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AI IN AGRICULTURE: EXPLORING THE PROMISES AND PERILS OF AN AI-ENABLED GREEN TRANSFORMATION IN THE PHILIPPINES

SOPHIA FALK

Bonn Sustainable AI Lab, Institute for Science and Ethics, Rheinische Friedrich-Wilhelms-Universität Bonn, Germany

IWE Institut für Wissenschaft und Ethik

UNIVERSITÄT BONN

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INTRODUCTION

Who am I

- **PhD Candidate Bonn Sustainable AI Lab, 2022**
- MSc ‘Environmental and Resource Economics‘, 2022
- BA ‘International Culture and Business Studies‘, 2019
- **Research:**
  investigating if addressing the climate crisis with technological solutions such as AI achieves a sustainable sociotechnical transformation

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AGENDA

Shaping the Green Transition with AI

Role of the Agricultural Sector

Agricultural Sector & Climate Change

Digital Agriculture

Potentials

Risks and Limitations

Policy Recommendations

Conclusion

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SHAPING THE GREEN TRANSITION WITH AI

IN THE PHILIPPINES

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GREEN TRANSITION WITH AI

Environmental administration

- decision-making, management and monitoring of environmental policies

Circular Economy

- Efficient resource allocation & utilisation

Carbon neutrality

- AI in the energy sector
- AI in the transport sector
- AI in the agricultural sector

GREEN TRANSITION WITH AI

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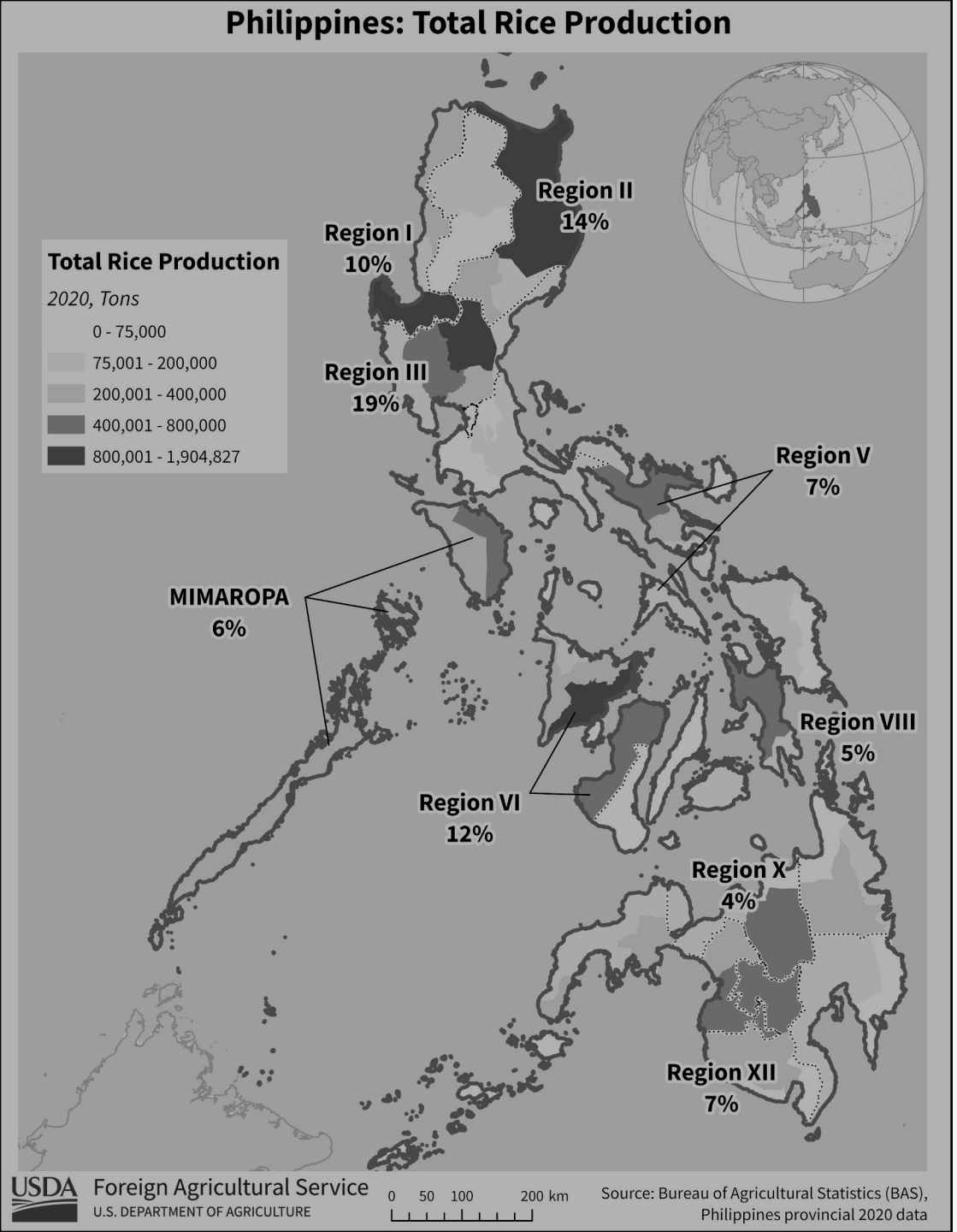

