PRECISION LIVESTOCK FARMING

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ACKNOWLEDGEMENTS

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- Prof. Irene Naas (University of Campinas, Brazil)
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- Prof. Paul Hemsworth (Victoria)
- Dr Robert Baker (PIRSA)
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When not otherwise stated, photos were taken by the author

ABOUT ME

- Prof. Thomas Banhazi, Lecturer and Scientist
- Strong interest in commercialisation, involvement in companies in AU & EU
- (1) Precision livestock farming and (2) environment/climate management in and around livestock buildings
- Involved approx. 40 projects at the total value of AU$47M, including 12 large EU projects
- Published 3 Books, 25 book chapters, 65 journal articles, 165 conference papers, 120 industry reports/seminar/extension articles and 8 patents
- Supervised 35+ post-grad students (PhDs, Masters & Honours), contributed to 8 undergraduate courses, guest lectured in 5 countries
- I am hoping to share some of my experiences with you

MY PROJECT AREAS

- Sensor developments, machine vision, data analysis/modelling, artificial intelligence, communication related studies on farms
- Automation, livestock equipment and robotics related to livestock production (poultry and pig farms)
- Environment/climate management, environmental sustainability, in and around livestock facilities (thermal conditions and air quality)
- Emission reduction from livestock farms
- Ventilation, hygiene/cleaning methods, manure/odour management
- Animal welfare, general livestock management issues (poultry, pig and dairy cattle production)
- On-farm research, commercialisation and patenting

COURSE OBJECTIVES

- To understand the principles and the potential impact of new technologies on livestock production
- To combine theoretical foundations with technological expertise and data analysis skills
- To develop modern sensor and automation technologies for monitoring and optimizing animal health, welfare and production efficiency
- To develop a basic understanding of different data systems and multimodal Machine Learning as a method to fuse information from multiple sensors
- To promote interdisciplinary cooperation, hands-on exercises and insights into current trends in research and industry to enable students to develop and discuss innovative solutions in digitalized livestock farming

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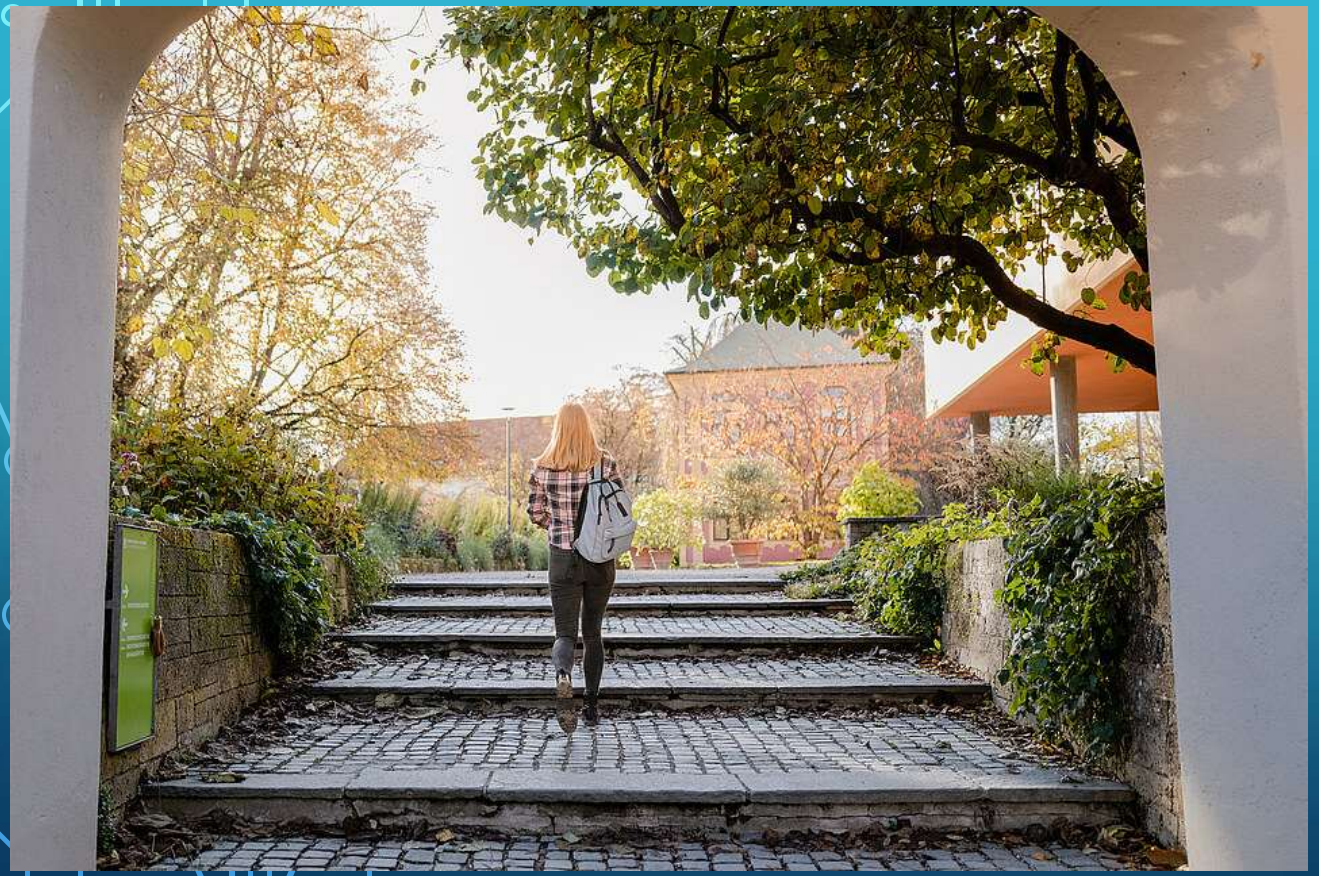
WEIHENSTEPHAN-TRIESDORF UNIVERSITY OF APPLIED SCIENCE

WELCOME AND INTRODUCTION

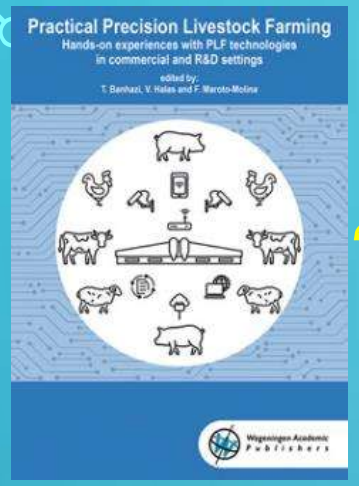


Source: https://www.hswt.de/

- **Practically orientated, applied university with strong focus on “green engineering”**
- **It aims to train the engineering scientists of tomorrow: interdisciplinary, international and practice-oriented**
- **This course is part of the study area of “Digital Farming” to shape the future of agriculture**

TIMETABLE AND STUDY MATERIAL

- **Lecture / Tutorial times**
  - **Flexible, Thursday & Friday (10:00 am – 12:00 pm) on-line**
- **Reading material**
  - **The course and reading materials will be made available via the *Moodle***
  - ***Suggested reading:* Practical Precision Livestock Farming**



WAP/BRILL PUBLICATION

Practical Precision Livestock Farming book
'Hands-on experiences with PLF technologies in commercial and R&D settings'
T. Banhazi, V. Halas and F. Maroto-Molina

published by Wageningen Academic Publishers in September, 2022

- Precision livestock farming (PLF) technologies have been heavily promoted in the past, but the **implementation of these technologies is not easy**.
- Numerous technical challenges need to be solved before PLF technologies will supply the desired information in a reliable and consistent manner. Farm **implementations regularly encounter difficulties**. The practical experience associated with these technologies do not always match their theoretical potential.
- 90+ authors from 16 countries were asked to report on the actual practical experiences technology developers and users had under farm conditions to try and understand this difference between practice and theory. This book aims to **eliminate the 'mystery' behind the 'Smart' PLF tools**, and presents the hard facts reported by individuals that have practical experience using these technologies.
- The book also explores various aspects of PLF, including the
  - **challenges associated with developing and using various technologies**,
  - (2) the importance of **training and ethical aspects** of PLF tools,
  - (3) the difficulties related to **commercialisation of PLF systems**.
- We hope that the **honest presentation of the pros and cons** of PLF management tools **will help the supporters of precision farming concepts to better use and interact with these modern technologies.**

TOPICS/MODULES

Definition and conceptualization of precision livestock farming: history, goals and benefits
Farm Management Information Systems, Internet of Things and cloud computing
Integration of modern sensor technologies into agriculture production
Monitoring of health and behavior as an early warning system
Use cases of digital technologies in overall farm management
Practical exercises: digital sales, communication and documentation solutions
Multimodal Machine Learning (MML): Data heterogeneity, visual representations, language representations, signals and graphs

