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Agricultural Transformation in the Rural Farmer Communities of Stung Chrey Bak, Kampong Chhnang Province, Cambodia

Ham Kimkong ^{1,*}, Buapun Promphakping ^{2,*} , Harri Hudson ³ and Samantha C. J. Day ⁴

¹ Faculty of Humanities and Social Sciences, Khon Kaen University, 123 Mitraparp Road, Khon Kaen 40002, Thailand

² Development Sciences Program, Faculty of Humanities and Social Sciences, Khon Kaen University, 123 Mitraparp Road, Khon Kaen 40002, Thailand

³ A Ph.D. Candidate in Geography, Royal Holloway University, Egham TW20 0EX, UK

⁴ A Ph.D. Candidate in Geography, King's College London, London WC2B 4BG, UK

* Correspondence: kimkongham@kkumail.com (H.K.); buapun@kku.ac.th (B.P.); Tel.: +855-012-406-716 (H.K.)

Abstract: This paper examines the processes of agricultural transformation and their impacts within six rice farming communities in Cambodia. For this, we explored four drivers of agricultural transformation: (1) market integration, (2) modern technologies, (3) household assets, and (4) institutional-policy processes. The paper employs qualitative methods, using document analysis on the policy literature and datasets, field observations, focus groups, and key informant interviews in six rice farming communities in the Stung Chrey Bak Commune, Kampong Chhnang Province. Herein, we analyze the processes of agricultural transformation that shape farmer livelihoods and contribute to the literature regarding the dynamic and uneven politics of implementing the green revolution. Our findings show that agricultural transformation in the six rice farming communities has had mixed results. While the transitions have improved household income, they have also led to insecurity, with potential impacts on the long-term sustainability of the rice-production sector. These include higher input costs, fluctuating rice revenues, and environmental impacts from increased chemical use. We show that greater support is needed in these farming communities in order to achieve sustainable rice production going forward, particularly in light of climate change, indebtedness, and the migration of young labor to off-farm employment, leading to aging farmer populations.

Keywords: agrarian transformation; agricultural intensification; institutional-policy process; market integration; modern technologies



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1. Introduction

The world's agriculture has been shaped by neoliberalism over the last few decades. The agrarian transformation that is taking place in the developing world is predominantly shifting from traditional agriculture to integrations with urbanization, industrialization, and market-based production (Ravazi 2003 [1]). According to Vos (2018) [2], most Asian countries have undergone relatively rapid agricultural transformations over the past 50 years, which helped to rapidly grow their economic development. However, the agricultural transformations have differed markedly in their nature and speed across those countries of the region.

Cambodia's agricultural transformation was set back by the Khmer Rouge regime and the subsequent civil war. For Cambodia, integration into the international markets began in the 1990s following the transition towards democracy under the general election of 1990, wherein rice production has become an important agenda for the country's development (Razavi 2003 [1]). As a result, the land markets and speculation have brought in many companies, land investors, middle-men, and cash crop planters, along with migrants to the new frontiers of agricultural production that have reshaped indigenous communities, social and gendered relations, and the movements of capital (Park and Maffii, 2017 [3]).

With the recognition of market forces, the government of Cambodia passed the Subdecree on contract farming in 2011 with the aim of improving market access and productivity (Sreyimo, & Pirom, 2015 [4]).

While the country has experienced growth in the agricultural sector which has contributed to the GDP, in 2017, the agricultural share of GDP was around 19.1%, the share of agriculture is (similarly to the transitioning economy) in a declining trend, but growth within the agricultural sectors continues. The share of GDP growth from the agricultural sector has declined since the early 1990s, with tourism, garment manufacturing, and construction dominating the nonagricultural economy (Hill and Menon, 2014 [5]). According to FAO data (2022) [6], the share of agriculture, forestry, and fisheries as a total of GDP fell from 45% in 2000 to 21.7% in 2020. (For comparison, in neighboring Thailand, it dropped from 12.7 to 8.7, and in Vietnam, from 26.8% to 14.4%).

The role of agricultural growth in development has been subject to much debate as to whether the aims of growth in GDP and poverty alleviation are met simultaneously (Christiaensen, Demery, and Kuhl, 2010 [7]). In 2015, over 56% of the working-age population of the country was employed in the agriculture sector (ODC 2020 [8]). The World Bank reported that over 60% of poverty reduction in Cambodia during the end of the 2000s and early 2010s was attributed to agricultural growth (World Bank, 2015 [9]). Cambodia's agricultural growth rate in the 2000s was the highest in the world (5.3%), with rice production predominantly contributing toward this.

However, the growth experienced after the 2000s was achieved through agricultural intensification and has relied on the reliance on costly inputs, such as agriculture mechanization, pesticides, new crop varieties, and chemical fertilizer (MAFF, 2018 [10]). This realm of transformation reflects the green revolution that was generated during the 1970s and was widespread in the Global South (Castella, 2012 [11]). Furthermore, growth has involved access to local and global markets.

The agricultural transformation in Cambodia has not taken place without its problems for rice-growing communities. For example World Bank (2015) [9] looked at farm incomes from rice compared with different crops and found that, in Cambodia, income per hectare was higher for vegetables (USD 2843/ha) and cassava (USD 1297/ha) with dry season rice in the middle (USD 992/ha) and wet season rice (USD 756/ha) and maize (USD 744/ha) at the bottom, which reveals the market factors in the regional trends for rice farmers to move to more profitable crops. Changes in export partners have also impacted rice farming incomes. While China has become a new market for rice export, the revenue is lower than that which was formally obtained from the EU, with farmers being the most affected, as middle men adjust buying prices to avoid losses (Hutt, 2020 [12]). Cambodia also faces future uncertainty in microfinance indebtedness, which reached US\$4213 per capita in 2021, and is more than double the GDP per capita (Guermond et al. 2022 [13]), to which smallholder farmers are increasingly contributing to (Green 2022 [14]). Furthermore, some reports point to the negative impacts of modern agricultural inputs, especially chemical use in agriculture. For instance, Silva, Johnston, and Try (2013) [15] found that the chemical used in rice growing poisons fish in the rice field, therefore reducing traditional fishing products. The loss of income from fishing has led to some fishing households diversifying into rice farming, often encroaching on forest lands. This presents a feedback loop in environmental and climate change vulnerability for rice farming, with the sector being the main water user in Cambodia (Wokker et al. 2011 [16]). In recent years, increasingly irregular rainfall, generally associated with climate change, has adversely affected crop production and led to water conflicts among farmers (Nang et al. 2011: 37–39 [17]). Purvis et al. (2019) [18] argue that the concept of sustainable agricultural intensification requires careful consideration of the potential trade-offs between the social/human, environmental, and production/economic outcomes. The complexities in the rapid transformation of agriculture in Cambodia, thus, require further exploration into the consequences on the livelihoods of local people and the broader development outcomes in order to achieve sustainable outcomes.

