The paper argues that the rapid, global expansion of greenhouse agriculture represents a significant and understudied new phase of agricultural intensification. The paper tells that this "boom" cannot be understood through traditional agricultural geography alone.

This study frames it through the critical lenses of

environment-society geography

critical agrarian studies

most importantly, the Plantationocene.

**Core thesis**: The main argument of the paper is that the recent global expansion of greenhouse agriculture can be understood using the concept of the **Plantationocene**.

* **Plantationocene**: This is an idea that describes our current age as shaped by large-scale, industrial farming systems. It highlights features like:
  + growing just one crop in large areas (**monocultures**),
  + extracting natural resources intensively,
  + using and exploiting racialized or marginalized labor,
  + and connecting everything through long-distance global supply chains.
* **But greenhouses are different too**: While they share some of these characteristics, they also bring **new features**:
  + They are **volumetric, 3D enclosures** (not just open land, but controlled environments).
  + They are deeply connected to **peri-urbanization** (the spread of cities into nearby rural areas).
  + They rely on **advanced technologies and materials**—especially plastics (“plasticulture”).
* **Big takeaway**: Because of these differences, the greenhouse boom doesn’t fit neatly into traditional geographic models of how farming gets more intense. Instead, it challenges those models and shows the need for new kinds of research, especially around **social and environmental justice** (e.g., who benefits, who is harmed, how it impacts land, workers, and ecosystems).

**Critical Agrarian Studies**: This perspective asks: Who benefits? Who loses? How are land, labor, and resources reorganized in ways that create new forms of dispossession and vulnerability?

**Environment-Society Geography**: This bridges the physical and social. The paper doesn't treat greenhouses as just technological objects but as socio-ecological systems that reshape hydrology, soil, air, and pollution patterns, which in turn affect human communities.

**Sociotechnical Assemblages** (from science‐and‐technology studie): A greenhouse isn't just a structure; it's an assembled network of:

**Technology**: Plastic films, drip irrigation, desalination plants.

**Infrastructure**: Highways, ports, cold chains.

**Finance**: State subsidies, international investment (e.g., EU agribusiness in Morocco).

**Policy**: Free trade agreements (NAFTA), national development plans (Plan Maroc Vert).

**Knowledge**: Both high-tech digital systems and localized techniques (e.g., Spain's enarenado sand-plot technique).

The "**Volumetric Enclosure**": This is one of the paper's most innovative concepts. Traditional land enclosures were about fencing off two-dimensional land. The authors argue that greenhouses create three-dimensional, volumetric enclosures.

They don't just enclose land; they enclose and privatize air, water and soil.

In this study four case studies including Spain, China, Morrocco and Mexico expertly chosen to show the global scope and varying dynamics of the boom.

In every example studied, the greenhouse boom happens **near cities**.

It grows in the **peri-urban zone** (the area between city and countryside).

This area is often not **well-regulated**.

Greenhouse farming benefits from **being close to roads and transport, workers, and markets** where products are sold.

At the same time, **it uses up land and water on the edges of cities**.

The "**Disruption**" of Geographic Precepts

Normally, in geography, we expect intensive farming (farming that produces a lot) to happen in places with good natural conditions like rich soil and reliable water. This is what old models, like von Thünen’s model, suggested.

But the greenhouse boom is changing this. Thanks to **technology, capital, and logistics**, farmers can now grow intensively almost anywhere.

Greenhouses create their own conditions (enclosures) and use advanced systems (sociotechnical assemblages) like plastics, irrigation, and controls.

Under-Explored Themes:

The "**More-than-Human**" Dimension: What are the microbiomes, insect life, and ecological changes within these enclosed volumes?

**Datafication and Automation**: A huge growth area. The rise of AI, sensors, and robotics in high-tech greenhouses (e.g., Netherlands, Canada) represents a further intensification of control.

**Energy Flows**: These systems are energy-intensive (for temperature control, lighting, desalination). A full metabolic analysis is needed.

**Intersectional Analysis**: A deeper dive into how gender, race, and citizenship status intersect to shape labor hierarchies and precarity.