COURSE ASSESSMENTS

A 90-minute written examination via the module catalogue and link.
Digital Farming: Masterstudiengang an der HSWT | HSWT

Grading:
A minimum of 50% must be achieved to pass, as per normal grading procedures.
Bewertungsschlüssel - Free University of Berlin

CONTACTS

For any assistance with course, please contact:
Prof. Dr. Simon Walther or Dr. Ehsan Yaghoubi

Other Lecturers involved:
Prof. Dr. Simon Walther
Prof. Dr. Daniel Werner
Dr. Ehsan Yaghoubi
Dr. Petra Thobe

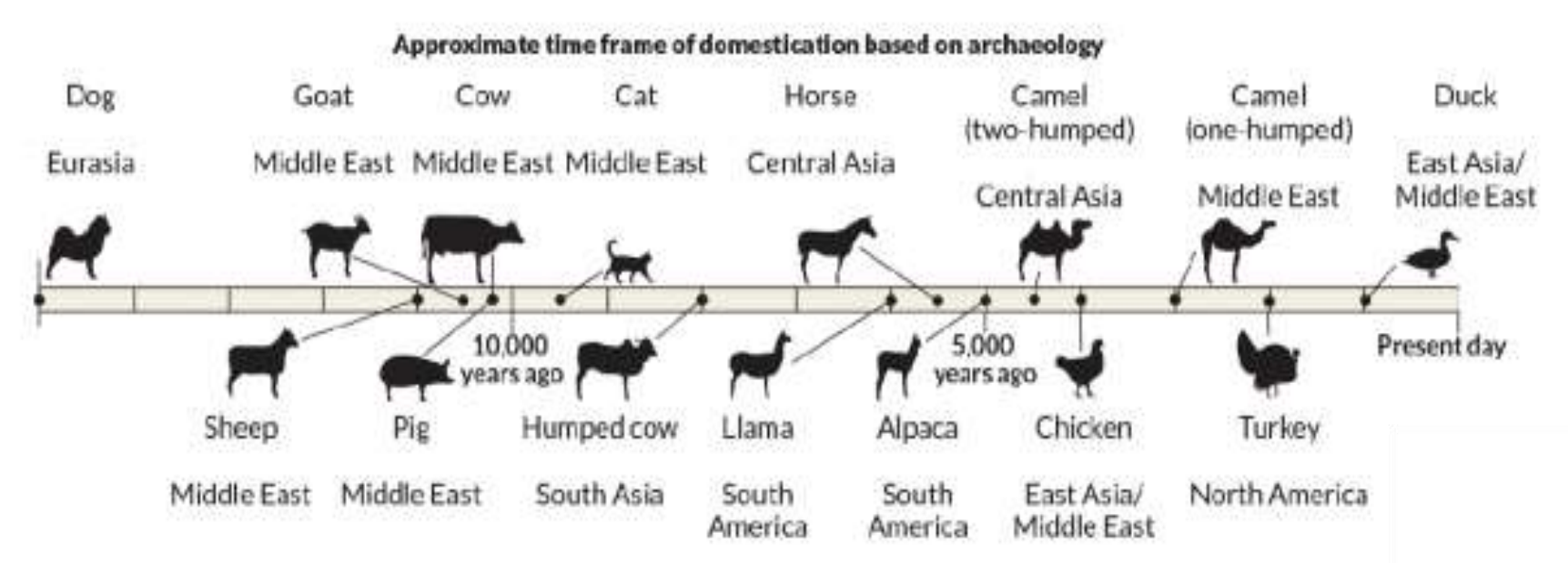
MODULE 1
INTRODUCTION TO AGRICULTURAL SYSTEMS

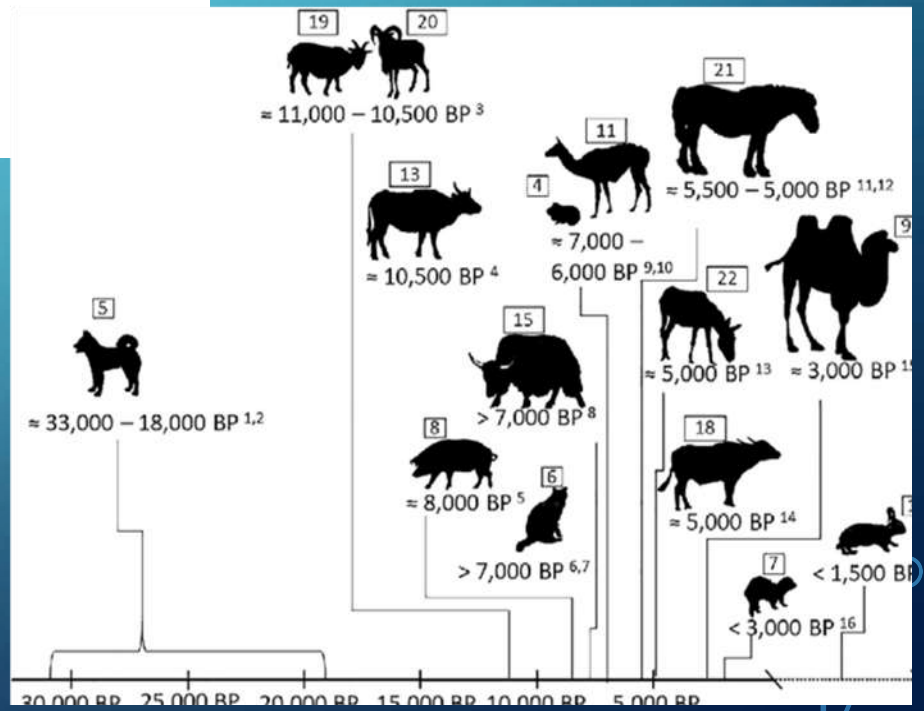
LECTURE A: IMPORTANCE OF AGRICULTURE, LIVESTOCK PRODUCTION

MODULE OVERVIEW AND LEARNING OBJECTIVES

- Introduction to Agriculture
  - Importance
  - Historical developments
- Outline and explain the major challenges facing agriculture
- Comment on the opportunities that could arise from the challenges
- Outline and explain application of technological innovations in agriculture

DOMESTICATION OF LIVESTOCK SPECIES





domestication-based-on-archeology.png (604×199) (vassar.edu)

Zeller, Ulrich & Göttert, Thomas. (2019). The relations between evolution and domestication reconsidered - Implications for systematics, ecology, and nature conservation. Global Ecology and Conservation. 20. e00756. 10.1016/j.gecco.2019.e00756.

AGRICULTURAL REVOLUTION

- Cultivation ⇒ domestication of plants and animals
- Excess production ⇒ food storage
- Less need for nomadic life style
- Diversification of non-agricultural workers
- Enabled increase in population

AGRICULTURAL REVOLUTION

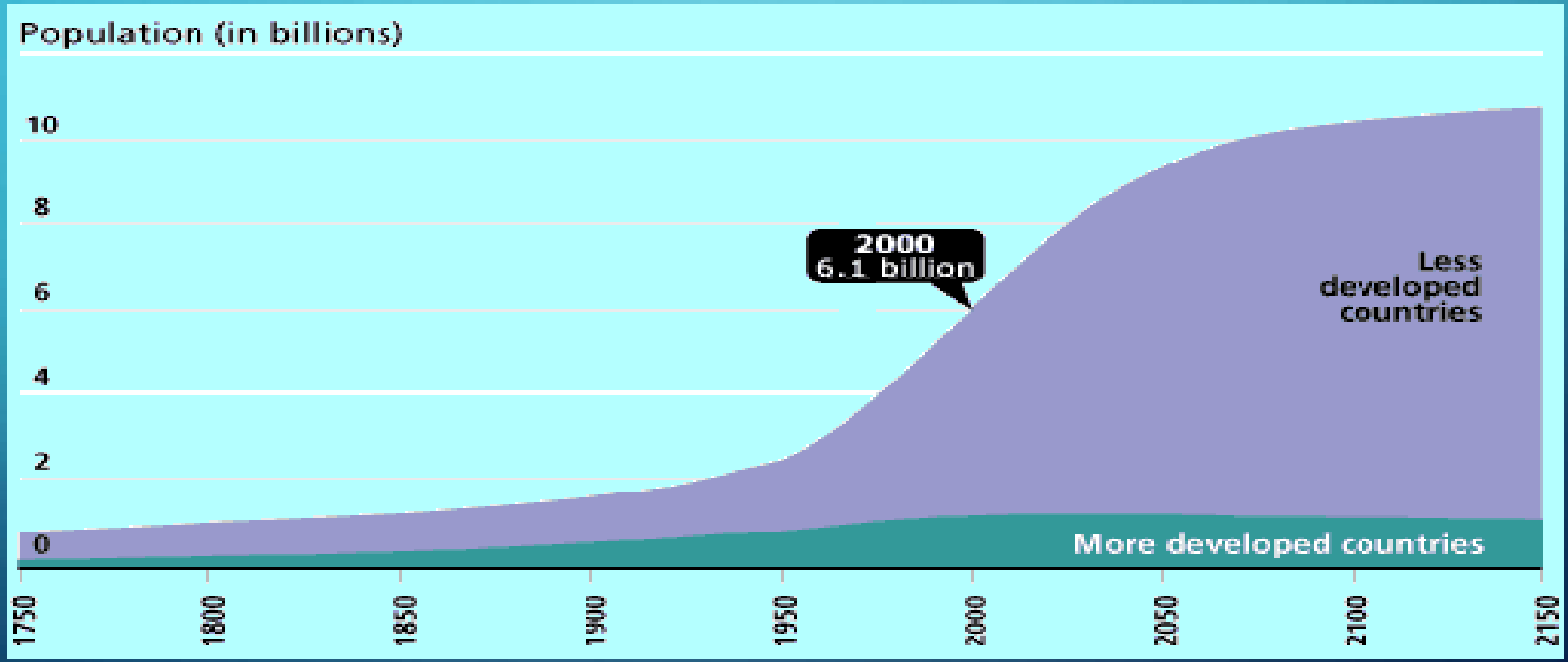
https://www.youtube.com/watch?v=IVHD9wGIbho

