Environmental Assessment of Integrated Food and Cooking Fuel Production for a Village in Ghana

Small-scale farming in Ghana is typically associated with synthetic fertilizer dependence and soil degradation. The farmers often rely on wood fuel for cooking imported from outside the farmland, a practice that is associated with deforestation. Integration of food and energy production may be a holistic approach to solving these issues. We study four approaches to providing food and fuel for cooking in a small-scale farming community. Present practice (PP) of synthetic fertilizer based food production and provision of wood fuel from outside the farming area is compared to three modeled, integrated technology options: integrated food and household-scale biogas production (HH Biogas), integrated food and village-scale biogas production (Village Biogas), and integrated food and wood fuel production (Agroforestry). Integrated approaches are able to eliminate the import of wood fuel, reduce synthetic fertilizer use by 24%, 35% and 44% and soil loss by 15%, 20% and 87%, respectively, compared to present practice. An Emergy Assessment (EmA) shows that integrated approaches are relevant substitutes to present practice considering biophysical efficiency indicated by Unit Emergy Value (in solar emjoules (sej) per J of output) and dependence on renewable inputs indicated by the Global Renewability Fraction (in %): 2.6–3.0 × 10⁵ sej/J and 38%–48% (PP), 2.5–2.8 × 10⁵ sej/J and 41%–46% (HH Biogas), 2.4–2.6 × 10⁵ sej/J and 45%–47% (Village Biogas), and 1.7–2.4 × 10⁵ sej/J and 49%–66% (Agroforestry). Systematic recycling and use of local resources may play a pivotal role in reducing the dependence on non-renewable resources in Ghanaian farming, ensuring long-term soil fertility and stemming the current deforestation of wood reserves.