This paper highlights the need for a view beyond the one-size-fits-all view within the green revolution, highlighting the need for context for the village- and household-specific nonlinear adoption of green revolution farming practice. This paper examines the processes of agricultural transformation and their impacts on livelihoods using a case study approach, looking at six farming communities within the Stung Chrey Bak catchment. The first section of this paper presents a review of the literature, analyzing debates on the nature of transformations and their impacts. Following that, the methodology is presented, in which the analytical approach and data collection methods are explained, followed by the results from our qualitative data in four areas of transformation: agricultural technologies, market integration, household capital assets, and institutional and policy processes. Finally, the discussion and conclusion section outlines the complex and uneven outcomes of agricultural transformation that create differentiated opportunities for different scales of farming. We explore how small-scale farmers are disadvantaged, the reshaping of the social and economic capitals of agricultural households, and the varied outcomes of adopting ‘modern’ agricultural inputs and machinery, including recommendations for policy makers. We anticipate that this study offers a valuable contribution to the literature on the nature of the uneven politics of agricultural transformations, with a particular focus on sustainable rural livelihoods, by presenting the effects of national policy and global markets at the local scale.

2. Materials and Methods

2.1. Literature Review

Under globalized neoliberalism, state roles in agriculture, such as price stabilizations and different forms of subsidies, are limited. Agrarian production relations, thus, have transformed into market relations at a global scale—global capitals come into play in shifting the surplus production as a means of funding a modernized economy (Hart et al. 1989 [19]). Meanwhile, agricultural ‘modernization’ processes have taken place, characterized by the unequal implementation of the ‘green revolution’. Within this, agricultural transformation is centered around processes of productivity improvement (Pingali 2023 [20]) and the use of modern agricultural inputs to obtain more outputs on the same size of land. There is a growing concern over the various trade-offs of rapid transformation and marketization, particularly the negative impacts on local livelihoods. Agricultural innovations have been touted to be essential to the development of sustainable rural livelihoods rooted in the perceived successes of the green revolution that had lifted millions towards food security (Mutsvangwa-Sammie and Manzungu 2021 [21]). The same study argues, however, that the positivist narrative surrounding these innovations overlooks the nuances of the biophysical, socioeconomic, and cultural aspects, alongside the political economies of scale of agricultural production, and the fact that rural livelihoods cannot be so simply defined as they become increasingly diversified. The agricultural revolution has composited other issues with implications for smallholder farmers; for example, Anti (2021) [22] argues that large-scale land acquisitions (LSLAs) cause a shift away from independent agricultural production towards employment in agricultural labor in adjacent regions.

A number of studies show that the processes of agricultural transformation are not universal but are context-specific. For example, regional studies show that transition processes are not uniform across Asia (Viswanathan et al. 2012 [23]) and provide perplexing, contradictory, and paradoxical effects, which can at once empower and dispossess (Choenkwan and Fisher 2018 [24]).

Viswanathan et al. (2012) [23] argue that, rather than understanding microenvironments, planning takes place at the macro level. The green revolution has been promoted as a universalistic paradigm, with templates used in places that have vastly different contexts (Graham and Pino 2012 [25]). Transformation is shaped by specific historical paths, politics, and socioeconomics at the national and subnational scale; for example: average land sizes (Viswanathan 2012 [23]); extent of land grabbing (Schoenberger, Hall, and Vandergeest 2017 [26]); investment in research and technology transfer (Pray and Fuglie 2001 [27]), and

microfinance over-indebtedness (Green 2022 [14]). Impacts also vary by place and can be paradoxical; Das (2002) [28] argues there have been no statistical relationships to poverty reduction, particularly where persistent poverty can be characterized by both technological advancement and the lack of it (Das, 2002 [28]); Gill & Singh (2006) [29] report on farmer suicides in India due to debt-related stress occurring two decades after the green revolution. Increased agricultural production is achieved partly through market integration, which is achieved through the conducive policy environments for the private sector or ‘markets’ to operate (World Bank, 2015 [9]). Some research has indicated that compliance with the liberalization of agricultural policy is necessary to improve and promote the quality of life among rural farmers, with improved agricultural productivity claimed as being critical to the growth of income and well-being for household farmers (Brown and Haddad 1994 [30], Iheke and Arikaibe 2012 [31], Bhandari, 2017 [32]). Contract farming is generally seen as a means to deal with both the problem of access to agricultural inputs and marketing (Reardon et al., 2019 [33]); however, the negative impacts of contract farming are differentiated; for example, Olounlade et al. 2020 [34] found an unevenness of economic distribution between smallholders and large agribusiness, as well as negative impacts on health and the environment, with the lowering of incomes affecting some but not all farmers (Olounlade, et al. 2020 [34]). There is an uneven ability among farmers to adopt modern agricultural inputs due to their limited access to land, financial capital, and labor, and some have found interventions being subject to elite capture (Mdee et al. 2021 [35]). A number of rice farmers have chosen to invest their labor into more attractive off-farm employment (Tomich et al. 1995 [36]).

