Decomposing food production into its underlying bio-physical mechanisms and human agency

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Crop production functions are often defined either as functions of water and nutrient deficiency or are based on economic production theory that conceptualize production as a result of human activities that take in inputs such as water, capital and labor and produce crop biomass as output. In this research, we differentiate bio-physical mechanisms driven by hydro-climatic factors from socio-economic activities, both of which contribute to agricultural production. Uptake of water and nutrients are considered as two dominant biophysical processes of crop growth. Social factors representing various aspects of human agency, including irrigation machine power, land-preparing machine power and human labor force, are treated as factors behind water and nutrient use efficiency. The human agency therefore determines upper limits of water and nutrient resources that are accessible to crops. Seven crops, i.e. wheat, rice, potato, maize, soybean, cotton and rapeseed, which account for the majority of crop production in Jiangsu, are included in modeling crop production as a function of water and nutrient uptake that is limited by human and machine power. In this manner, crop production is decomposed into its biophysical mechanisms that are essentially catalyzed by human agency. The modeling results are then compared with an economic theory-based Cobb-Douglas production function that has been estimated for Jiangsu province.