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Integrated Multi-Trophic Aquaculture (IMTA) of Seaweed and Rabbitfish: A Low-Carbon Bio-mitigation Strategy for Climate Resilience and Multidimensional Poverty Reduction

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Coastal Kenyan communities rely heavily on marine resources for food, income, and ecosystem services. However, marginalized groups, particularly women, face systemic barriers to accessing these resources, exacerbating vulnerabilities to climate change and food insecurity. This study investigates the potential of IMTA systems—integrating seaweed (*Eucheuma denticulatum*) and rabbitfish (*Siganus sutor*)—as a low-carbon, gender-inclusive solution to address multidimensional poverty and climate resilience.

The IMTA model leverages symbiotic interactions: fish excreta and feed residues fertilize seaweed, while seaweed absorbs excess nutrients (reducing eutrophication risks by 16.58 t PO_4^{3-} eq. and 32.29 t N eq.) and sequesters CO_2, mitigating coastal acidification. Trials demonstrate 60% nutrient recovery efficiency, tripling biomass output compared to monoculture systems. Seaweed's carbon sequestration capacity further supports global climate goals, while rabbitfish provide protein-rich food, enhancing dietary diversity and income streams.

Economically, IMTA reduces reliance on costly external inputs, lowering production costs by 40% and diversifying revenue through sale of fish, seaweed. This targets poverty indicators like unemployment and food insecurity, while alleviating pressure on overfished wild stocks. Socially, IMTA empowers women through inclusive aquaculture training and ownership opportunities, challenging entrenched gender norms in Kenya's coastal regions.

Preliminary data from the Blue Empowerment Project (Kwale County, Kenya) highlights IMTA's dual role in fostering climate resilience and equitable livelihoods. However, scaling requires addressing socio-technical barriers, challenges and opportunities for leveraging IMTA of seaweed and fish as a low-carbon, gender-transformative, environmentally and economically sustainable innovation for equitable empowerment.

This study proposes a holistic analysis of IMTA's viability, integrating social, technological, and institutional dimensions. By collaborating with local stakeholders—including Bahari CBO and Sea Moss Corporation—the project aims to co-design replicable, gender-responsive IMTA models. Policy recommendations emphasize the need for climate-smart aquaculture incentives and equitable resource access to position IMTA as a pillar of Kenya's blue economy transition.

Keywords: IMTA, seaweed, rabbitfish, climate change, poverty

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