Agricultural transformation is said to inhibit the rural-to-urban migration of people. However, the interpretation of migration remains divided. Modernization theory sees migration as being pushed by rural poverty or pulled by the higher wages of urban industries (Lee, 1966 [37]). However, the sustainable livelihood framework sees migration as part of the household strategies for achieving and maintaining a desirable level of quality of life or well-being, which is one of a portfolio of ‘capital assets’ that, together with the labor force, are utilized to achieve the best possible outcomes (Chambers and Conway 1992 [38]). Labor migration and aging rural populations have long been a concern for policymakers. In low- and middle-income countries, aging farmer demographics in low- and middle-income countries is said to pose potentially negative implications for agricultural production and food security, while others point to insufficient evidence to draw such conclusions (Heide-Ottosen 2014 [39]).

2.2. Methodologies

2.2.1. Analytical Framework

From the literature review above, we draw a framework that demonstrates a causal structure of factors driving agricultural transformation, which is presented in Figure 1. The diagram identifies the four components of agricultural transformation, including agricultural technologies, market integration, household capital assets, and institutional and policy processes. From these, we investigate the drivers and processes that shape transformation in rice production at the local level. Our analytical approach looks at how these processes reveal economic challenges and livelihood risks and benefits at the household level, including access to technologies, the market, and labor, as well as changes in income and support from policy and institutions aimed at farmers. We investigate how these reflect on the uneven politics of the green revolution and speculate what these might mean for sustainable livelihoods and rice production among Stueng Chrey Bak farmers in the future.

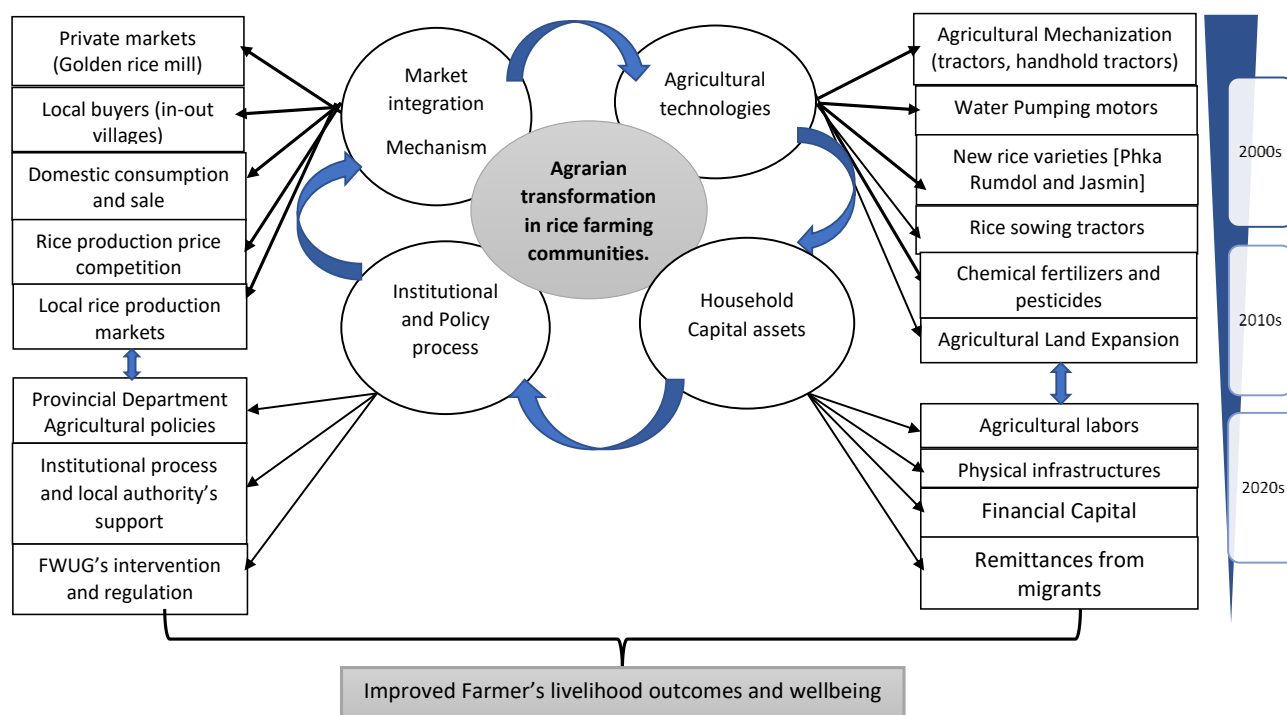


Figure 1. Analytical, conceptual framework on the agrarian transformation of Tang Krasang and Trapang Trabek rice farming communities. Source: Author, 12 June 2022.

Figure 1 shows how the components of agricultural transformation used in the conceptual framework in the themes of agricultural technologies, the integration of market integration, household capital assets, and institutional and policy processes components have nonlinear relationships.

2.2.2. Site Selection

The Stung Chrey Bak is situated in the Southwest of Kampong Chhnang Province. The Stung Chrey Bak covers an 80 km stream, a medium-size tributary, originating from the Cardamom Mountains, and drains water from a total catchment area of 663 km² into the Tonle Sap river. It shares a border with the Teuk Pos and Rolea Bier districts. Stung Chrey Bak is remote and sparsely populated, with a distance of close to 90 km from the nation's capital, Phnom Penh (Sam and Pech 2015 [40]).

Stung Chrey Bak was selected as a study site because of its relatively high incidence of poverty and high dependency on natural resources. Stung Chrey Bak has multiple functions for providing rain for rice production and is rich in natural resources ((Sam and Pech 2015 [40]).

However, studies have shown that the communities face increasing vulnerability due to their strong dependence on water, land, and forest resources and projected increases in climate change-related impacts, relatively poor water governance, and limited resilience strategies (Sam and Pech 2015 [40]).

Two rice farming communities within the Stung Chrey Bak (see Figure 2) were chosen: the Tang Krasang and Trapang Trabek communities. Tang Krasang's community is situated upstream, in the middle part of the catchment. Three villages, named Tamom, Tang Krasang, and Chas, were selected randomly among the total of five villages in the Tang Krasang commune, Teok Pos district.

