China-U.S. Scientific Engagement on Sustainability: A Workshop Series
Workshop Ⅲ: Food Systems and Sustainability

Challenges and Opportunities on Sustainable Urban Food system

Shenghui Cui

Institute of Urban Environment, CAS

November 22, 2024 Budapest

Outline

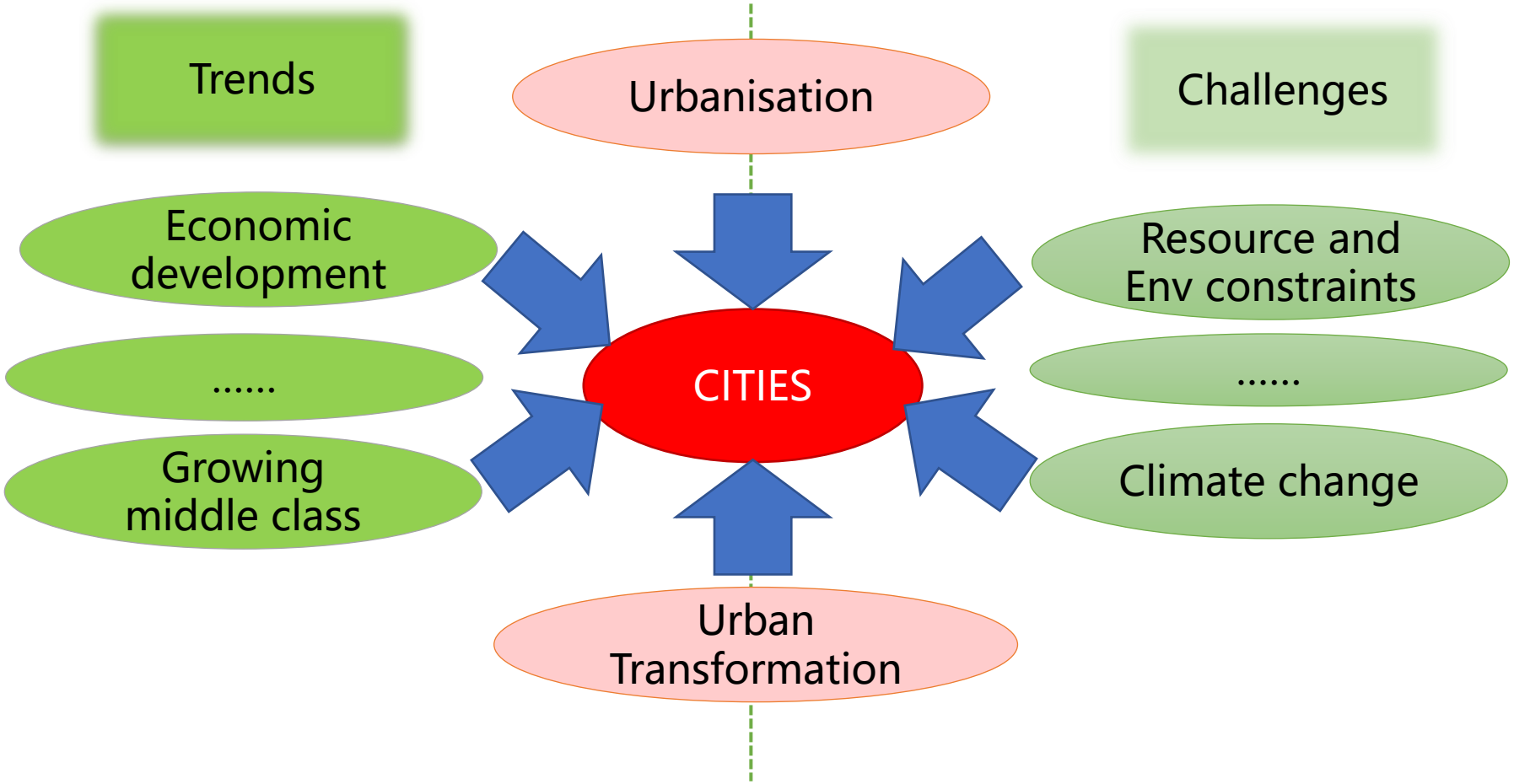
01 Concept framework for sustainable food system

