

# Residues India Status

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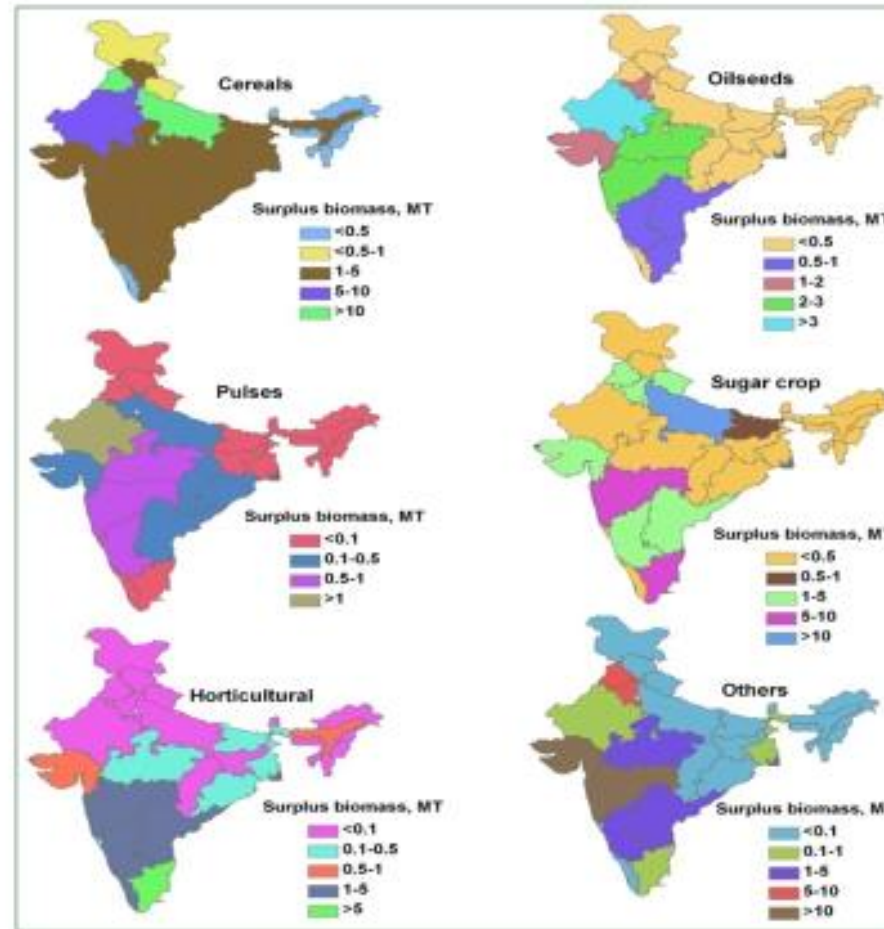


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## India's crop residue bioenergy strength

- Gross residue potential: 686 million tonne/year
- Net residue potential: 234 million tonne/year
- Can meet 4.15 EJ of India's primary energy demand (17%)
- Rice, sugarcane, wheat, cotton major feedstocks