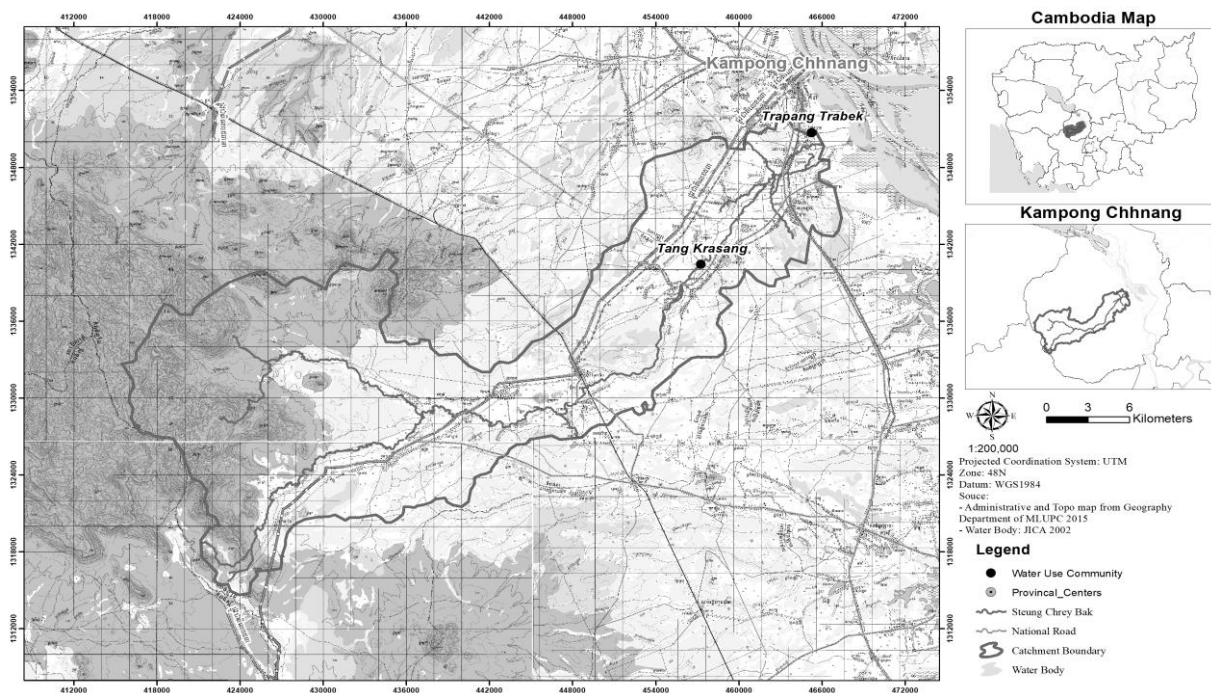


Figure 2. Map of the locations of the farming communities in the Stung Chrey Bak catchment. Source: Author, 12 June 2022.

The Trapang Trabek community is located downstream of Stung Chrey Bak, joining the Tonle Sap Lake. Three villages: Kouk Beanteay, Popeal Pork, and Proneam Pich were selected randomly among the total of four villages in the Kouk Beanteay commune.

2.2.3. Research Method

The qualitative methods that were used for data collection included document analysis, field observation, focus groups, and key informant interviews. Document analysis used datasets acquired from relevant ministries, including the Ministry of Water Resource and Meteorology, The Ministry of Agriculture, Forestry and Fisheries, The Ministry of Environment, and The Ministry of Rural Development, and annual reports were taken from provincial department lines. By using qualitative methods, we were able to understand the how and why of the processes and relationships of transformation from the perspectives of the community. We began with field observations aimed at identifying key provincial and local people who facilitated access to the participants from their networks. From this, two representatives from each of the farming communities of Tang Krasang and Trapang Trabek were selected to contact individuals for focus group discussions. The two focus group discussions (FCDs) concentrated on village history, livelihood diversification, rice production marketing, water-use problems, and household capital assets, such as labor division.

Rice farming systems were discussed with the help of a resource-mapping activity. Key informant interviews (KIIs) were conducted with 25 participants who were selected from the four different governance scales, including village, commune, district, and province levels. These were chosen due to their in-depth knowledge of the changing situation of rice farming and how they cope with the changes. They included four representatives from the provincial departments, two representatives from the district's governors, four representatives from the commune heads, six people from the village heads, four representatives from FWUCs, one high school teacher, two people who were local rice-buyers, and two representatives from the private rice companies.

3. Results and Discussion

3.1. Results

From our interviews, we found that the population in the three study villages in the Tang Krasang commune were predominantly farmers growing wet-season rice, and some farmers have increased their land size for growing dry-season rice. In the three study villages in the Trapang Trabek commune, the farmers are growing dry-season rice. These six selected villages share a river for rice growing during both the wet and dry rice seasons and have access to natural resources, such as fishing and the collection of nontimber forest products, and share a similarity of sociocultural values and agricultural markets.

3.1.1. Farm Mechanization

The interviews and focus group discussions revealed that, from 2010, changes in agricultural practices were evident in all six villages. The farmers indicated that, in the 1980s, a large population of farmers in Tang Krasang and Trapang Trabek relied on animal labor (buffalo) for plowing, transplanting, and transporting and human labor (family members) for rice growing, including land preparation, transplanting, and harvesting. Rice farmers increasingly turned to the use of machinery, such as modern tractors and water-pump machines. The replacement of buffaloes with machines has been evident since 2010. Initially, two-wheel tractors (2W) were introduced and quickly became widespread; later, four-wheel tractors (4W) grew common. Our interviews and focus group discussion counted that 161 farmers used 2W tractors in the six villages. In total, 97.2% of farmers used tractors, and 2.8% used animal and human labor forces. From 2018 onwards, there was a change from 2W tractors to 4W tractors. Most farmers in both communities reported that, in 2018, eight farmers owned 4W tractors. In 2020, the number of 4W tractors increased to 11, as the farmers in the Trapang Trabek community owned seven 4W tractors. At the time of the study in 2021, we found that there were 17 4W tractors owned by farmers. The focus group discussions in the Chas and Tang Krasang villages indicated that about 82% used 4W tractors (hired), while only 18% used 2W tractors. The changing mechanization of rice growing over the period between 2010 to 2021 is shown in Figure 3.