ROLE OF THE AGRICULTURAL SECTOR IN THE GREEN TRANSITION

A SECTOR OVERVIEW

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THE AGRICULTURAL SECTOR

socio- economic aspects

- 24% of Philippine population work in the agricultural sector [31]
- Agricultural land accounts for 42% of total land area (126,750 sq.km) [37]

Most produced crops [36]

- Sugarcane (26.28 million metric tons)
- Palay (rice) (19.96)
- Coconut production (14.72)
- Banana (9.09)

World market:

- Second leading exporter of pineapples (560 000 tonnes) [14]
- Second leading exporter of coconut (23,1% of global production) [13]

Inflation [7]

- Food prices increased by 8.1% year on-year in August 2023
- Reason: El Nino, export ban (India, Myanmar)

THE AGRICULTURAL SECTOR

Impact of Climate Change on Agriculture

- increasing prevalence of typhoons, intensification of monsoons, slow moving tropical cyclones, drought
- **During dry season:**
  - notable decline in precipitation events
  - Requires more irrigation
- **During rainy season**:
  - significant increases in maximum five-day precipitation (especially northwest and central Philippines)
  - Severe damage to the crop (end of crop cycle)
- **Agricultural sector is highly vulnerable to climate change**
- Climate change is disrupting planting calendar, crop quality, and food security (inflation)

