TEEB AgriFood Thailand

Measuring what matters in sustainable rice production

Funded by the European Union

TEEB
The Economics of Ecosystems & Biodiversity

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FACULTY OF ECONOMICS, KHON KAEN UNIVERSITY

eei
Economy and Environment Institute
LOWER MEKONG SUBREGION
A member of the Economy and Environment Partnership for Southeast Asia (EEPSEA)

TEAM INTRODUCTION

TEAM MEMBERS

Phumsith Mahasuweerachai 01
Behavioral Economics and Valuation

Voravee Saengavut 02
Spatial analysis Expert

Jakrapun Suksawat 03
Ecological Economics

Piyaluk Buddhawongsa 04
Economincs Expert

Warong Sukavate 05
Quantitative Ecologist

Tanapipat Walalite 06
Landscape Ecologist

Nittaya Cha-oon 07
Soil, Climate Change, and GHG Expert

Phasita Toonsiri 08
Soil, Climate Change, and GHG Expert

Atcharapron Phakdee 09
Ecology and Management of Natural Resources Expert

Nuchanat Chamchoi 10
Pollution and Environmental Management Expert

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BACKGROUND

Why rice matters

#1

Rice cultivation area extends **more than 50%** of agricultural area in Thailand.

#2

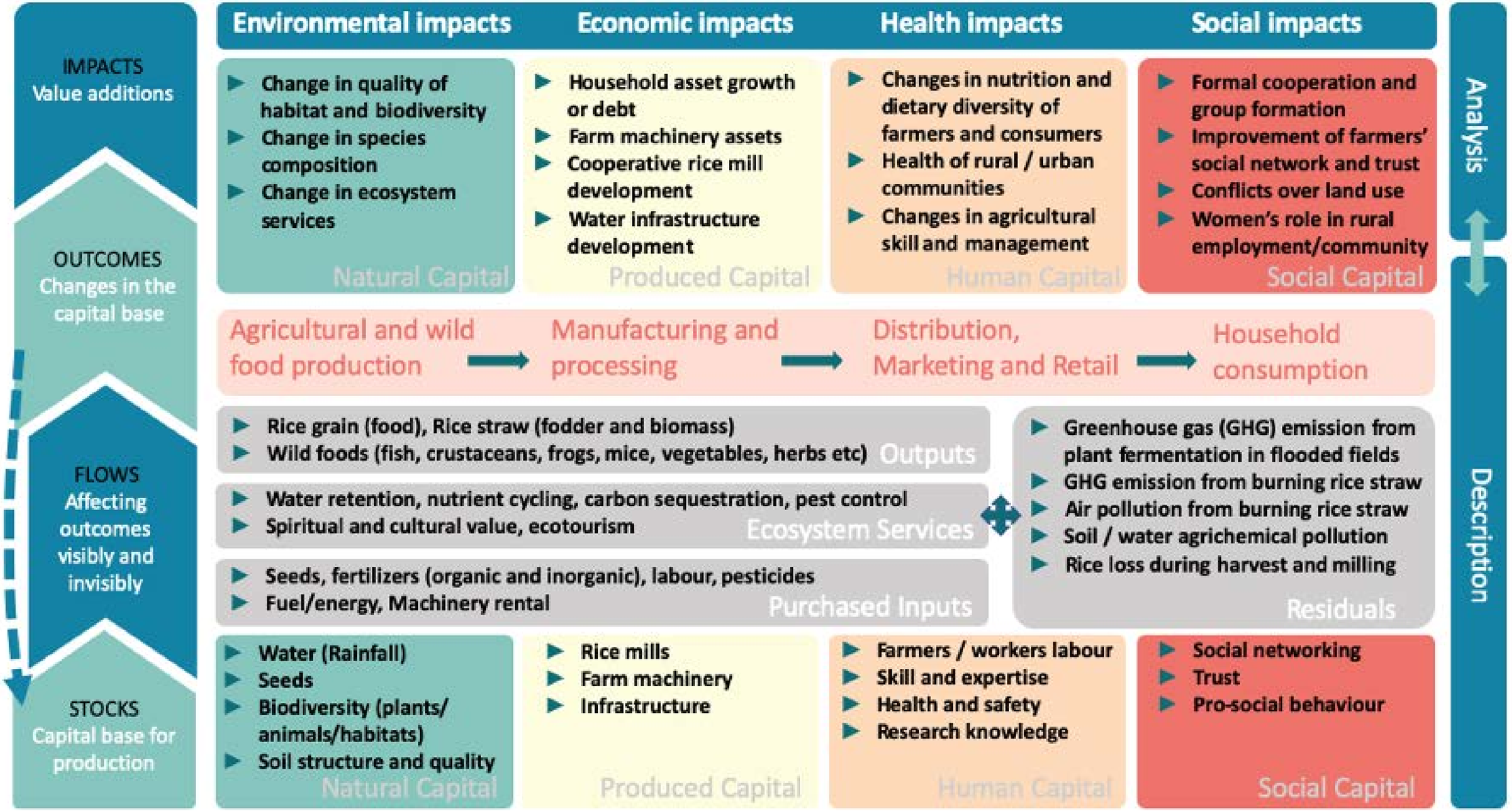
The number of rice farmers is approximately **20%** of the Thai nation's households.

#3

The number of rice farmers is **over 50%** of the agricultural households.

#4

For decades, Thailand has been one of the top three rice exporters in the world.



Adapted from TEEBAgriFood Evaluation Framework (UNEP, 2018)

The issues from the conventional rice practice (CRP) in Thailand

ECONOMY AND SOCIAL SIDES

- **High costs** of production
- **Low** level of **productivity**
- **Low profit** in rice farming
- Unstable income, leading to **increased levels of debt**
- Using pesticides and chemical fertilization that are not appropriate, leading to **negative effects on farmers' health**

ENVIRONMENT SIDES

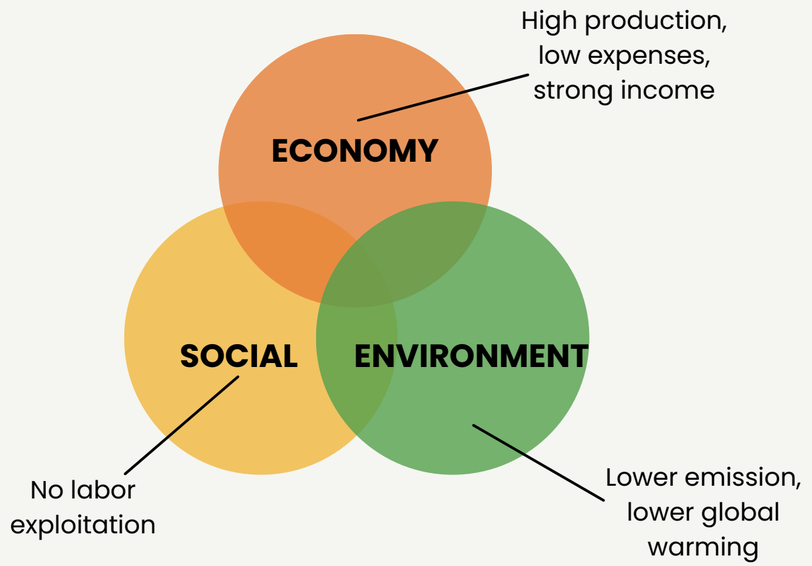
- **The conventional rice practice in Thailand contributes to approximately 8% of the country's greenhouse gas emissions (GHGs)**
  - **Nitrous oxide**: too much fertilizers
  - **Methane**: lack of water management
  - **Methane, Nitrous oxide and PM 2.5**: rice stubble and rice straw burning

What is Sustainable Rice Practice (SRP)?

(GIZ Thailand)

The meaning of sustainable rice:
Sustainable rice refers to rice that is grown and harvested in accordance with the Sustainable Rice Platform: SRP Standards established by the United Nations: UN and the International Rice Research Institute (IRRI) in collaboration with network member countries. These standards were developed to address issues related to improper rice cultivation that negatively impacts the environment.

This includes practices such as keeping water in rice fields for extended periods leading to methane gas emissions, harvesting rice that requires prolonged drying resulting in energy wastage and burning rice stubble which contributes to global warming.



Basic principles for sustainable rice practice:

- Improving the quality of life for both present and future farmers
- Supporting community development and protecting communities from the effects of incorrect farming practices
- Responding to the demand for food security with safe and high-quality rice
- Reducing greenhouse gas emissions, and adjusting the rice practicing system to be in line with climate change
- Ensuring that rice practice utilizes natural resources efficiently
- Upholding labor rights and promoting the well-being of workers
- Protecting the environment from the adverse effects of improper farming practices
- Engaging in a stable farming career with honesty and transparency

The difference of SRP and CRP

1. Cultivation planning	• Set a schedule in order to control all cultivation process • SRP training and preparing for farming documentation
2. Pre-cultivation	• Land leveling for water use efficiency • Measure soil nutrients and elements for adjusting fertilizers • Seed selection and eliminate invasive plants for sustainability and productivity
3. Water management	•Water use efficiency • Water contamination and quality
4. Nutrient management	• Appropriate quantity and formulas of fertilizers applied to reduce GHGs emission and cost of cultivation
5. Pest control	• Use natural methods to prevent pests • Chemicals pesticides applied with cautions
6. Harvest and post harvest management	• Harvest at the right time to ensure maximum quantity and quality of rice • No rice straw and stubble burning to reduce PM 2.5 and GHG emissions
7. Health and safety	• Using appropriated agricultural equipment and tools • Chemical pesticides applied with cautions
8. Labor right	• Labor's rights and gender equality • Fair benefits sharing

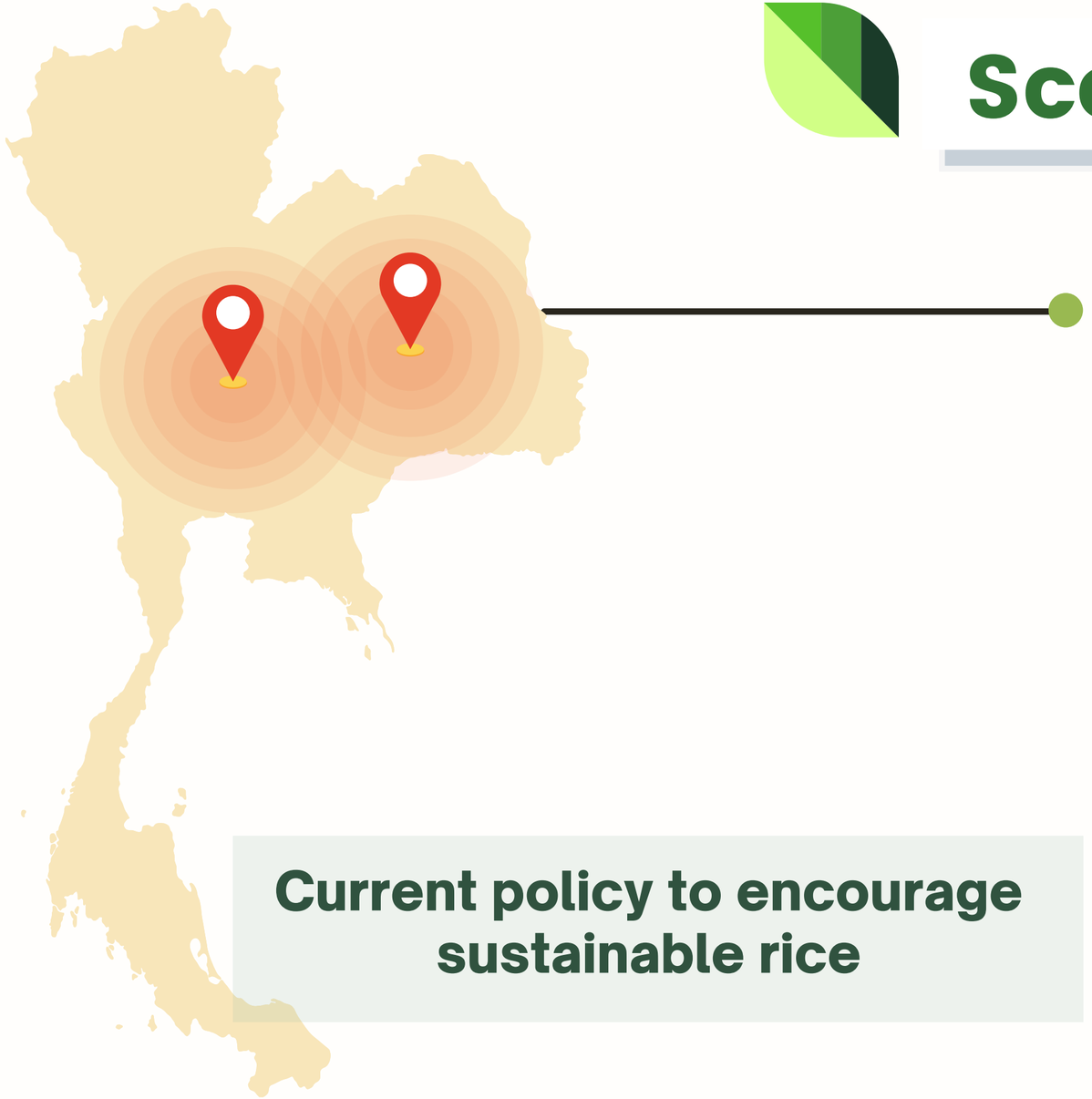
The important process of SRP

1. Cultivation planning
2. Adjusting the level of lands
3. Soil nutrients and elements analysis
4. Tracking and documenting during cultivation process
5. Harvesting process
6. Post harvest management
7. Analysis and evaluation
8. Verification and certification

Main objective of this study

To compare net benefit between conventional rice and sustainable rice practices

SCENARIO DEVELOPMENT



Scenario Development

Scenario analysis land platform change to sustainable rice in Northeastern and Central Thailand

- Whole rice area 68 miliion rai
- Northeast region 41 miliion rai
  Central region 12 million rai
- Sustainable rice area 0.01 miliion rai

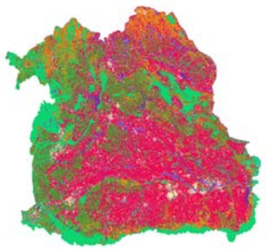
(Land Development Department , 2019)

Current policy to encourage sustainable rice

- Thailand's 20-year Strategic Plan (2017-2036)
- GAP project, the GAP++ project and the Megafarm project