*Hiloidhari et al., 2014. Renew. Sust. Energ. Rev.*



2

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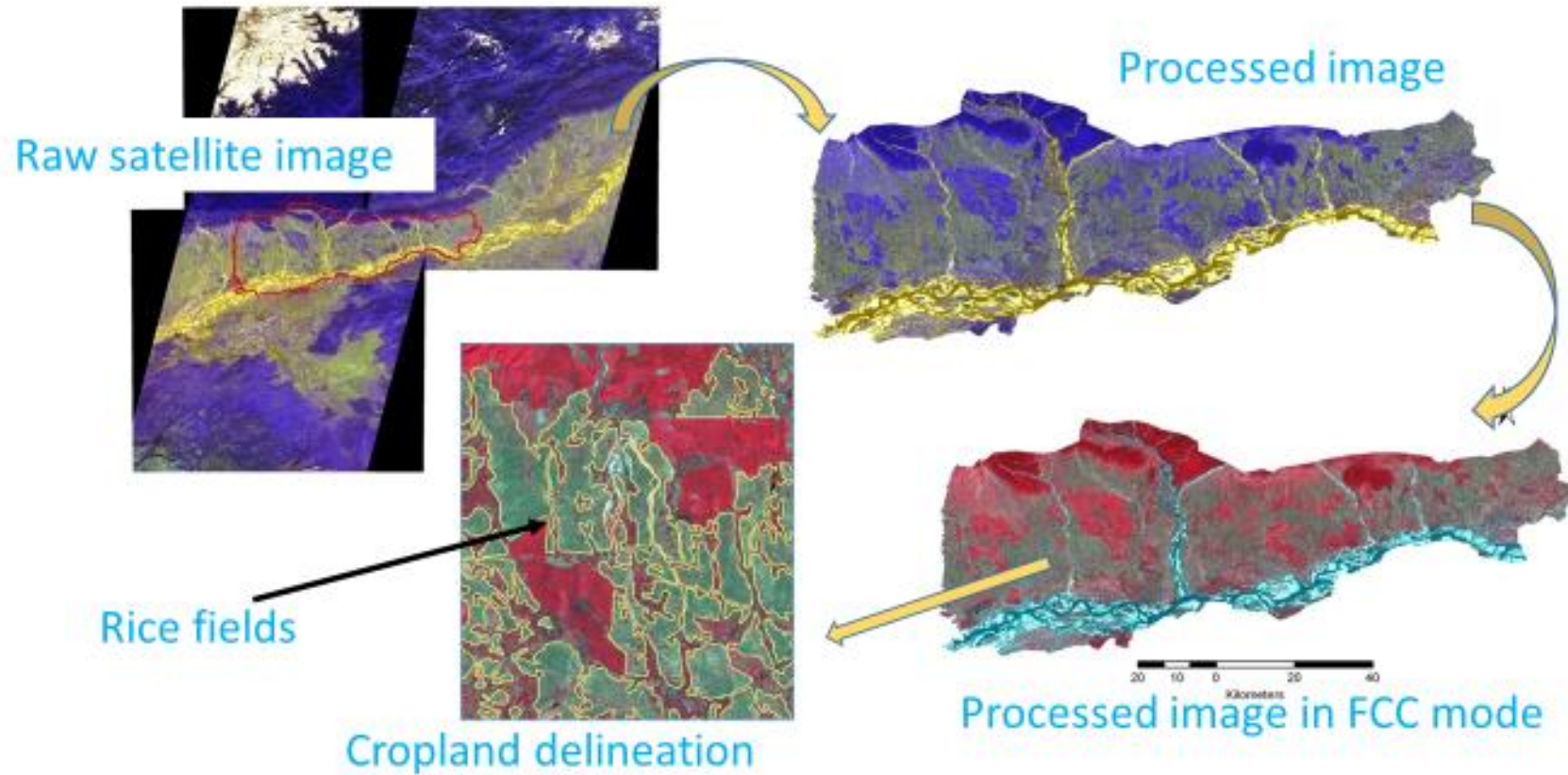
Residue type	Residue potential, million tonne/year
Rice residue	154
Wheat residue	131
Sugarcane bagasse	111

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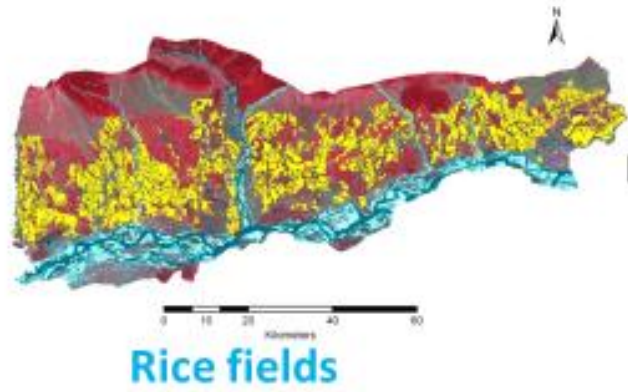
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# Spatial tool for bioenergy mapping (village level)



Hiloidhari et al., 2011. *Renew. Sust. Energ. Rev.*  
Hiloidhari et al., 2012. *Biomass Bioenerg.*





