Adaptation to Climate Change in Agricultural Systems

Climate Change –
Causes and Scenarios- 2o25

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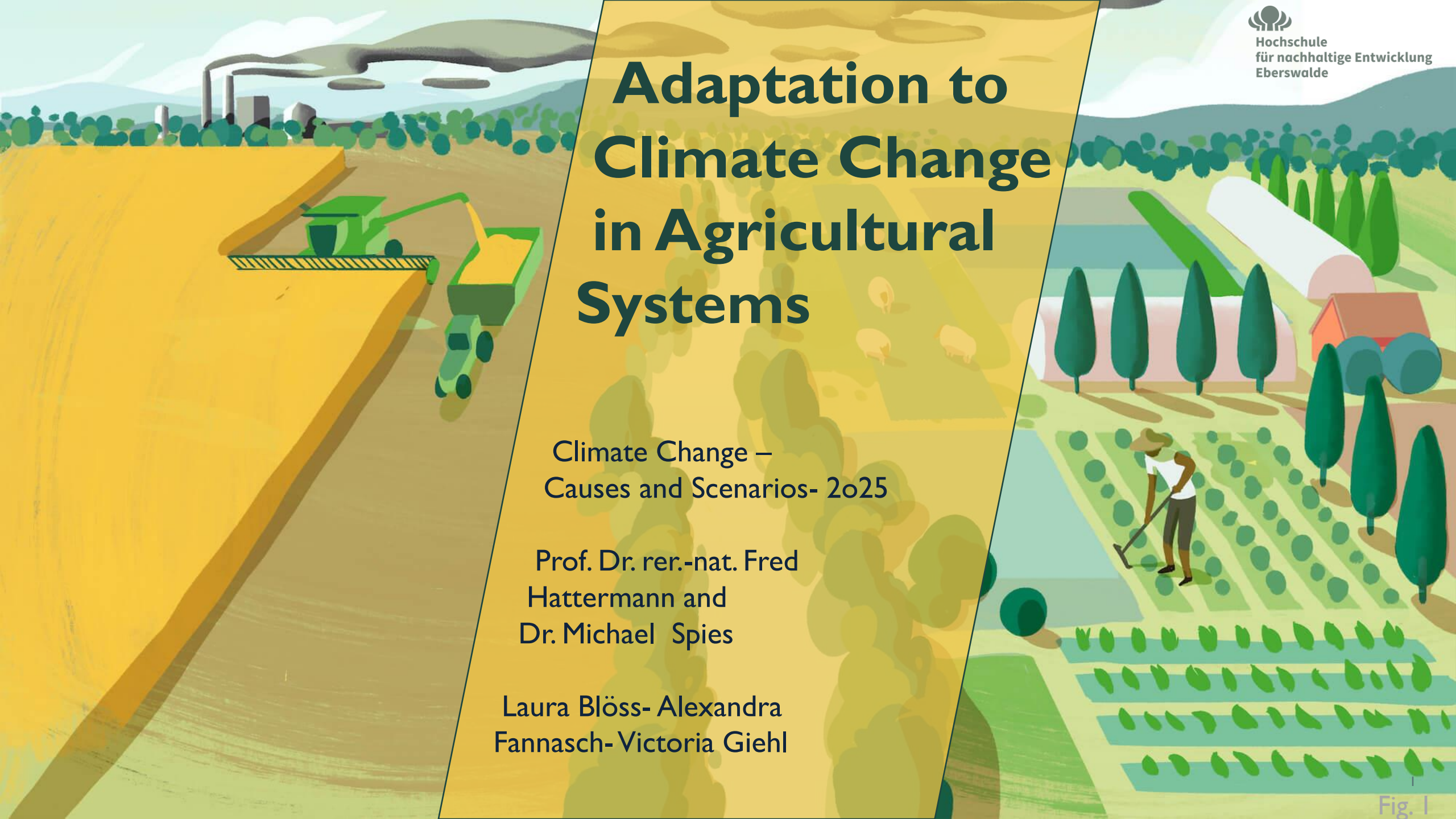
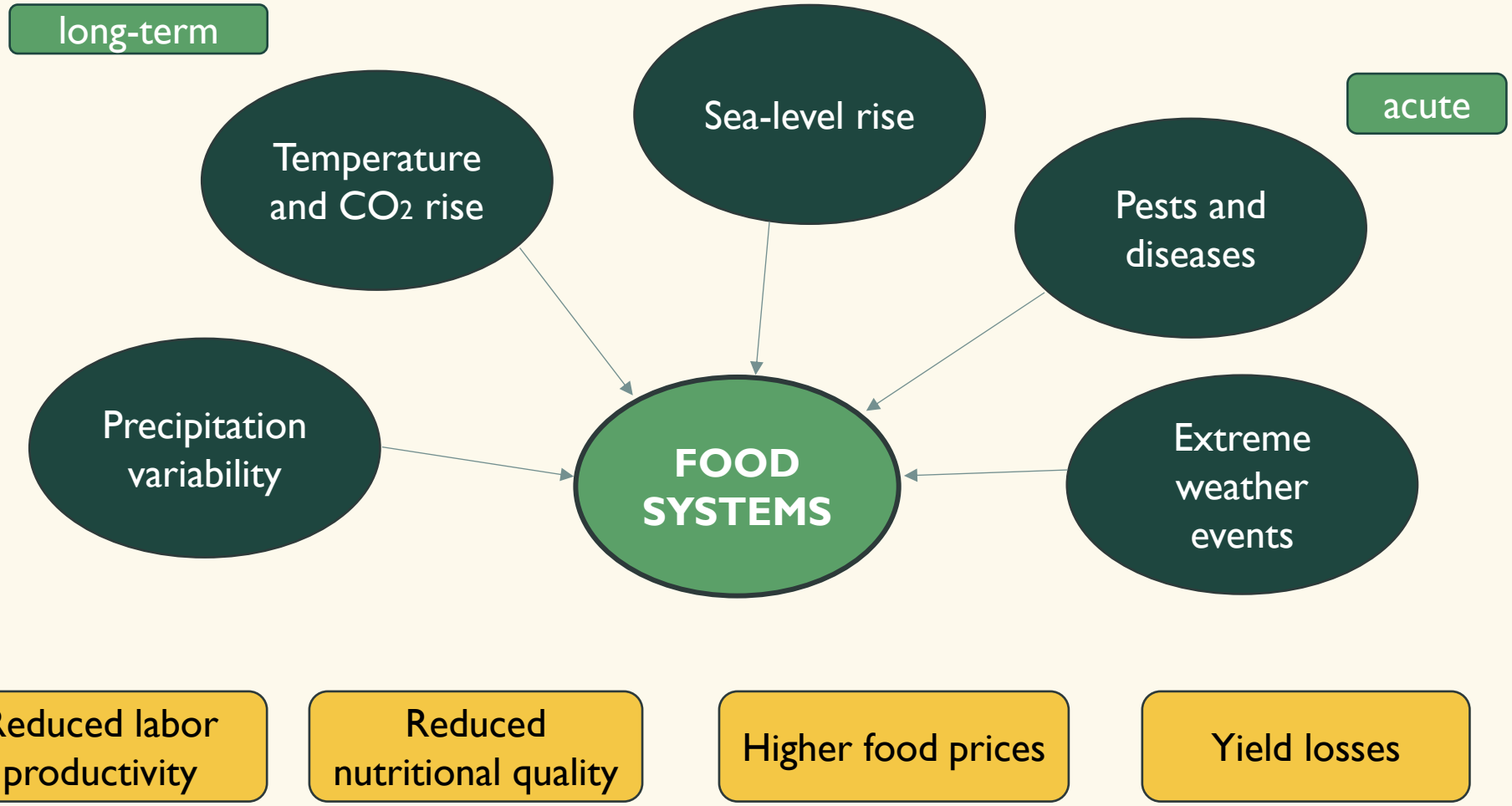