Sustainable rice expansion in each scenario 2022-2050

Year/ Sustainable area (Ha)

	BAU	S2	S3	S4
				
2022/0.22 million Ha (3.44%)	2050/0.45 million Ha (6.88%)	2050/1.23 million Ha (18.93%)	2050/3.27 million Ha (50.24%)	2050/5.06 million Ha (77.77%)
				
2022/0.10 million Ha (4.96%)	2050/0.19 million Ha (9.92%)	2050/0.73 million Ha (37.71%)	2050/1.4 million Ha (72.44%)	2050/1.93 million Ha (100%)

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METHOD AND RESULTS

Cultivation conditions

Doubble corps of rice per year

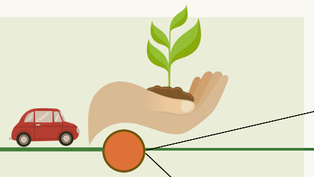
Conventional rice

- **Non-Irrigated areas**
  - Single rice
  - Burning residues
  - Using chemicals
  - No AWD
- **Irrigated areas**
  - Double rice
  - Burning rice residues
  - Using chemicals
  - No AWD

Sustainable rice

- **Non-Irrigated areas**
  - Single rice
  - Sunn hemp is crop rotation
  - No burning rice residues
  - Using chemicals according to Rice deparment's recommadation
  - No AWD
- **Irrigated areas**
  - Double rice
  - No burning rice residues
  - Using chemicals accroding to Rice deparment's recommadation
  - AWD

Methodology and results

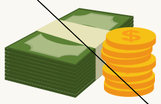


ENVIRONMENT
- GHGs
- Biodiversity
- Water

PEOPLE
- Health cost
  - PM 2.5
  - Pesticide

ECONOMICS
- Rice production
- Cost production

SOCIETY
- Happiness
- Cooperation
- Prosocial
- Social network



monetary value ▶

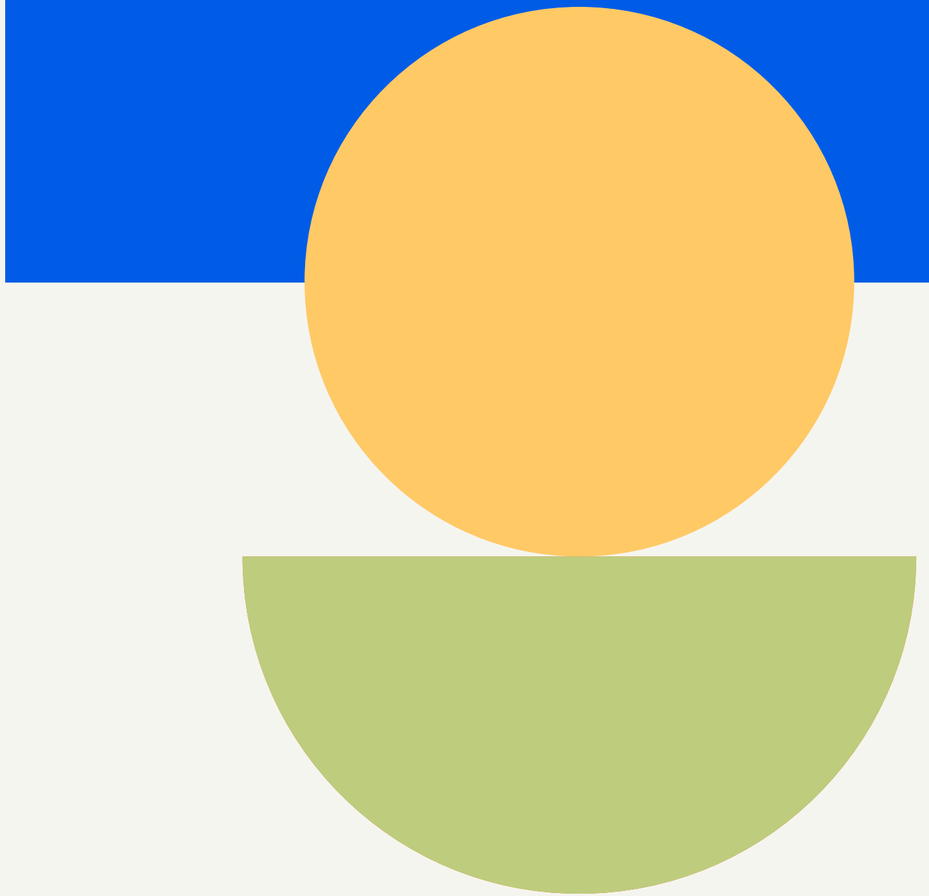
SCENARIO ANALYSIS

ENVIRONMENT

- GHGs
- Biodiversity
- Water

GHGs Emission

- During cultivation
- Soil organic carbon sequestration
- Rice residues burning



ENVIRONMENT

Methodology and results

GHGs emission: SOC and During cultivation

Methods:

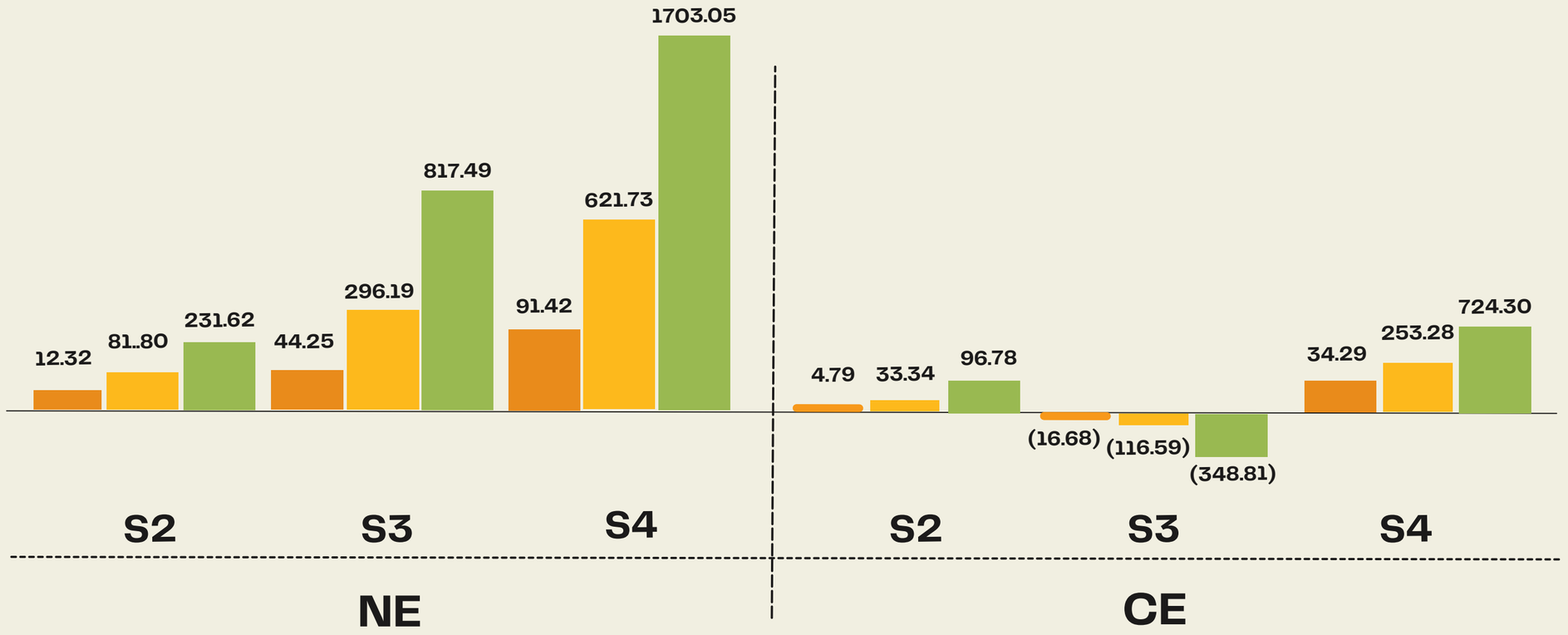
- Literature review
- DNDC Model (version 9.5)
  - Climate
    - 2001-2020 (20 years) from TMD
    - 2021-2050 (30 years) RCP4.5 & 8.5 from RU-CORE
  - Soil
  - Cropping process

GHG emissions: SOC stock

UNIT: MILLION TON CO2

2030 2040 2050

BAU IS REFERENCE



Average: Northeast region

- sustainable 712.42 ton CO2 /ha
- Conventional 452.81 ton CO2 /ha

Average: Central region

- sustainable 1999.59 ton CO2/ha
- Conventional 1625.23 ton CO2/ha

GHG emissions from cultivation processes

UNIT: MILLION TON CO2

2030 2040 2050

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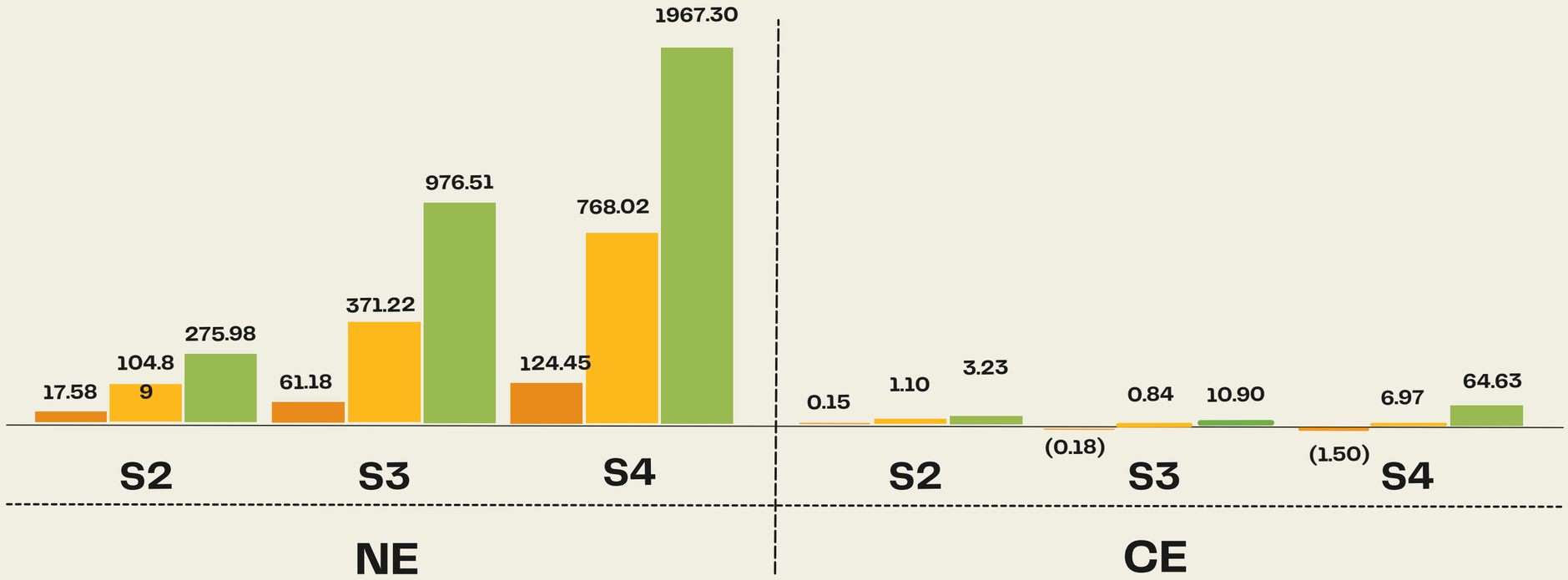


Average: Northeast region

- Sustainable 705.46 ton CO2/ha
- Conventional 405.55 ton CO2/ha

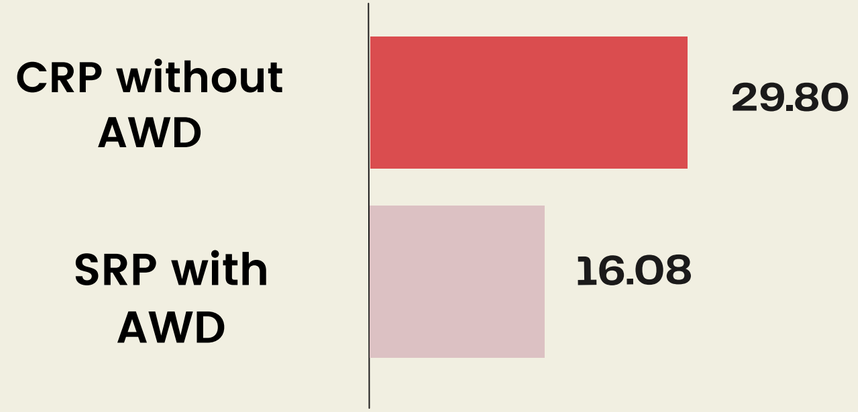
Average: Central region

- Sustainable 565.61 ton CO2/ha
- Conventional 532.20 ton CO2/ha

GHG emissions from cultivation processes without AWD compared to AWD

AMOUNT OF GHGS RELEASED IN THE NORTHEAST REGION (UNIT: TON CO2/HA)

AMOUNT OF GHGS RELEASED IN THE CENTRAL REGION (UNIT: TON CO2/HA)



Methodology and results

GHGs emission: Rice residues burning

Methods:

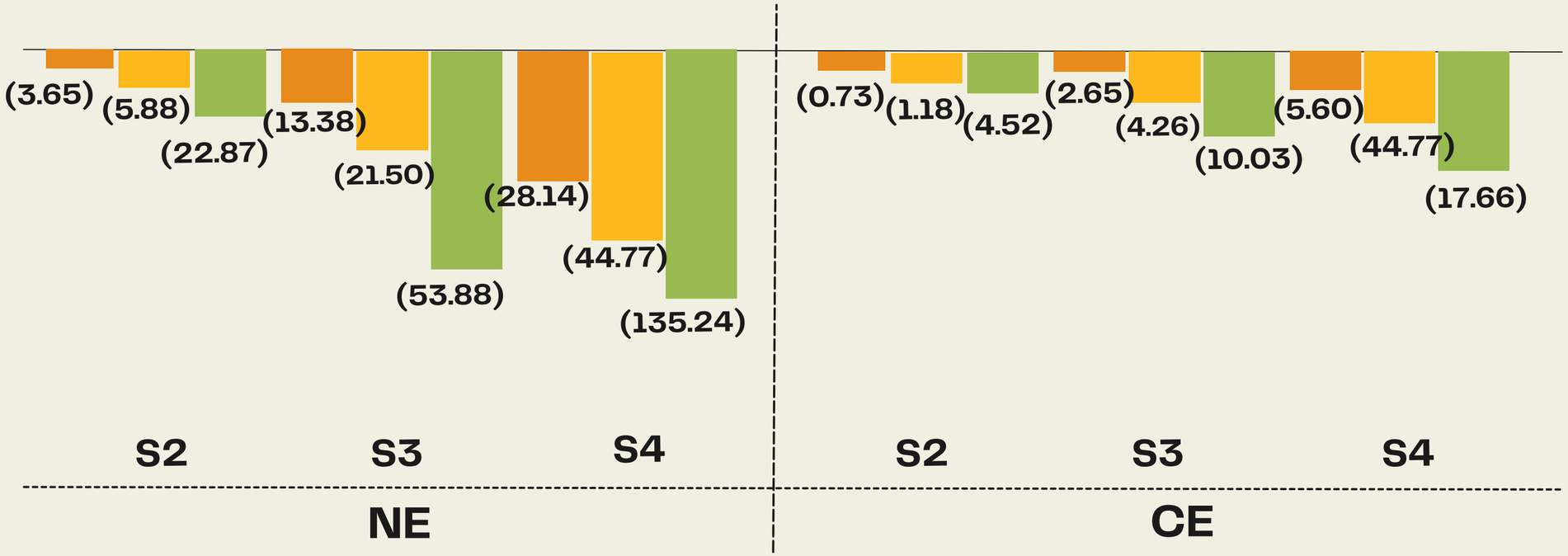
- **Literature review**
  - GHGs and air pollution from burning of rice residues
    - Carbon monoxide (CO)
    - Carbon dioxide (CO2),
    - Methane (CH4)
    - Nitrogen oxides (NOx)
    - Sulfur dioxide (SO2)
    - Black carbon (BC)
    - Organic carbon (OC)
    - PM10
    - PM2.5

GHGs Emission: Burning Rice Residues

UNIT: MILLION TON CO2

2030 2040 2050

BAU IS REFERENCE



Average Northeast region

- Sustainable 0 ton CO2/ha
- Conventional 20.62 ton CO2/ha

Average Central region

- sustainable 0 ton CO2/ha
- Conventional 9.13 ton CO2/ha

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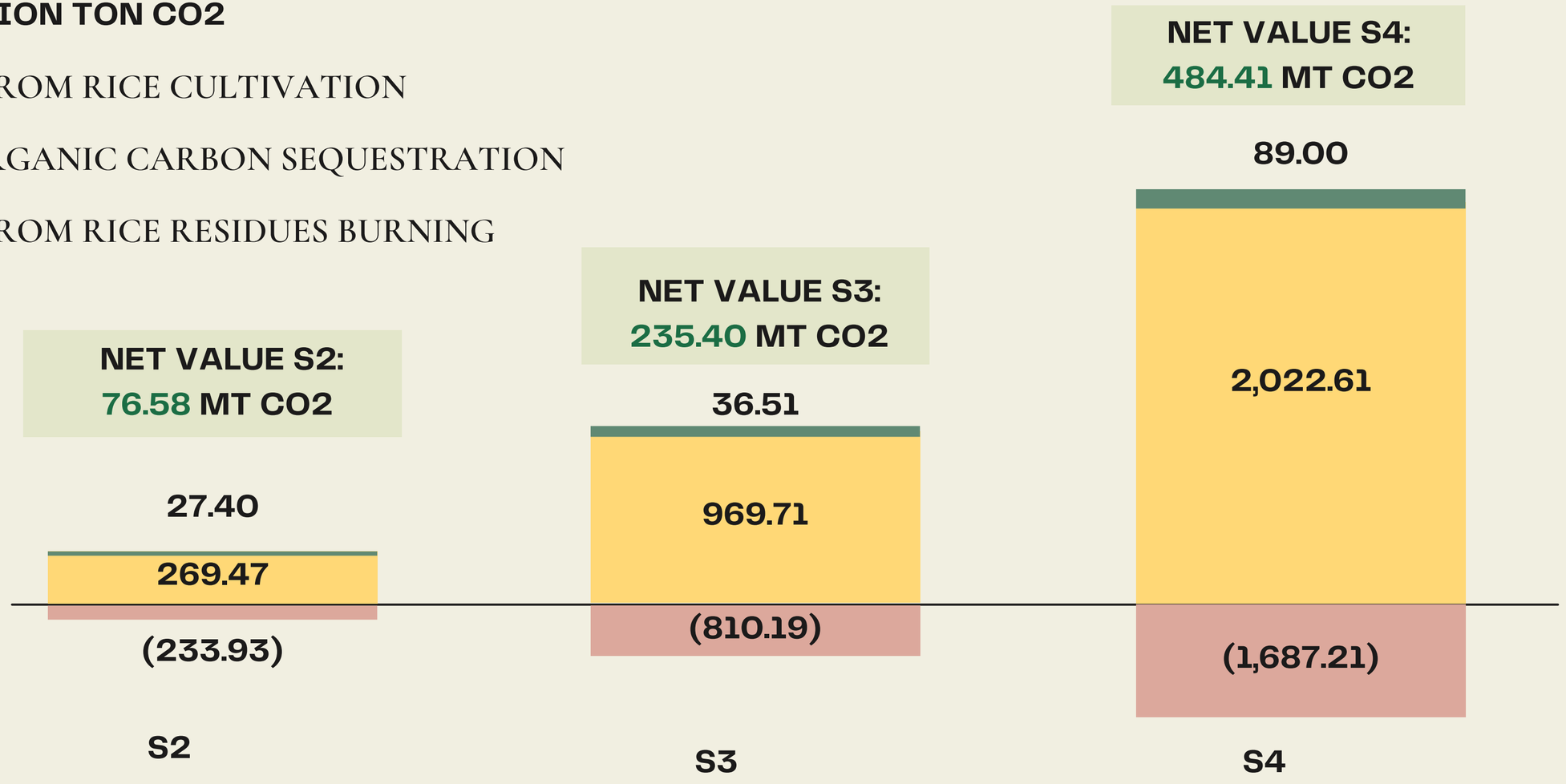
Total net volume of GHGs by dimensions due to the expansion of sustainable rice area

UNIT: MILLION TON CO2

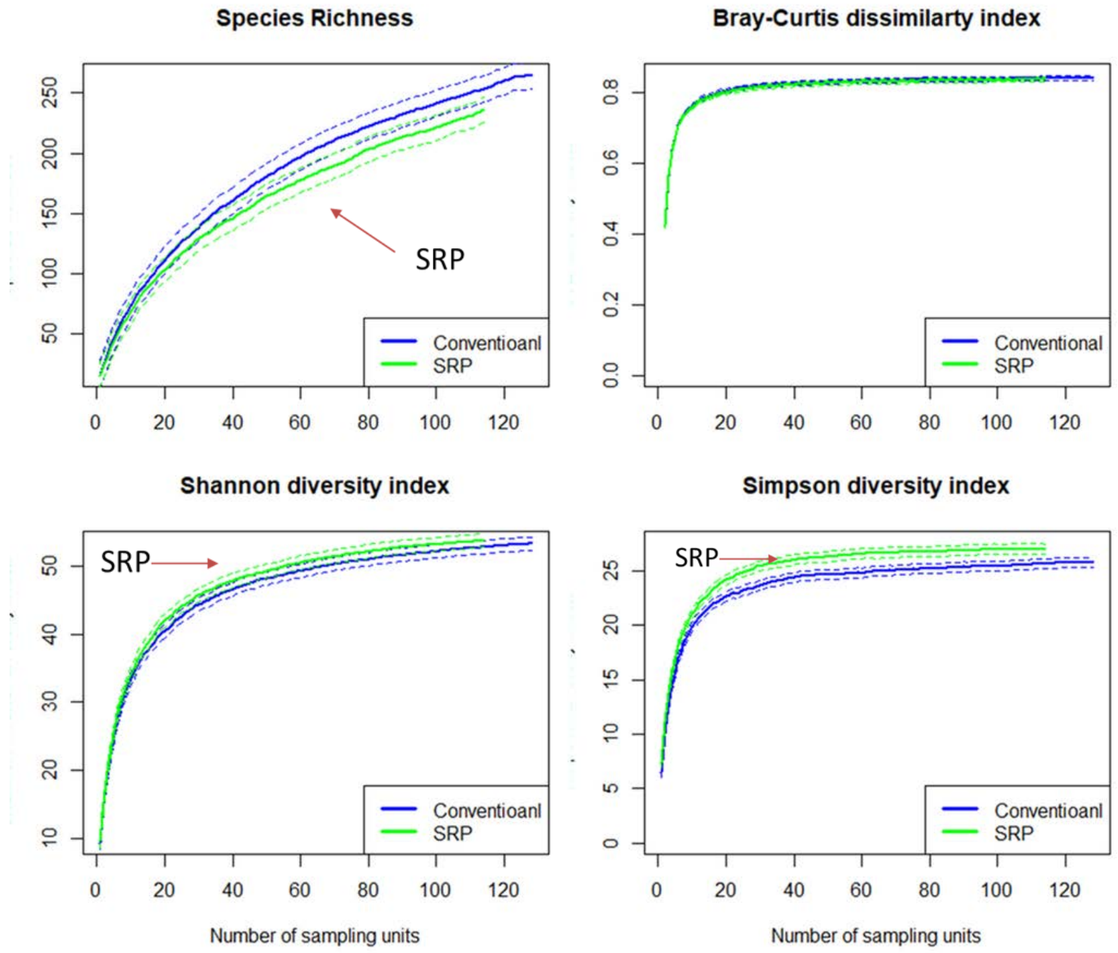
- GHGS FROM RICE CULTIVATION
- SOIL ORGANIC CARBON SEQUESTRATION
- GHGS FROM RICE RESIDUES BURNING