02 Drivers of urban food system

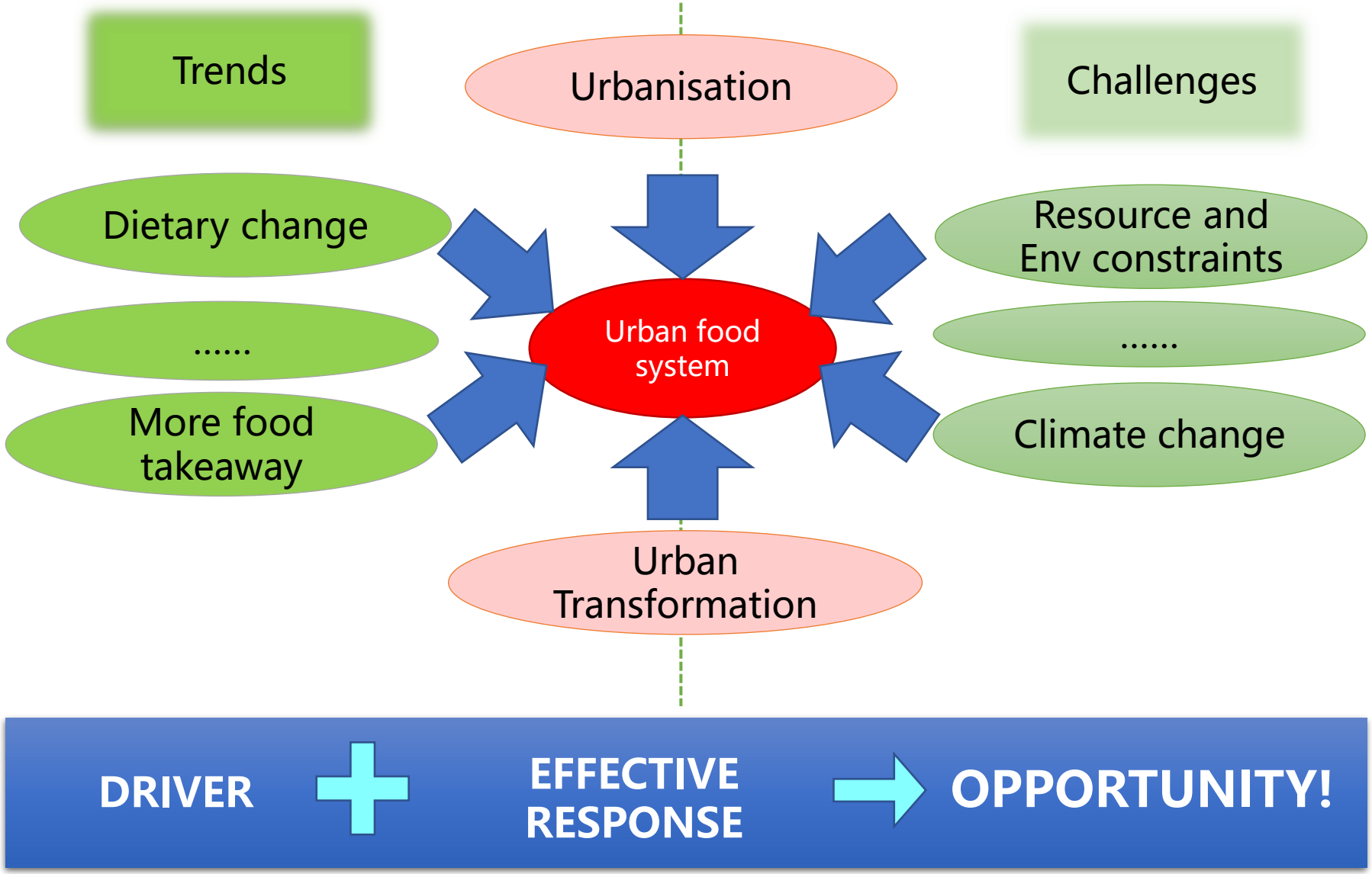
03 Challenges of sustainable food system

04 Opportunities of sustainable food system

Challenges & Trends of Cities development



Conceptual framework of sustainable urban food system



Drivers of urban food system

- Urbanization in China
  - ✓Before 2030, urbanization rate will reach 70%,the speed is decreasing .
  - ✓China has seen a population decline since 2022, urban sprawl will be controlled well.

Drivers of urban food system

- Urban Transformation
  - ✓A systemic change of the urban system. It is a process of fundamental irreversible changes in infrastructures, ecosystems, agency configurations, lifestyles, systems of service provision, urban innovation, institutions and governance (Thomas Elmqvist et al.2019).


nature sustainability

PERSPECTIVE

https://doi.org/10.1038/s41893-019-0250-1

Sustainability and resilience for transformation in the urban century

Thomas Elmqvist[1*], Erik Andersson[1,2], Niki Frantzeskaki[3], Timon McPhearson[1,4,5], Per Olsson[1], Owen Gaffney[1], Kazuhiko Takeuchi[6,7] and Carl Folke[1,8]

Urban Transformations in China

- Infrastructure: especially high effective transportation
- Ecosystem: China has seen a population decline since 2022, thus urban sprawl will stop and cities call for high quality development.
- Agency configurations: Big Data Agency in NDRC
- Life styles: food takeaway, the way buy food, pack the leftover
- Systems of service provision : live-broadcasting platform sale
- Innovation: prepared dishes, artificial meat
- institutions and governance: national policy for green transformation

Challenges of sustainable food system

- Nutrients urbanization and the broken biogeochemical cycle
- Climate change
- Concern tele-coupling & transboundary impacts (industrialization and globalization)
- spatial heterogeneity for food production, processing, transportation & consumption
- free market behaviors for local food trade & supply
- Synergy and tradeoff on SDGs