AGRICULTURAL REVOLUTION

From Hunters and Gatherers to Farmers - YouTube

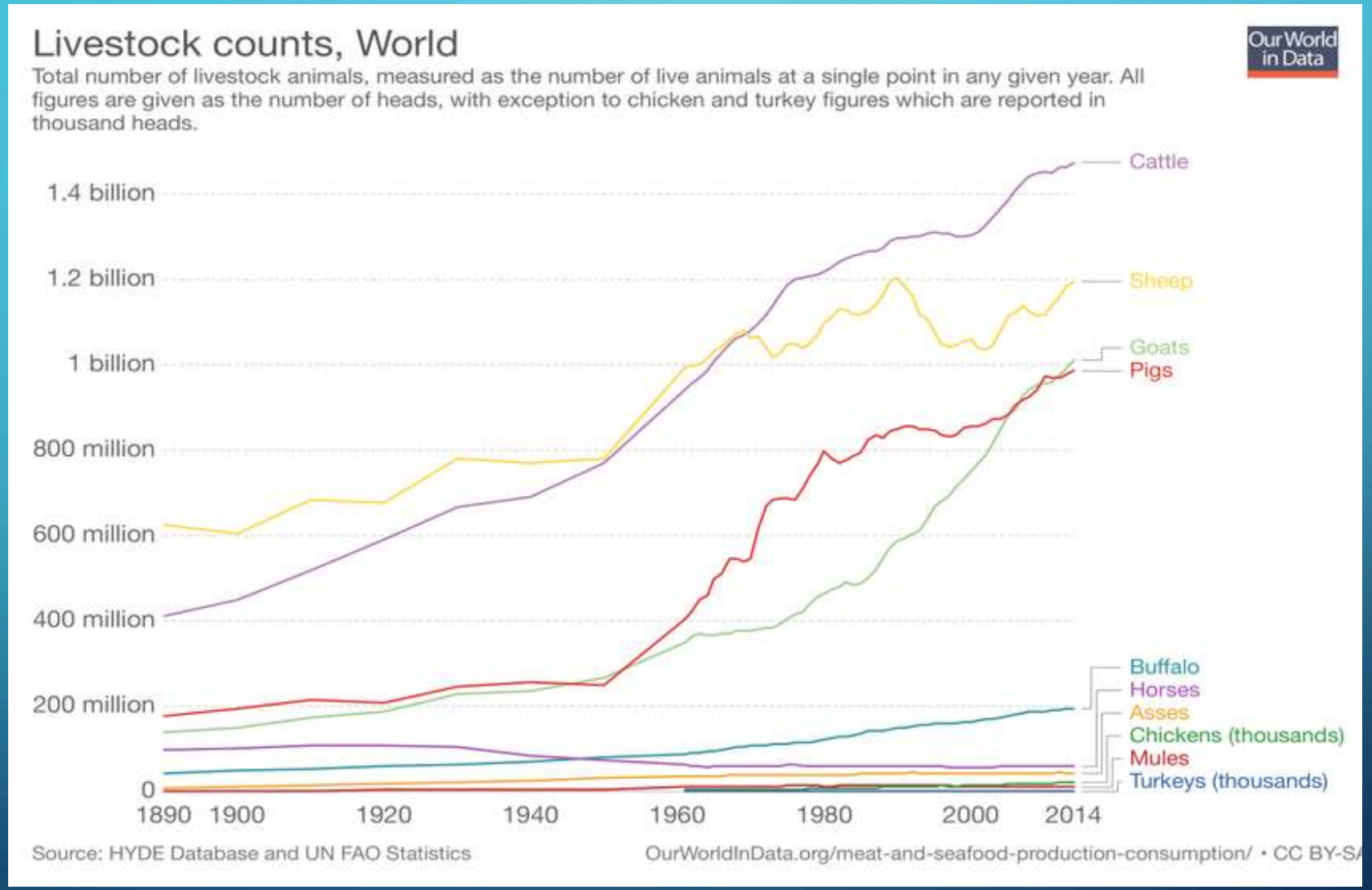
NEED FOR CONTINUED AGRICULTURAL PRODUCTION

- World population, exponential trend, 10 billion in 2050



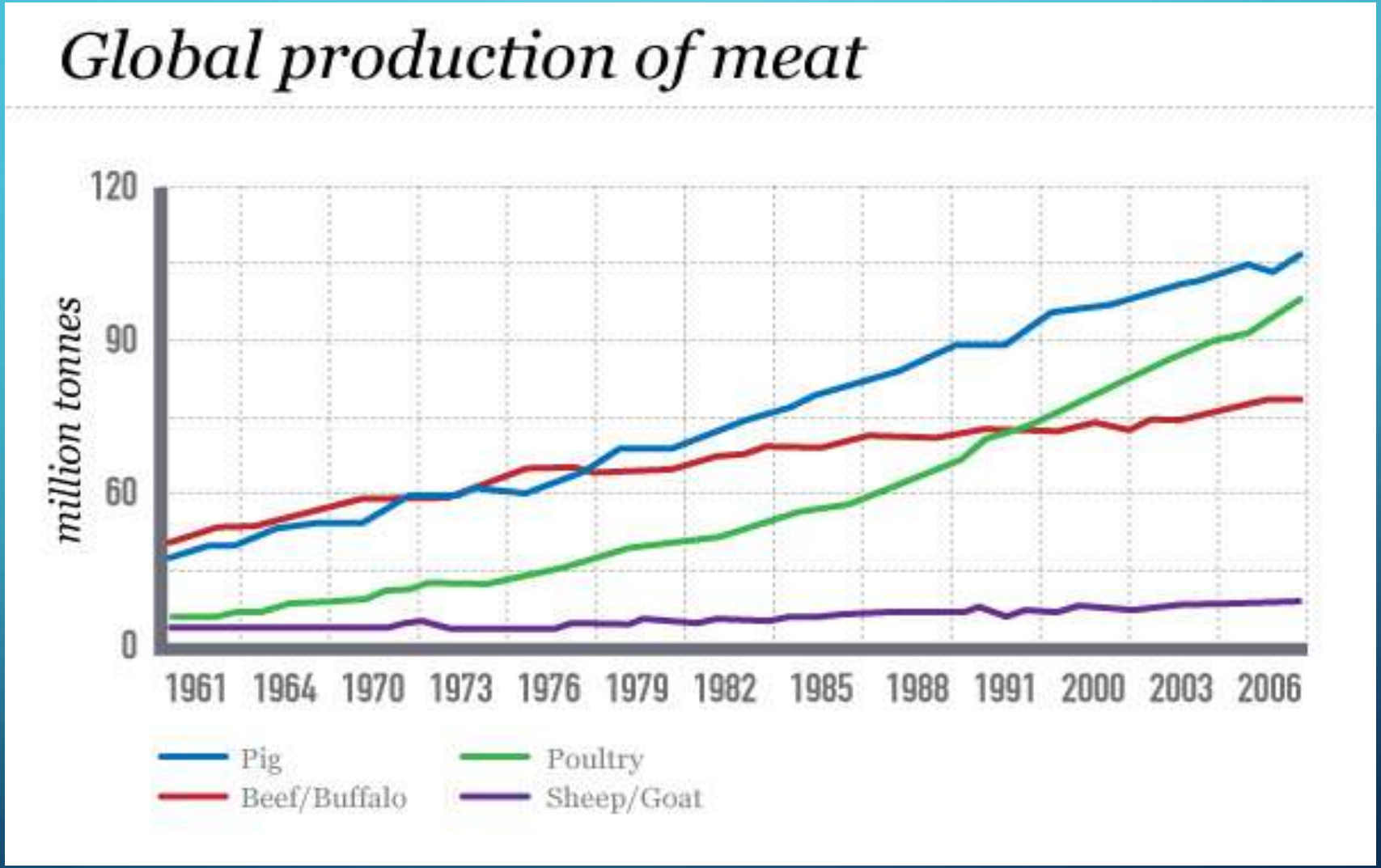
Source: Population Bureau (2005). Human Population: Fundamentals of Growth.
http://www.prb.org/Content/NavigationMenu/PRB/Educators/Human_Population/Population_Growth/Population_Growth.htm