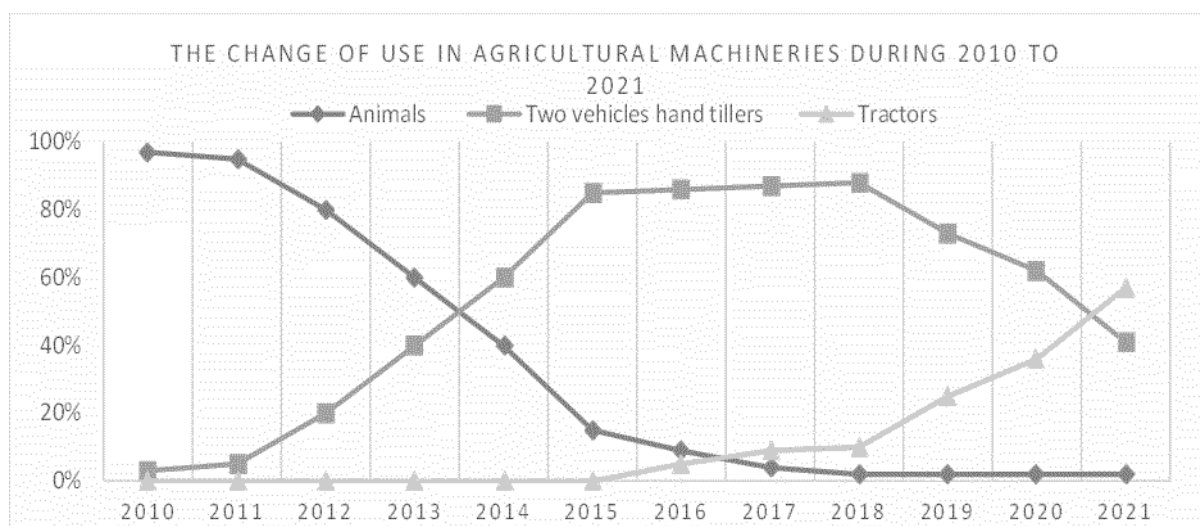


Figure 3. Agricultural machineries in communities from 2010 to 2021. Source: fieldwork, 2021.

Our results show that, in comparison to the figures for Thailand (100%) and Vietnam (80%) (Hossen 2020 [41]), our study site falls in the middle (97.2%) for the extent of adoption of machinery.

As most farmers do not own tractors, they hire machines to prepare the land. Hiring a 2W tractor costs KHR 200,000 riels (USD 50) to prepare one hectare of paddy. The difference in costs for hiring is evident. A 4W tractor costs KHR 800,000 (USD 200), and manual labor

costs KHR 350,000 (USD 87.5). The physical geography of the paddy fields also influences farmers' choice of tractors. For instance, Trapang Trabek, as a part of Tonle Sap Lake, has a hard clay soil type and is muddy, which is suited to the 4W tractor. Farmers in Trapang Trabek told us that while a 4W tractor takes one hour per hectare to cultivate paddy land, 2W tractors take 2–3 h per hectare. On the other hand, the farmers in Tang Krasang, which is in the middle part of the catchment, and has a hard-dry-sandy soil type resulting from soil erosion from a mountainous area, are better suited to a 2W tractor for their paddy field preparation. Tractor owners providing land-preparing services have increased over time, and some also extend their business to cover other types of agricultural inputs.

3.1.2. New Rice Seed Varieties

From the 1980s to 2000s, farmers cultivated rice varieties known as IR36, Neang Kok, and Sen Pidor; however, our interviews with the community leaders revealed that over 80% of the farmers in both communities now use a hybrid rice variety known “Phka Krovan”. This rice variety was widely introduced to farmers in early 2015 by Kampong Chhnang’s provincial department of agriculture, forestry, and fisheries and local authorities. It has been widely adopted for having a shorter crop growing period, greater yield, and is better adapted to limited rainfall than existing varieties. Farmers also view Phka Krovan as effective in attracting good prices in the markets. The Phka Krovan rice has a growth period of medium duration and is a photoperiod-sensitive variety. However, the use of the new rice variety requires the adoption of modern agricultural inputs, such as fertilizers, pesticides, and diesel engine water pumps. Figure 4 shows that the greater yields from the adoption of Phka Krovan are linked to the increased use of machinery, chemical fertilizers, pesticides, and the adoption of diesel water pumps.