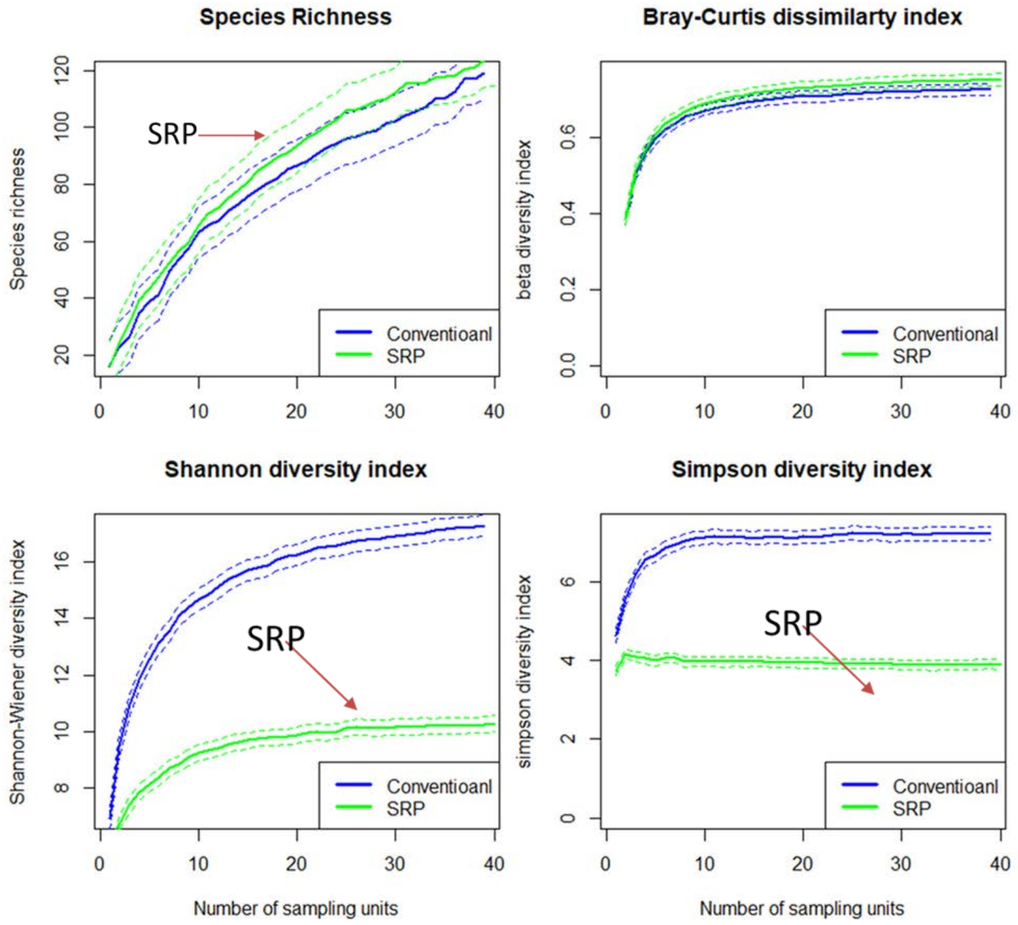
Biodiversity

ENVIRONMENT

Insect pooled biodiversity



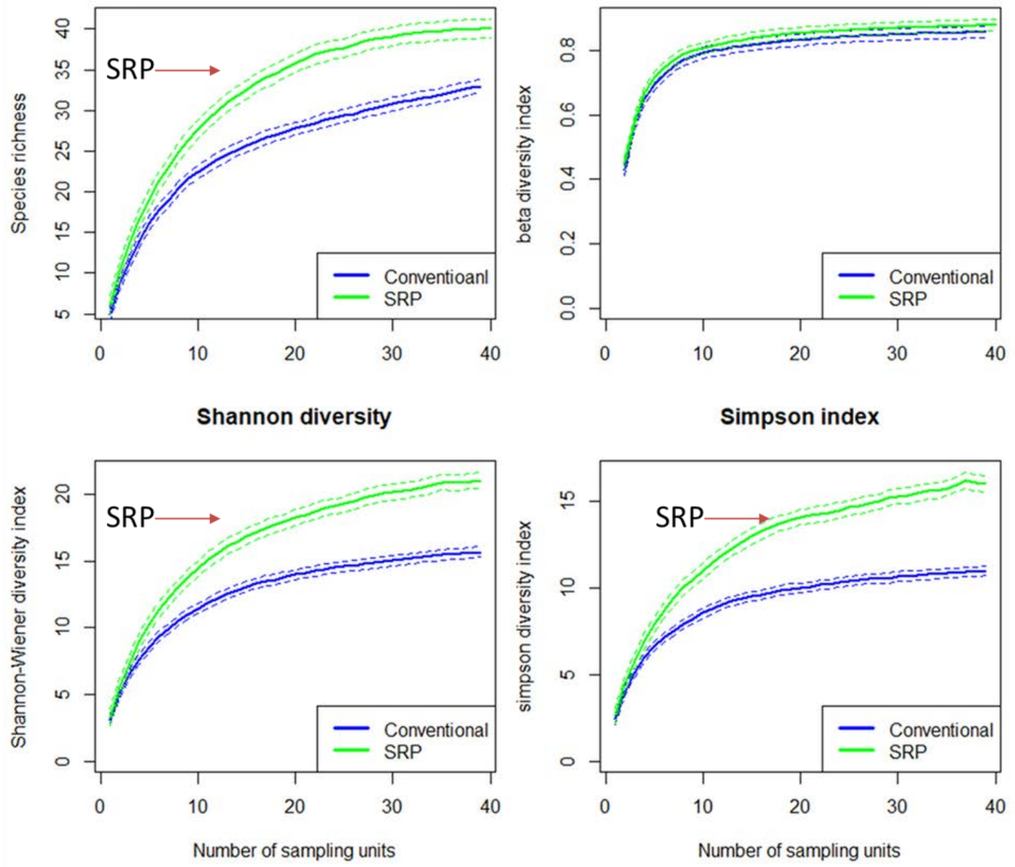
Northeast



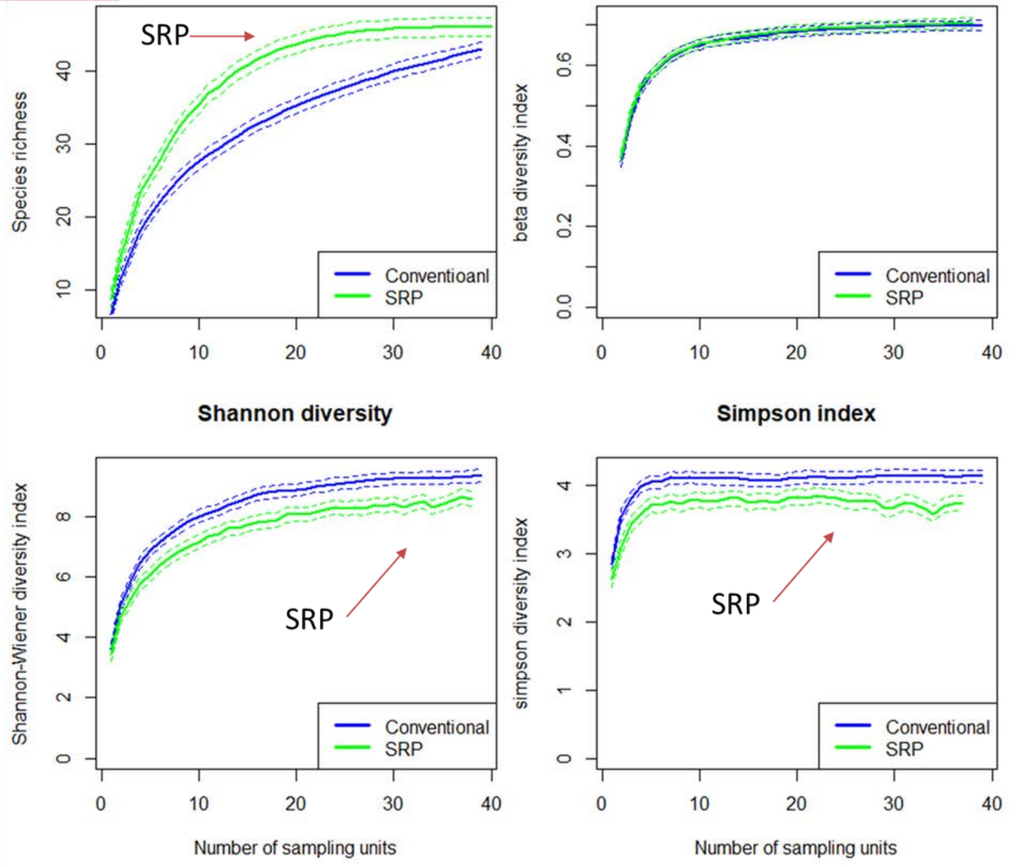
Central

Insect Functional group (predators and pests)

Predator

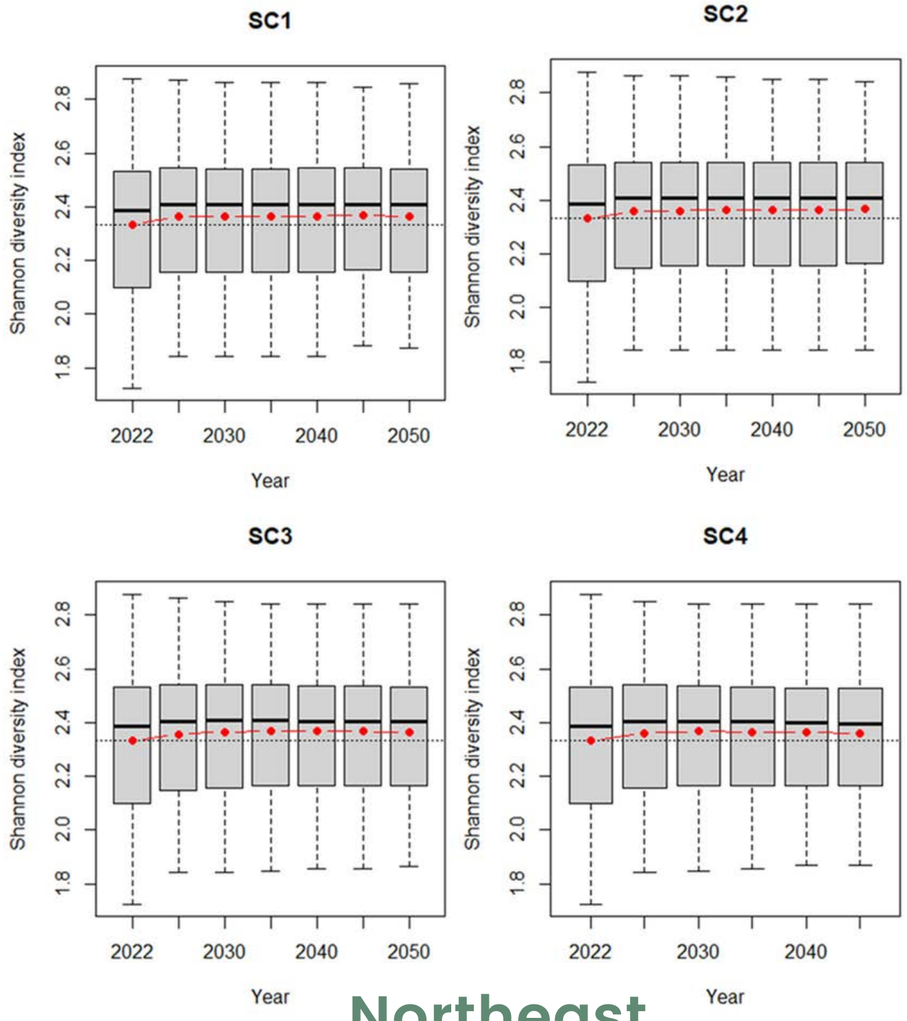


Pest

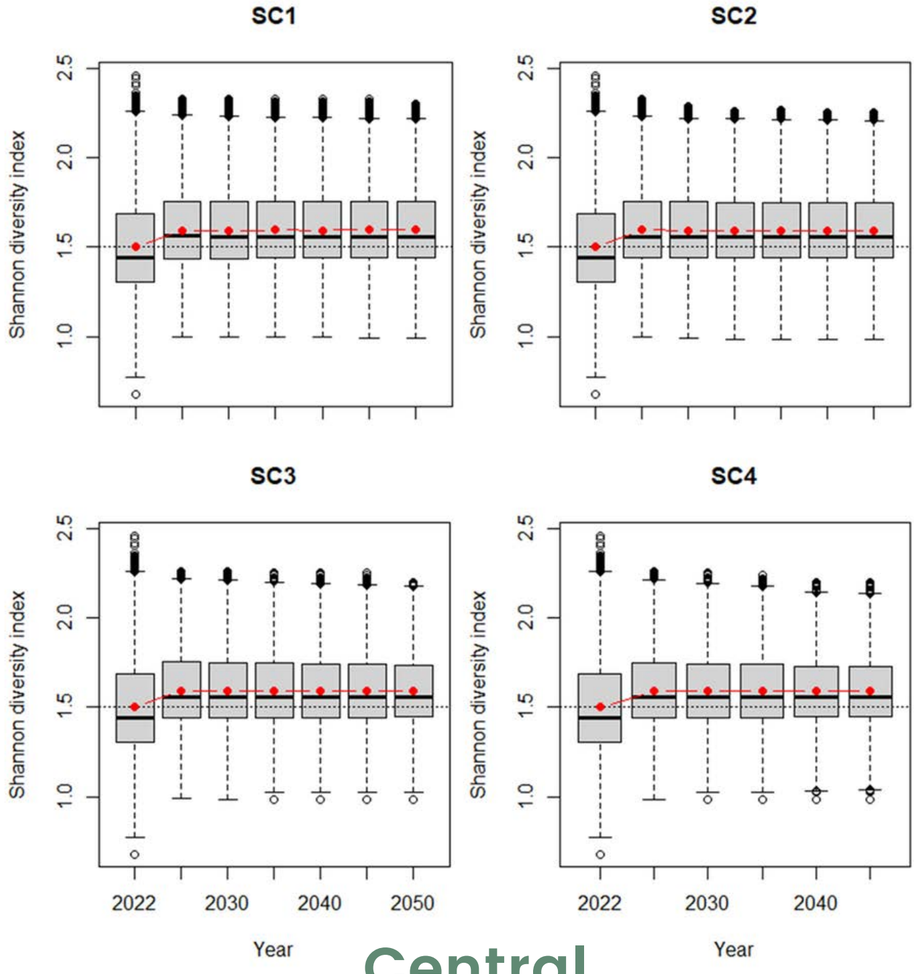


Central region

Predicted future for biodiversity of insects



Northeast



Central

Methodology and results

Trees on the farm:

Method:

1. Household survey

Trees on the farm:

- Total tree density
- The native tree density
- The total tree species
- The diversity of native species

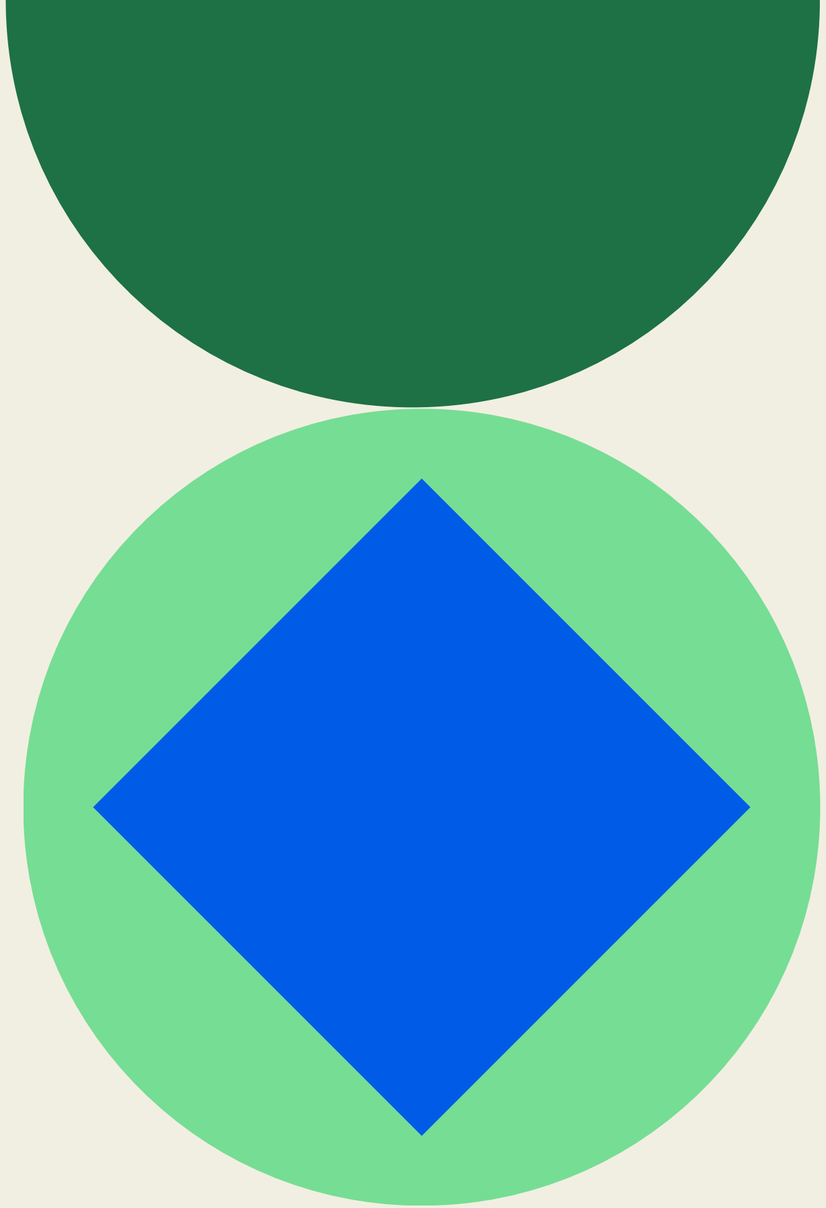
/ Objectives

- To observe “trees on farm” or “agroforestry” in rice cultivation if there are any patterns between regions and cultivation practices: CON vs. SRP

Trees on the farm

Vegetative structure	Conventional practices		Sustainable practices	
	CE	NE	CE	NE
Total tree density (trees/ha)*	23.77	33.59	105.19	67.11
Native tree density (trees/ha)*	1.67	6.44	17.10	11.86
No. of tree species per ha*	2.68	4.66	7.19	5.25
No. of native species per ha*	0.71	1.81	3.04	3.04

Note: * depicts significant differences of the means from t-tests: CON vs. SRP, for the tested variables at 0.01



Water

ENVIRONMENT

Methodology and results

Water use assessment

- **Water provisioning** → Water supply measurement
- **Water quality** → Measurement of eight water quality parameters
- **Water footprint** → Green, blue, grey water footprints