AGRICULTURAL PRODUCTION INCREASE



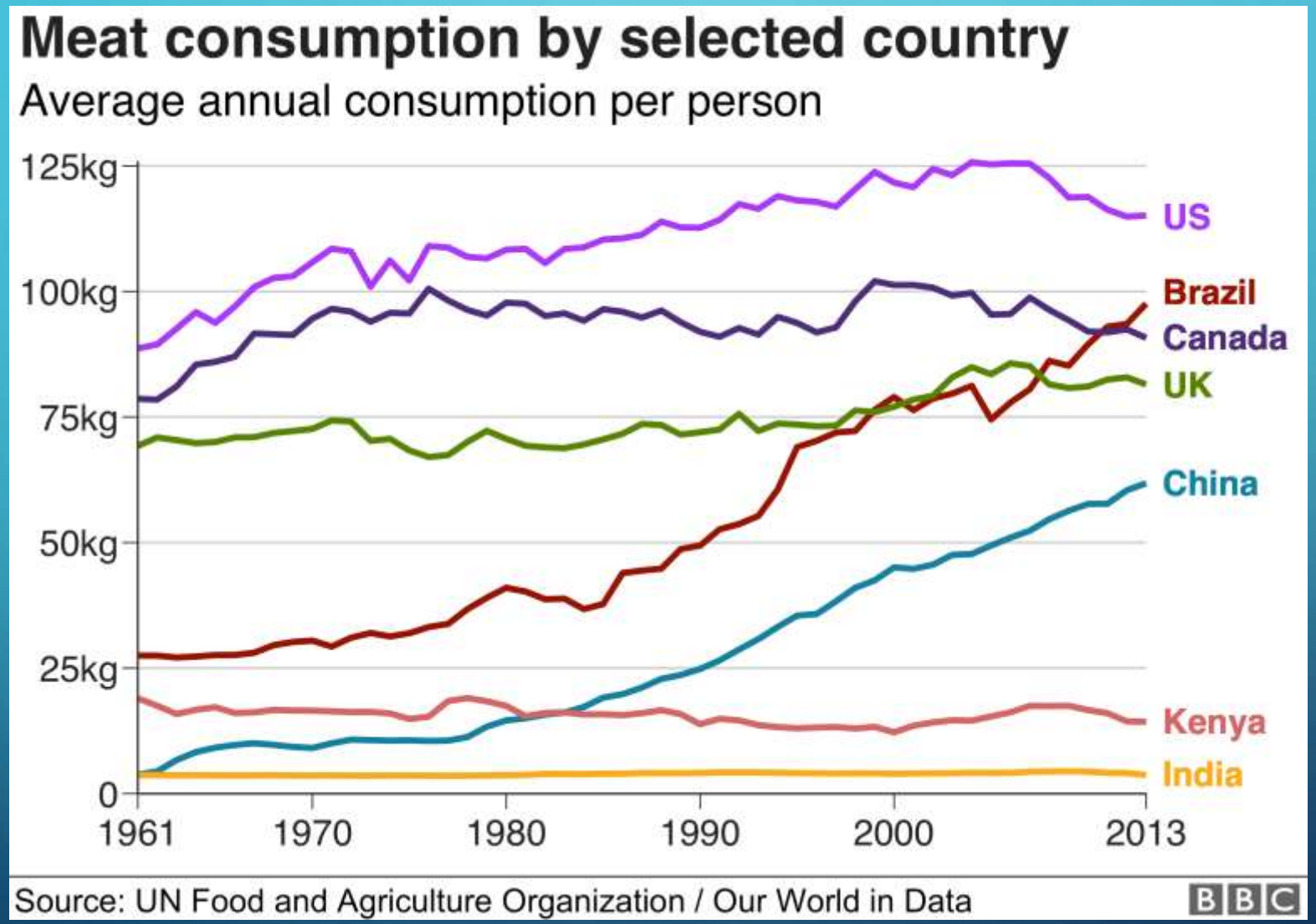
Zoupanidou, Elisavet. (2019). METHODOLOGY FOR THE REDUCTION OF ENTERIC METHANE EMISSIONS FROM RUMINANTS THROUGH THE USE OF 100% NATURAL FEED SUPPLEMENT. 10.13140/RG.2.2.21534.69448.

AGRICULTURAL PRODUCTION INCREASE



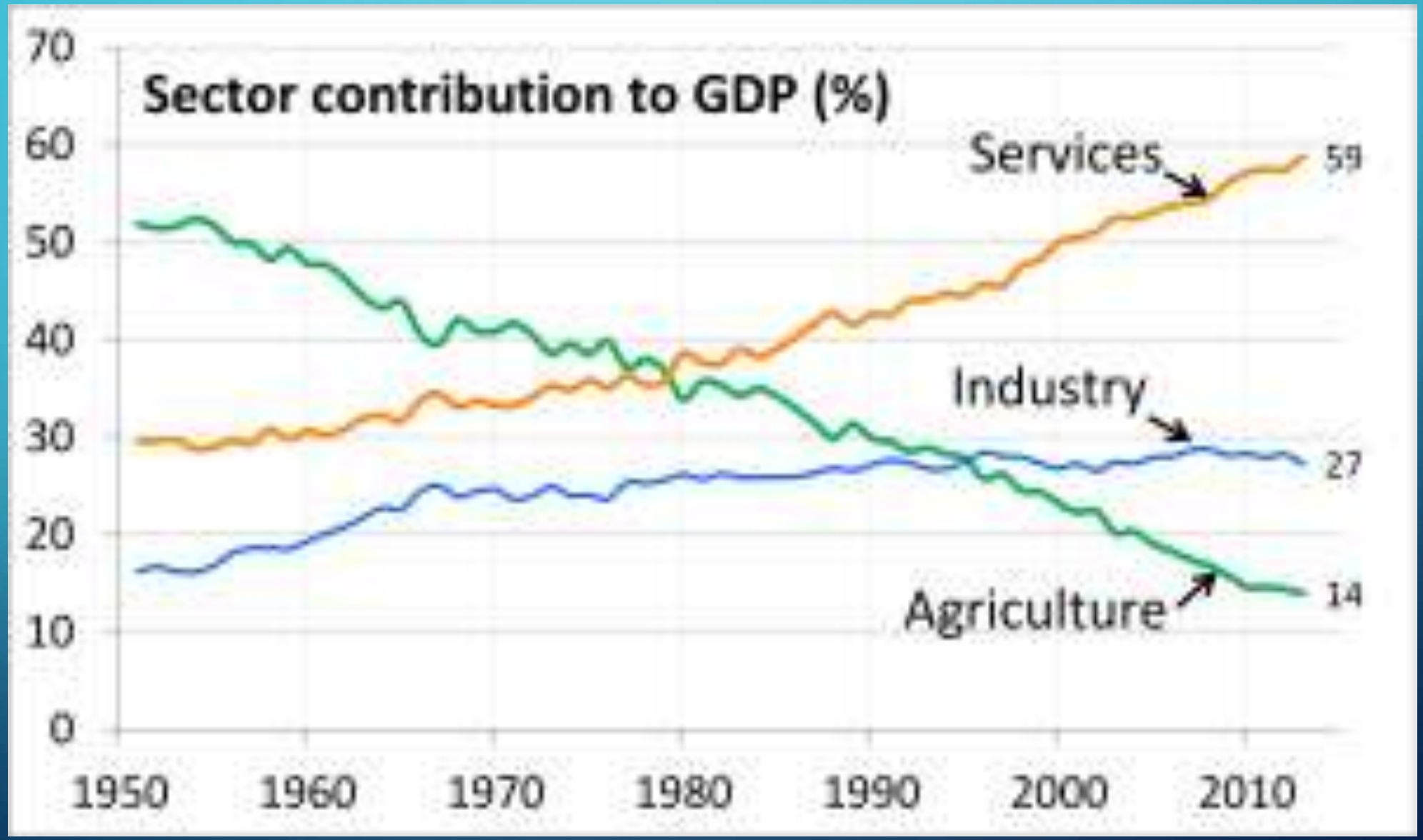
Tokyo Drifts from Seafood to Meat Eating - Our World (unu.edu)

