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AGENT-BASED MODELLING OF FARMERS' CLIMATE-RESILIENT CROP CHOICE IN THE UPPER MEKONG DELTA OF VIETNAM

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ABSTRACT

Flood-adaptive crops are desired alternatives in the flood zone areas of the Mekong River Delta of Vietnam in order to lessen the negative impacts on the environment caused by widespread use of high dyke systems and triple rice monocultures. This study uses an agent-based modelling system to gain insight into the factors driving farmers' decisions to switch between triple rice monocultures and other flood adaptive and resilient crops. It was found that the influential determinants are dyke construction, labor availability, perception of environmental sustainability, knowledge about new low-dyke alternatives, availability of collateral to access credit, and risk preference. It is suggested that in order to facilitate sustainable transformation of this area in the future, the government should move away from high dyke construction and focus on raising awareness and perception, promoting agricultural mechanization, improving credit access, and developing agricultural insurance and risk management schemes.

1 INTRODUCTION AND METHODOLOGY

Besides conventional studies at one point in time and in a static system, there is an increasing interest and effort to understand the complex farmers' decisions that consider the dynamic interactions between farmers and the socio-economic and biophysical environment (Kremmydas et al. 2018). This research contributes to the discourse by developing an agent-based model for the Upper Mekong Delta of Vietnam (VMD) to answer two research questions (1) "What factors influence the shift from rice monocultures to alternative crop systems?"; and (2) "What factors influence the shift from high-dyke to low-dyke cropping systems"?.

Phu Huu commune in An Giang province was selected as a case study as it represents a deep-flood area and agriculture is the main livelihood of a large number of farmers. The model integrates various dynamic socio-economic and environmental factors in an expanded conceptual framework of the theory of planned behavior and the Belief-Desire-Intention architecture. It was built in Matlab version R2019b (MATLAB 2019) and has three modules: (i) Module 1 - Farmer agents (agricultural and non-agricultural income, living costs, agricultural and non-agricultural labor, land area, perception of environmental sustainability, access to credit, and risk preference); (ii) Module 2 - Land use (yield, fixed and variable costs, labor requirement, dyke infrastructure, market access, and convertibility of crops); (iii) Module 3 - Socio-economic and biophysical context (policy interventions; market price; and flood level). The model was run for 1,000 iterations on an annual time step over the 6 years from 2011 to 2016. Model predictions were calibrated against 2016 agricultural census (GSO 2018) and sensitivity analyses were conducted for parameters of interest (e.g. perception and knowledge, financial capacity, labor availability, high dyke, risk preference).

2 RESULTS AND DISCUSSION

The agent-based model provided insights about the most influential determinants of farmers' decision to switch from high-dyke to low-dyke crop systems, and from rice monocultures to other alternatives. These determinants were high dyke construction, labor availability, knowledge of new alternatives, and perception of environmental sustainability. Other factors such as risk aversion and collateral for bank loan had a moderate influence while financial support and interest rate had the lowest impact (Figure 1 and Figure 2).

The findings suggest that key policy messages for the VMD should include (i) avoid high-dyke construction; (ii) raise farmers' awareness and knowledge; (iii) address labor constraints by promoting mechanization; (iv) improve access to finance by developing diversified forms of collateral; (v) develop agricultural insurance and risk management schemes.

Future model development will involve (i) running by seasonal steps (3/year) and for a longer period of time; (ii) adding more stochastic processes such as trends of price, production cost, and flood level; and (iii) incorporating interactions with agribusinesses to reflect market access.

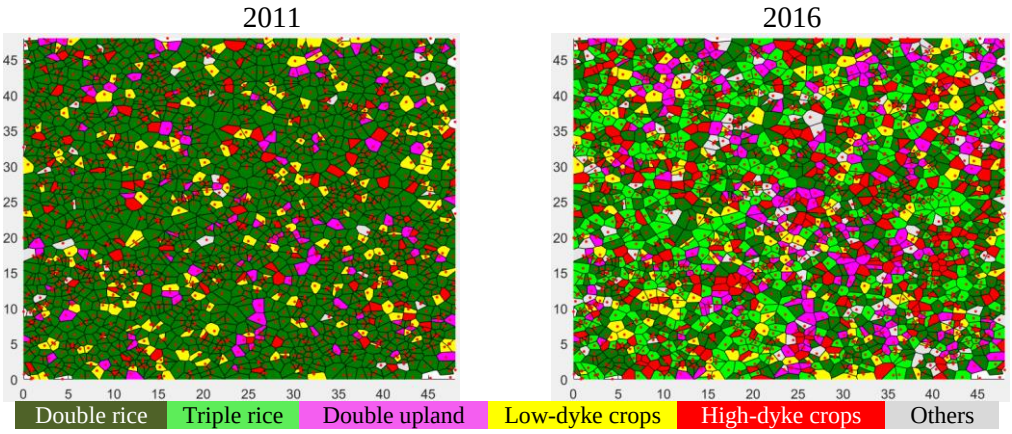

Figure 1: Mapping crops in simulated year 2011 and 2016.

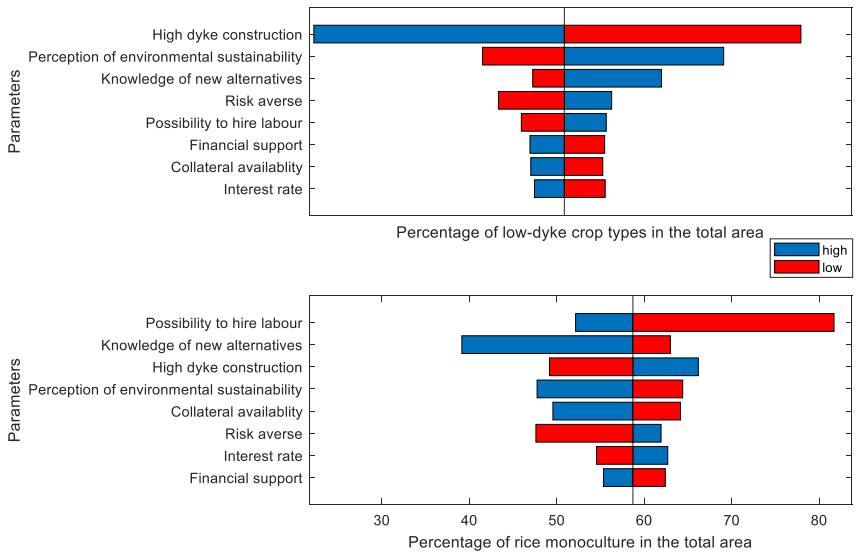

Figure 2: Tornado diagrams for the sensitivity analyses of parameters' influence on the percentage of low-dyke crop types and rice monocultures in the total area.

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