Fig. 1

Content

Impact on Food Systems

→ **multiple** & varied



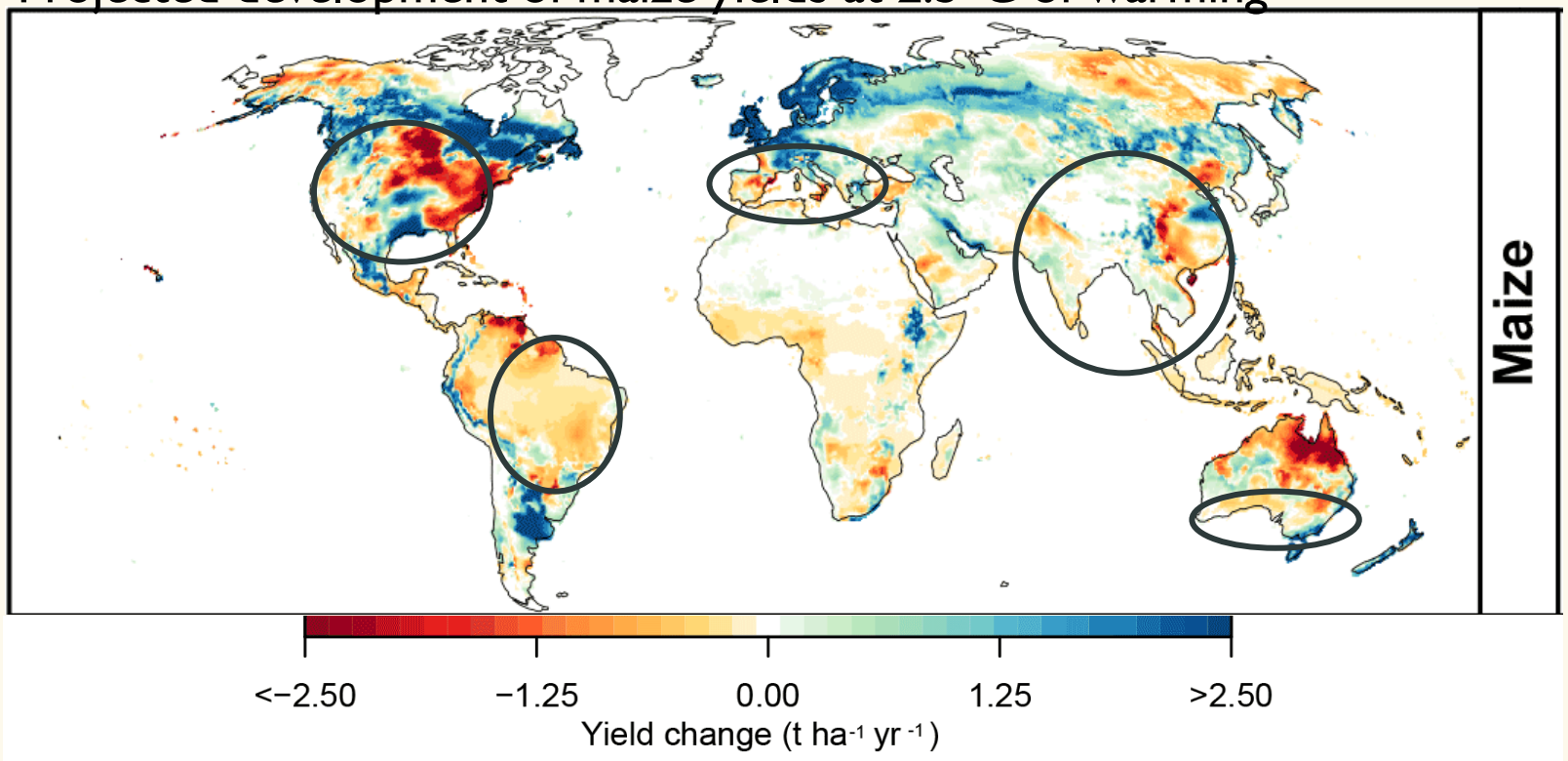
(IPCC 2022; Nelson et al. 2024)

Impact on Food Systems

→ multiple **& varied**

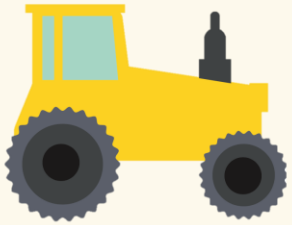
Projected development of maize yields at 2.5°C of warming

Fig. 2

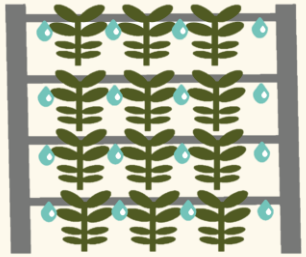


SSP5-8.5 SH: 40% decrease; NH: 20% increase
SSP1-2.6 SH: 25% decrease; NH: 10% increase

Fields of Adaptation



- **Geographical shift**
  - Towards the poles
- **Ground Management**
  - Soil conserving technologies
  - Agroforestry
- **Water Management**
  - Direct sowing, mulch sowing
  - Efficient irrigation
  - Rainwater harvesting