Opportunities of sustainable food system

- Xiamen Cases

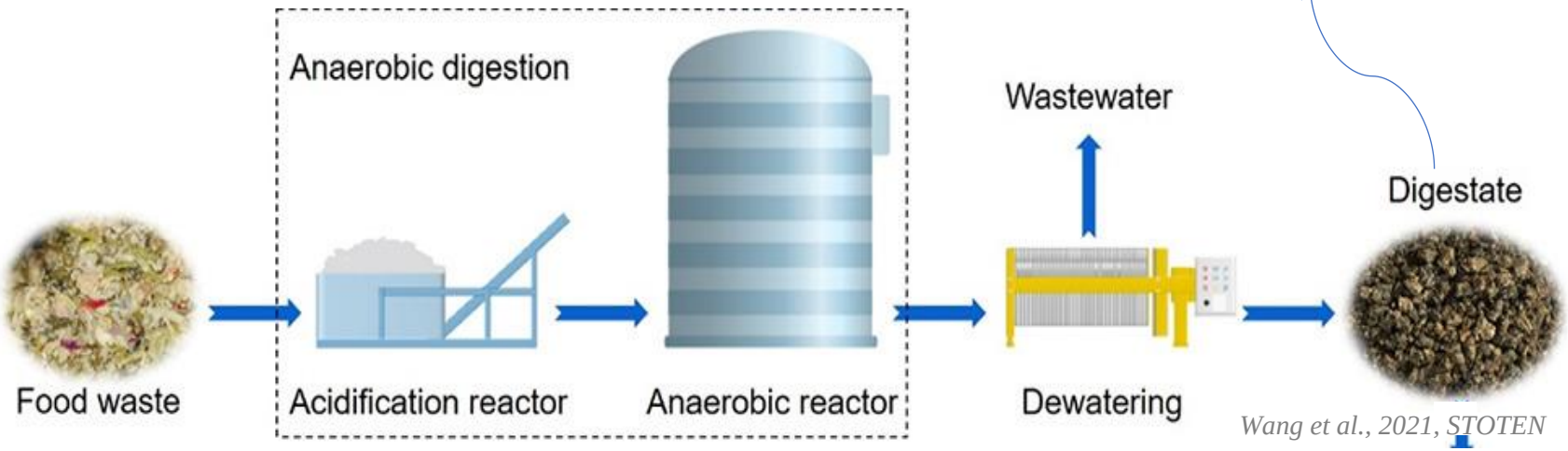
Three main kinds food waste resourceful utilization products in China

-China has >100 pilot citys food waste resourceful utilization

Typical city: Xiamen

- incomplete decomposed and unstable substance;
- high water content: 70%-90%

Biochar



Wang et al., 2021, STOTEN

Food waste

Microbial aerobic reactor

Aerobic fermentation residue

screening

Aerobic compost

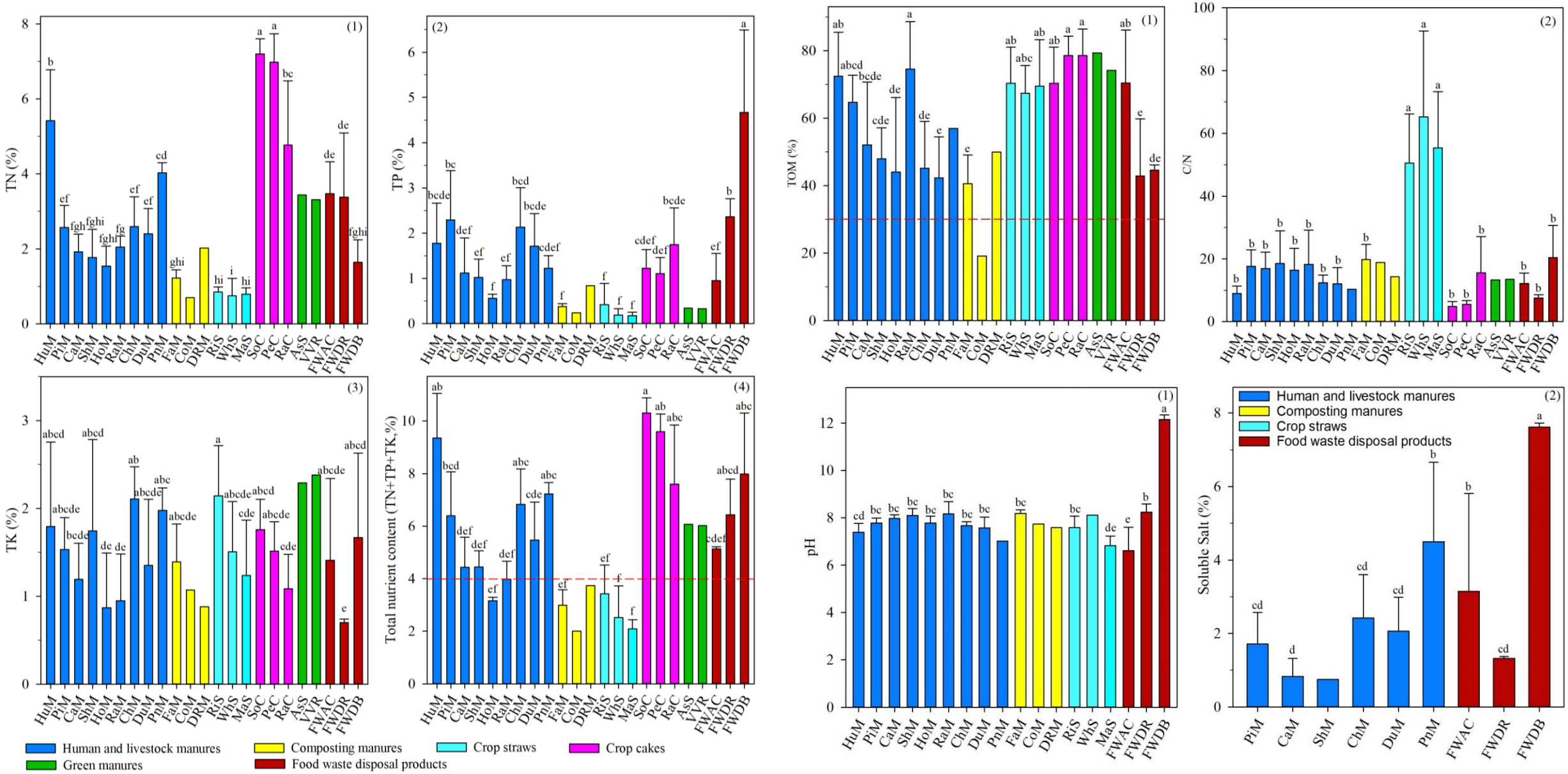
Scientific Questions?

