From agro-waste to sustainable building materials; a systematic study on corncob

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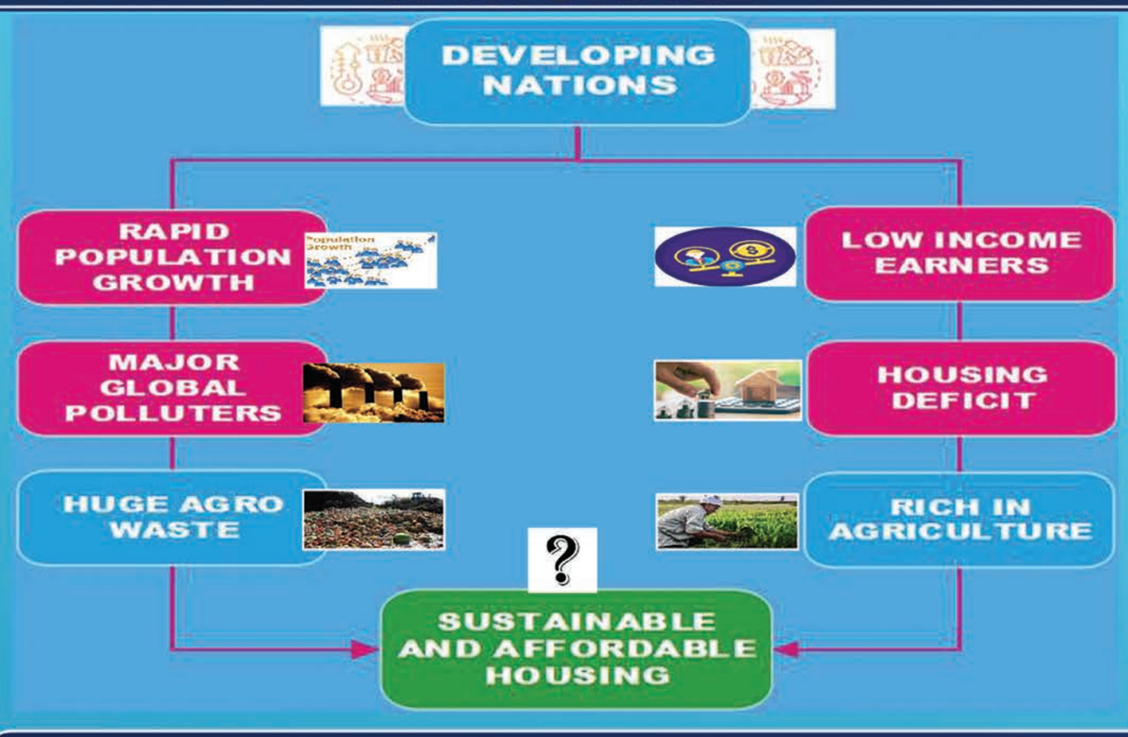
RATIONALE

