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Research article

Questioning triple rice intensification on the Vietnamese mekong delta floodplains: An environmental and economic analysis of current land-use trends and alternatives

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ABSTRACT

Large areas of the Vietnamese Mekong Delta floodplains (VMDF) are protected by high dikes to facilitate three rice crops per year. While this has increased rice production, there is evidence that triple rice systems have negative long-term effects, both environmental and economic. Double rice cropping, or other alternatives, may be more advantageous. We analyzed the costs and benefits of intensive rice systems over time and compared these with alternatives farming systems, based on data collected via field surveys and interviews with farmers in two provinces in the VMDF. Results show that farmers in areas with dikes high enough for triple rice production incurred rising production costs over time. Production costs were 58%–91% higher in high-dike, triple crop areas, than in low-dike double rice crop areas. Higher production costs are mainly the result of increased fertilizer and pesticide use. Profitability of triple rice farming systems was initially 57% more compared to double crop systems. After about 15 years, however, triple rice farmers earned only 6% more than double crop counterparts. Our results indicate that alternative farming systems, such as rice combined with vegetables, fisheries or other flood-based livelihood, could offer greater benefits than intensive rice monocultures. Importantly, these higher benefits can be obtained without the environmental costs and impact currently endured across the delta with triple rice cultivation in high dikes.

1. Introduction

Deltas around the world face environmental degradation caused by agricultural intensification (Renaud et al., 2013). For sustainable intensification, appropriate land-use policies and methods are crucial (Dogliotti et al., 2014). The environmental and economic costs of intensive production systems are sometimes found to outweigh their benefits in the long term (Rasul and Thapa, 2004; Bezlepkina et al., 2011; Murshed-E-Jahan and Pemsl, 2011; Gerdessen and Pascucci, 2013). The current intensified rice production system in the Vietnamese Mekong Delta (VMD) is an example of this dilemma.

Vietnam has been a leading rice exporter for two decades (Kingdom of the Netherlands and The Socialist Republic of Vietnam, 2013). Known as the rice bowl of the nation, the VMD contributes more than half of Vietnam's total rice output (GSOVN, 2015). This success could not have been achieved without the Doi Moi reforms of 1986 (Kingdom of the Netherlands, 2011; Sebesvari et al., 2012; Cosslett and Cosslett, 2014). In particular, Vietnam's "rice first" policy initiated an expansion and intensification of rice production on the VMD floodplains. This was made technically possible by construction of a system of dikes, canals and sluice gates to regulate water flows. Since 2000, farmers have been encouraged to further intensify production, shifting to triple rice systems on fields protected by high dikes (Sakamoto et al., 2009; Chen et al., 2012;

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Renaud and Kuenzer, 2012). Today, high dikes are a prominent feature throughout the VMD upper floodplains, and agricultural policies still promote expansion of the high-dike, triple rice production system (MARD, 2015).

Large-scale construction of high dikes, however, has had numerous negative side effects. On the regional and delta scale, high dikes have reduced the water retention capacity of the floodplains (Kingdom of the Netherlands and The Socialist Republic of Vietnam, 2013). Because there is less space for floodwater storage, river levels have increased, leading to greater flood risk downstream (Dung et al., 2017 forthcoming). Reduced water retention capacity, furthermore, has led to diminished flows in the dry season, exacerbating saltwater intrusion into freshwater areas (Hoang et al., 2016). In addition, the high dikes have erected a barrier between the floodplains and rivers, interrupting ecosystem services (Opperman et al., 2013). On the local scale, the high dikes have prevented fertile sediments and wild fish from washing into and replenishing the rice fields (Käkönen, 2008; Danh and Mushtaq, 2011; Danh, 2011; Trung et al., 2013). All such downsides of high dike construction need to be weighed against the potential benefits of triple rice production across the different scales and over time, to determine what land-use policies are suitable and sustainable in the long term.