Digestate residue

Digestate residue biochar

Aerobic compost

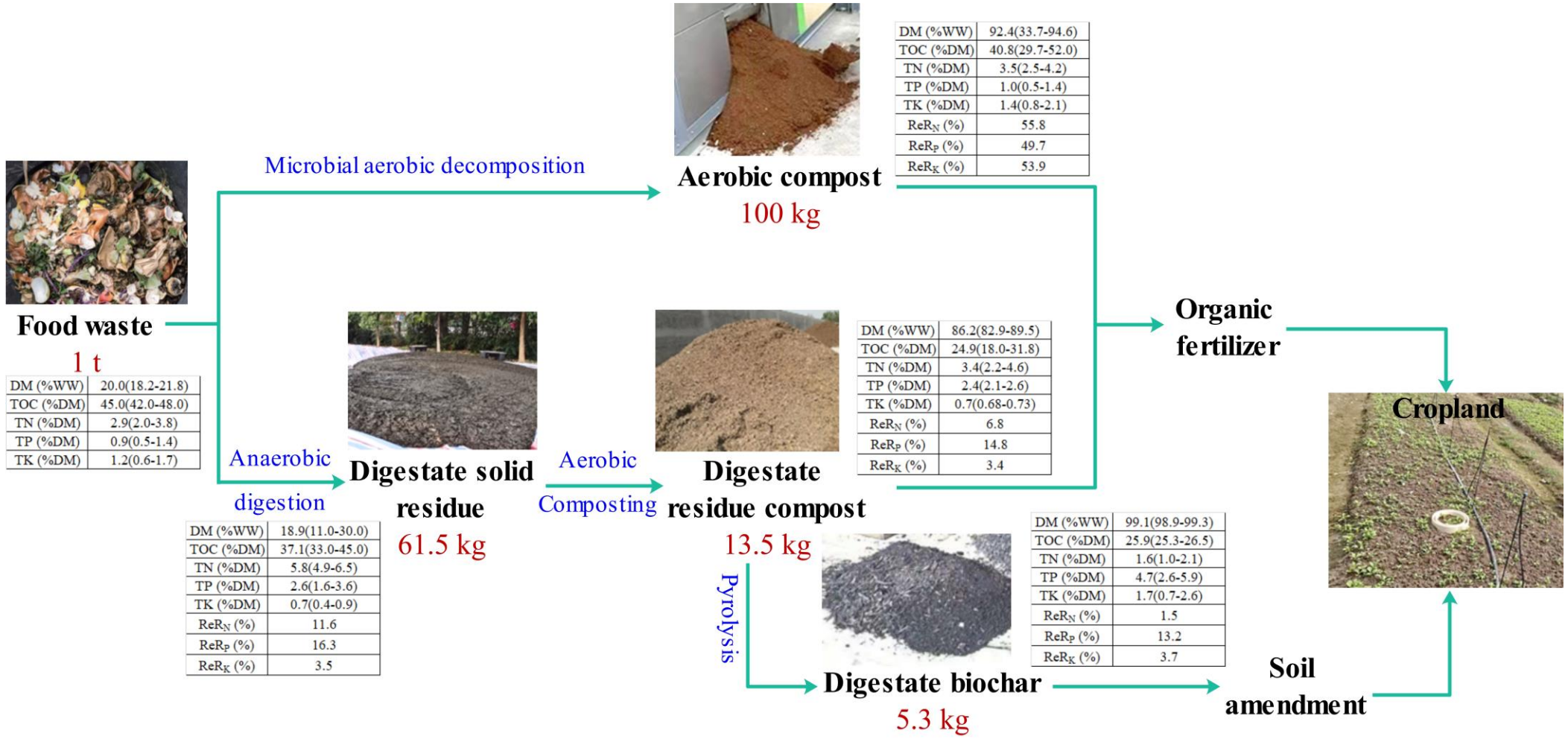
1. How about the status of nutrient (C/N/P/K) contents, pH, soluble salt in three food waste resourceful products, compare with the different conventional organic manures?
2. What is the application potential of food waste resourceful products in Xiamen?
3. How about the integrated impacts of different food waste composts on GHG emissions of open-field vegetables in subtropical China?



The TN, TP, TK, and TOM contents of the three food waste resourceful products are analogous to several livestock manures (pig, chicken, duck, pigeon manures) broadly accepted by Chinese farmers.

