



Impact of access to capital and abiotic stress on production efficiency: Evidence from rice farming in Cambodia

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ABSTRACT

Cambodia is one of the climatic stress-prone countries in Southeast Asia. Rice is the dominant cash crop for Cambodians, and is adversely affected by recurrent droughts and floods. In addition, farmers have limited or no access to capital markets. This article investigates the impact of abiotic stresses (droughts and floods) and access to capital on the farming efficiency of smallholders in Cambodia. We find that the mean technical efficiency of rice farmers is about 0.60, implying that farmers can increase their production by about 40% with existing resources. Drought and soil fertility were identified as the major sources of inefficiency in rice production. Adoption of drought-tolerant varieties could help increase output and efficiency. We also find that access to capital and educational attainment significantly improved rice farming efficiency. Finally, we conclude that increasing rice productivity can help in improving income and thereby reducing poverty among Cambodian rice producers.

1. Introduction

Cambodia is one of the climatic stress-prone and the poorest countries in Southeast Asia (Solar, 2010; WB, 2016). Every year, Cambodia experiences two devastating abiotic stress events, droughts and floods (Chhinh and Millington, 2015), and the intensity of these events has been more frequent in recent years.¹ During the past five years, Cambodia experienced four moderate to severe stress events, which destroyed a significant amount of crops, including rice. For example, the intensity of drought in 2015 was the highest within the past decade and it destroyed about 41,000 ha of rice fields (Table 1). Similarly, floods in 2011, some of the largest since 2000, destroyed about 171,000 ha of rice fields. These recurrent events may be the result of the climate change that the world has been witnessing in recent times. For instance, the degree of intensity of El Niño events in the tropical Pacific in recent years has been strong to very strong (Golden Gate Weather Services (GGWS, 2017)). Cambodia is one of the victims of El Niño events, and it is experiencing less rainfall, warmer weather, and delayed or shorter monsoon (Chum et al., 2016). According to a recent global climate risk index, Cambodia is ranked 13th in the world (Kreft et al., 2016).² Because of climate change, it is likely that the most affected

area will be around the Mekong River, where the majority of Cambodians reside (Chinvanno et al., 2006).

Droughts and floods affect the agricultural productivity of land, an important production asset to crop farmers as well as inland and coastal fishing communities. The majority of Cambodians reside in rural areas (around 80%), and their livelihoods are dependent on agriculture and fisheries. Approximately 25% of Cambodians are food deprived, implying that they consume less than the daily minimum required calories and proteins. Additionally, smallholders are dependent on agriculture; the majority are involved in rice cultivation and most of them are poor. A recent study by Hong and Furuya (2016) found that climate change, which is more incidence of droughts and floods, would affect marginalized groups in Cambodia.

Indeed, the royal kingdom of Cambodia (RKC) has initiated a strategic plan, “Cambodia Climate Change Strategic Plan 2014–2023,” to tackle the impact of unavoidable climatic changes (RGoC, 2013). This strategic plan is aligned with the national development goals and priorities, including promotion of rice production and rice exports. During 2004–2012, approximately 63% of Cambodia’s poverty reduction, declined from 50.2% in 2004 to 17.7% in 2012, was due to the development of the rice sector (World Bank (WB, 2013, cited in World

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¹ Approximately 39% of the villages in Cambodia experienced flooding and another 38% faced drought and food insecurity during 2008–2012 (MAFF, 2015).

² This index measures the extent to which countries affected by the impacts of weather-associated events (i.e., floods, storms).

Table 1
Crop damage due to abiotic and biotic stresses in Cambodia.

Year	Temperature ^a (°C)	Rainfall ^a (mm)	Paddy area destroyed (000 hectares)			
			Drought	Flood	Pest outbreak	Total ^b
1996	26.80	146.59	5.50	222.29		227.79
1997	27.26	167.31	3.59	6.29		9.87
1998	27.84	140.70	1.40	1.25		2.65
1999	26.78	166.45	0.11	8.86		8.98
2000	27.07	177.53	13.09	389.61		402.70
2001	27.28	152.69	21.43	78.29	1.13	100.84
2002	27.32	148.19	36.58	35.27	0.89	72.73
2003	27.27	145.46	13.97	3.84	0.94	18.75
2004	27.27	157.52	445.91	26.49		472.40
2005	27.24	147.33	1.50	3.17		4.67
2006	27.35	174.76	2.89	15.35	0.44	18.68
2007	26.99	163.72	2.32	25.35	6.38	34.05
2008	26.92	163.68	0.31	2.71		3.02
2009	27.22	160.54	3.01	91.55	1.19	95.74
2010	28.03	132.54	3.25	28.64	0.01	31.90
2011	27.14	180.76	0.44	171.14		171.59
2012	28.03	164.12	36.45	13.26		49.71
2013			0.52	0.95	0.05	1.52
2014			19.86	2.16		22.02
2015			41.16 ^z			41.16

Sources: Disaster loss database, National Committee for Disaster Management, UNDP, available at <http://camdi.ncdm.gov.kh> (Accessed 21 February 2017).

^a The World Bank Group, available at http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical (Accessed 21 February 2017).

^b Total paddy area damaged.

Bank (WB, 2016). We argue that improving rice production and identifying inefficiency factors in rice production could help smallholders in achieving higher income and food security, and alleviating rural poverty.