Yield  
RPR



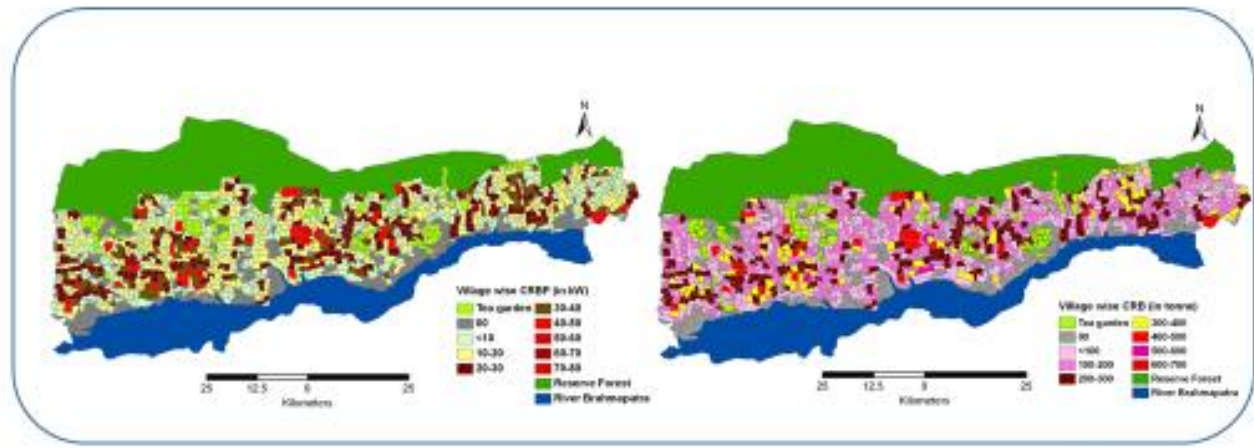
Sustainability factor

Net residue

Energy value

Residue bioenergy

District/Block/Village  
bioenergy map



Hiloidhari et al., 2011. *Renew. Sust. Energ. Rev.*  
Hiloidhari et al., 2012. *Biomass Bioenerg.*