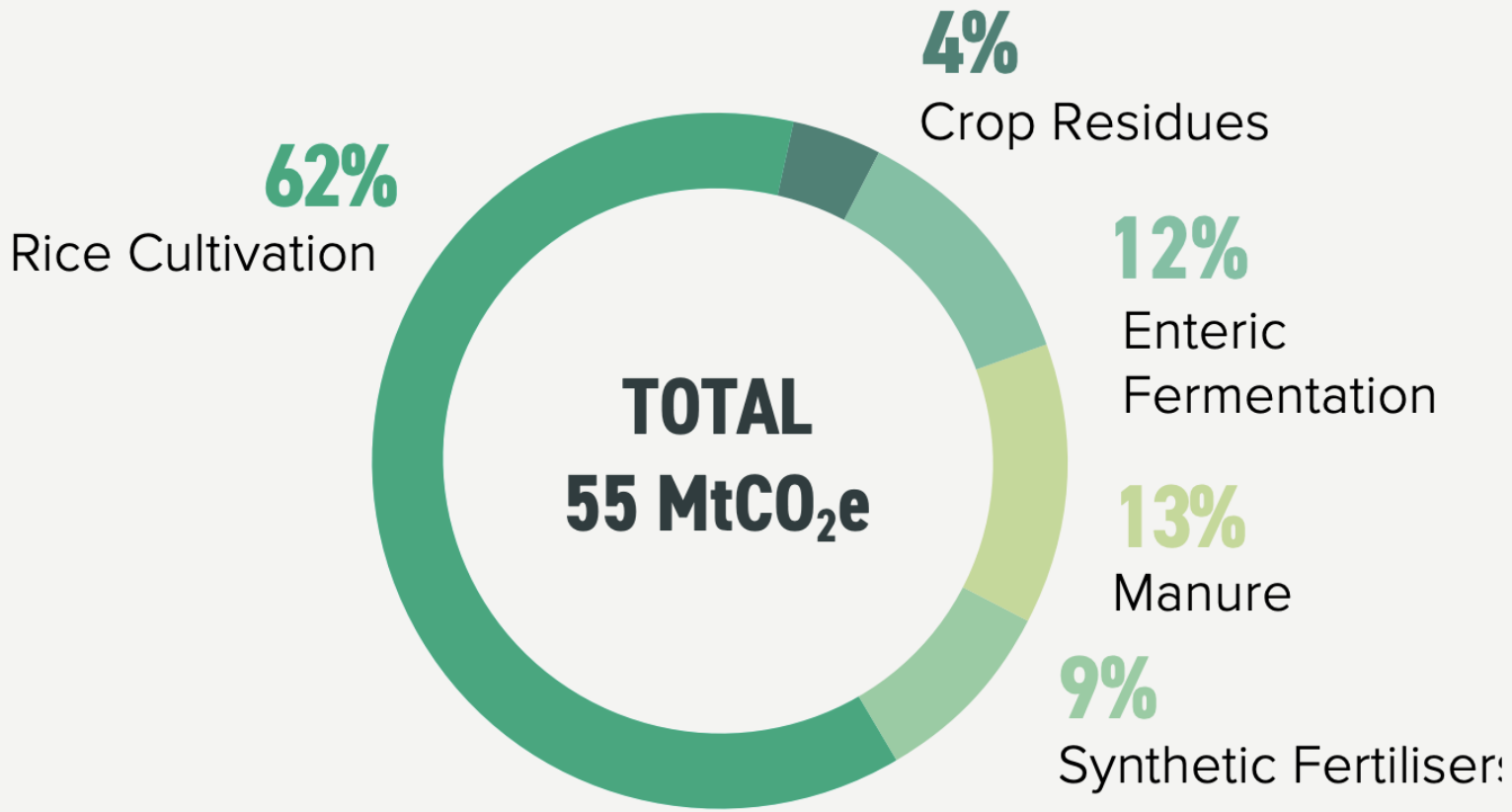

Manish Swarup / AP Photo

THE AGRICULTURAL SECTOR

Agricultural Impact on Climate Change

- **Global emissions**
  - 9.3 billion tonnes of CO2 eq. [12]
  - 21-37% of global GHG emissions [30]
- **Asia and Pacific region**
  - responsible for the largest share of GHG emissions associated with agriculture → 90% of rice production [2]
  - Methane from rice production = 12% of global methane emissions (1.5% of total global GHG) [25]
  - 10% of global cropland nitrous oxide from rice fields (fertilizer) [24]
- **Reason**
  - Growing Population (worldwide and SEA) [2,30]
    → Synthetic fertilizer & increasing energy consumption

Emissions from the agricultural sector of the Philippines



Data for 2017. Source: FAO, 2019

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POTENTIALS

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Potentials

Director of the Bureau of Plant Industries, Gerald Glenn Panganiban, is advocating for „*the strengthening of digital agriculture in the Philippines to further develop the sector*“ [29].

Digital agriculture: the use of digital technologies to make farm operations more insightful and efficient

- automated techniques, AI, IoT, etc.
- gathering and analysis of agricultural data, decision support systems in farming applications, wireless sensor networks, network-connected weather stations, monitoring cameras, drones, etc. [6, 8, 30, 33, 42]

→ enhances resource management & optimized production

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Potentials

- **Image collection (drones)** – status of soil, e.g. nutrient deficiency, soil moisture
  - Fertilize & irrigation recommendations
  - Can reduce unnecessary fertilizer use by 80%
  - Decrease expenditure on pesticides & herbicides by 90% [8, 33,40]
- **"XARVIO"**
  - In Europe: 30% reduction in fungicide application
  - In Brazil: 61% reduction in weed spraying - reducing herbicide and water consumption by 2/3 [34]
- **Optimizing irrigation and harvest** pattern depends on accurate weather information – adopt harvest calendar based on AI data analysis