Fang and Cui et al., 2022, JCLP

The application potential of food waste resourceful products in Xiamen

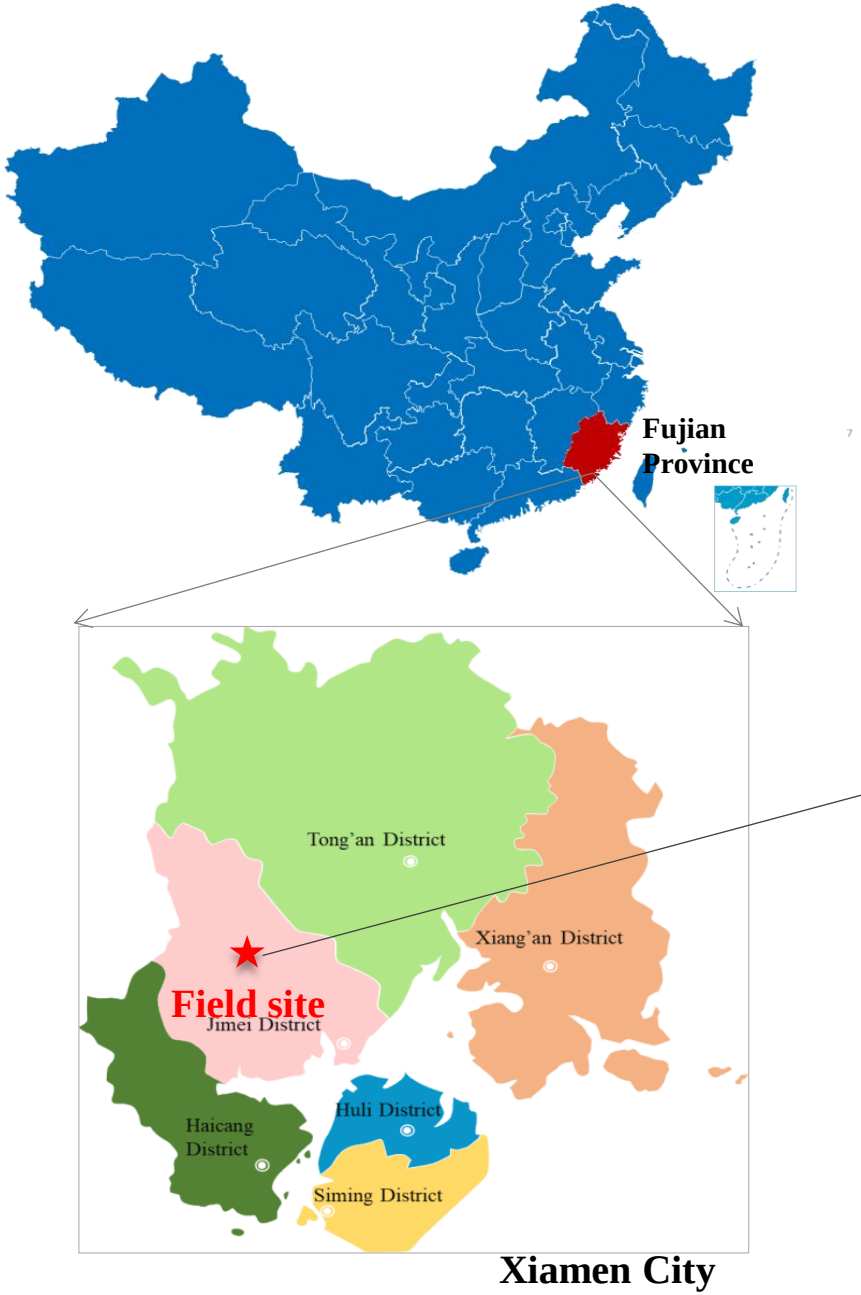


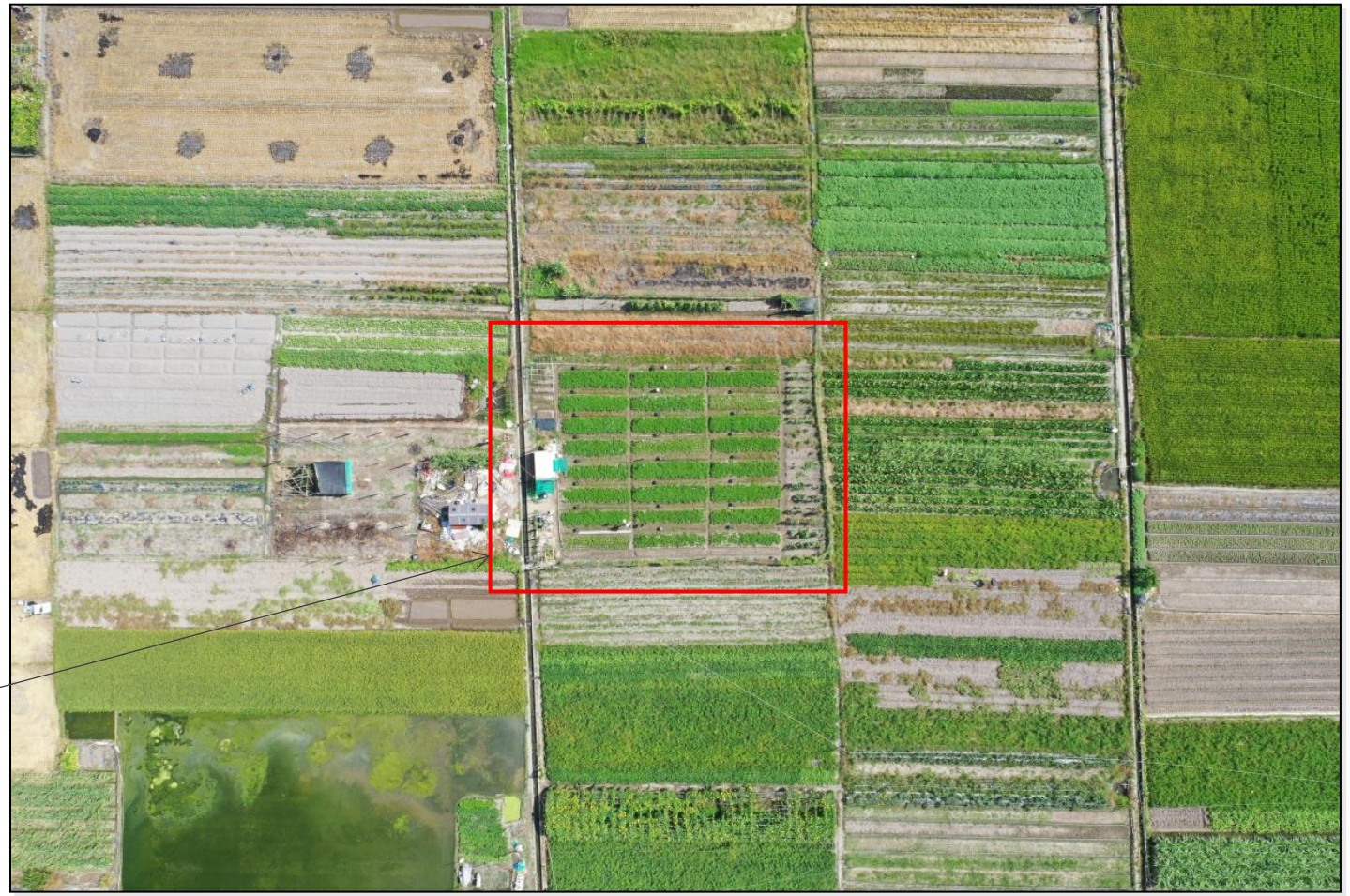
Almost 1,400 t d^{-1} of restaurant FW is generated in Xiamen, while only about 452 t d^{-1} of them is collected. Supposing the digestate were recycled to produce FW digestate residue (6,100 kg d^{-1}), they could replace 5.6% of chemical fertilizers (1.6% N, 3.6% P, and 0.4% K) per year.