AGRICULTURAL PRODUCTION AND CONSUMPTION INCREASE



Which countries eat the most meat? - BBC News

AGRICULTURE CONTRIBUTION TO GDP



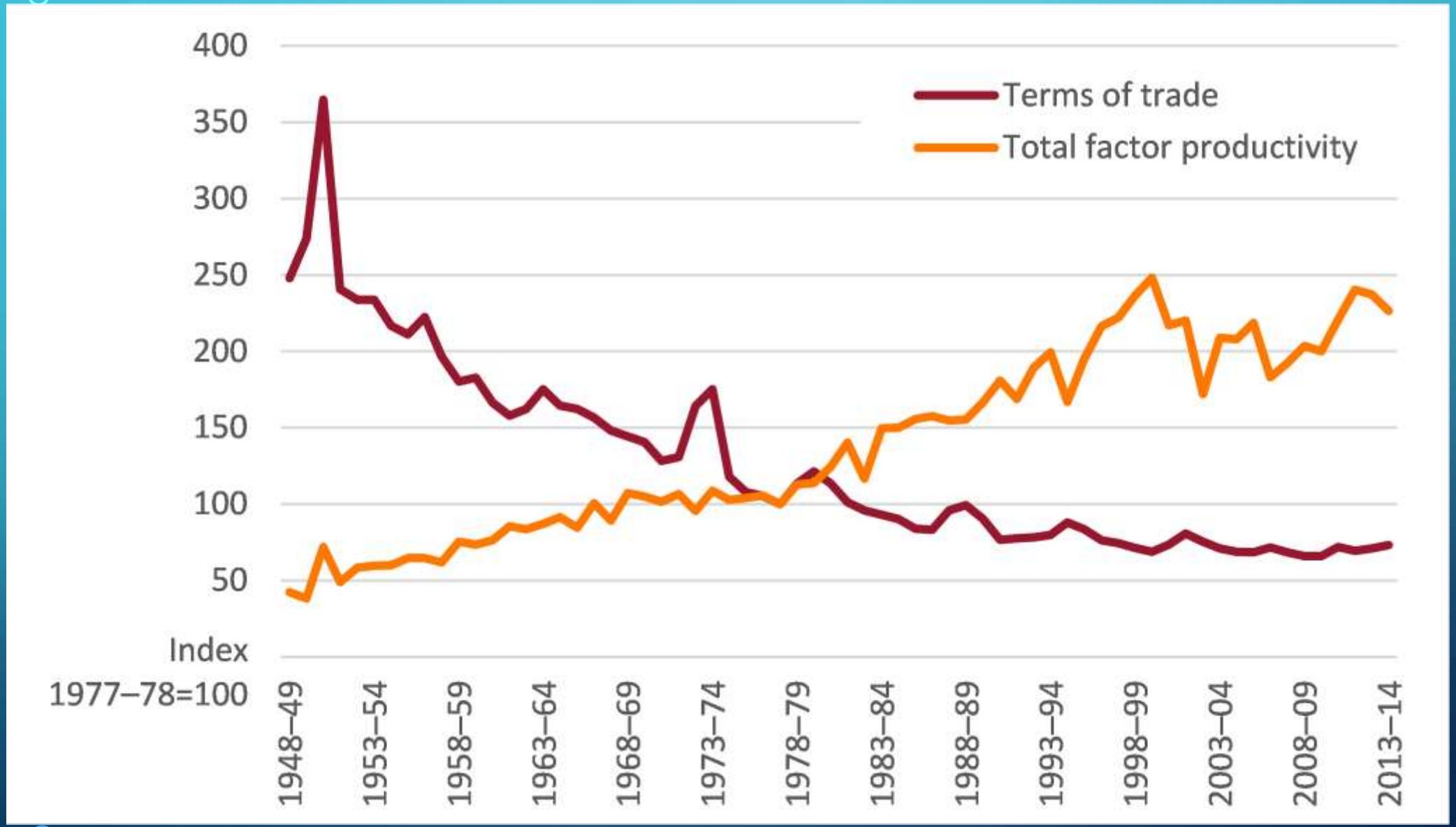
Giritharan, Ravichandran & Koteeshwari, R. (2016). Agricultural crop predictor and advisor using ANN for smartphones. 1-6. 10.1109/ICETETS.2016.7603053.

TYPICAL COSTS BEEF FARM, UK, 2016

	(£ per head output)				(£ per dwt kg output)		
Financial Performance (£ per head output)	Bottom Half	Average	Top Half		Bottom Half	Average	Top Half
Cattle output	1166.06	1190.23	1206.49		3.53	3.6	3.65
Other income	17.1	16.94	16.97		0.05	0.05	0.05
Gross Output	1183.17	1207.17	1223.46		3.58	3.65	3.7
Purchase costs	628.01	535.6	477.2		1.9	1.62	1.44
Output less purchase costs	555.16	671.57	746.26		1.68	2.03	2.26
Total variable costs (feed, health, bedding etc.)	380.18	317.71	278.2		1.15	0.96	0.84
Gross Margin	174.98	353.85	468.05		0.53	1.07	1.42
Cash Only fixed costs (labour, electricity, fuel, overheads etc)	224.62	239.45	250.56		0.68	0.72	0.76
Cash Only Cost of Production	1232.8	1092.77	1005.96		3.73	3.31	3.05
Cash Only Net Margin	-49.64	114.4	217.5		-0.15	0.35	0.66
Non-Cash fixed costs (depreciation, rent, finance, etc.)	211.87	181.69	164.64		0.64	0.55	0.5
Full Investment fixed costs	436.49	421.14	415.2		1.32	1.27	1.26
Full Investment Cost of Production (inc purchase costs)	1444.67	1274.46	1170.6		4.37	3.86	3.54
Full Investment Net Margin	-261.51	-67.29	52.86		-0.79	-0.2	0.16

Beef: cost of production benchmarks | AHDB

FARMER'S TERMS OF TRADE VS. PRODUCTIVITY



Productivity introduction - DAFF (agriculture.gov.au)

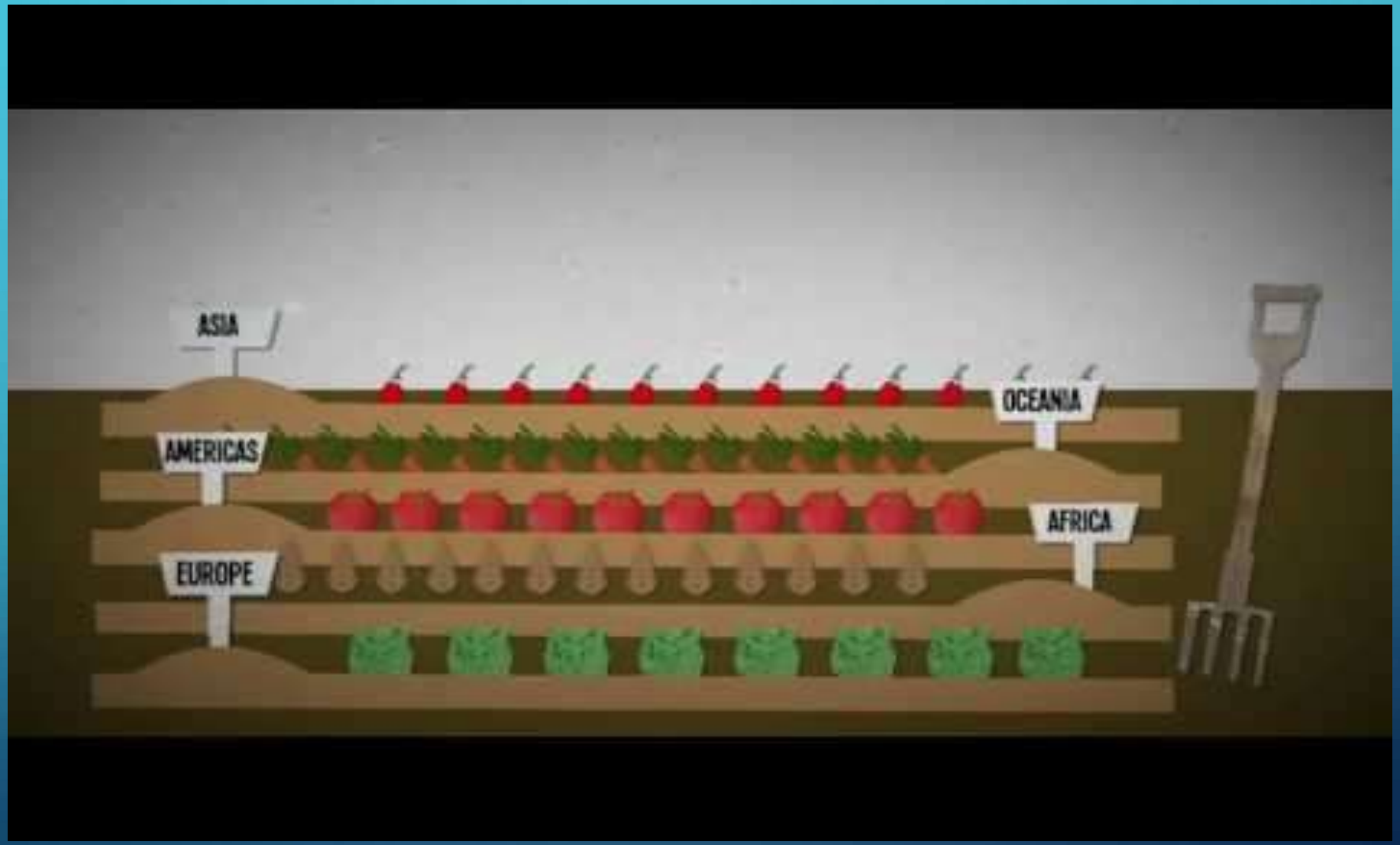
CHALLENGES

- Population – increasing human population and therefore demands for food
- Food security – social and economic dimensions
- Resource depletion and scarcity
- Environmental – adverse changes in the environment
- Economic/Value Chain – the long term declines in terms of trade for agricultural products

