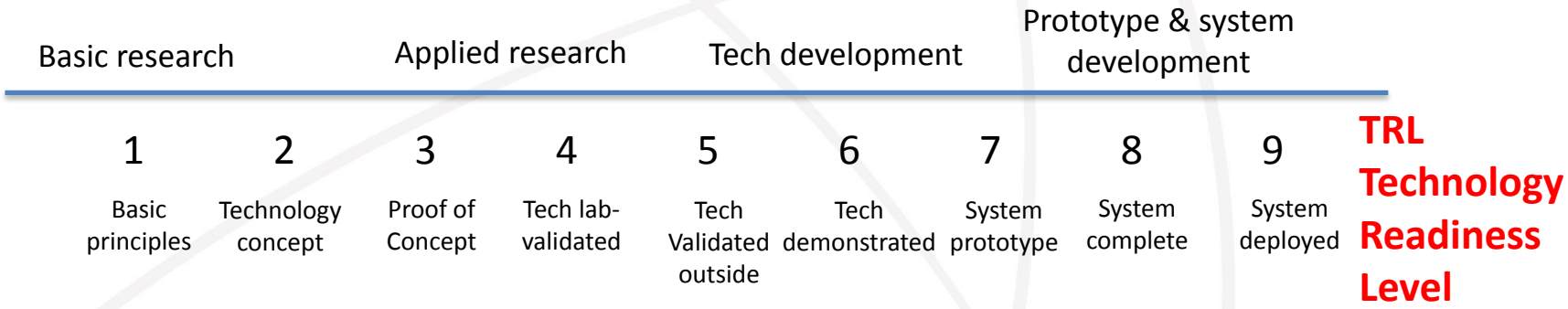
How ready is a discovery or technology?

Many ideas originate in public institutions



The Valley of Death (VOD) curve describes the period in the life of a startup in which it has begun operations but has not yet generated revenue.

Many startup enterprises do not survive the VoD.