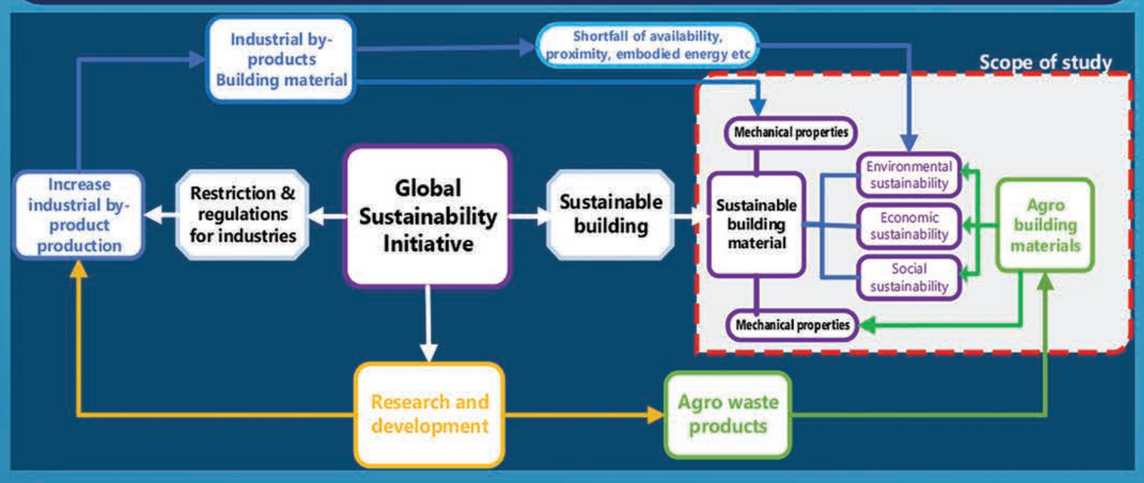


BACKGROUND

BUILDINGS IMPACT

MATERIALS IMPACT

CONCEPTUAL FRAMEWORK

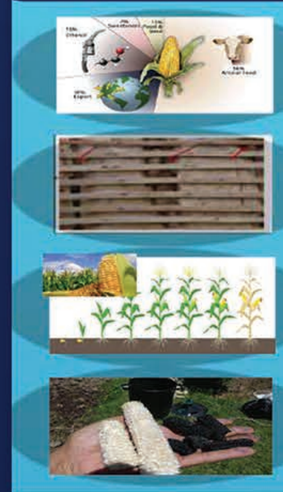


PREVIOUS BUILDING MATERIALS PROPOSALS

Heavy restrictions and regulations aimed at reducing air pollution have led to the production of considerable amounts of industrial by-products, which could be repurposed as pozzolanas or supplementary cementitious materials (SCMs) in building construction. Such industrial waste which include fly ash, limestone powder waste, volcanic slag, reservoir sediments, silica fume, calcined kaolin, furnace slag etc are the proposed alternatives for conventional building materials. While studies on the use of most industrial waste demonstrate positive results, its readily availabilities (Cardwell and Krauss 2017) and proximity of supply (Athira et al., 2020) are yet an unanswered puzzle and hind-cost and reduced embodied energy of building materials.

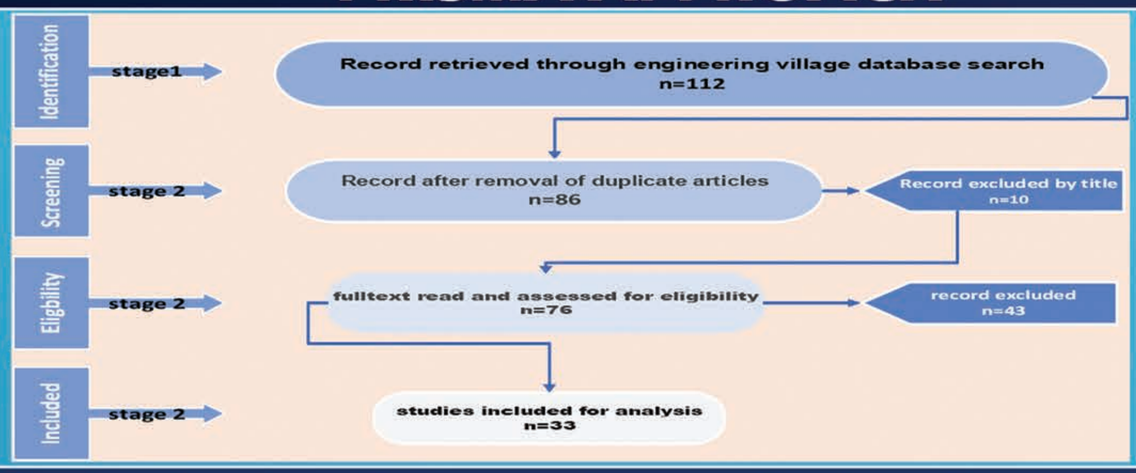
TYPICAL LIFE CYCLE OF CORN

MANY AGRO WASTE: WHY CORN?