FOOD SECURITY

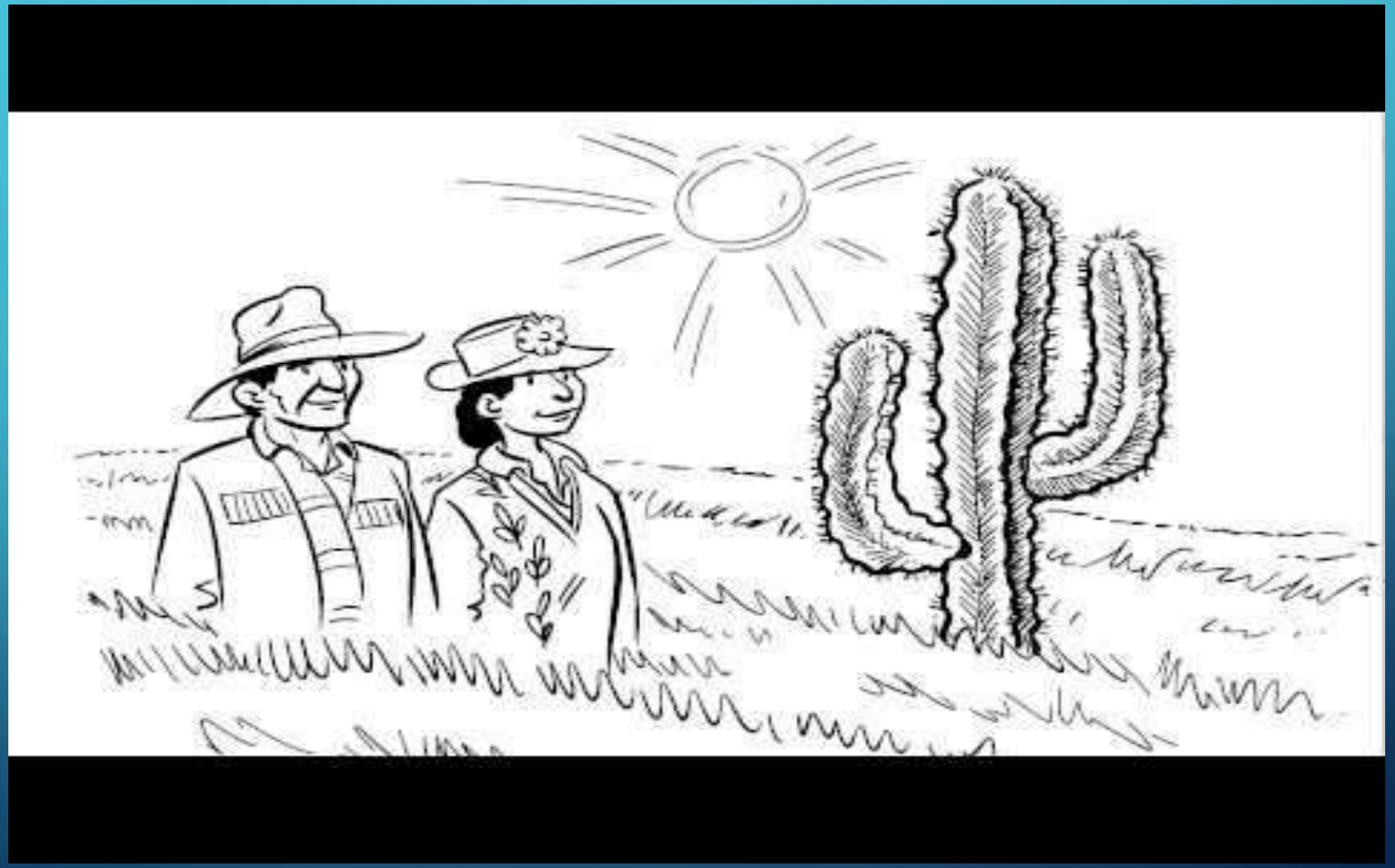
https://www.youtube.com/watch?v=VCYeLuURxRM

FOOD INSECURITY



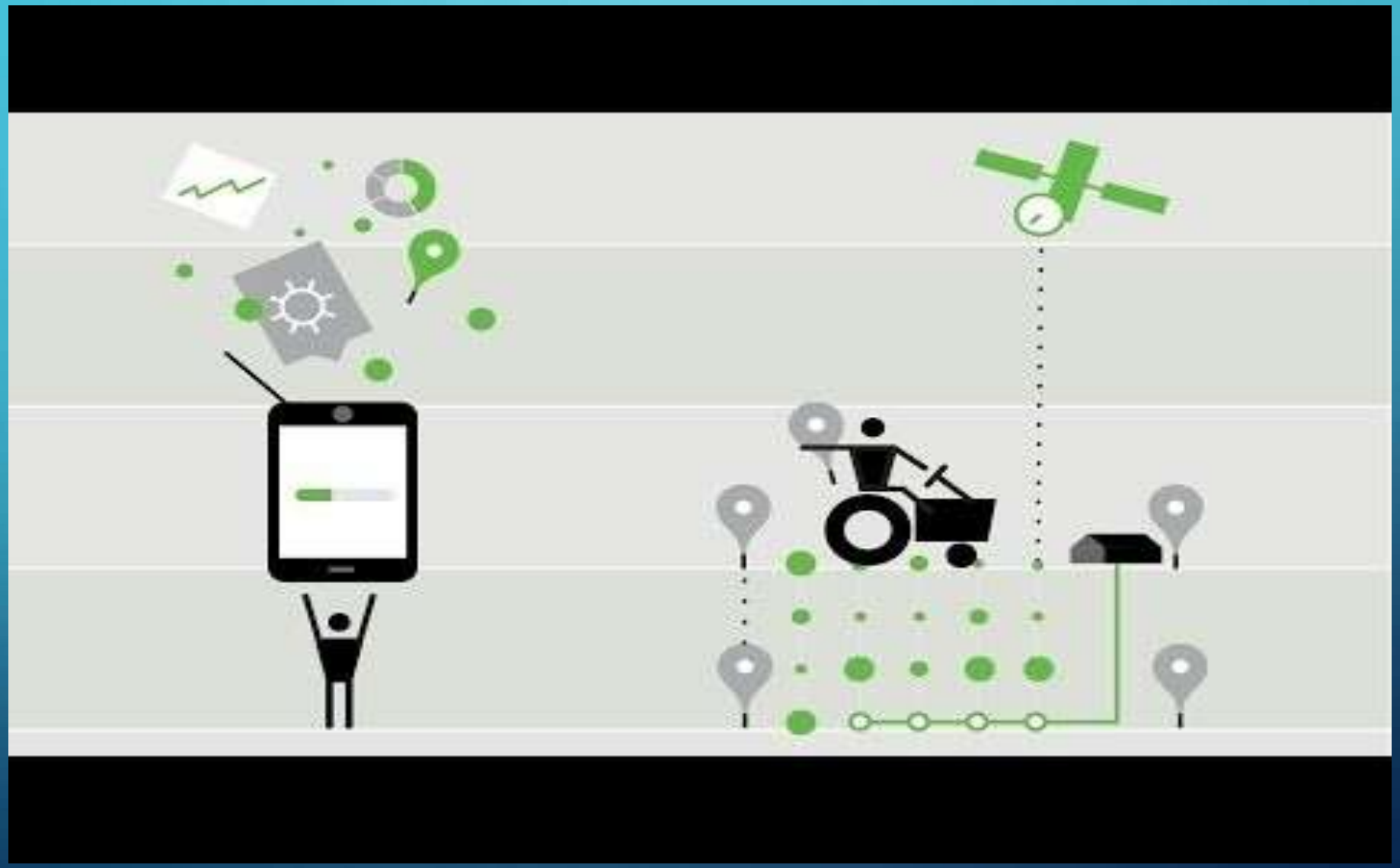
https://www.youtube.com/watch?v=z0J2VELZ4RU