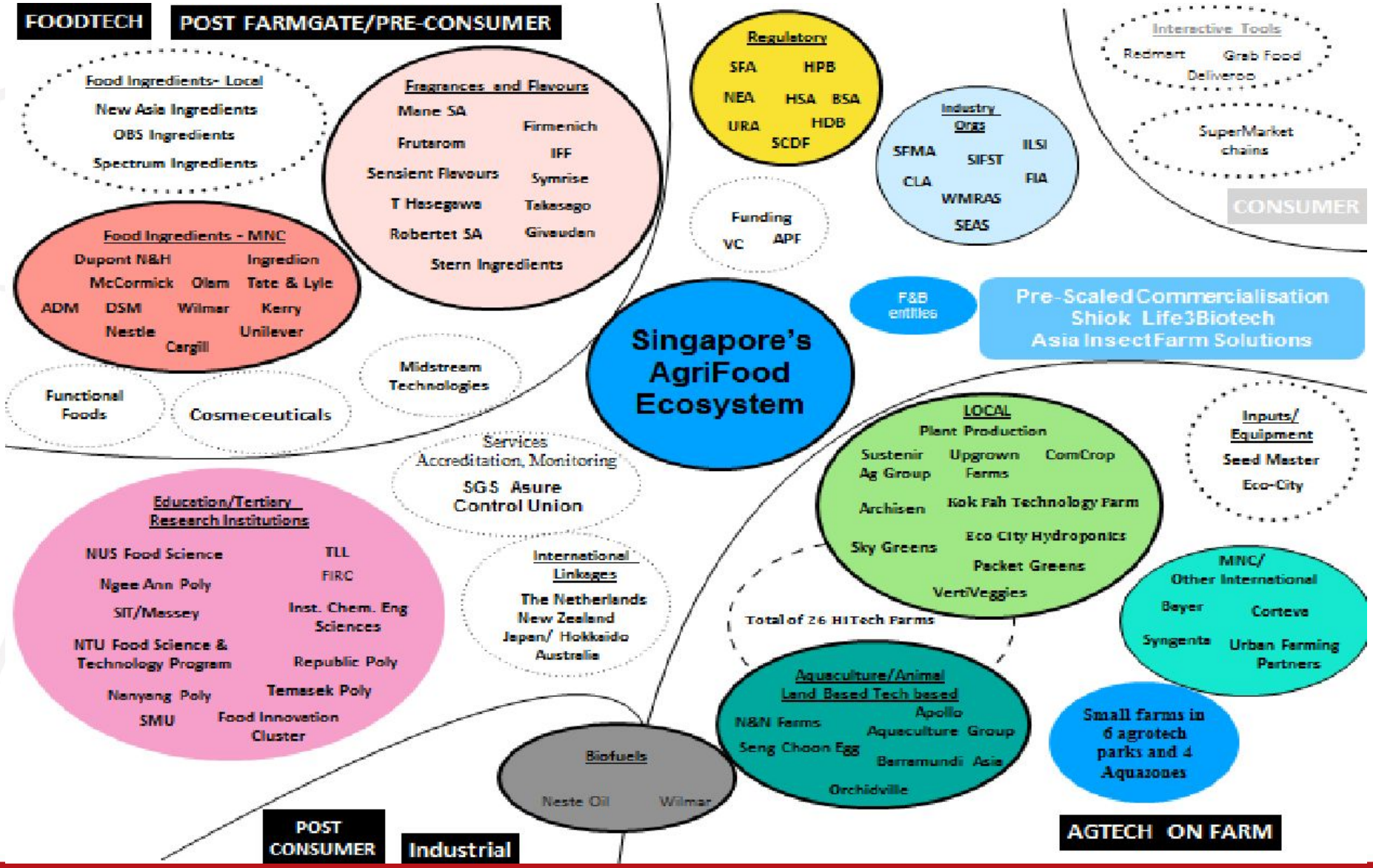
Enablers of Bio-Innovation

- ✔ Supportive government **policies**, regulations and instruments
- ✔ **Financing** mechanisms and Engagement of capital markets
- ✔ **Investment** in relevant human resources, education and training
- ✔ Agri-Food production and marketing **ecosystem** (Government agencies, Industry experts, Financiers/Investors, HR developers, Mentors, Accelerators, Startups), with **focal organizations** ("champions") that coordinate
- ✔ Coordinated **infrastructure** for R&D, commercial enterprise and supply chain
- ✔ Culture of innovation and entrepreneurship (technology-enabling)
- ✔ **Inclusiveness** mechanisms for smallholder farmers
- ✔ **Social License**

"Overall, a successful agri-food innovation system requires an ecosystem in which many components function well individually but derive synergies when working together. Without this ecosystem and coordination thereof, individual components of a food system fail to utilise the synergies that can be created."

Report by Asia BioBusiness Pte Ltd., January 2019

INNOVATION ECOSYSTEM



Moving to 2050

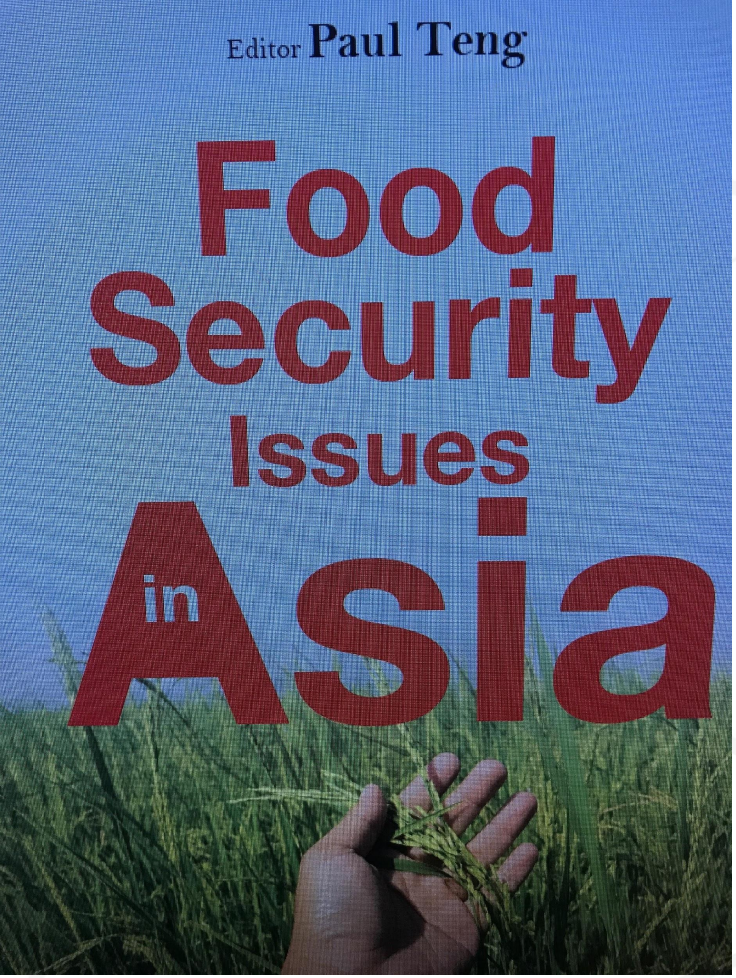
Need to increase food supply by >50% by 2050 (FAO, 2016)

In 2019, nearly one in ten people in the world were food insecure

In 2021 30% of global population were moderately – severely food insecure

By 2030, likely that 8% of world population will still be under-nourished

….State Of Food Security and Nutrition in the World, 2022



Forthcoming Book – Dec 2023

World Scientific Publishers

Thank you - 谢谢 - Terima Kasih - धन्यवाद - ありがとう – Maraming selamat - Merci - Gracias - 너를 감사하십시요 - Thank you

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