- **Crops and cultivation**
  - Breeding of resilient varieties
  - Crop diversification and rotation

Fig. 3

(European Environment Agency 2019)

Fields of Adaptation

- **Livestock farming**
  - Alternative feed sources
  - Improved grazing management

- **New Technology and Digitalisation**
  - Precision Farming
  - Early alert system
  - Indoor Farming

- **Education and Society**
  - Farm advisory system
  - Adaptation Networks

Fig. 3

(European Environment Agency 2029)

Agroforestry- an overview

Land-use systems where woody plants (trees or shrubs) are combined with crops and/or livestock on the same area, creating ecological and economic benefits through interactions between the components. (Nair 1993)

Silvopastoral

Fig. 4

Agrosilvopastoral

Fig. 5

Silvoarable

Fig. 6

Agroforestry

Advantages

- Soil protection
- Water quality
- Biodiversity
- Yield stability
- Sustainable energy
- Landscape aesthetics
- Income diversification

Challenges

- High establishment costs
- Higher management afford & costs
- Long-term capital & land use
- Competition between trees & crops
- Research needs

(DEFAF e.V. 2024; Schulz et al. 2020)

Indoor Farming

- Plant factory- usually with artificial lighting
- Farming in isolated environments
  - Greenhouses, container, warehouses
  - full control over environmental parameters (e.g. temperature or humidity)

Vertical Farming

Fig. 7

Hydroponics

Fig. 8

Aeroponics

Fig. 9

Aquaponics

Fig. 10

Indoor Farming

Advantages

- High predictability
- Low environmental risks
- Independent from location conditions
- High efficiency- water and space
- Short transportation distance
- Reduced chemical input
- All year production

Challenges

- High Investment cost
- High maintenance cost
- Requires high levels of knowledge
- Limited product variety
- Surface sealing

Framework Conditions

Political	Economical	Social and cultural	Technological and infrastructure
• **Subsidies & incentives** • Policies • Education & advisory services	• **Climate risk insurance** • Market access • Investment & financing options	• **Awareness & acceptance** • Local community involvement • Education & knowledge transfer	• **Access to technology** • Research & innovation

(BMEL 2020; Anwar et al. 2013)

Limits to Adaptation

"soft" limits

options are currently not available to avert intolerable risks through adaptive action

- Lack of know-how
- Financial constraints

"hard" limits

no adaptive actions are possible to avoid intolerable risks

- Lack of freshwater resources

Space for adaptation is limited!
The effectiveness of adaptation will decrease with increasing warming.

(Wallimann-Helmer et al. 2021; IPCC 2022)

Thank you for your attention!!

Fig. 11

„Should adaptation in agriculture focus more on high-tech solutions like indoor farming, or should we strengthen traditional, nature-based approaches like agroforestry?"

Literature

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Figures

Fig.1: Titel Picture, in: https://biologix.co.nz/blogs/news/how-well-is-the-term-regenerative-agriculture-understood [20.03.2025].

Fig. 2: Yield change of maize, in: https://esd.copernicus.org/articles/9/479/2018/esd-9-479-2018-f06.pdf [20.03.2025].

Fig.3: European Environment Agency (2029). Climate change adaptation in the agriculture sector in Europe. ISBN 978-92-9480-072-5

Fig..4: Silvopastoral, in: https://paranawood.com.br/en/silvopastoral-system-can-help-those-who-want-to-start-planting-forests/ [20.03.2025].

Fig.5: Agrosilvopastoral, in: https://agribrasilis.com/2021/04/14/sistemas-agrossilvipastoris-aportam-carbono-aos-solos-atraves-da-diversificacao-sustentavel/ [20.03.2025].

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Fig.7: Vertical Farming, in: https://www.gruenkauf.de/2021/06/14/vertical-farming-was-steckt-dahinter/ [20.03.2025].

Fig:8: Hydroponics, in: https://www.marlohydroponics.com/what-is-hydroponics-and-why-is-it-a-good-idea-2/ [20.03.2025].

Fig.9: Aeroponics, in: https://www.securities.io/de/aeroponics/ [20.03.2025].

Fig.10: Aquaponics, in: https://www.rekubik.de/magazin/effektives-ebbe-flut-system-fuer-die-aquaponic-anlage/ [20.03.2025].

Fig. 11. https://biologix.co.nz/blogs/news/how-well-is-the-term-regenerative-agriculture-understood [20.03.2025].