Ideally, supposing all restaurant FW generated were collected and treated by AD, the FW digestate residue could result in a total of 17.5% (4.9% N, 11.2% P, and 1.4% K) substitution ratio of chemical fertilizers.

Fang and Cui et al., 2022, JCLP

Field demonstration of different food waste composts





The conventional fertilization status of leaf vegetables in Xiamen

N fertilizer (kg N ha^{-1})	P fertilizer (kg P_2O_5 ha^{-1})	K fertilizer (kg K_2O ha^{-1})	Basal/topdressing ratio	Organic/Inorganic
375	225	263	6:4	3:7

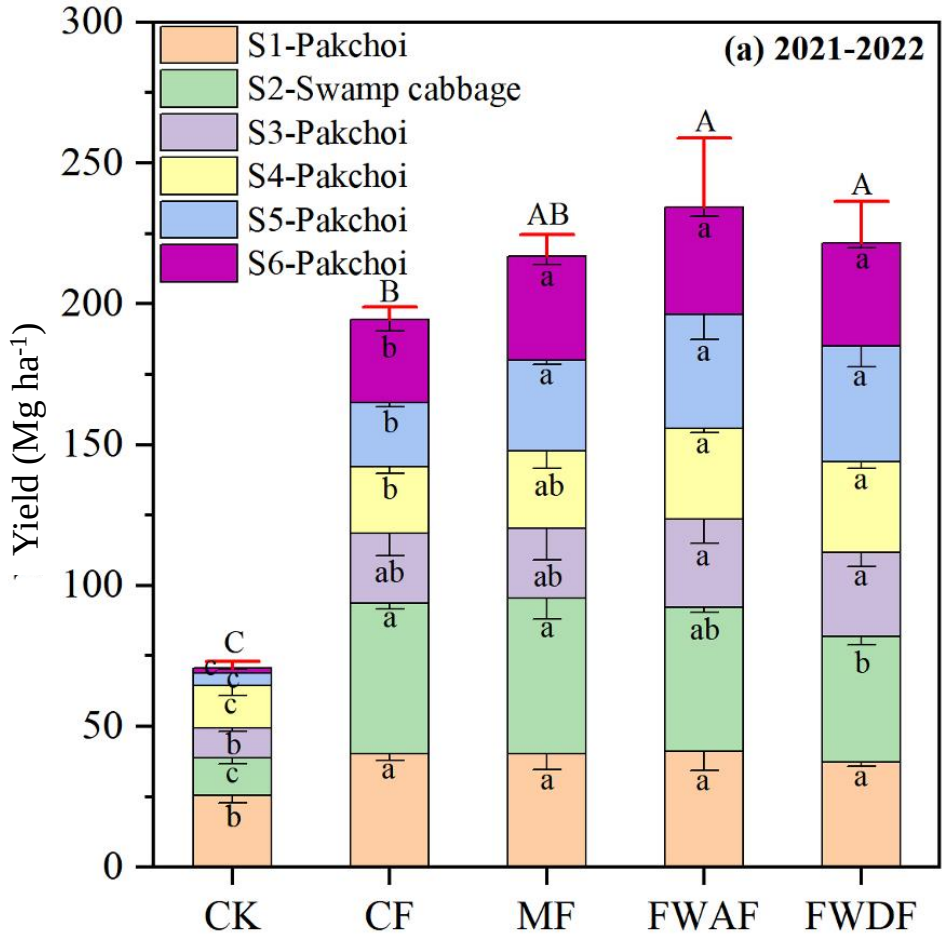
2. Field demonstration

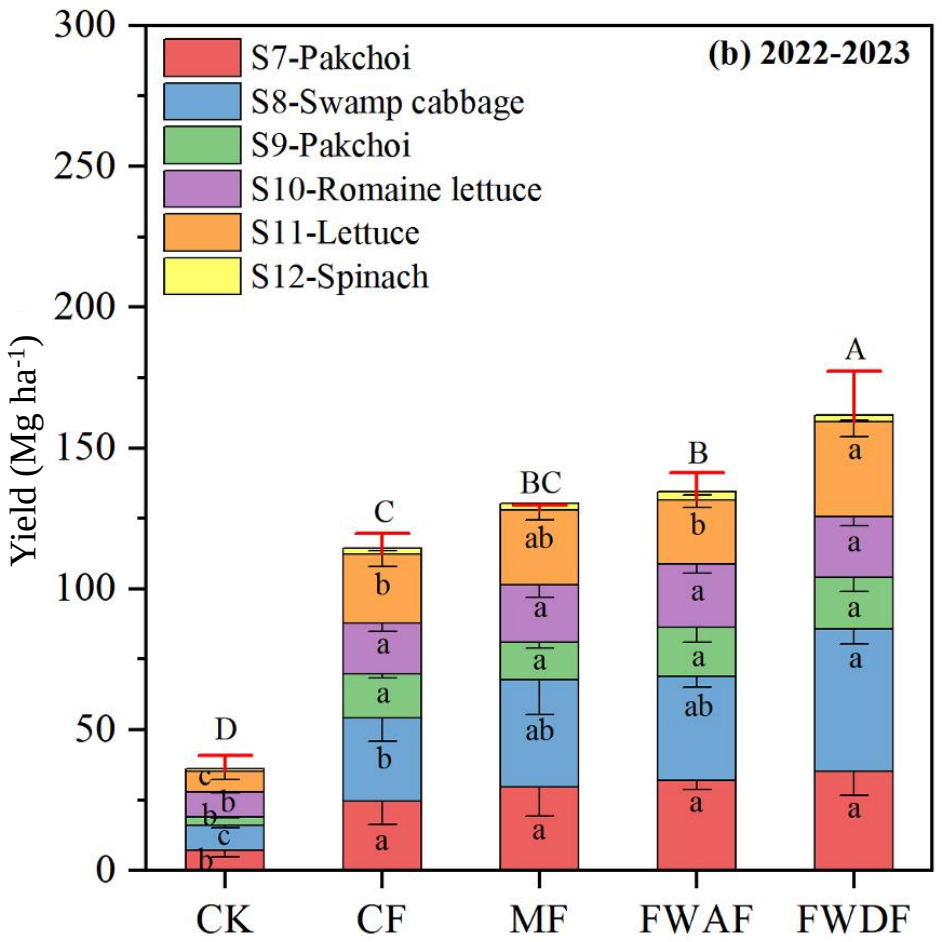
Treatments of the field experiment

Code	Fertilizer management
A	No N control
B	Conventional 100% chemical N fertilizer
C	Conventional 30% chicken manure N + 70%B
E	30% food waste aerobic compost N + 70%B (be adjuested to 50%B from 2nd year)
G	30% food waste anaerobic digestate compost (FWAD) N + 70%B (be adjuested to 50%B from 2nd year)
H	20% FWAD N +10% FWAD biochar N + 70%B (be adjuested to 50%B from 2nd year)

Note: all the treatments have the same amounts of P and K fertilizers and once applied as basal fertilizer.