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Resources

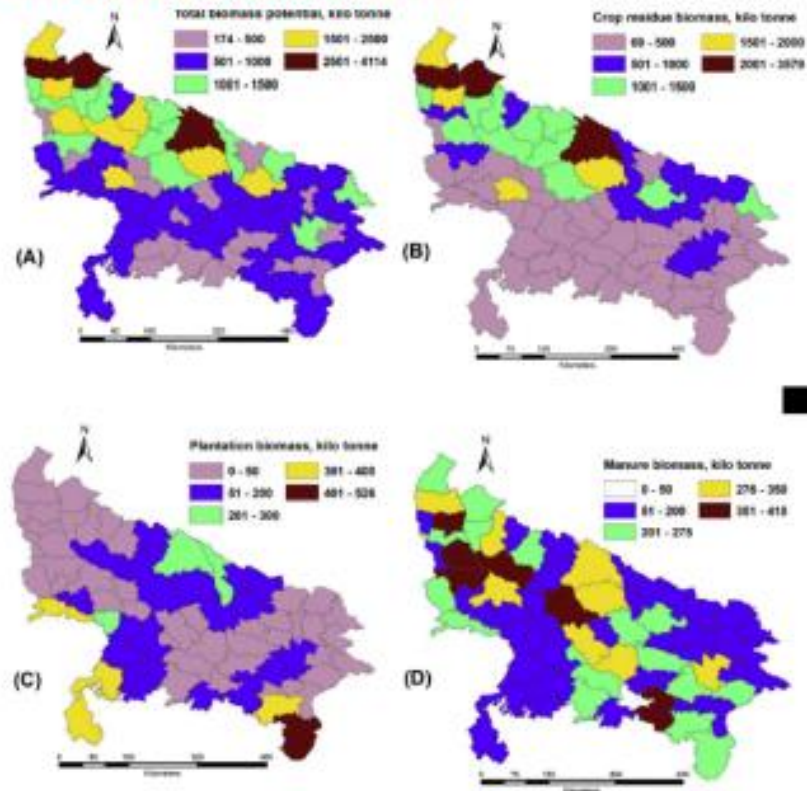
Pre-treatment and conversion

Vectors

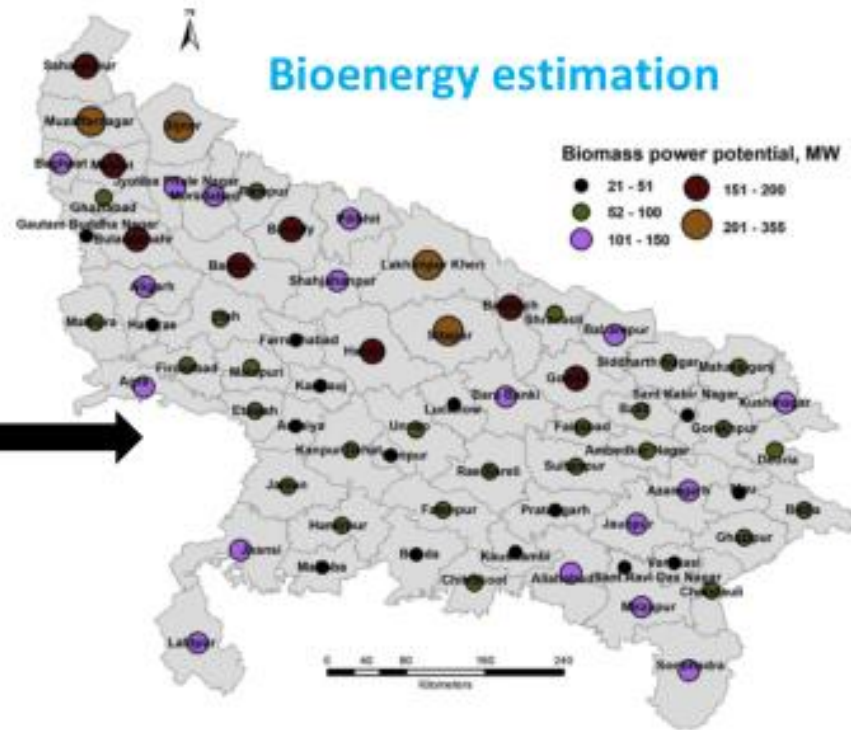
Systems

# Spatial tool for bioenergy mapping (district level)

## Resource assessment



## Bioenergy estimation



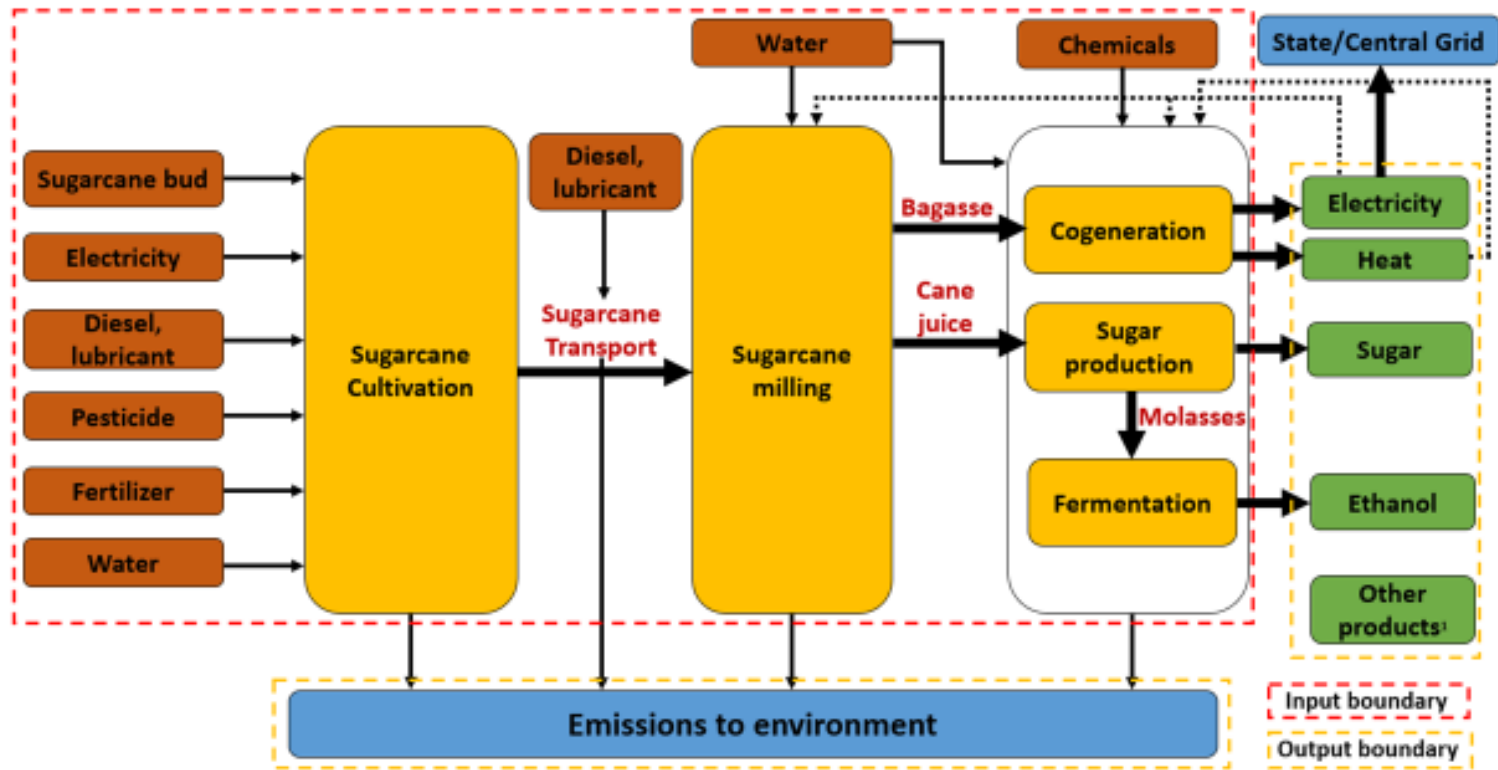
Hiloidhari et al., 2019. *J. Clean. Prod.*