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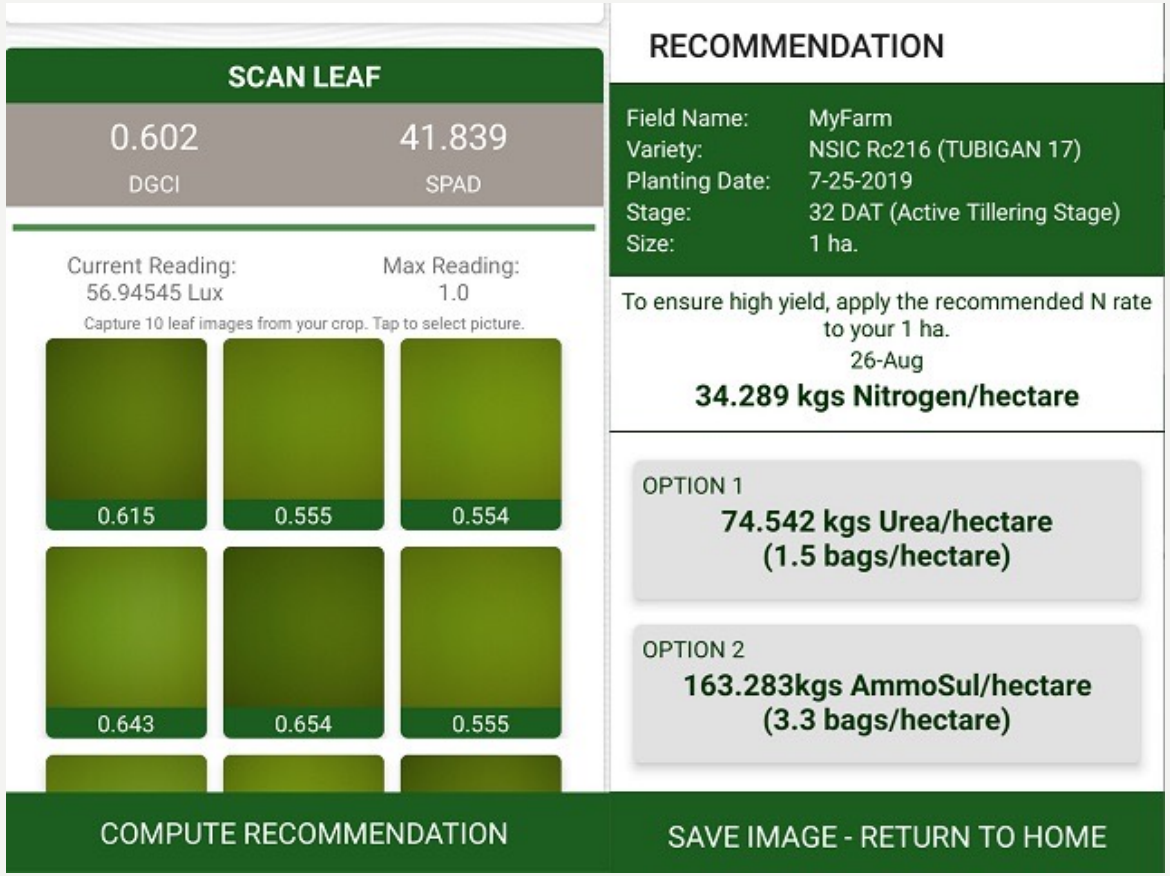
Example **PhilRice LCC App**

- Department of Agriculture-Philippine Rice Research Institute (DA-PhilRice) developed the free PhilRice Leaf Color Computing Application [3]

- Nitrogen fertilizer is important in rice production and has to be applied several times during the growing season to ensure that the crop's nitrogen need is supplied, particularly at critical growth stages.