CLIMATE CHANGE AND FOOD PRODUCTION



https://www.youtube.com/watch?v=cYq2elstFWQ

TECHNOLOGICAL ISSUES: ENGINEERING INNOVATIONS

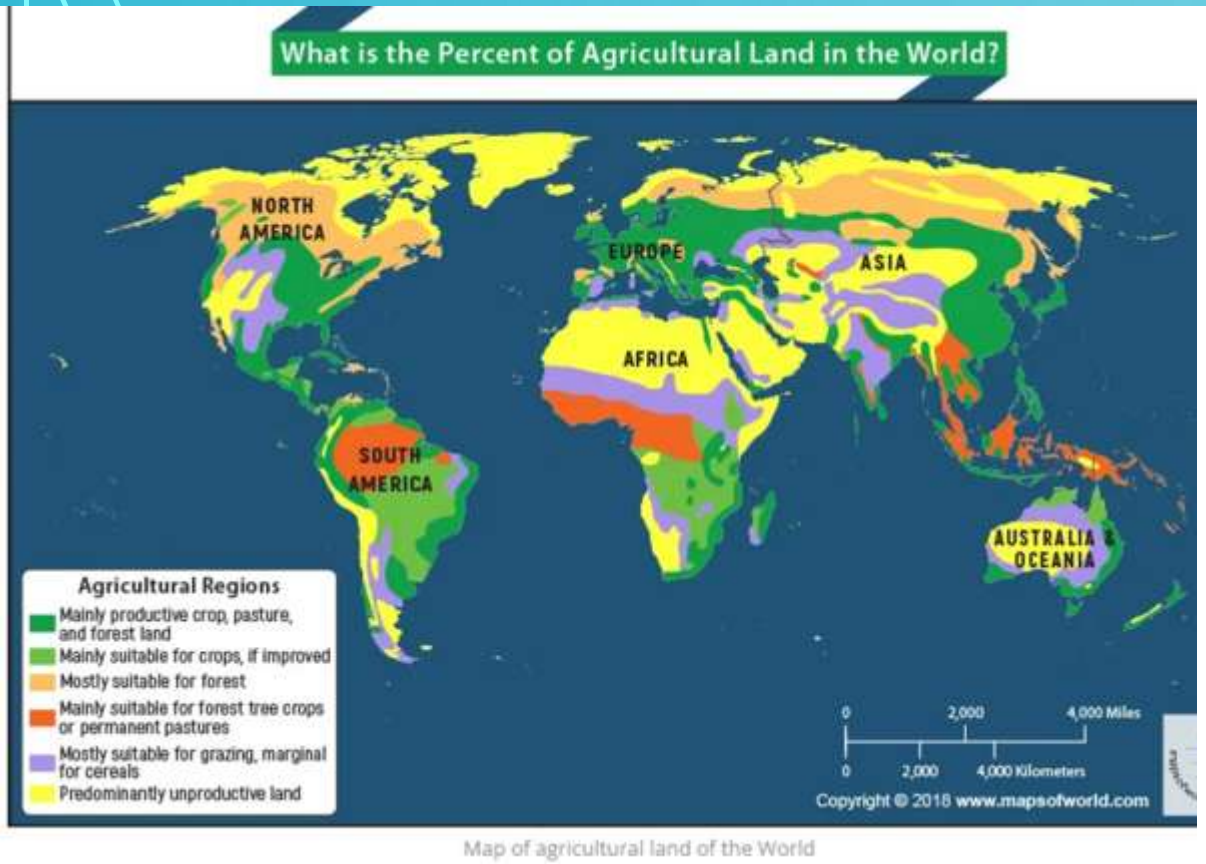


https://www.youtube.com/watch?v=tbkTi3zNN9s

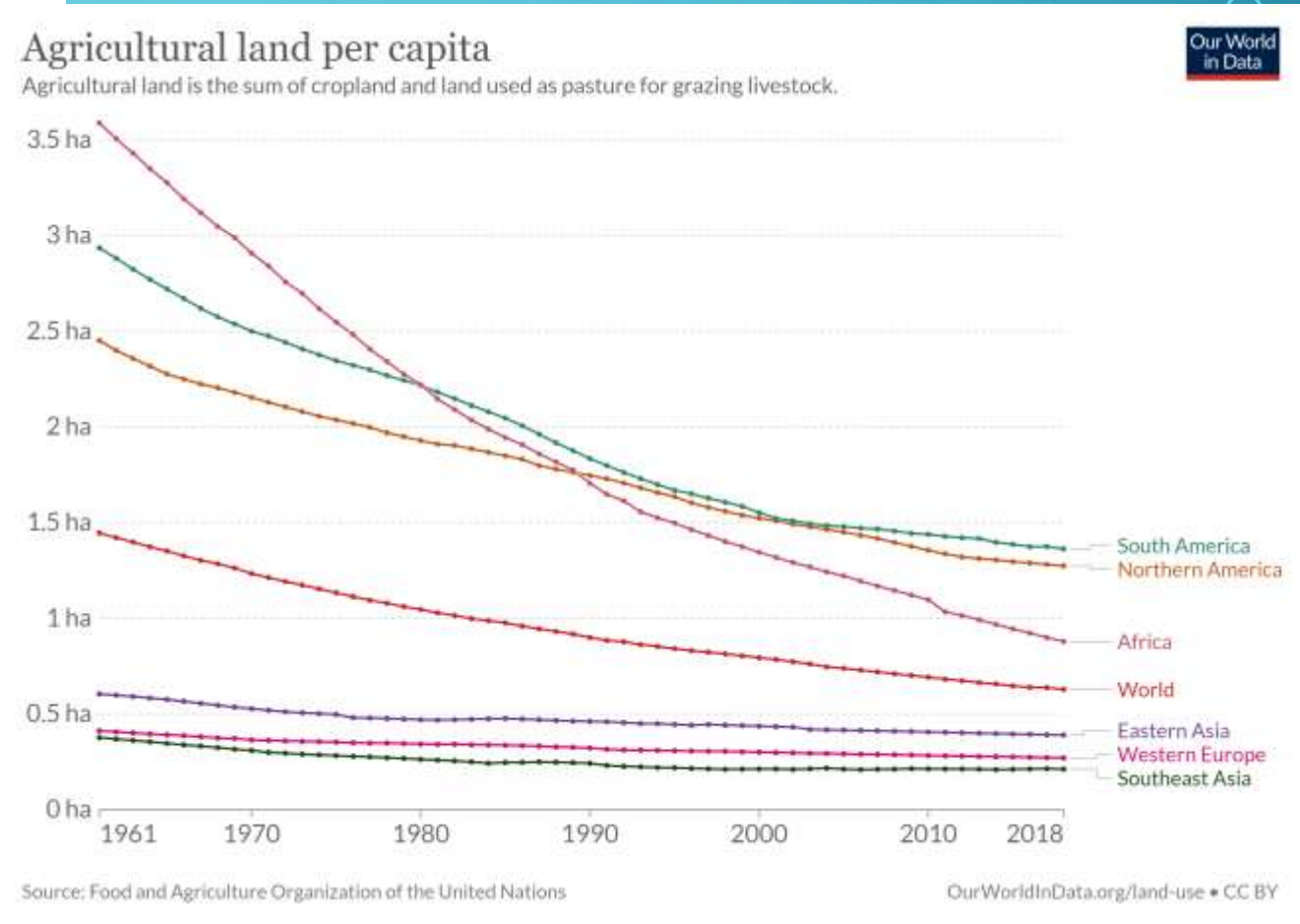
AGRICULTURAL PRODUCTION: NEEDS AND OPTIONS

- Increased production to meet population growth
- Increase area used for production: no possible
  - Large percentage of the world surface area simply not suitable for agricultural production
  - Available agricultural area per capita is steadily decreasing
- Increase in production efficiency
  - Substantial gains have already been achieved
  - Further gains will require the appropriate use of advanced technologies
  - Most promising are poorly performing areas of agriculture