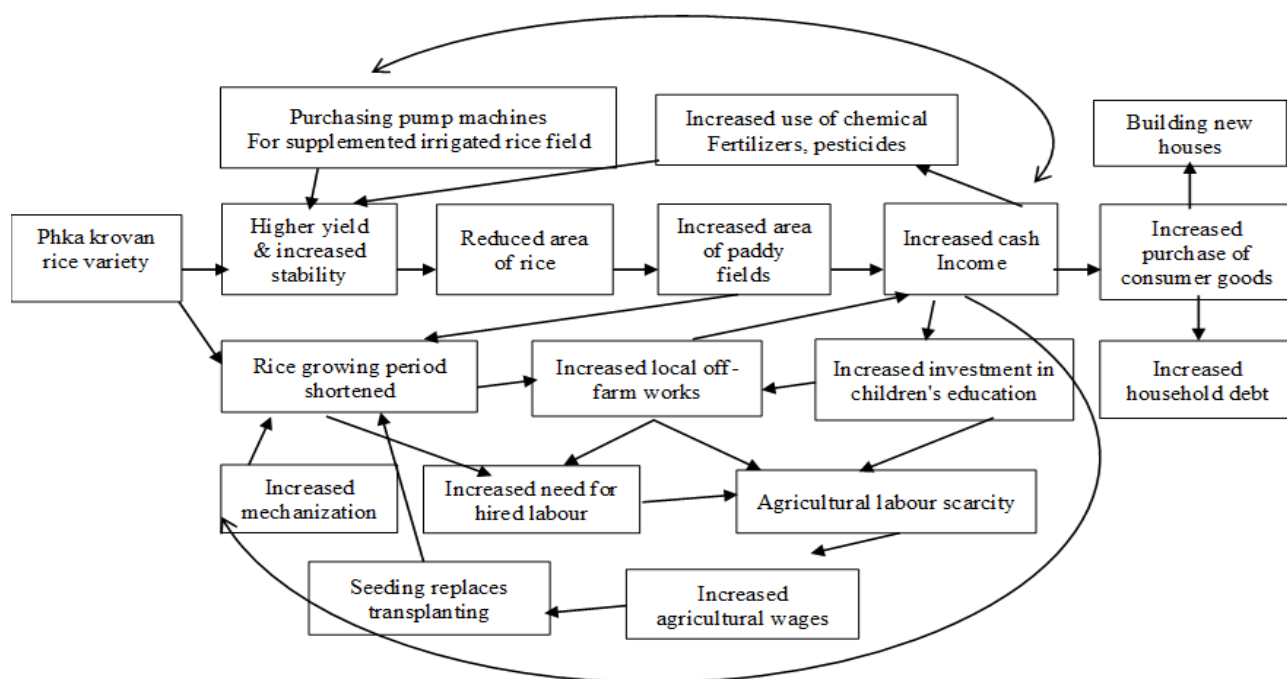


Figure 4. Household rice production in the communities. Source: author, 2021.

The shorter period of time of rice growing, together with the use of machines, permits some laborers to engage in off-farm employment. Other interviews reveal an evident increase in rice yield and, therefore, a higher income from rice growing. However, most of the income is spent on agricultural inputs, as shown above in tractor hire. Furthermore, access to modern agricultural inputs is uneven, with the results showing that middle- and large-scale farmers are more likely to adopt modern agricultural inputs than small-scale farmers with less than one hectare of paddy field.

3.1.3. Chemical Fertilizers and Pesticides

From the early 2010s, farmers turned to the heavy use of chemical fertilizers, which enables plant nutrients and good yields in adverse weather conditions when rice requires additional nutrients. The intensification of chemical fertilizers increases the yield of rice crops but raises a number of questions regarding productivity and sustainability. Farmers reported that the chemical fertilizer used amounted to half a bag (25 kg) per hectare of rice fields in the 1980s. This increased to two bags in the 1990s and further increased to six bags per hectare in 2019. In the interviews, the farmers revealed that their yield per hectare increased from four to six tons. The increase in paddy yield, following the increase in chemical fertilizer used, reached 6 tons per hectare during 2020 and 2021.

Three different types of chemical fertilizers were found in the studied villages; Urea (46-0-0) Black buffalo Head made in Vietnam, White-Urea (49-0-0) made in Thailand, and Sunrise made in Japan. All of these are imports, with their prices tied to international exchange rates, with a trend of increasing prices. In 2010, the price of one bag of chemical fertilizer (50 kg) was KHZ 80,000 (USD 20). The price rose to KHZ 120,000 (USD 30) per bag between 2017 and the time of data collection. Even with the price of chemical fertilizers continuing to soar, farmers are required to purchase them, as, without them, the yield will be insufficient to meet demand. A few of the farmers we interviewed pointed to the overuse of chemical fertilizers causing negative impacts, damaging rice paddies, with the soil composition becoming harder and infertile. In the Chas, Tamom, and Preah Neampich villages, the farmers reported concerns about water pollution, chemical burning of crops, the acidification of the soil, and mineral depletion in the soil. However, a number of villagers showed a reluctance to use organic fertilizers, even though they were cheaper, due to them producing lower rice yields.

According to the Word Bank (2015) [9], the adoption of fertilizers by farmers in Cambodia might have been previously low due to the high risk of obtaining tainted, low-quality fertilizers in the marketplace. However, they found that the availability of low-quality and sometimes fake fertilizers sold in Cambodia does not appear to be a major issue (WB, 2015 [9]).

3.1.4. Market Integration

A key component of the agrarian transformation is market integration; during the Khmer Rouge, the market was nonexistent. Shifting market integrations consisted of the following types of markets; exchange, wax-markets, community markets, and regional markets. The markets have grown from interhousehold exchanges of produce to regional markets selling imported goods (Figure 5). From the 1980s to the early 1990s, farmers produced rice for their own consumption or exchanged their produce with other households. From the 1990s, farmers traded products in 'wax markets', deriving their name from the melting of beeswax by heat, which functioned in the morning until after sunset. These markets sold agricultural commodities, such as rice, fish (caught from the paddy fields, canals, and reservoirs), home-grown vegetables, meats, groceries, and nontimber forest products (NTFPs). Wax markets then expanded to supply more products in community markets, particularly rice. Home-scale markets received limited imported products and services. From the 2000s, markets grew to the domestic scale and then the middle scale, with an increasing diversity of products, services, and buyers from outside the communities. This was enabled due to the construction of a concrete road in 2015, which helped farmers in Tang Krasang access the Prey Khmer market. In the 2020s, markets have grown to a regional scale. Market growth has coincided with increased farmer household wealth, creating greater demand for imported goods and services, including agricultural inputs and machinery. Rice production has grown with rapidly increasing rice yields for the regional market, resulting from the intensification of rice production from the farms, growing to a middle-scale level, which has attracted more buyers and companies. This has been accomplished with the expansion of the paddy fields and the use of modern agricultural inputs, such as new rice varieties, fertilizers, pesticides, and machinery.