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# Life Cycle Assessment of Bioenergy (Sugarcane)



<sup>1</sup>Other products include Sugarcane trash (Cultivation stage), Press mud (Sugar production stage) Fusel oil and spent wash (Ethanol production stage) and Bagasse Ash (Cogeneration stage)

Hiloidhari et al., 2021. *Bioresour. Technol.*

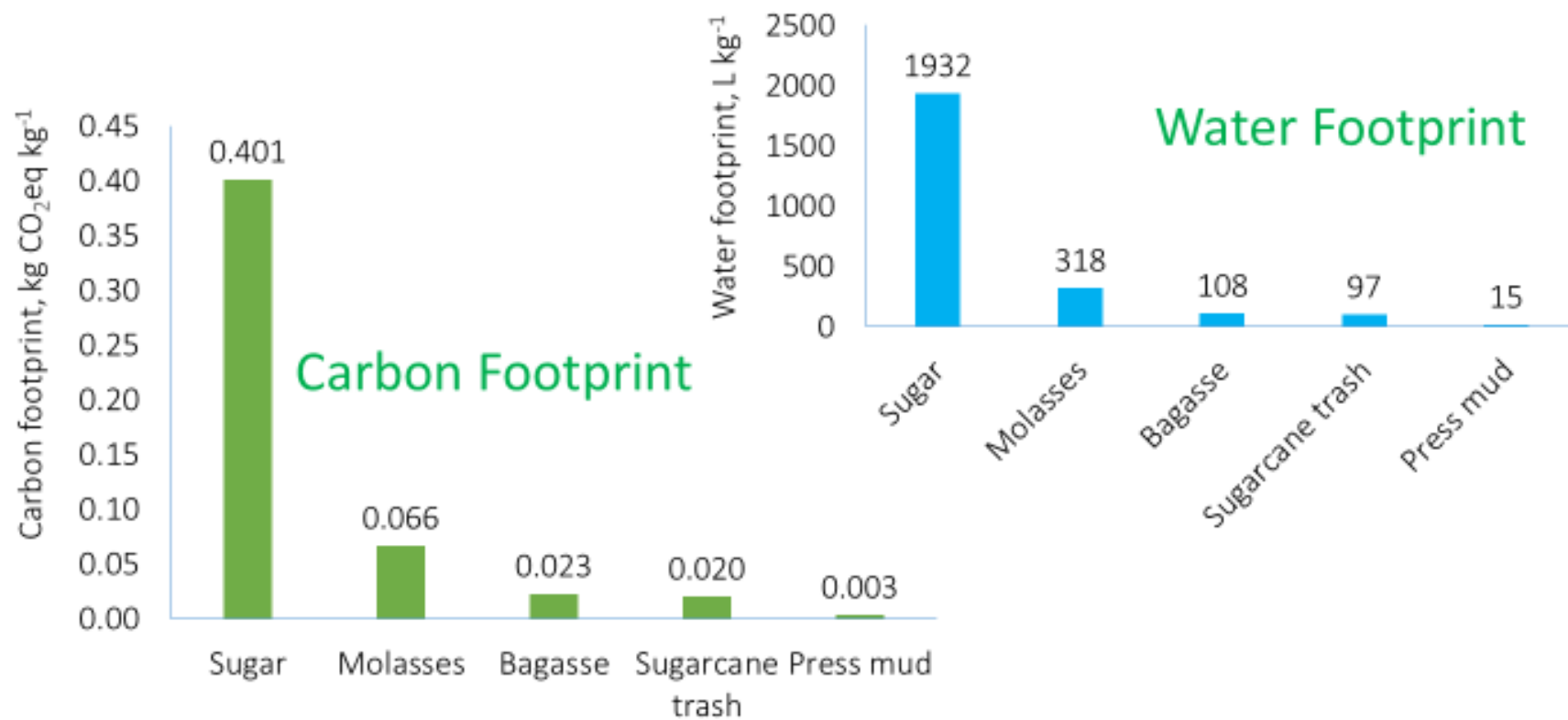
7

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Hiloidhari et al., 2021. *Bioresour. Technol.*