Yield comparison of different treatments

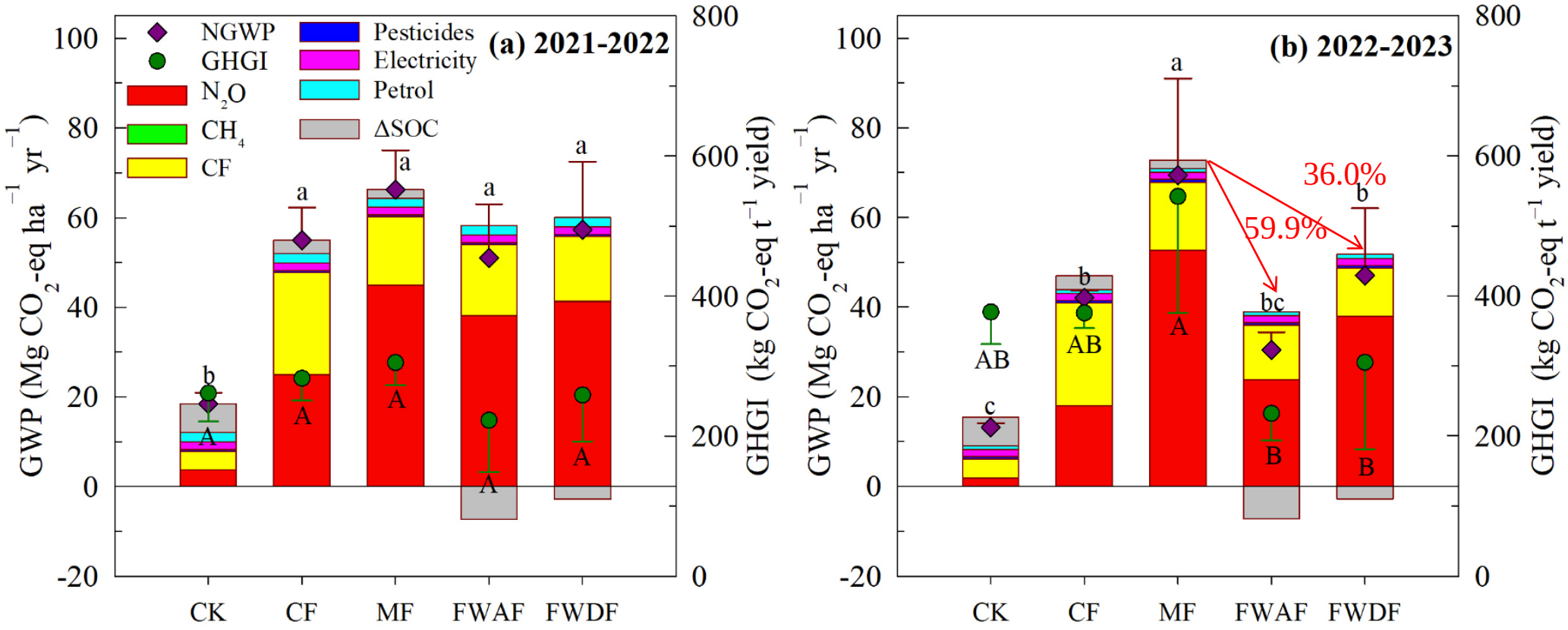




- Food waste aerobic compost (FWAF) and anaerobic digestate compost (FWDF) treatments can maintain the yield level as the conventional chicken manure + chemical fertilizer N treatment (MF), even reducded 20% of the total N application in the 2nd year in the former two treatments.

Fang and Cui et al., 2024, RCR

Net global warming potential and GHGI of different treatments



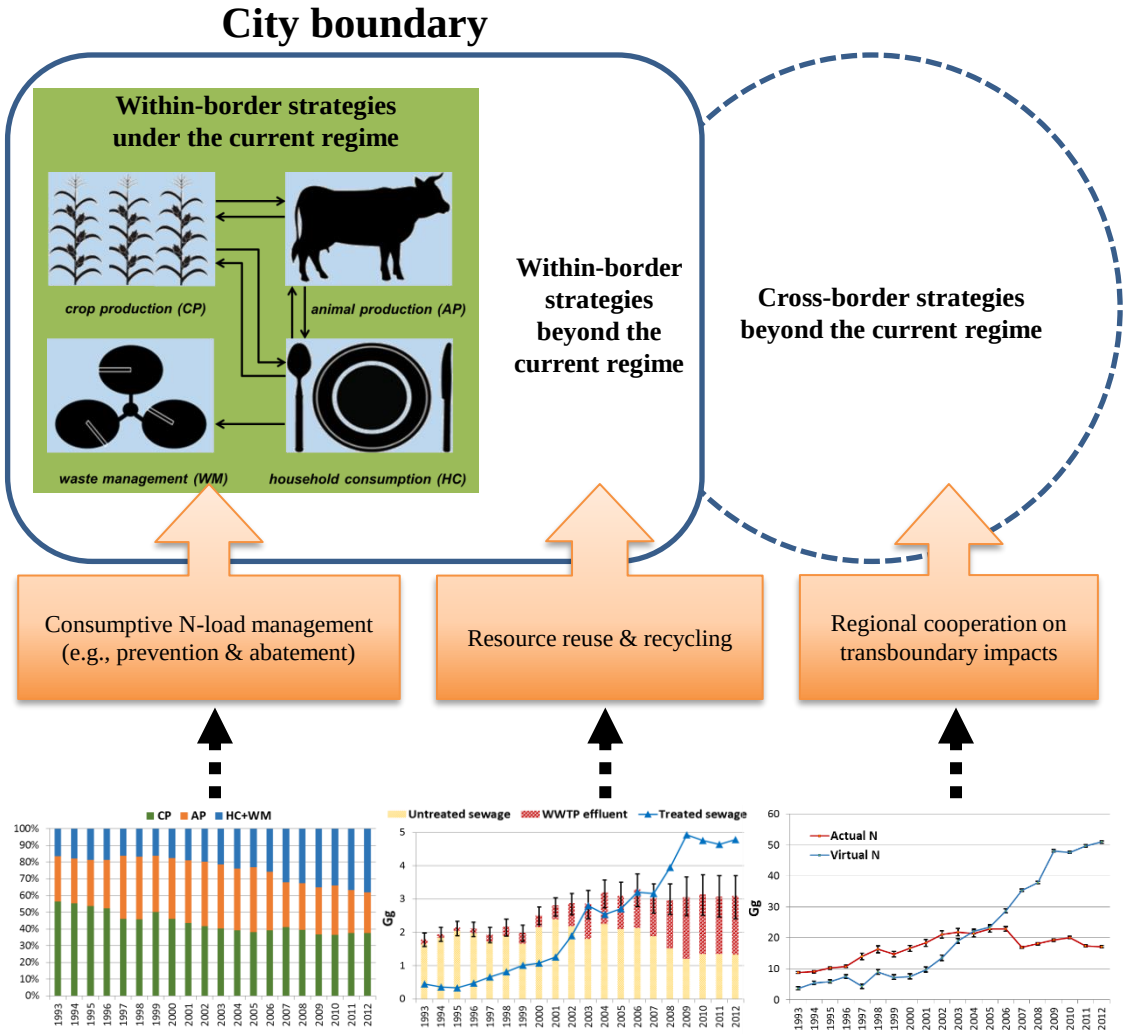
- Subtropical vegetable field is a lagre souce of GHG emission, caused by chemical fertilzier (CF) N application and its induced N_2O emissions.
- Substitute 50% CF N with 30% food waste composts (FWAF and FWDF) N can significant decrease GWP and GHGI in the 2nd year.

Fang and Cui et al., 2024, RCR

Three-tier template framework of city strategies

Transforming N management

Changing N flow patterns



Template framework of a city's strategies for N-load reduction from the food system

Thank you for your attentions!