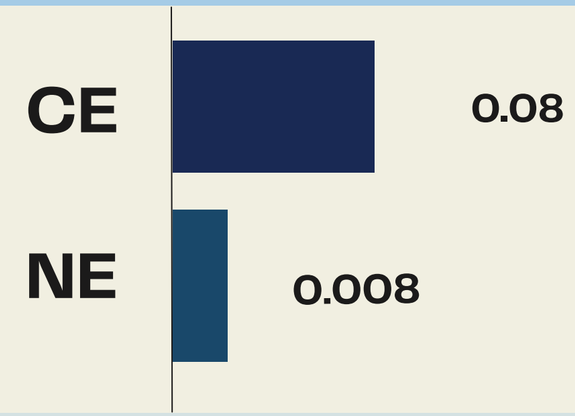
Rice cultivation
- Conventional cultivation
- Sustainable cultivation

Analysis of water footprints

Analysis is to measure and value hydrological ecosystem services, which would be provided differently in the future under alternative scenarios

Water management: the amounts of water use

EFFICIENCY OF BLUE WATER USE KG/CUBIC METERS



Efficiency: Central region
- sustainable 1.44 kg/cubic meters
- Conventional 1.36 kg/cubic meters

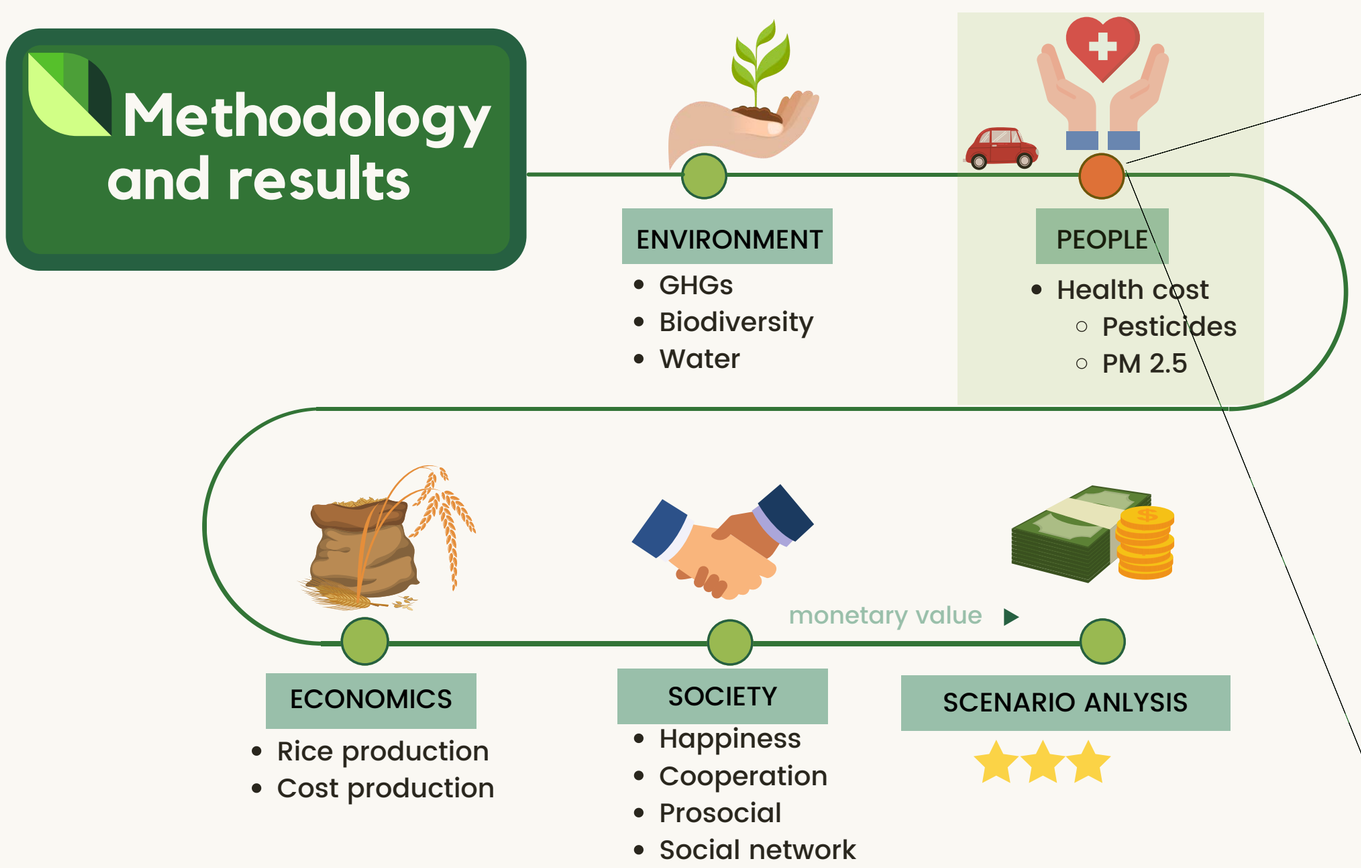
Efficiency: Northeast region
- sustainable 0.765 Kg/cubic meters
- Conventional 0.757 kg/cubic meters

EFFICIENCY OF GREY WATER USE KG/CUBIC METERS

Efficiency: Central region
- sustainable 1.31 kg/cubic meters
- Conventional 1.47 kg/cubic meters

Efficiency: Northeast region
- sustainable 0.86 Kg/cubic meters
- Conventional 0.76 kg/cubic meters

Methodology and results



Health cost caused by Pesticide

PEOPLE

Methodology and results

Health cost: medical treatment

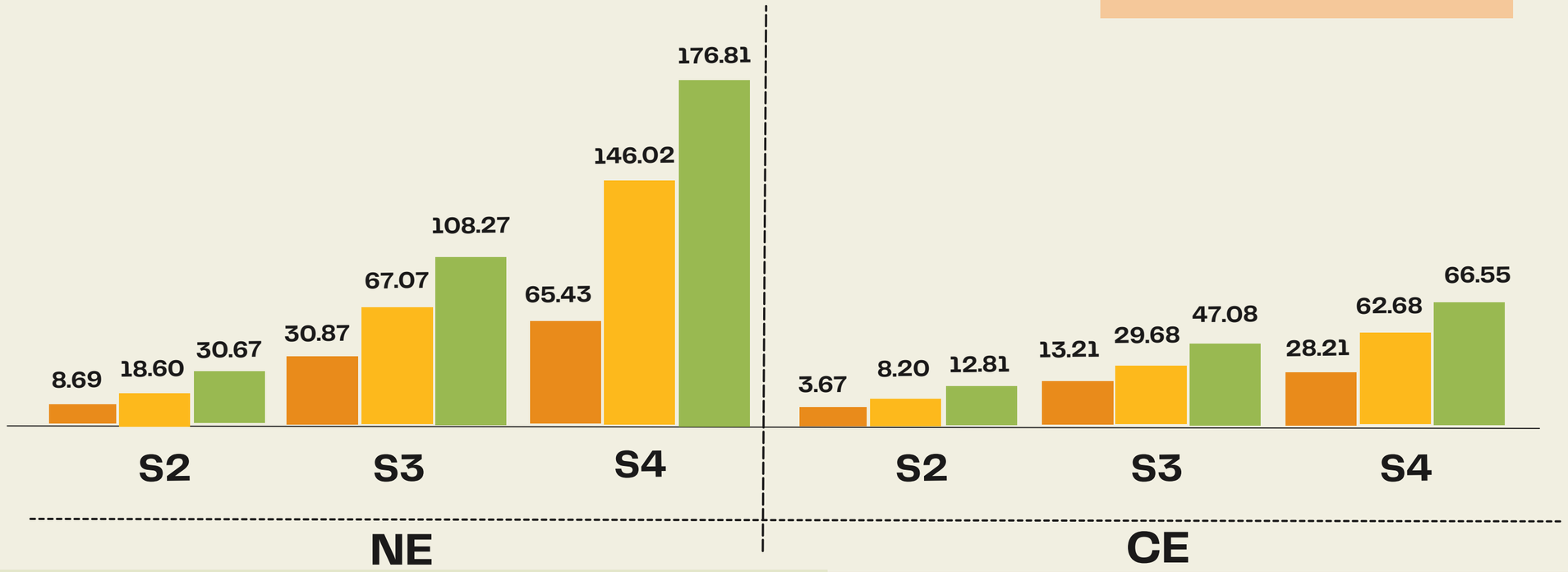
Method:

1. Household survey
2. Benefit transfer

Health care cost:

- Cost of illness
  - Medical cost
  - Opportunity cost

Benefit from health cost reduction caused by pesticides



Average Northeast region
- sustainable 27 USD/ha
- Conventional 0 USD/ha

Average Central region
- sustainable 33 USD/ha
- Conventional 0 USD/ha

Health cost caused by PM 2.5

PEOPLE

Methodology and results

Health cost: Caused by PM2.5.

Method:

1.Exposure Response Function

Cost of premature mortalities

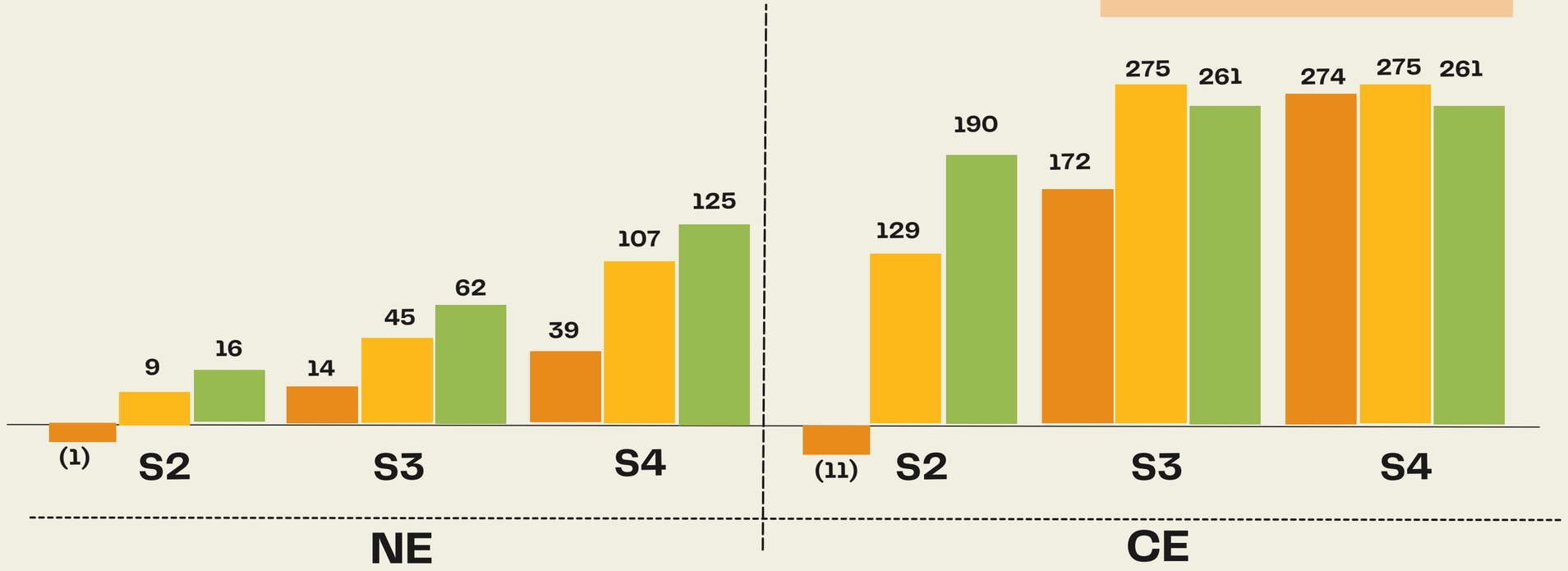
- Concentration of PM2.5.
- Gross Provincial Product (GPP)
- Population growth rate

Benefit from health cost reduction caused by PM 2.5

UNIT: MILLION USD

2030 2040 2050

BAU IS REFERENCE



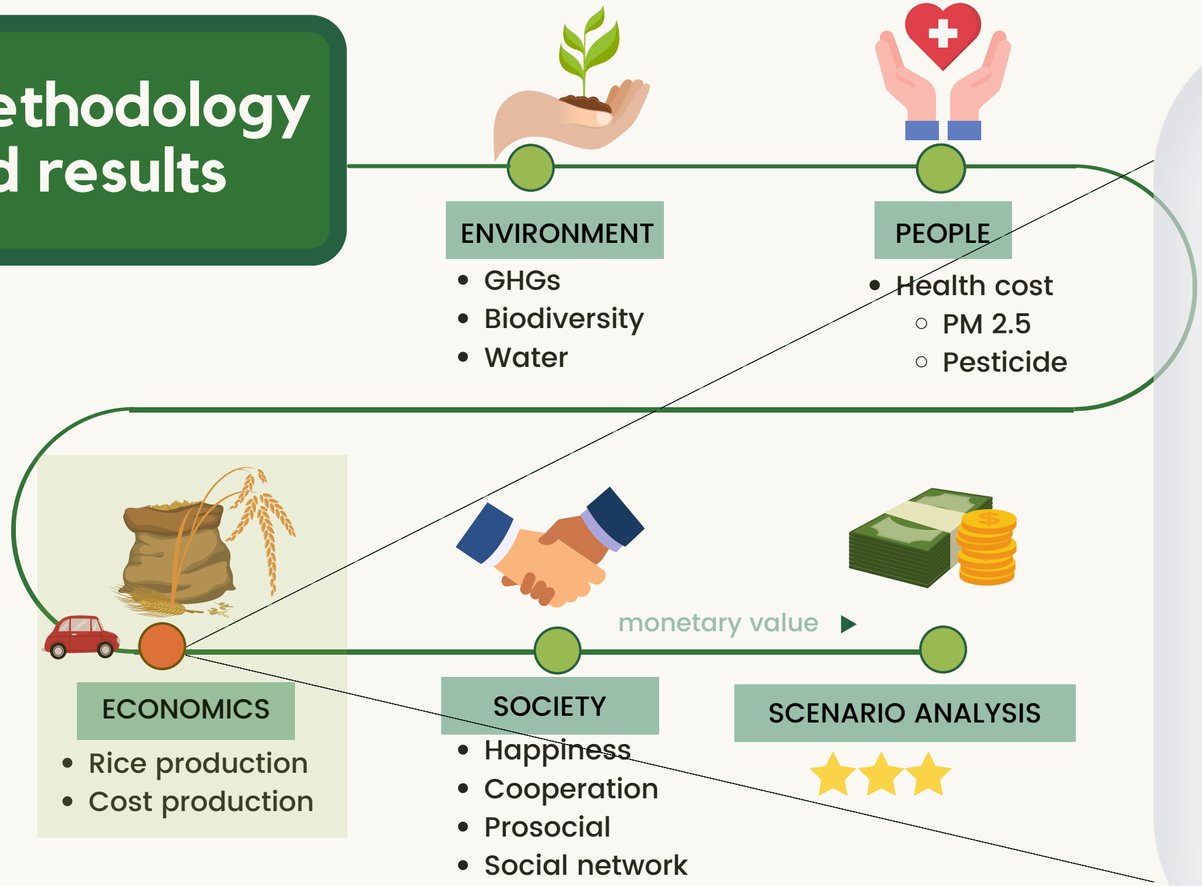
Average Northeast region

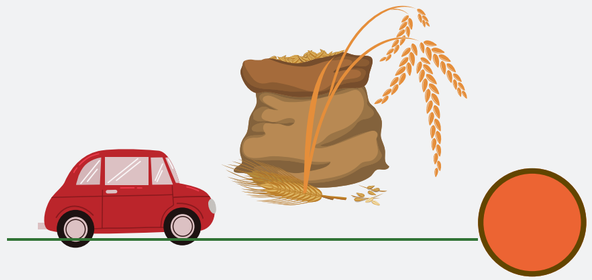
- sustainable 19.23 USD/ha
- Conventional 0 USD/ha