→**The app** assesses nitrogene status of the rice plant & generates nitrogen fertilizer recommendations [3]

PHILRICE LCC APP



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RISKS AND LIMITATIONS

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ILO Asia-Pacific (flickr)

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Country-specific Risks and Limitation

- **ITC literacy presumed**
  - Aging rice farming communities (average farmer 55-59) [16]
  - High access to ICT =/= high usage
  - Digital divide
- **AI applications focus on large scale farming systems**
  - average size of a farm in the Philippines, mostly small-scale family farms, is 1.29 hectares
  - 38% are under half a hectare [32]
- **Digital farming is costly**
  - acquisition of advanced and modern farm tools and equipment remains a privilege

ILO Asia-Pacific (flickr)

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Country-specific Risks and Limitation

Development focus of AI "blind spot of Western technologies" [18]

- Focus on widely grown crops (wheat, maize, rice) in industrialized agricultural areas and climate conditions
- Usage in different climatic conditions may lead to unsustainable intensification of irrigation or fertilisation

Careful considered which models are selected [21]

In the Philippines, seasonality is very strong → analysis by an AI system is more meaningful if regional seasonal values are used [21]

Climate conditions unique to its context and dissimilar to the Northern/Western countries

- Pacific ring of fire, Pacific typhoon belt, the possibility of flash floods, droughts, volcanic eruptions, and regional pest infestations

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System-specific Risks and Limitations

Fairness

- actively promote social justice, uphold principles of equity and non-discrimination
- advantages offered by AI technologies are open and attainable for everyone [39]
- In farming context: power imbalance that grant privileges to a particular group (access or control of farm data) [28,40]

Transparency

- the extent to which humans can comprehend the outcomes generated by AI algorithms
- AI tools used for the assessment and management of carbon dioxide in production facilities: Farmers should be able to challenge the given assessment of their carbon footprint, in case they believe the decision was unjust or inaccurate [6, 39].

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System-specific Risks and Limitations

Accountability

- lack of legal and policy transparency or clarity on who or which organization will be held accountable for any mismanagement, errors, or wrong decisions/recommendations made by the AI systems [39, 42]
- Example: AI irrigates crops too much resulting in loss of harvest – who is responsible? [6]

Privacy

- Data collection, utilization, sharing, archiving, and deletion[39]
- Concern: control over data – what data are collected, how are they used, with whom shared? [6]

