GIS Assessment of Adoption Likelihood and Resistance of Biodegradable Mulch Suitability to Future Climate Scenarios

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Abstract

Agricultural systems face increased perturbations including environmental challenges, necessitating agroecological practices like biodegradable mulch (BDM) application. However, adoption remains limited due to uncertainty in biophysical suitability and socioeconomic barriers. Using a GIS-based fuzzy multicriteria evaluation model, we integrate climate variables, soil properties, land use, and socioeconomic data to map adoption likelihood under recent conditions across U.S. We further assess suitable area resistance, defined as the degree of change in suitable area under projected climate scenarios (SSP126, SSP370, SSP585). Regional differences in resistance were examined using one-way ANOVA followed by Tukey's HSD post-hoc test. Results show that adoption likelihood aligns with suitability patterns in counties within the Southern Plains, Northern Plains, upper Corn Belt, and Pacific regions, where both climatic and soil conditions favor BDM performance and degradation. In terms of suitable areas stability, resistance varies significantly across regions and scenarios with SSP126 showing relatively stable patterns while SSP370 and SSP585 exhibiting spatial disparities in resistance. The ANOVA and Tukey's HSD confirm the regional differences in resistance ($F = 3.06$ to 13.80, $P < 0.001$), with areas in Northern Plains and Lake regions being more resistant and the Appalachian and Southeast being less resistant. These findings are indicative of spatially uneven opportunities for scaling BDM adoption and suggest the need for region-specific product development, targeted adaptation strategies, and climate-informed agricultural planning to support the transition to more sustainable food systems.