Average Central region

- sustainable 130 USD/ha
- Conventional 0 USD/ha

Methodology and results





Economics

- Rice production
- Cost of cultivation

Factors Influenced Rice Production

Method: DNDC Model

CLIMATE CHANGE:

- Daily Max Temp (C)
- Daily MinTemp (C)
- Daily Rainfall (cm)
- Atmospheric NH3 (ug N/m3)
- Atmospheric CO2 (ppm)
- CO2 increasing rate (ppm/y)

CROP MANAGEMENT:

- Crop type
- Crop calendar
- Tillage
- Fertilization
- Irrigation
- Flooding

SOIL:

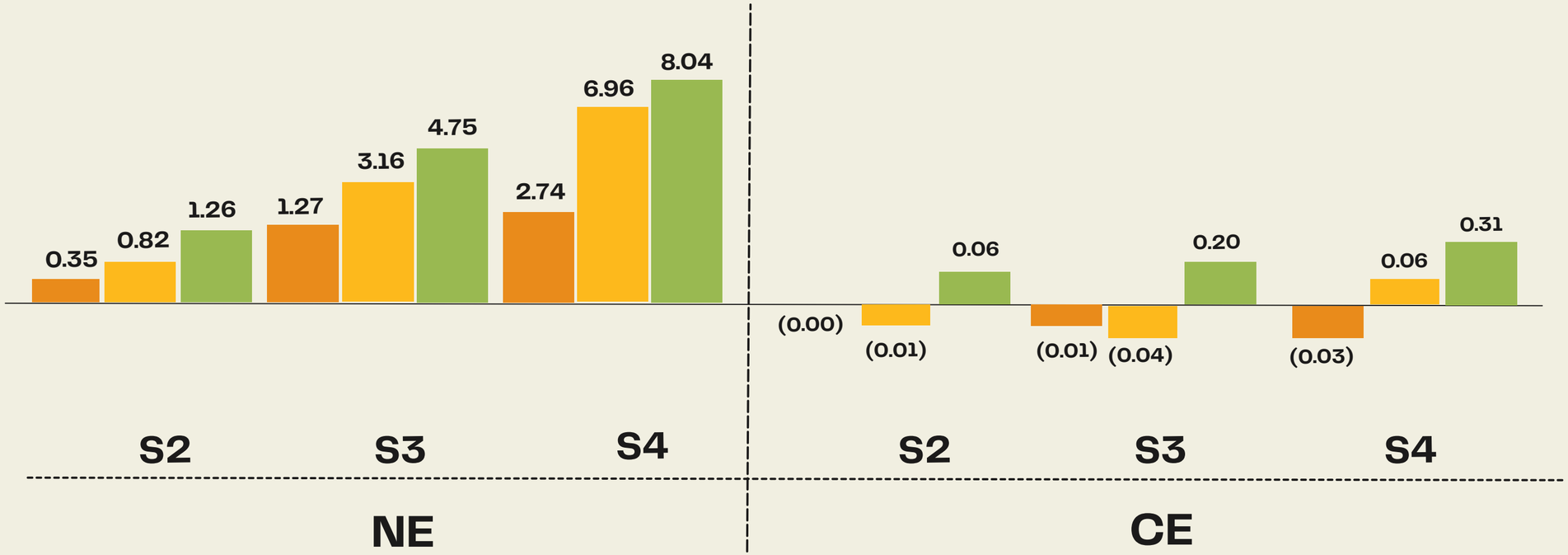
- Texture
- BD
- PH
- Clay fraction
- SOC surface

Economics: Rice production
Method: DNDC Model

UNIT: MILLION TON

2030 2040 2050

BAU IS REFERENCE



Average: **Rice-Rice** condition in NE

- Sustainable 4.14 ton/ha
- Conventional 2.90 ton/ha

Average: **Rice-Rice** condition in CE

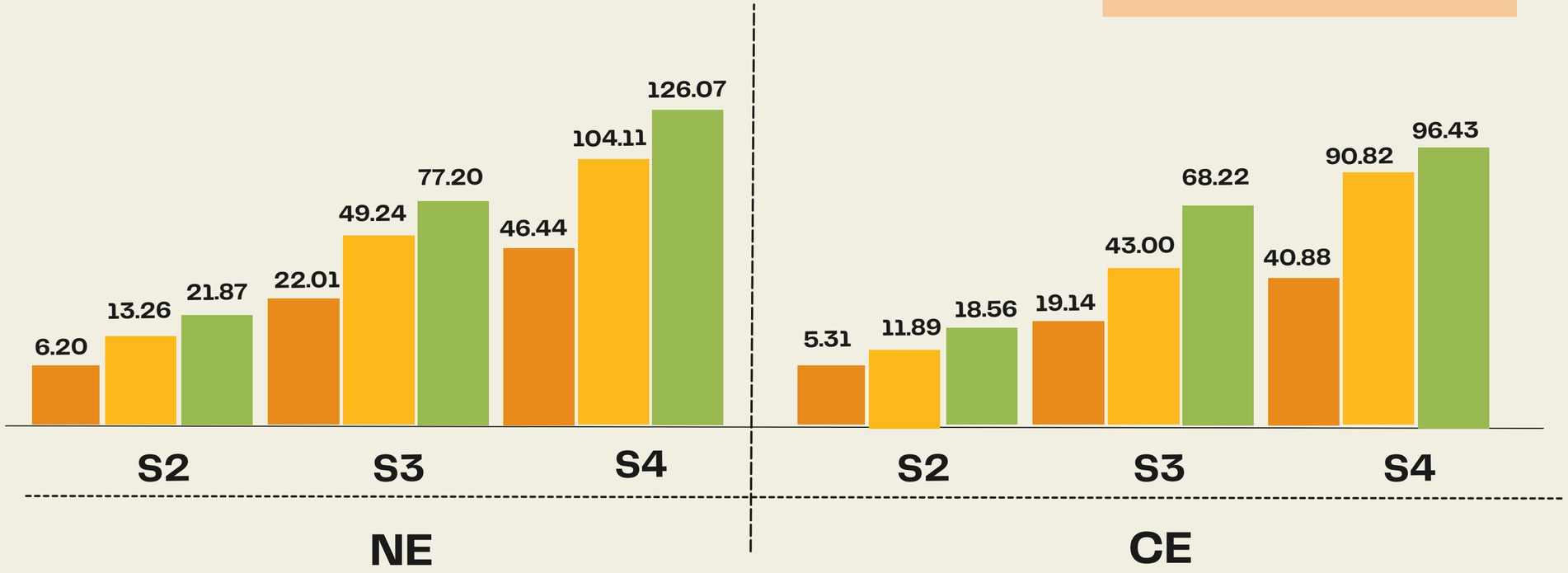
- Sustainable 8.50 ton/ha
- Conventional 8.35 ton/ha

Benefit of cost reduction of changing from conventional rice to sustainable rice

UNIT: MILLION USD

2030 2040 2050

BAU IS REFERENCE



Average (Northeast region)

- Sustainable 21.23 USD/ha
- Conventional 1.84 USD/ha

Average (Central region)

- Sustainable 53.58 USD/ha
- Conventional 5.36 USD/ha

Methodology and results

ENVIRONMENT

- GHGs
- Biodiversity
- Water

PEOPLE

- Health cost
  - PM 2.5
  - Pesticide

ECONOMICS

- Rice production
- Cost production

SOCIETY

- Happiness
- Cooperation
- Prosocial
- Social network

monetary value ▶

SCENARIO ANALYSIS

ENVIRONMENT

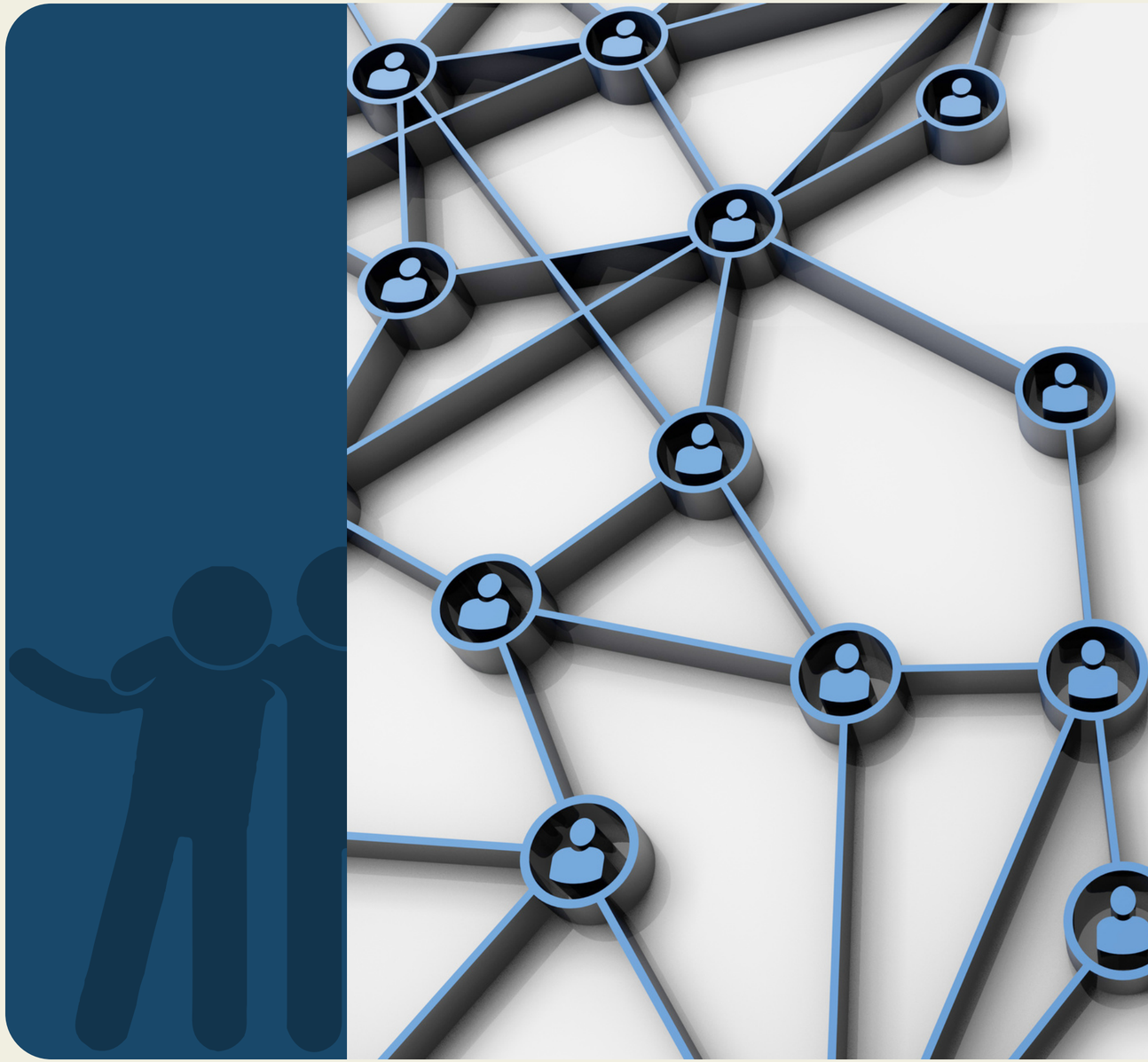
- Happiness
- Cooperation
- Prosocial
- Social network