AGRICULTURAL PRODUCTION: NEEDS AND OPTIONS

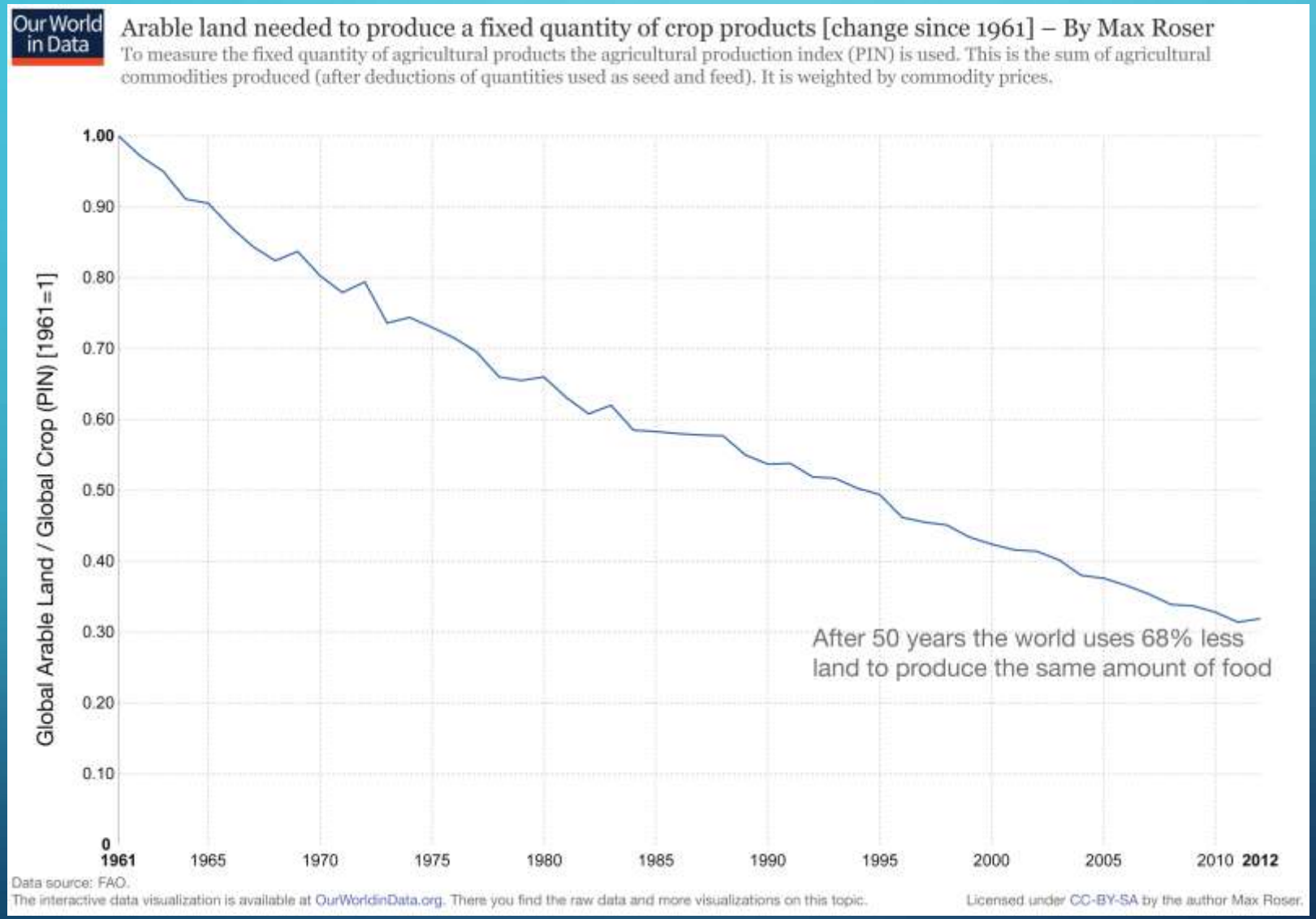


Map of agricultural land of the World



Map of agricultural land of the World - Answers (mapsofworld.com)
Land Use - Our World in Data

AGRICULTURAL PRODUCTION



Arable land per crop production index for the world, since 1961 (https://ourworldindata.org/land-use-in-agriculture/)

AGRICULTURAL PRODUCTION: FUTURE OF FARMING

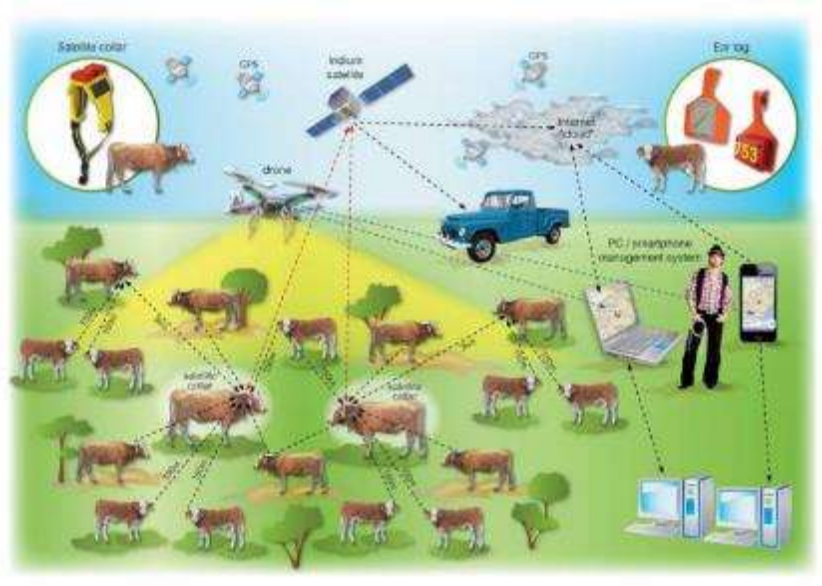
Lely bright farming solutions - YouTube

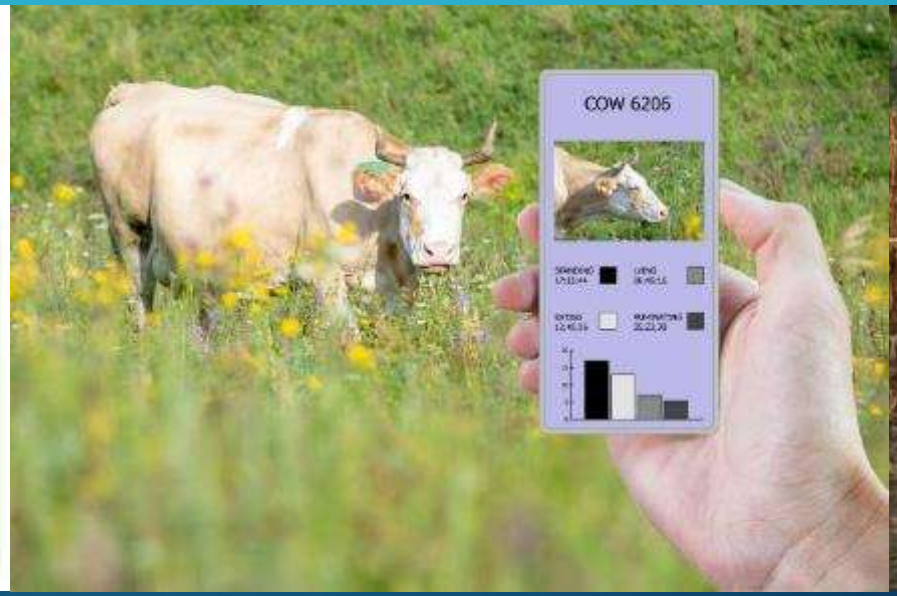
AGRICULTURAL PRODUCTION: FUTURE OF FARMING

https://www.youtube.com/watch?v=Xg27iMXwdV0

WHAT IS PLF?

Precision Livestock Farming (PLF) is aimed at enhancing farm profitability/efficiency, social acceptance and sustainability by improving on-farm acquisition, management and utilisation of INFORMATION that can be used to improve the management of various livestock species





http://www.ong2zero.org/en/blog/ict-for-farming-videos-and-sms-to-protect-livestock-in-senegal/
https://www.businesslive.co.za/fm/features/2019-01-31-connected-cattle-how-technology-is-benefitting-rural-sa/

SENSOR BASED SMART AGRICULTURE

- Helps to understand the underlining processes on farms and their importance on profitability and sustainability (social and environmental)
- Automatically measures and analyses key variables
- Sets optimum values for variables to be controlled
- Potentially develops automated (semi-automated) control procedures

https://www.roboticstomorrow.com/article/2014/12/robotic-farming-for-the-future/5238
https://start-life.nl/startups/agri/livestock-robotics/
https://www.youtube.com/watch?v=-XI4siKp-nU

SUMMARY AND CONCLUSIONS

- Historical developments in Agriculture
- Agricultural revolution
- The importance of agriculture
- Global status and trends in livestock production
- Needs and options to increase agricultural productivity
- Outline and explain the major challenges facing agriculture

- *A better use of SMART agricultural systems is needed*

AGRICULTURAL PRODUCTION: FUTURE OF FARMING

https://www.youtube.com/watch?v=dlnrvkzEv9w&list=PLn9gUqW6huXWZ7ZUTXeqZD7HzYJVhgmJn

AGRICULTURAL PRODUCTION: FUTURE OF FARMING

https://www.youtube.com/watch?v=Qmla9NLFBvU