Darwin Laganzon / Pixabay

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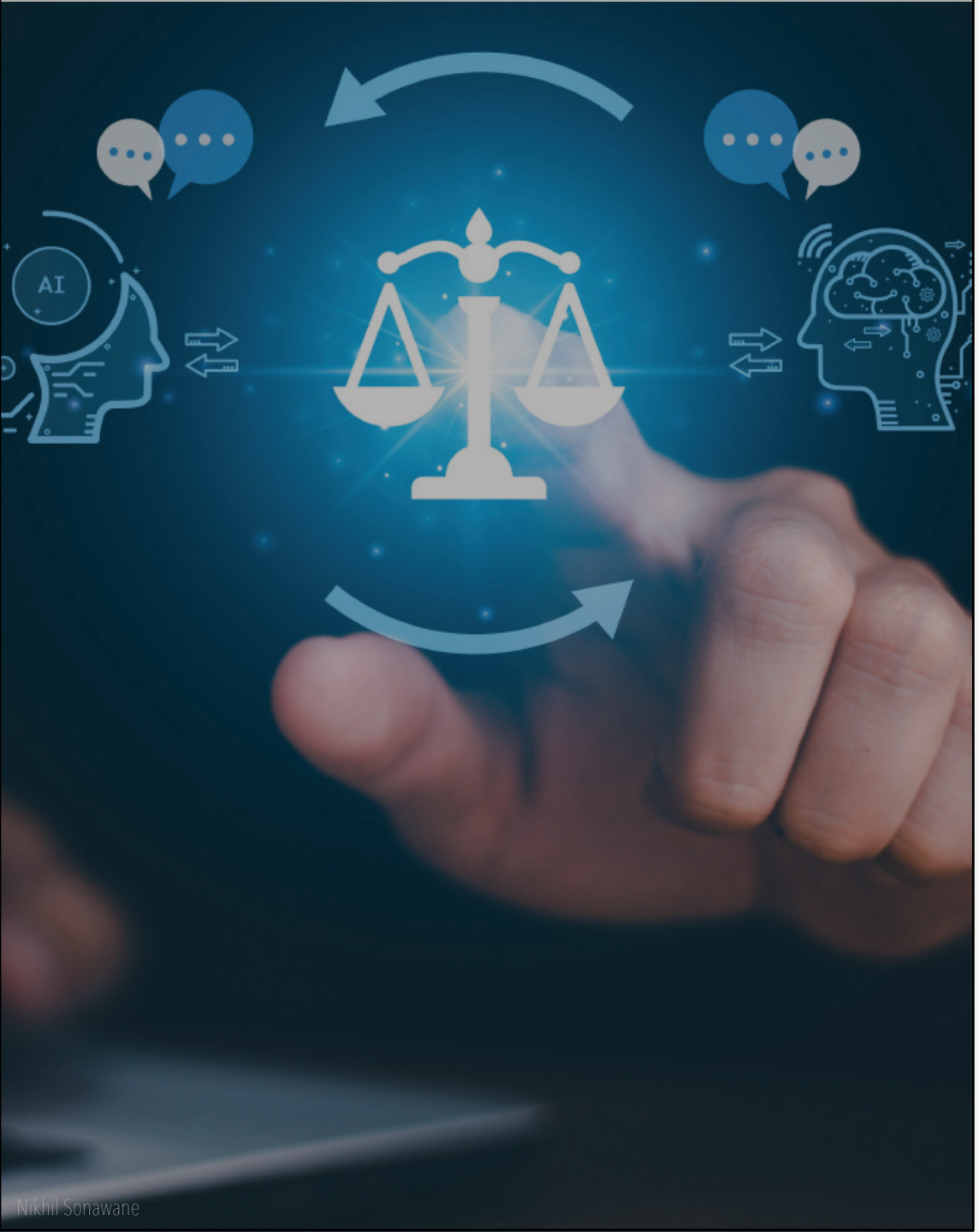
System-specific
Risks and Limitations

Robustness

- Reliability and performance of the system [27]
- **Software:** security threats (hacking) require defence mechanisms
- **Hardware**: farm equipment work properly and reliable

Example: in large-scale livestock industry, milking dairy cows is performed every day by automatic equipment.

→ In the event of an abrupt technological malfunction, manually milking hundreds of cattle becomes unfeasible →risk to the animals' welfare & financial harm to farmers [27, 35]



