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Simulating future Food Value Chain components through the integration of biophysical and techno-economic spatial models

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We describe the methodological development and preliminary results of a new spatial modelling framework to support the evaluation and design of novel Food Value Chains (FVC). The sustainability of future FVCs will depend on how effectively these can be adapted to environmental (e.g., climate change) and socio-economic (e.g., resource access and dietary preferences) changes projected for coming decades. Our approach aims to account for the spatial and temporal complexity inherent to both biophysical (e.g., climate, genotypes and soils) and techno-economic (e.g., processing technologies and markets) components of FVCs to optimise supply- (e.g., production areas) and demand- (processing-plant locations) across landscapes. For that, we integrated georeferenced biophysical outputs of a process-based agricultural model (Agricultural Production Systems sIMulator, APSIM-NextGeneration) into a spatial techno-economic model (IIASA-BeWhere). We test the approach through a case-study to evaluate a novel (hypothetical) FVC to produce plant-based proteins from lucerne crops (*Medicago sativa*) across New Zealand's agricultural landscapes. Results highlighted spatial protein production patterns driven by changes in crop canopy expansion and net carbon assimilation, with lower yields estimated in cooler and dryer environments, particularly when water supply was limited under rain-fed (non-irrigated) conditions with soils of low water holding capacity. Spatial variability in protein yields, production costs and emissions estimated by APSIM-NG running in the ATLAS framework were then used as inputs by BeWhere to optimise the location of production areas and protein-processing plants. We discuss potentials, limitations, and future development areas of this approach.