Cambodian farmers face several major challenges, including the supply of inputs (availability), ability to purchase inputs (access), and capacity to appropriately apply inputs to optimize their profits (technical capacity) (Yu and Fan, 2009). To support and strengthen micro-finance and rural credit services, the RKC created the Rural Development Bank of Cambodia (RDB) in 1998. Since 2005, the RDB has provided short-term loans to buy rice from farmers and long-term loans to modern equipment (i.e., mills, dryers). Another goal of the RDB is to help farming communities with high quality and quantity in rice production for exportation. Observations from previous studies support the notion that poor farmers in Cambodia need long-term financial and technical support (Neth et al., 2009). Indeed, the literature has shown that relaxing credit constraints could boost accessibility to inputs and markets for farmers in many South and Southeast Asian countries (Poliquit, 2006; Duy, 2015; Khanal and Regmi, 2018).

Therefore, the objective of this article is to assess the performance of rice farmers in four provinces of Cambodia. Specifically, we investigate the impact of abiotic stresses (drought and submergence or flooding³) and access to capital in rice production by smallholders in Cambodia. Additionally, the study investigates the factors which affect inefficiency in rice production. We believe that the results drawn from this study would benefit Cambodian rice farm households' productivity, competitiveness, and food security, and policymakers in formulating policies to increase rice production and productivity and reduce rural poverty.

³ Floods could be good for rainfed rice-based farming; however frequent floods could exert an adverse impact on agriculture production and rural livelihood systems (Keskinen, 2006).

2. Cambodian rice sector: an overview

The rice sub-sector is the backbone of agricultural sector in Cambodia. It contributes around 25% of the total agricultural gross domestic product; employs about 20% of the total population in rice production, processing, and marketing activities (IFC, 2015). The growth in agriculture was mainly driven by this sector. As before, the development of rice sector helped decrease poverty significantly in Cambodia (a 63% reduction in total poverty occurred due to the development of the rice sector during 2004–2012, as above). Rice is the dominant cash crop in Cambodia (Yu and Diao, 2011). It is grown in all provinces of Cambodia and throughout the year. The largest concentration of rice production is around the Tonle Sap Lake and the Mekong River. In Cambodia, about 1.0 million smallholder households are involved in rice cultivation. The average farm size is about 1.50 ha (ha). Furthermore, compared to other rice-producing countries, a unique feature of the Cambodian rice sector is that rice cultivation is one of the prime labor tasks, undertaking in rural households. About 85% of the total rice is grown in wet-season, whereas the rest is grown in dry-season (Zhao et al., 2016). Wet-season rice depends primarily on rainfall from May to October. Dry-season rice depends on full or supplementary irrigation or in receding floodwaters from November to April (Sarom, 2001).

Cambodians consume about 3.7 million metric tons (*mmt*) of rice annually. Rice is their staple food, with per capita consumption of 235 kg per year. In terms of daily calorie and protein intakes, rice constitutes approximately 63% of total calorie intake and 50% of total protein intake (FAOSTAT, 2017). It is expected that demand for rice will still be strong even with growth in urbanization and income growth. Therefore, rice is crucial for sustaining and improving the country's food and nutritional security. On the supply side, in 2016, approximately 3.0 million ha of rice area was harvested, about 1.50 times higher than in 2000 (USDA PS&D, 2017). Between 2000 and 2016, rice production almost doubled (current production is 7.34 *mmt* of rice about 4.70 *mmt* of milled rice). However, rice yield in Cambodia is still the lowest among all the neighbouring rice-producing countries, even though yield has increased significantly over time (from 1.35 *mt/ha* in 1990 to 2.45 *mt/ha* in 2016). The yield difference could be attributed to the country's soil quality, biotic and abiotic stresses, and other constraints faced by rice farmers.⁴ Abiotic factors such as drought could cost rice farmers from USD 23.01 to 51.47 per ha, estimated by Chhinh et al. (2014) in two communes of Kampong Speu in Cambodia. Similarly, Magnan and Thomas (2011) estimated that, by 2050, the long-run cost of climate change could lead to a 20% reduction in Cambodia's total cultivated rice area.

In terms of trade, Cambodia has been a net rice-exporting country since 2005. It is currently exporting about 1.0 *mmt* of milled rice to the world market. Cambodia exports two types of rice, white and fragrant, 30% of which is fragrant. The main buyers of Cambodian fragrant rice are China and France, whereas the main competitors are Thailand and Vietnam. Cambodia has a huge potential to export a significant amount of fragrant rice because of its high demand. In sum, rice is a very crucial sector for smallholder Cambodians in terms of an engine of agricultural growth, food security, reducing poverty, and improving nutritional security. Any shocks to rice production could significantly affect the agricultural sector in general and the rice sector in particular. For example, abiotic stresses could hamper plant growth and reduce rice productivity (Boyer, 1982; Larcher, 2006; Miti et al., 2010). Additionally, many factors, such as access to capital, training, and

⁴ Previous studies identified the following constraints: lack of purified seeds, knowledge of new technology, and access to commercial credit and because of loans with a high interest rate; poor irrigation infrastructure; the high cost of energy, fertilizer, and pesticides; weak marketing infrastructure; and the lack of marketing information (Singh et al., 2007; Sophea, 2012).

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