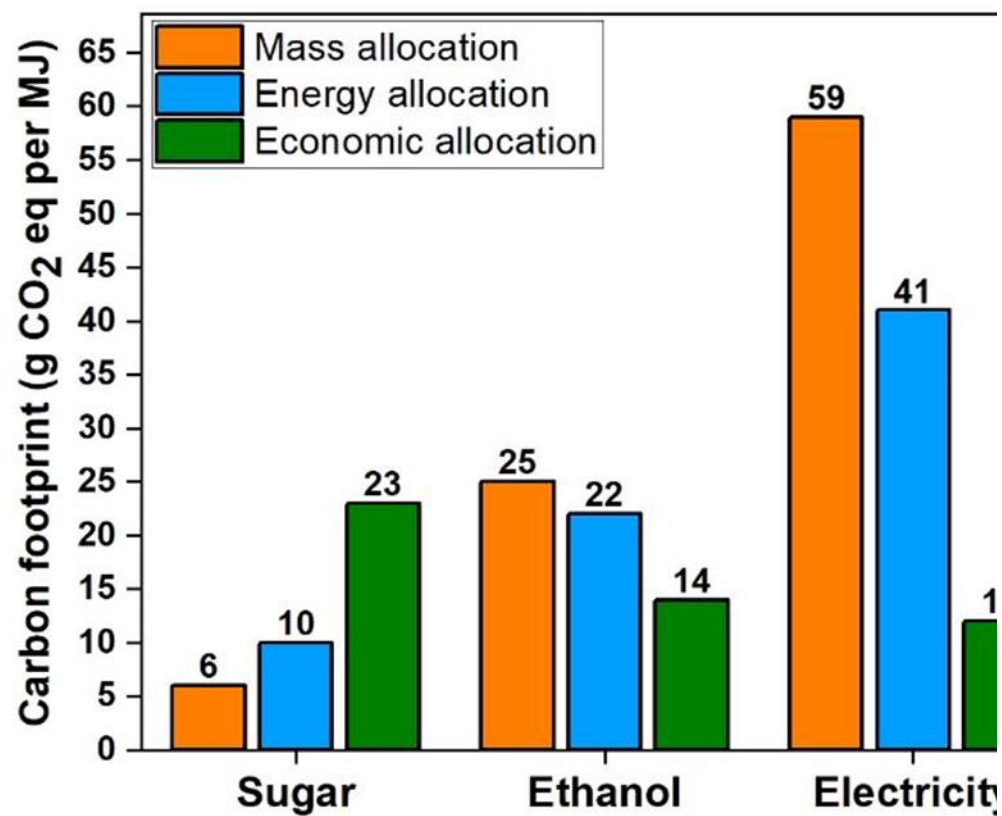
8

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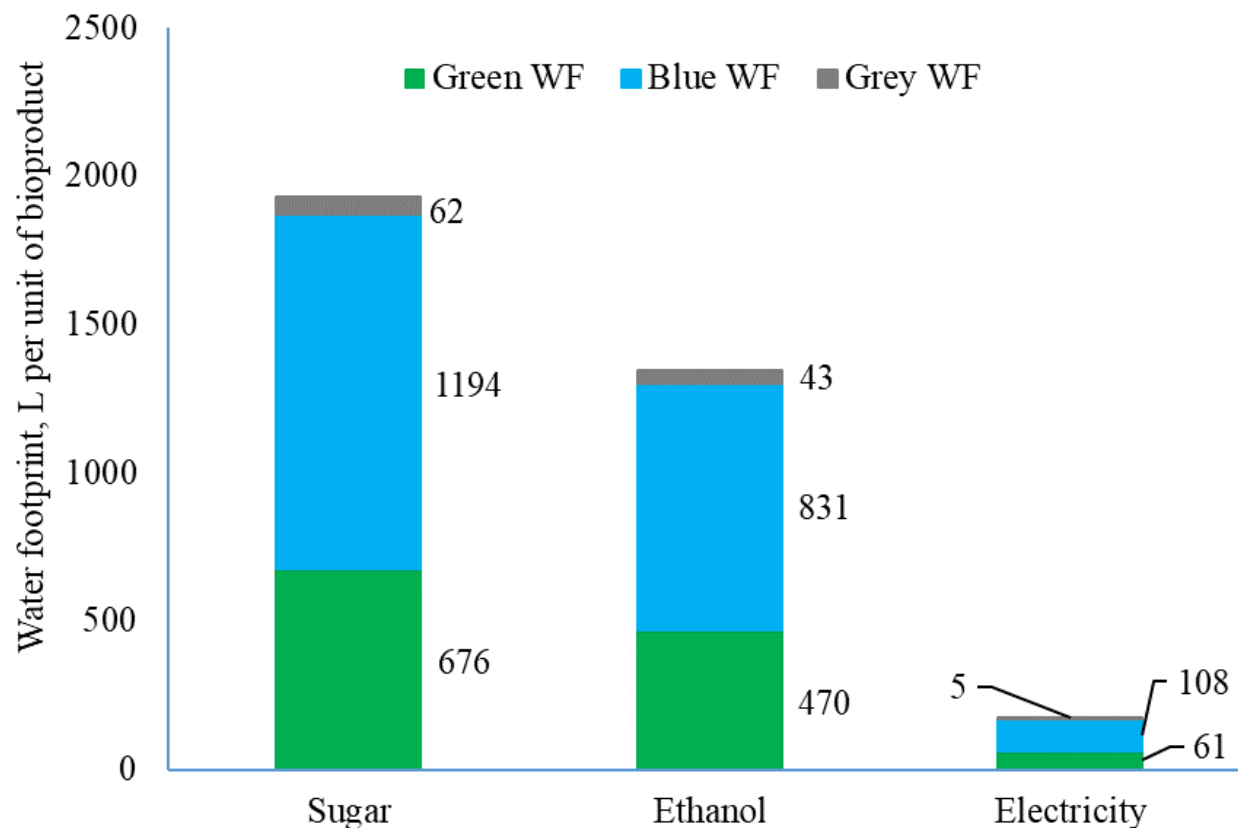