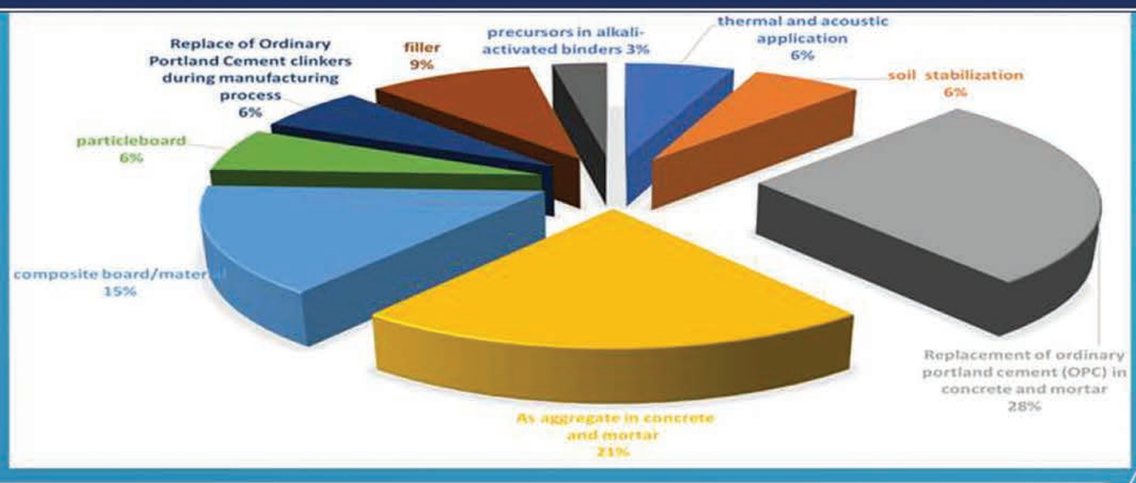


- Reputed to be most important cereal crop in 3rd world (Nnochiri, 2018) and produces about 70–50% of residues, which constitute waste
- Renewable character (Produced twice a year in large quantity) and low environmental impact
- Long standing history as building material (Pinto et al., 2010) most investigated raw material for building insulation applications
- Excellent bearing capacity with a low bulk density. The corn cob contains the same fiber components as wood (Binici et al., 2016)
- Its production rate has increased by 40% over the past decade (Choi et al 2022).
- Produced globally and cobs lack nutrients, therefore a large amount of waste is generated
- Corn cob is a rich biomass resource and One of the agro crop residue that produces a huge amount of ash when burnt
- The physical properties suggest that it can be used as an alternative raw building material (Viel et al., 2018), and a traditional material with a low life-cycle

PRISMA APPROACH



Categorisation of repurposing application of corncob



Replacement of ordinary Portland cement with corncob ash in concrete & mortar production

Cement industry emits 7–8% of global carbon dioxide. Reducing greenhouse gas emissions from cement and concrete production by 25% by 2030 is estimated to have the effect of reducing carbon dioxide emissions by approximately 5 billion tons. Therefore alternative cementitious material is been investigated.

Analysis of chemical composition between CCA and Ordinary Portland cement

compound	SiO_2	Al_2O_3	Fe_2O_3	CaO	SO_3	Na_2O
PC	18.11	4.31	2.38	60.22	2.87	0.18
CCA	67.23	6.34	5.33	10.75	1.04	0.37

From the analysis, corncob ash is classified under class F pozzolana hence its use as an additional cementitious material in the manufacture of concrete

Sustainability analysis of concrete materials and corn cob

compound	OPC	Corncob ash	Fly ash	Coarse Aggregate	Water
Embodied carbon ($kgCO_2/Kg$)	0.82	0.002	0.0139	0.0408	0.0
Embodied energy (MJ/kg)	5.50	0.002	0.0048	0.0048	0.0

From the analysis, incorporation of corncob ash indicates the sustainability and performance of concrete mixtures can be improved with the use of these waste materials as the binder in concrete

Conclusion/Planned future research

The systematic study has shown that the addition of corncob ash as a supplementary cementitious material can lead to a reduction in the amount of cement required in the mix, resulting in cost savings and a decrease in carbon dioxide emissions associated with cement production and use, consequently reducing waste accommodation. Bheel and Adesina, 2020; Serbanoiu, et al., 2022; Shakouri et al., 2020; Bagcal & Baccay 2019; Aprianti 2017; Thomas et al. 2021; Aprianti et al., 2015, have indicated a drop in the slump test and compressive strength of concrete after 28 days curing and above 10% substitution of CCA to cement; highlighting a deficiency in its civil work application. Therefore it opens up area of further research (the optimization of corncob ash for improve mechanical qualities)

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