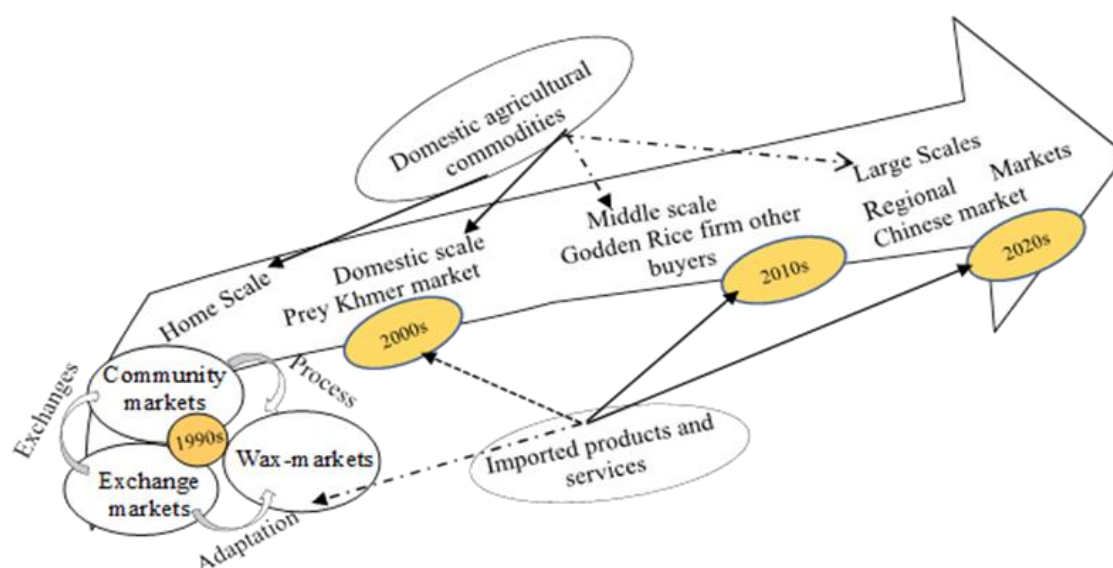


Figure 5. Market Integration in the Tang Krasang and Trapang Trabek rice farming communities. Source: author, 2021.

The market integration of paddy production into our studied sites has meant that local family farms are now drawn into market mechanisms. This integration has resulted in improved productivity, but the increase in yields is accompanied by increases in expenses, and in order to maintain favorable profits, farmers must maintain or increase the scale of their production, particularly their land size. Our interviews revealed that those who are satisfied with the market prices are middle and larger farms, while smaller production scales (less than 1 ha) are disadvantaged. The market integration in this respect seems to pave the way for the larger scale of production, and this reflects the work of the ‘economy of scale’.

3.1.5. Migration and Off-Farm Employment

One of the challenges that farmers frequently raised during the interviews was soaring labor costs for rice growing. Finding human labor for harvesting is difficult because young labor typically migrates out of the villages to seek higher-paid employment in other industries. As a result, migration to off-farm employment causes labor shortages and has driven wage increases in agriculture; the cost of labor for one ha paddy harvest has risen to KHR 450,000 (USD 110).

In Tang Krasang and Trapang Trabek, the farmers reported that over 60% of the active labor forces have migrated and/or are employed in off-farm jobs. Young females are dominantly working in the garment sectors, while males are working in the construction sector. The presence of local garment factories presents a good opportunity for young female employment. Around 35 garment factories were established in nearby village areas in 2010, and the number increased to 56 in 2019. Furthermore, localized employment also allows young labor forces to contribute to farming on weekends and holidays, which partially eases the labor shortages in the agricultural sector. The local livelihoods of the farmers are, thus, shaped by multiple socioeconomic conditions. On the one side, farmers are reliant on their land, while laborers who till the land are increasingly scarce, causing farmers to turn to mechanization to replace human labor. Despite this, agricultural outputs cannot satisfy capital needs, and therefore farmers seek off-farm employment. Those farmers choosing to remain in agriculture seem to be determined by the size of their land; if their land is smaller than 1 ha, there is a strong likelihood that they exit agriculture and rely entirely on off-farm employment.

The combination of nonfarm work (garment factories and construction) and agriculture seems to be the best plausible livelihood option for local people. However, this option

is dependent on the dynamic changes in both the agriculture and local industrial sectors. In this respect, the livelihoods of local farmers are unsettled. In the short term, people seem to be satisfied with the increase in income; however, modern agricultural inputs are increasing. Local people opt to smooth out their livelihood outcomes by diversifying the use of human capital assets. The desirable livelihood outcomes may alter following a change in both the agriculture and modern industrial sectors.

3.1.6. Impacts from Institutional Policy Processes on Agricultural Transformation at the Farming Community and Local Level

The creation of farmer water user committees (FWUCs) in each community was undertaken in the early 2000s and was initially supported by the Provincial Department of Water Resource and Meteorology (PDOWRAM) and the local authorities. Their aim is to address the increase in competition for water, which was sparked by the development of irrigation systems. FWUCs work closely with farmers, who are ultimately the irrigation beneficiaries. The role of FWUCs is to manage, regulate, and distribute water from the main canals to the rice fields, address flood and drought problems for farmers, mobilize water users to rehabilitate and repair the canals when needed, and negotiate with other communities to address upstream and downstream water conflicts.

Some of the operational challenges that FWUCs face were found in the study. The FWUCs have an insufficient budget to enable them to carry out the work. FWUC members work on a voluntary basis, usually for many years, and the absence of incentives limits their work and commitment. The management committee of an FWUC consists of a nominal five people per community, but only one person, as the head of an FWUC, actively works on issues. FWUC relies on the help of commune councilors in areas such as conflict resolution, which typically occurs during water shortages in the dry season. This is primarily due to the influence that commune chiefs have established in the community through their assistance in many interventions, such as providing microfinance loans and supporting other social activities. However, the intervention from the commune council has, to some degree, negatively impacted the functioning of FWUCs due to commune chiefs being local politicians affiliated with political parties. FWUCs, by law, are nominally required to be independent. Therefore, the involvement of the council has stripped the FWUCs of accreditation as a local independent entity (Chem, 2013 [42]). The constraints they face in their financial and technical capacity also leads to them depending upon outsiders, such as the provincial department of water resource and meteorology (PDOWRAM) and local authorities to support them.