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Policy Recommendations

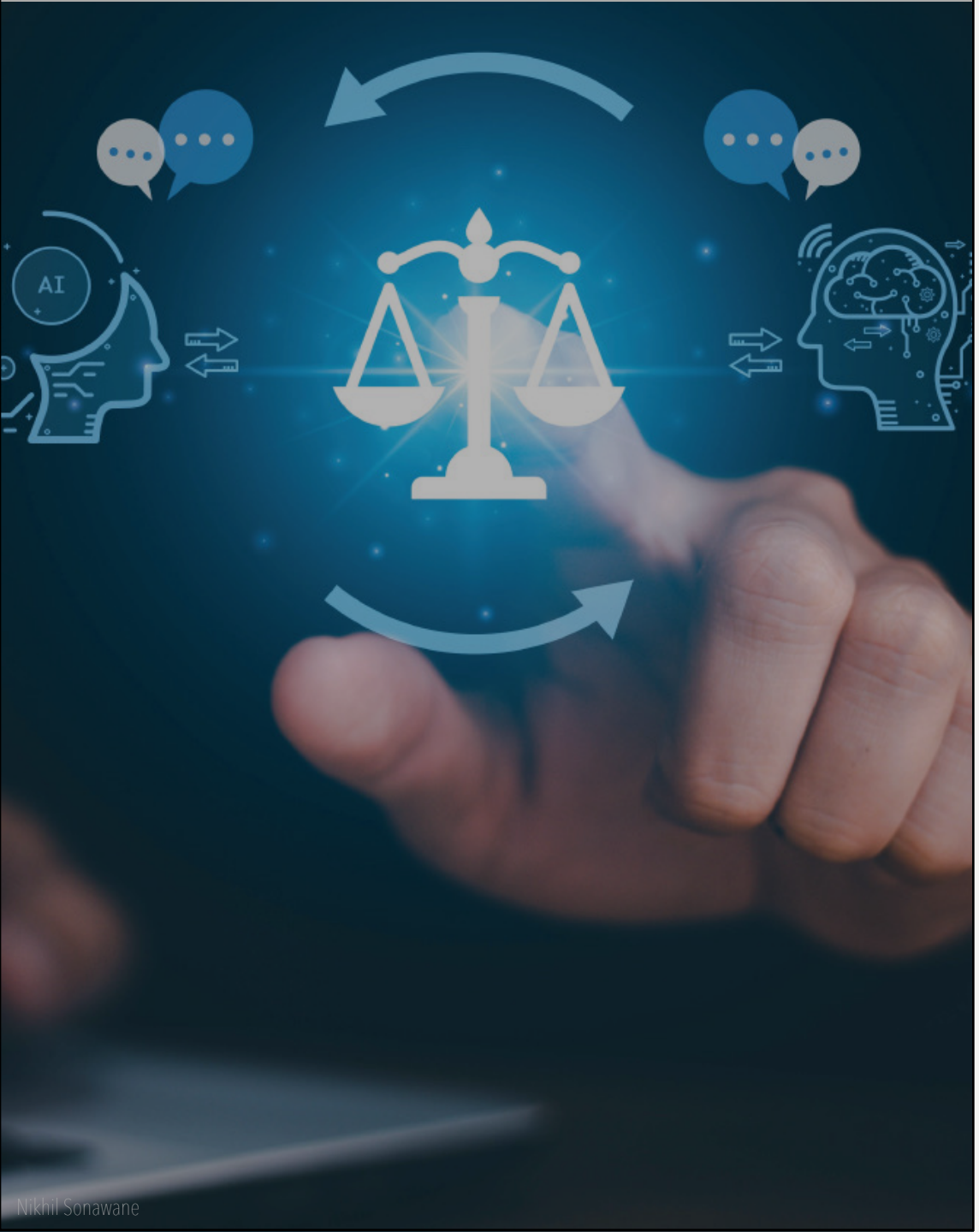
Policymakers play a key role in supporting "ethical and responsible AI" innovation for digital agriculture [27]

- Ensuring fairness, explainability, privacy, promoting digital literacy, and ensuring affordability

Philippine Secretary of Agriculture William D. Dar opens (2022) the Precision and Digital Agriculture Centre (PreDiC) to bring in the latest precision and digital agriculture technologies and [20]:

- *"help[ing] the lives of the community"*
- adapt digital agriculture to the Philippine setting to further improve agricultural production in the country

→ is the responsibility of the PreDiC centre and the department of agriculture to ensure and enforce ethical and responsible innovation in digital agriculture?



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Policy Recommendations

Identifying and assessing the vulnerabilities in the domestic social-ecological systems can increase the accuracy level and success of adopting AI systems:

- **Unfamiliarity** makes farmer uncomfortable working with new technologies [8]
  → the governance should provide training sessions for farmworkers to help them gain the right skills
- **Farmers should be invited** to take part in user studies and usability testing of the technology
  → ensure the usefulness and enhance user-friendliness of the tool
- **Brochures and guidelines** in a straightforward and understandable way → farmers are encouraged to use the resources and the technologies [6]
- **Equity and Inclusivity** → nurture the development of a digital ecosystem for AI technologies with small- scale farming in mind [6,27]

CONCLUSION

Digital agriculture presents a duality of promises and perils. Amidst the challenges posed by climate change, every sector must not only curtail its ecological impact but also seek resilience in the face of shifting climatic patterns.

Digital farming emerges as a potent ally in addressing both imperatives.
As our world undergoes relentless digitization, and data proliferates ceaselessly, the adoption of digital farming solutions becomes an inevitability. Therefore, policy must pave the way to maximize the benefits of the green transformation for all.

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Sophia Falk

falk@iwe.uni-bonn.de

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