Methodology and results

Community

- Happiness
- Cooperation
- Prosocial
- Social network and social relations

METHOD Household economics survey



Social capital

Happiness

- AVERAGE HAPPINESS LEVEL

SUSTAINABLE ★
●●●●●●●●●

CONVENTIONAL
○○○○○○○

Cooperation

- GENERAL ACTIVITIES
- RELIGION ACTIVITIES
- TRADITIONAL AND CULTURAL ACTIVITIES

SUSTAINABLE ★
●●●●●

CONVENTIONAL
○○○○

Prosocial

- COMMUNITY VOLUNTEERING ACTIVITIES

SUSTAINABLE ★
●●●●●

CONVENTIONAL
○○○

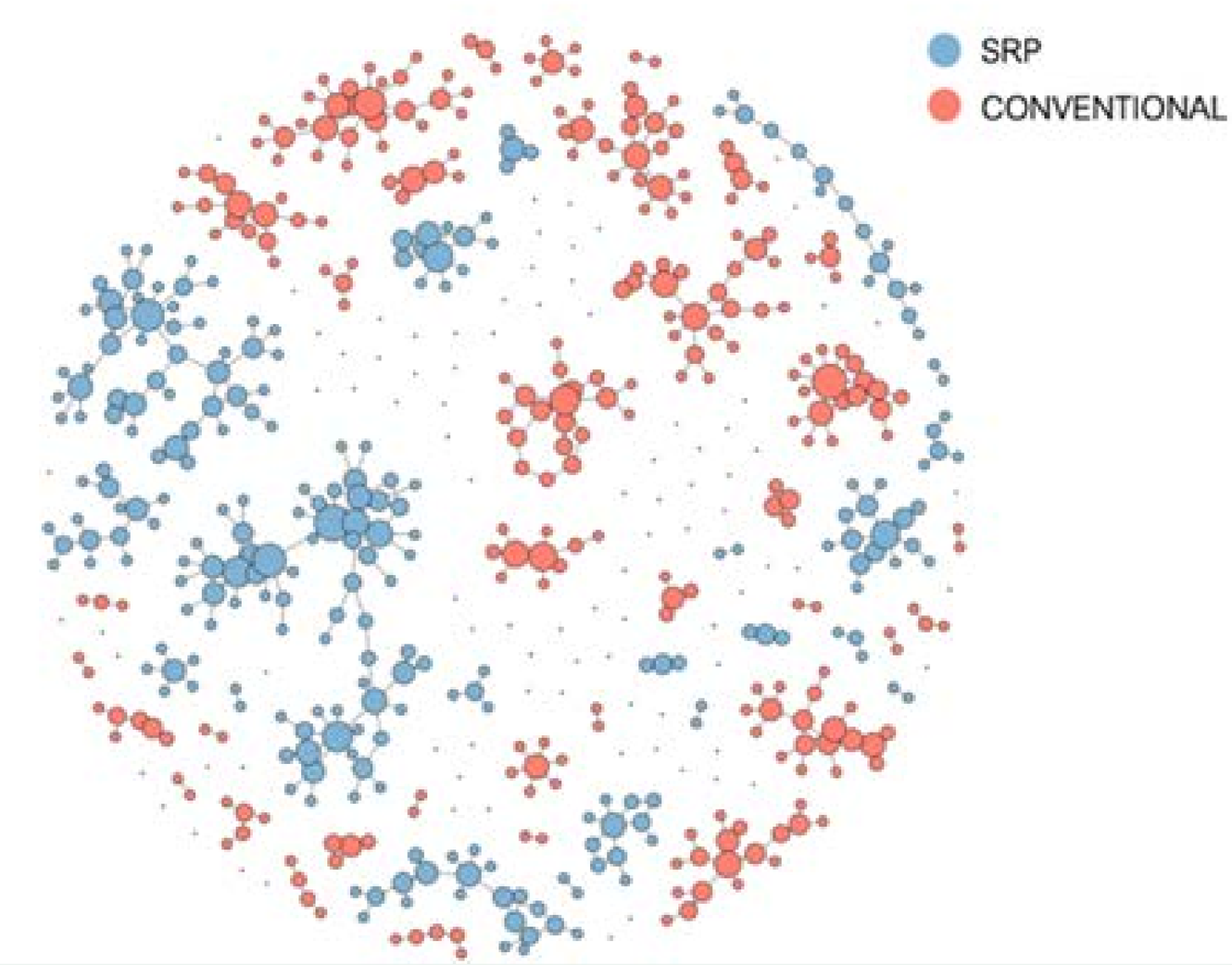
Gender

- NUMBER OF GROUPS JOINED BY FARMERS

SUSTAINABLE ★
●●●●

CONVENTIONAL
○○

Social Network



Method:

1. Household survey

Social Network:

- The comparison of the network density of villages between sustainable practices (SRP) and conventional practices

- Farmers receive information and follow guidance regarding to the new agricultural technology from their relatives and close friends

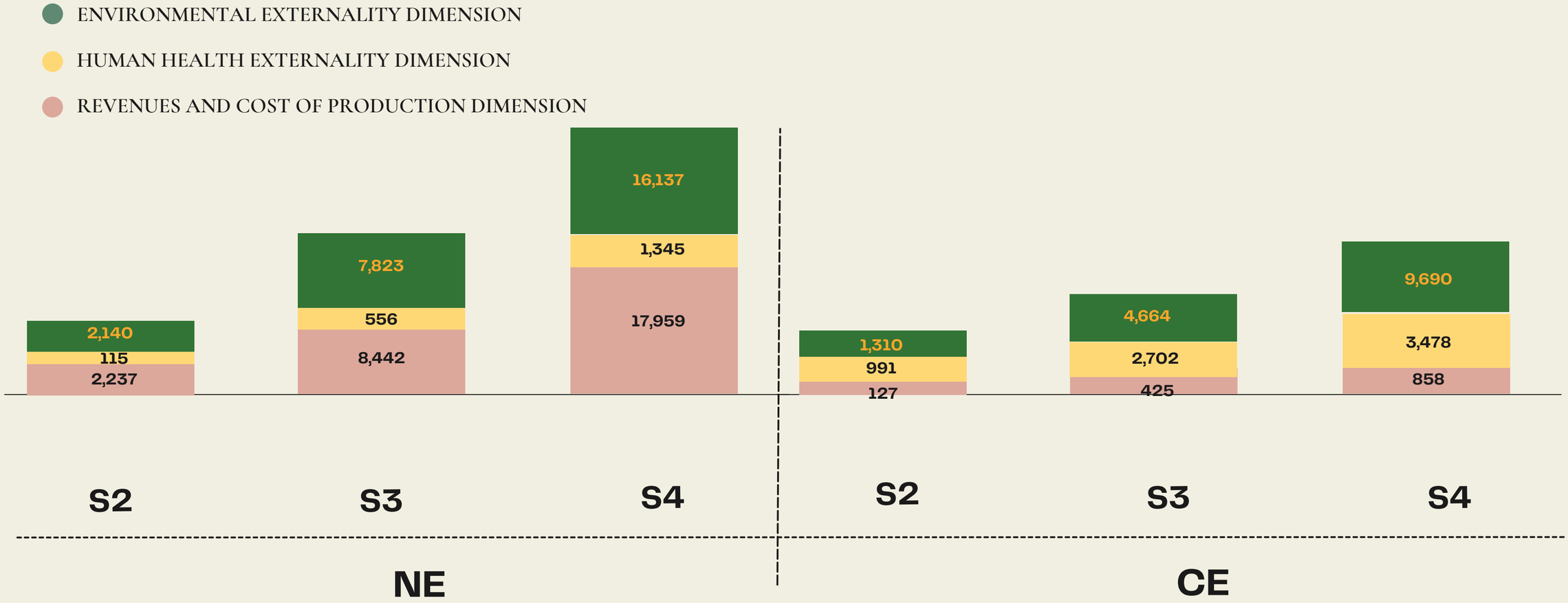
METHOD AND RESUTS

The monetary proxy per unit of factors

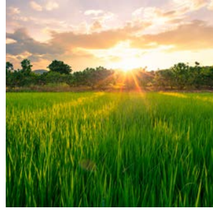
Measure	Dimension	Monetary proxy	Unit	Value (NE)	Value (CE)
Rice production	Financial	Price	$/ton	374.59	234.40
Cost of production	Financial	Cost	$/hectare	21.56	55.38
Health cost from PM 2.5	Health	PM 2.5 Health cost	$/year	Cost	Cost
Health cost from pesticide	Health	Value approach	$/hectare	38.22	38.22
GHG emissions (EU Emissions Trading system)	Natural	Carbon price	$/ton	38.19	38.19

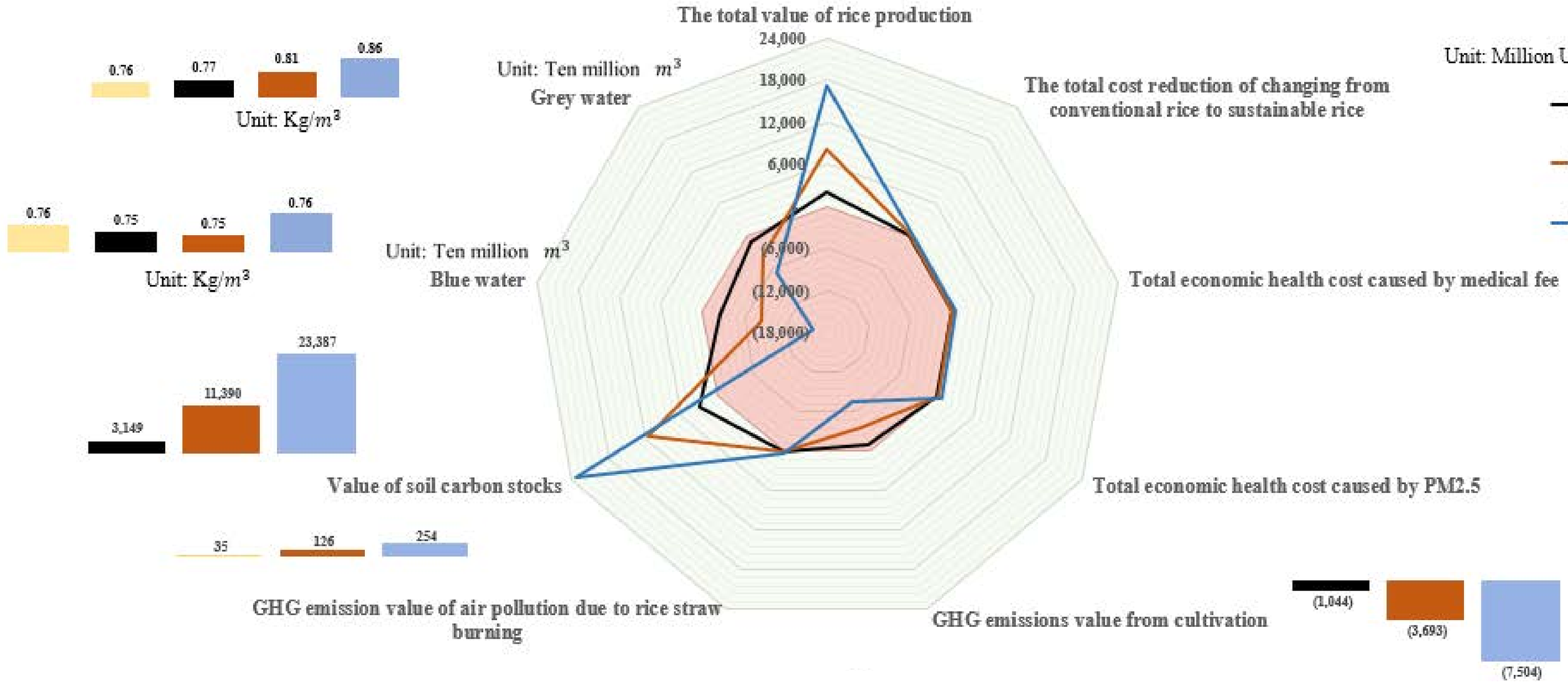
Total net benefits by dimensions due to the expansion of sustainable rice area

