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Defining the most suitable source of irrigation water for farmers and communities: a socio-agricultural model

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Supplemental irrigation is critical to ensure high and stable crop yields in many regions. Water needs for irrigation will increase in the future, because of higher demands for food, feed and biofuels, and warmer, more extreme, climates. Water withdrawals for irrigation has led to plummeting water tables in many aquifers. Water harvesting like on-farm ponds can be a more sustainable approach to meet water requirements for irrigation. Nevertheless, whether groundwater or on-farm pond is the most suitable source of irrigation water for a single farmer and the whole community depends not only on the crop water demands and the unpredictability of rainfall, but also on the farmers' preferences, in terms of risk aversion and long/short-view orientation and how they evolve in time. Here we couple the dynamics of crop development to that of soil water availability and water stored in on-farm ponds and aquifers. For a community of farmers, we also consider each farmer's short/long-view orientation, and how it evolves in time. While general, the model is applied to the case of the Lower Mississippi River Basin, in the southeastern USA, where irrigation has already led to a significant decline in groundwater levels. Results show that, for a single farmer, production maximization and risk of low yield minimization are often irreconcilable criteria when sizing the on-farm pond. Moreover, on farm ponds as source of irrigation can be more advantageous as source of water for the community, leading to a higher and more stable income. Yet, this choice is beneficial for the individual farmer only under extreme climates and in communities where the use of on-farm ponds is common.