A number of authors have looked at the economic and social outcomes of intensified farming systems in the VMD. Howie (2011) investigated state-farmer relations in agricultural transformation, including the advantages and disadvantages of low dikes and high dikes. He concluded that fertilizer use increased in rice fields under high dike protection. An economic evaluation by Kien (2014) showed that low-dike systems provided the greatest net benefit compared to no-dike and high-dike systems. A cost-benefit analysis by GIZ et al. (2014) considered four hypothetical scenarios and concluded that the scenario of floating rice plus vegetable cultivation without high-dike protection was most advantageous to farmers in both social and economic terms. Tong (2017) identified hidden costs of dike heightening, such as an increased need for pesticides, loss of natural floodplains and reduced profit with successive rice crops. These evaluations raise doubts about whether intensive rice cultivation in the VMD is indeed beneficial to farmers in the long run, after factoring in all of the costs involved. Nonetheless, regional and national policies continue to stimulate intensive triple rice production, proposing it as the best farming option, though without adequate study of alternatives, such as flood-based systems.

This research addresses that gap. Taking a long-term perspective, we compared the costs and benefits of different production systems in two provinces of the VMD. We hypothesized that agrochemical use in triple rice cultivation increases proportionally to the number of years of cultivation. Farm profits are therefore expected to diminish over time in the most intensive rice production systems: a triple rice monoculture with high dikes. We expected flood-based farming systems to be more sustainable, both environmentally and economically. We began our research with a cost-benefit assessment of different rice farming systems at different locations in the upper VMD. We then explored and analyzed alternative, flood-based options, comparing their profitability to the profitability of intensive rice cultivation. We tested our hypothesis using data from interviews with farmers in low dike and high dike areas in An Giang and Dong Thap provinces, in 2014 and 2016. We combined our interview findings with data from economic farm assessments done by the International Union for Conservation of Nature (IUCN, 2015).

2. Material and methods

2.1. Study site

An Giang and Dong Thap provinces are located in the upper VMD's two main floodplains: the Long Xuyen Quadrangle and the Plain of Reeds (Fig. 1). Similar to other floodplains worldwide, such as the ones in Bangladesh studied by Alam et al. (2017) and in Ghana by Tsujimoto et al. (2017), the soil in these floodplain provinces is fertile and suitable for rice production. These provinces therefore have registered the largest expansion of triple rice production in the VMD during the past two decades (Duong et al., 2014). To produce three crops of rice annually, high dikes have been built to protect fields from seasonal flooding. Both provinces have double rice production areas too. These feature low dikes that provide fields some protection from rising floodwaters, allowing two rice crops to be harvested before the floodwaters wash over the dikes and submerge the fields (Kingdom of the Netherlands and The Socialist Republic of Vietnam, 2013). Prior to 2000, low-dike rice farming was dominant throughout the VMD floodplains. However, from 2000 to 2006 there was an intensive effort to heighten dikes, in order to allow triple rice cropping (Sakamoto et al., 2009; Chen et al., 2012). Currently, two thirds of the rice-growing area in An Giang is under triple rice production (Tran and Weger, 2017). In Dong Thap, triple rice production accounts for one third of the total cultivated area (Tong, 2017). Fig. 1 presents the survey sites for our research.

In An Giang Province, our research focused on two districts: Phu Tan and Chau Phu. Phu Tan has a “closed” high-dike system. That means all agricultural fields are completely encircled by primary dike rings, which also provide footing for main roads. Thus, 28 cultivation compartments have been created, and water levels in the fields are regulated according to a schedule, either by pumping or by opening sluice gates (Tran and Weger, 2017). Most fields within the compartments are used for triple rice cropping, but vegetables and maize are also grown. The district of Chau Phu is relatively homogenous in physical characteristics (Kien, 2014). Its main agricultural products are rice, vegetables, orchard fruits and flood-based crops. Aquaculture is found here too. In both these districts, high-dike construction has been implemented over the past two decades.

In Dong Thap Province, our research focused on the districts of Thanh Binh and Thap Muoi. Thanh Binh has both vegetables and upland crops, though most area is under rice. Here triple cropping of rice is increasing, but double rice under low-dike protection is as yet dominant. Similarly, rice is the main agricultural product in Thap Muoi district, though upland crops and orchards are also common, as is aquaculture, including fishery and lotus farming. High-dike production systems have become increasingly prominent in both these districts during the past five years (Table 1).

2.2. Field survey

We conducted two field surveys, in 2014 and 2016, to collect information on the costs and benefits associated with rice-based farming systems. In both surveys, we approached farmers in areas with low dikes and in areas with high dikes. Both “new” and “old” high dikes were represented. “New” high dikes are defined as those completed within the past five years. “Old” high dikes are defined as those in operation for 15 years or more. Most of the farmers in our samples were relatively advanced in age (46 years old on average), and most (97%) were men. More than 90% had a