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**Carbon Footprint**



**Water Footprint**

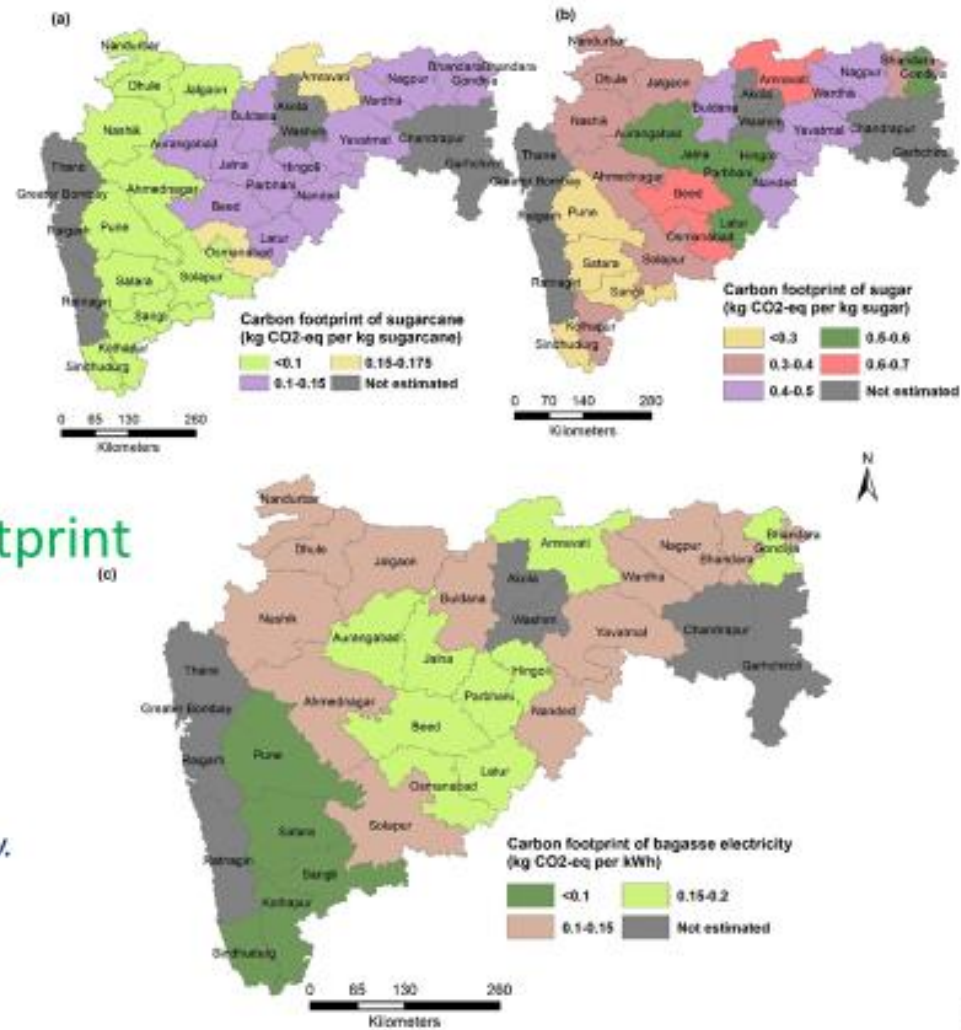
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# Life Cycle Assessment of Bioenergy at District-level (Sugarcane)