UNIT: MILLION USD

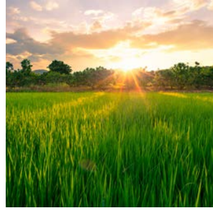


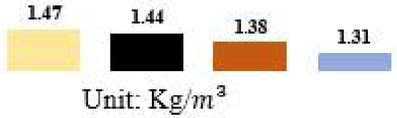
Scenario Analysis for Northeast Region

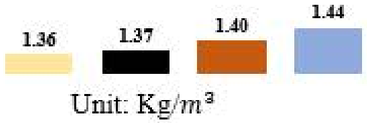


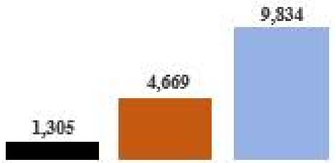


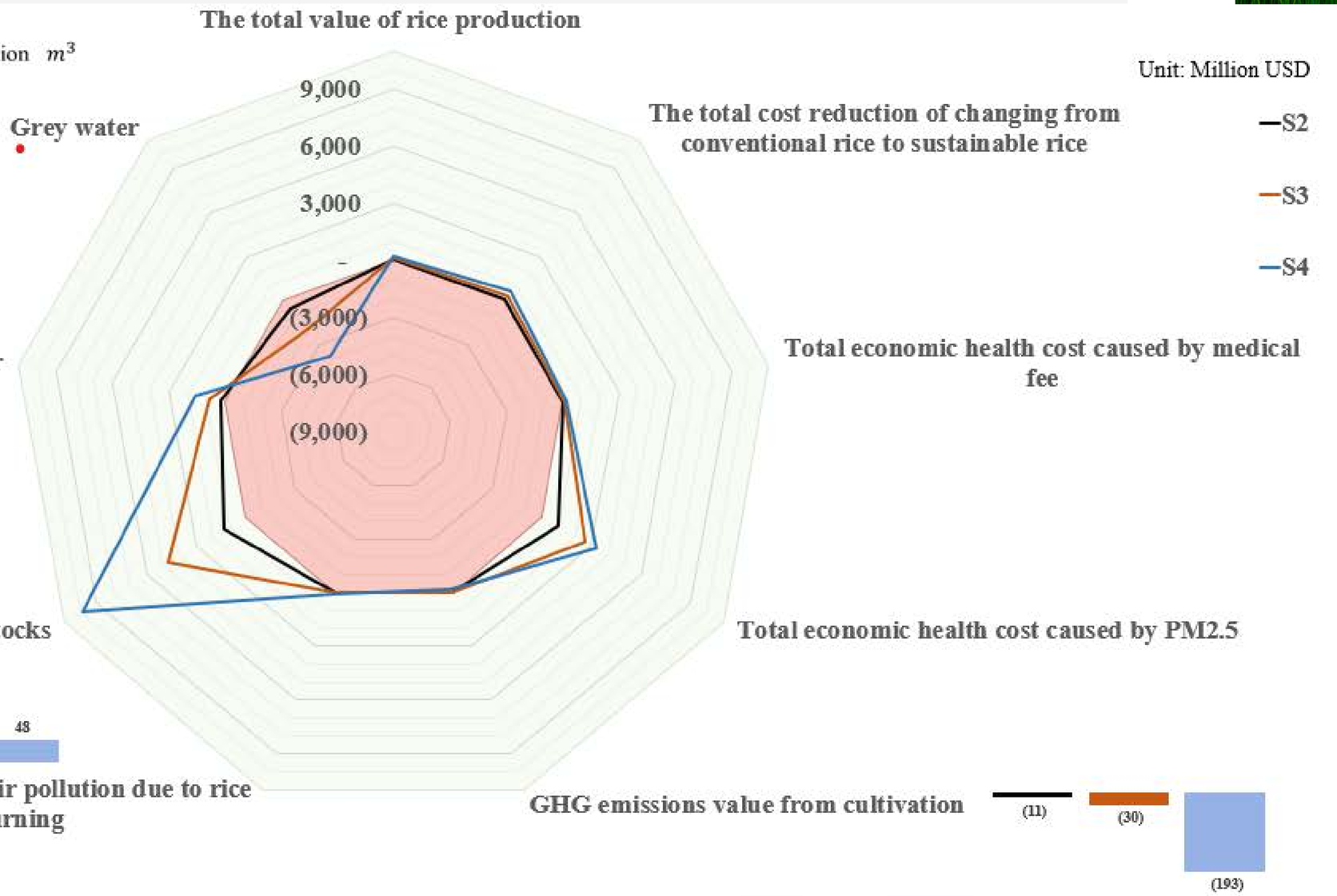
Scenario Analysis for Central Region





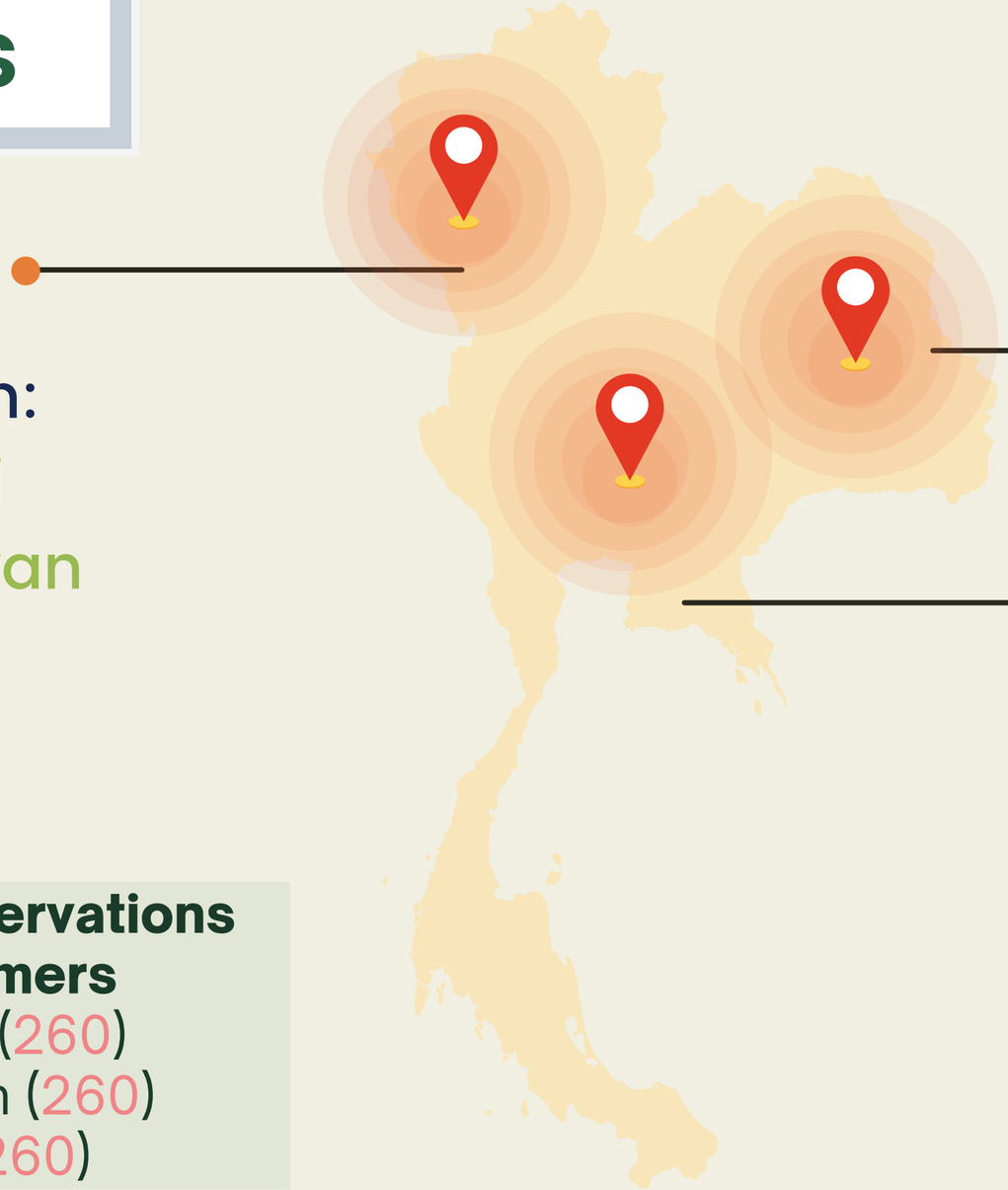






CONSUMERS' PREFERENCES

Study Sites



Northeast region:

- Udon Thani
- Nakorn Ratchasrima

Northern region:

- Chaing mai
- Nakhonsawan

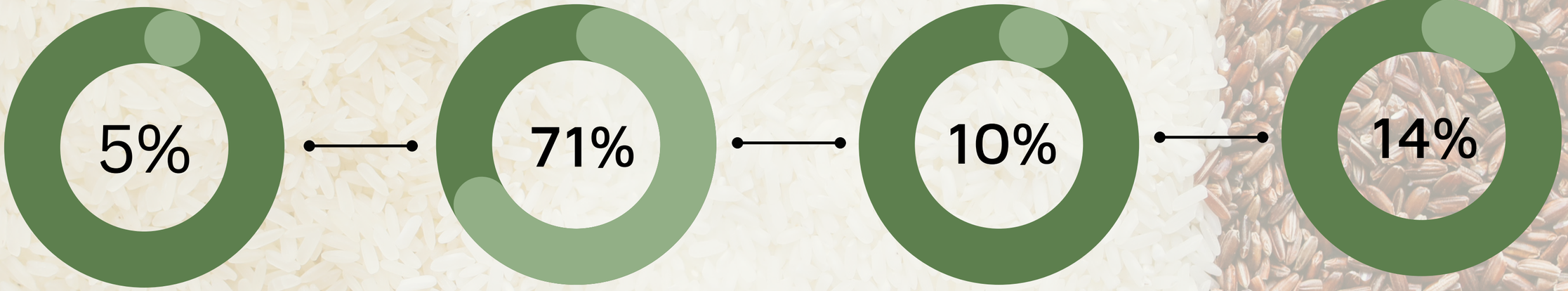
Central region:

- Bangkok
- Chonburi

The number of observations is 780 consumers

- Northern region (260)
- Northeast region (260)
- Central region (260)

TYPES OF RICE PRACTICES PURCHASED BY SAMPLES



Attributes and attribute levels for consumers

Levels: 40%, 60%, 80%

1 

Farmers'share of the retail price of milled rice

Levels: Low, No change, High

2 

Biodiversity level in rice field

Levels: No change, Reduce 50%

3 

Decreasing the amount of greenhouse gases emission from different practices

Levels: 70, 80, 90

4 

Number of days in which PM 2.5 exceeded standard levels

Levels: 30, 40, 50, 60

4 

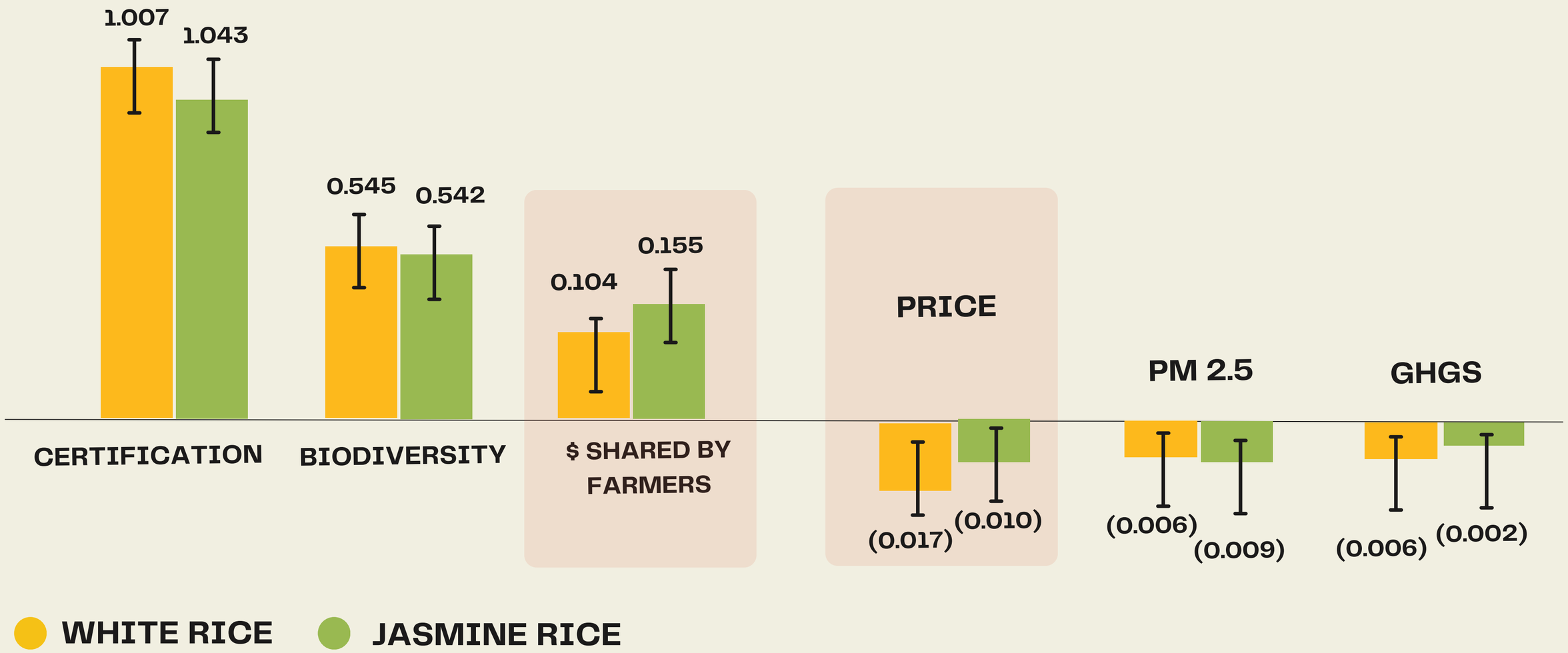
The price of milled rice per kilogram (Baht per Kilogram)

Levels: Yes, No

6 

SRP Verified

Consumers' preferences



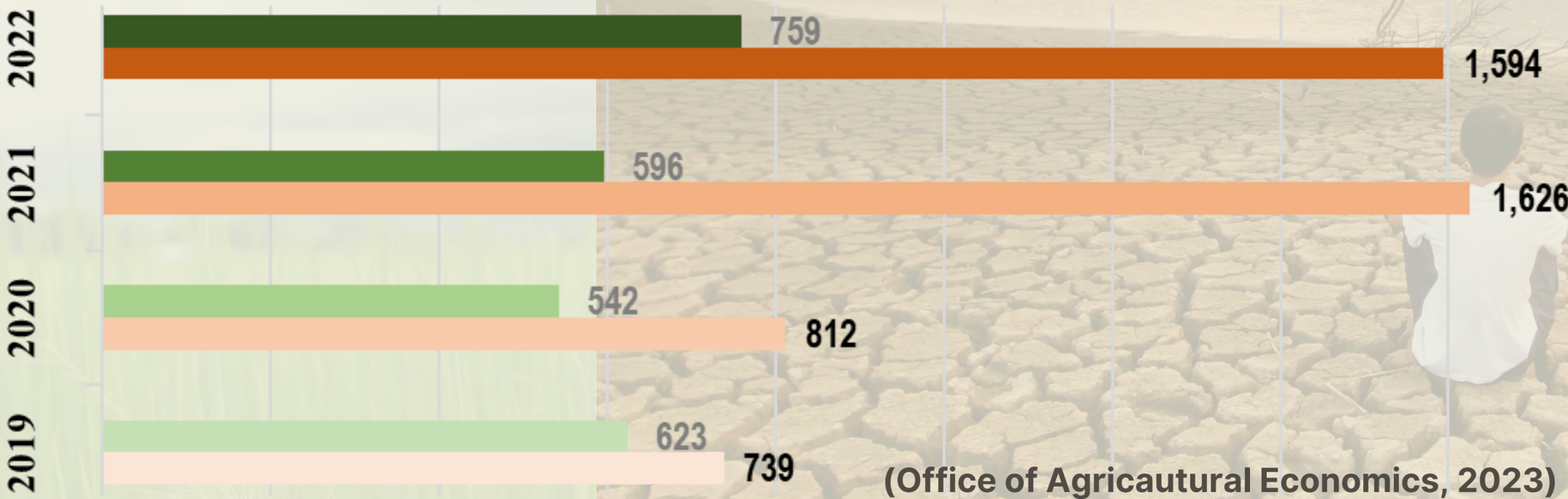
POLICY SUGGESTIONS

CURRENT GOVERNMENT SUPPORTS ON RICE CULTIVATION

- Income
- Cost

Subsidy on rice cultivation

Unit: Million USD



(Office of Agricautural Economics, 2023)

Price Insurance (In year 2023)

- **10,000-15,000** baht **(280-435)** per ton (depend on types of rice)

For example

- Jusmine rice **15,000** baht **(435$)** per ton
- White rice **10,000** baht **(280$)** per ton
- Sticky rice **12,000** baht **(348$)** per ton

Cultivation subsidy (i.e.harvesting) (In year 2023)

- **29$** per Rai (Less than 20 Rais per houeshold **(1,236 million USD)**

Disaster subsidy to help farmers (i.e. flooding and drought) (In year 2023)

- **39$** baht per Rai (Less than 30 Rais per household **(358 million USD)**

FARMGATE

ADOPTION → **TRANSITION** → **SUSTAINABLE** → **MARKET**

- **Temporary incentives**
  - Cost subsidy
  - Income subsidy
- **Social network**
  - Role model farmers

- **Incentives**
  - Income subsidy
- **Extension Support**

- **Incentives**
  - Income subsidy to reflect positives externalities
  - Price subsidy to reflect positives externalities

- **Domestics market**
  - SRP rice is not widely known
  - High potential, especially for jasmine rice
- **Global market**
  - High potential for Thai SRP rice
  - SRP Global Verify is crucial for export market

Funded by the European Union

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THANK YOU