3.2. Discussion

The agricultural transformation of the rice farming communities of Tang Krasang and Trapang Trabek has been shaped by an export market that is centered on policy and modern technologies, which includes the uptake of agricultural mechanization and the application of agricultural inputs, such as new seed varieties, chemical fertilizers, chemical insecticides, and pest controls.

The uptake of machinery among farmers has been high; however, the benefits are differentiated, with some farmers buying tractors for rental purposes, while others are burdened with the extra cost of machinery in comparison to human and animal labor. New rice varieties have also coincided with adopting 'modernized' approaches to agricultural inputs, particularly the variant of Phka Krovan, which is linked to increasing and intensified chemical fertilizer and pesticide usage. The heavier emphasis on chemical fertilizers and pesticides on paddy fields poses negative long-term impacts on the quality of paddy field soil, farmer health, and natural ecology. Agricultural transformation also results in the dependence of Cambodian agriculture on modern international agricultural input markets.

The intensification of the use of modern technologies happened alongside the market integration of agricultural households through the expansion of traditional 'wax markets', involving a shift in the rural economy of rice production (for household consumption)

toward market orientation. Integration into international markets increasingly demands mechanization and the improvement of yields at the farm level, putting greater pressure on requiring increasing agricultural inputs and an increased burden on loaning equipment and financial capital. Rice prices are now strongly linked to export competition and currency value. Price fluctuations mean that farmers, who are faced with low rice prices, see their farms becoming less attractive for laborers, and subsequently, many migrate to alternative off-farm employment. This coincides with rice farming households increasingly relying on incomes from off-farm sources to supplement this, agriculture declining in its importance for subsistence, and the increasing costs of modern inputs, as more young-generation laborers look to escape agriculture, ultimately resulting in agricultural labor shortages.

There has been much debate on the growth of circular migrant labor both to and from the agrarian regions of the global south in attempts to understand the relationships between the mobilities of labor and smallholder capital alongside large-scale land acquisitions and industrialized farming (Kelly et al. (2020) [43]). The agricultural transformation of farming communities in Stung Chrey Bak coincides with the migration of the young generation to work in urban industries in towns and cities throughout Cambodia. However, in this case, the garment industries had relocated to the local area, so a great number of young members of the local agricultural households were employed. This allows young labor forces to be involved in agricultural labor alongside employment in other off-farm industries during vacations or before/after working hours. In this way, the transformation process of local agriculture also reflects the reorganization of household assets, especially the diversification of investment of human capital.

The coexistence of agriculture and the garment industry in our case study contributes towards the continuity of agricultural households, but it is uncertain whether this is sustainable for the long term. Thus, understanding the dynamics of household capital assets plays a key role in understanding livelihood security. With limited capital assets, households may diversify the investments of their capital assets into both on-farm and off-farm activities. Recently, rice growing has become largely conducted by elder farmers, while the majority of young laborers are engaged in off-farm jobs. This type of investment, although allowing for the viability of a household in the short term, is challenging over the long term. These findings agree with the trends reported elsewhere, which concern the future of rural communities and food production in light of aging demographics (Heide-Ottosen 2014 [39]). Furthermore, this can be seen within the lens of increasing marketization, and land scarcity has reshaped gender roles and relations in other Cambodian provinces, where resource politics have alienated many prior landowners from their lands, with this hampering social reproduction (Park and Maffii 2017 [3]). Other scholars have realized a feminization of household agricultural roles in Nepal under the transition from an agrarian society, in which there is a shortage of male labor from outmigration (Pandit 2017 [44]). Meanwhile, these altering relations have marginalized many older generation farmers, particularly elder women based on emphasizing the value of financial capital, possession of goods, and concepts of modernity (Park and Maffii 2017 [3]).

The institutional-policy process plays a very important role in supporting farmers through farmer water user communities (FWUCs). The most effective level of influence vis-a-vis the daily operation of the FWUCs is at the commune level. Its role is to arrange the necessary public services and promote socioeconomic development and agricultural productivity. Despite this, the objectivity of the solutions can be called into question with commune chiefs' associations with political parties, and their efficiency can be hampered by operation on a voluntary basis.

4. Conclusions

In conclusion, agriculture has become more diverse, with the multifunctional rice farming communities of Tang Krasang and Trapang Trabek providing higher incomes as a part of livelihood improvement. Yet, while household income has improved among farming communities due to both increased yields and supplementary incomes from off-

farm employment, the increased costs of the inputs and lower rice prices have meant farmers are facing greater risks. As other studies show, Cambodia's widespread uptake of microfinance loans in response to rising input costs, which has already deepened the debt and financial shocks, including those with land held as collateral, has meant that farmers are at risk of losing their land and livelihoods, and this, in turn, contributes to out-migration and increasing debt burdens (Bylander 2013 [45], 2015 [46]).

We recommend policymakers look to supporting farming communities with improved water infrastructure, particularly for small-scale farmers where little provision currently exists. Market approaches that focus on export targets that lead to the intensification of rice production need to be decoupled from the low commodity pricing of rice to enable long-term sustainability in rice farming and rural livelihoods. This is important in light of Cambodia's competitive position in the regional rice market, wherein Cambodia is in competition with neighboring countries, some of which provide state subsidies, and have recently lost the advantage of having the EU as the primary export partner, being replaced by China who imports a greater quantity but at lower prices.

The time and funding limitations of this study meant that nonfarmers and those who had stopped farming for more than five years were not interviewed. Further research should look at other factors influencing the livelihoods of rice farming communities, such as indebtedness and land ownership. Furthermore, the long-term impacts related to soil and food quality from the intensive use of fertilizers and pesticides among farmers' plots warrant further research. Research on farmers' perceptions of well-being is forthcoming from the authors.

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