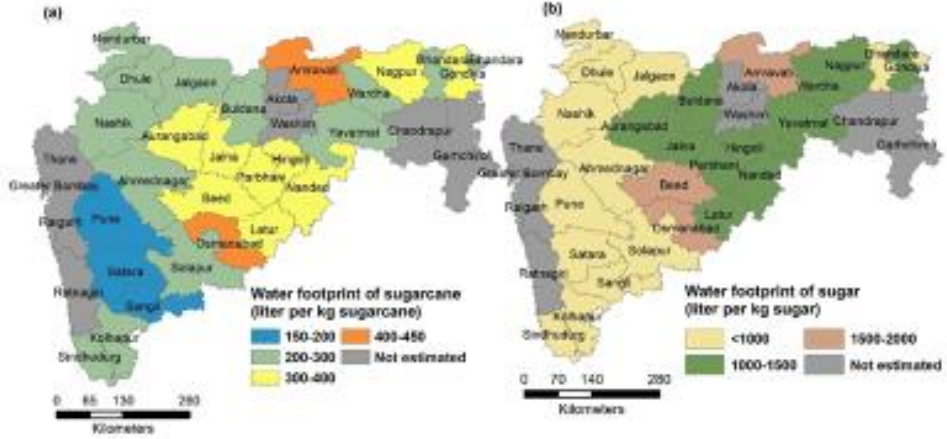
## Carbon Footprint



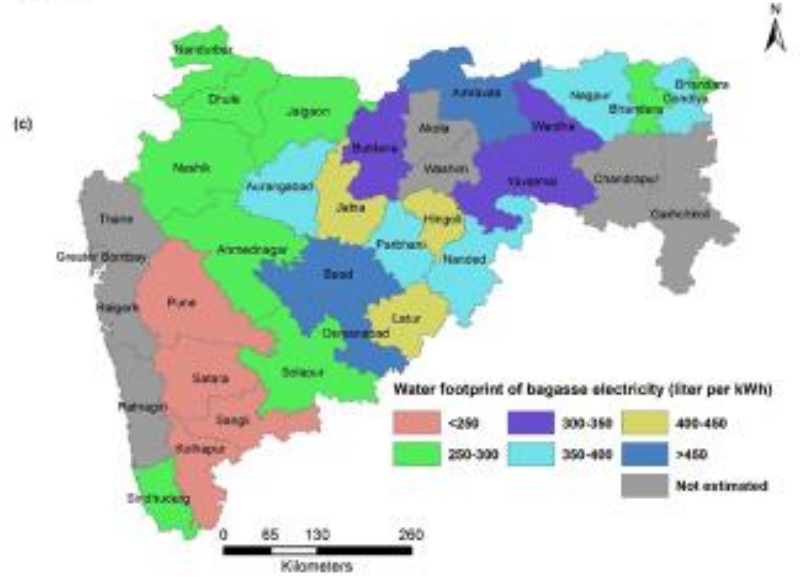
Hiloidhari et al., 2021. *Renew. Sust. Energ. Rev.*



# Life Cycle Assessment of Bioenergy at District-level (Sugarcane)



# Water Footprint



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# Existing projects in India

- Bagasse cogeneration for electricity (centrally supported scheme for sugar factories)
- Biomass gasification for power (mostly kilowatt level for village electrification)
- Residue for biogas production (mixed with cow dung, success yet not visible at large extent)
- Ethanol from crop residue (still at laboratory/pilot scale)

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# R&D institute for bioenergy

- IIT Delhi, IIT Bombay, IIP Dehradun, IIT Guwahati, Tezpur University, IISc Bangalore, SSS-NIBE: examples of major academic institutions involved in bioenergy research.

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# Gaps in the field

- Lack of precise, up-to-date biomass inventory covering all India at various scales (village, district).
- Lack of efficient biomass supply chain network (feedstock harvest, collection, storage, pre-processing, transport).
- Failure to realize the tremendous potential of residue bioenergy for power/biogas/ethanol/biohydrogen.
- Private players still not interested in bioenergy as seen for solar or wind

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# Research needs to address gaps

- Map India's bioenergy strength using modern tools (remote sensing, GIS) covering all types of feedstocks up to fine spatial resolution of village.
- Optimize biomass supply chain (management strategist and computer scientists must work together with energy researcher)
- Realize the full potential of sugarcane industry as biorefinery unit.
- Effort to utilize crop residues for biojet fuel, biohydrogen production.

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