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Price Support and Farm Incomes: Comparative Study of Rice Growing Regions in Southern India and Mekong-Delta Vietnam

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Abstract

Drawing on the broad literature on agricultural development and particularly on the contribution of price and non-price factors, this study examines how government support contributes to farm incomes from rice cultivation in two frontier rice-growing regions in Asia: Kerala, southern India and Mekong Delta, Vietnam. We use a detailed case study approach to offer a unique comparison between two best-performing areas that are similar in agroclimatic conditions and institutional trajectories, which is generally wanting in literature. Our farm budget analysis and counterfactual simulations using household-level data show that the local (state-level) price support contributes to more than half of the average crop income per hectare in Kerala. While the per hectare crop income for a single season in Vietnam was significantly lower than in Kerala, the annual incomes were higher due to multiple cropping. We combine these survey-based results with qualitative insights to examine how various factors have led to the observed scenario. This comparative analysis demonstrates the need for specific non-price interventions, particularly in terms of research and extension services, in enhancing incomes for agriculturally advanced regions within developing countries.

Key words: Farm households, Rice cultivation, Agricultural policy, India, Vietnam, Price support, Infrastructure

JEL codes: O13, Q12, Q18, Q16

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1. Introduction

Agricultural development of a region is dependent on various factors, including the initial endowment, levels of public and private investments leading to capital formation, introduction of new technologies, and changes in institutional arrangements. The relative contribution of these different factors to improving agricultural growth and incomes has been discussed extensively in the Indian context, with comparisons made between price and non-price factors in different periods of growth (Binswanger et al., 1993; Kurosaki, 2017; Lele and Mellor, 1990; Vaidyanathan, 2010). Although spatially concentrated, investment in irrigation infrastructure, introduction and spread of high-yielding varieties, and increase in application of fertilizers led to a substantial overall growth in agricultural output in India during the green-revolution era, which hase plateaued in the more recent periods due to inadequate public and private investments (Bisaliah et al., 2013; Fan et al., 2008; Joshi et al., 2015).

India's agricultural growth has been compared with other similar settings, most notably in relation to China with the studies assessing the relative impact of education, irrigation, and agricultural research (Fan and Gulati, 2008; Nin-Pratt et al., 2010; Raj, 1983; Saith, 2008). These studies follow from the tradition of long-term analysis on institutional factors that interact with and contribute to agricultural development (Hayami, 1969; Kikuchi and Hayami, 1980). The discussion on agricultural growth has led to an intense debate on effective returns from subsidies versus other public investments in India, which has continued even in the recent periods (Akber et al., 2022; Gulati et al., 2020). Nevertheless, our understanding of drivers of agricultural development is still limited, especially regarding more advanced rice-producing regions in low- or lower-middle income countries in tropical Asia. Most of the discussions at the country-level provide insights that may not be relevant to policy discussions at the local levels, especially if the countries are big and characterised by diverse agro-ecological and locally-varying policy settings. There could be regions within a developing country that is ahead of the average situation, which would be a result of peculiar conditions prevalent in the individual regions. There are limited comparative studies that considers this aspect, with an explicit focus on specific local-level differences in advanced regions within the developing countries.

Drawing on the broad literature on agricultural development and particularly on the contribution of price and non-price factors, this article examines incomes from rice cultivation in two historically rice-growing regions in Asia: Kerala in southern India and the Mekong Delta in Vietnam. Kerala and the Mekong Delta provide for a meaningful comparison in the following manner: similarities in broad agro-ecological conditions and the institutional contexts; but vastly different trends in rice production. Using a case study approach comprising detailed household level surveys, we compare two best-performing villages, one each in these regions, and examine how various interventions have contributed to the current levels of incomes from rice cultivation. Our focus on the most productive regions is motivated by the expectation that such comparison enables us to understand what can be achieved at the frontier when relevant policies are adopted, not bound by existing conditions characterizing average regions. Specifically, we answer the following questions through this comparative study: How do incomes from crop cultivation differ in the two regions? What factors, including the role of government policy, explain differences in incomes from rice cultivation between these two regions? The analysis is mostly based on the standard technique of farm budget analysis (Timmer et al., 1983). In quantifying the role of government policy, supply responses are incorporated using simulation analysis derived from mathematical modeling of agricultural households, possibly faced with incomplete markets (de Janvry et al., 1991; Singh et al., 1986).

This article thus contributes to two strands of literature. First, it adds to a large body of literature on effective policies for agricultural development in India and Vietnam (Binswanger et al., 1993; Kien et al., 2020; Lele and Mellor, 1990; Sanh et al., 1998; Vaidyanathan, 2010) through adding a case of best-performing villages. The empirical findings from the comparative study are expected to deepen our understanding of the potential of rice cultivation in tropical Asia achievable under appropriate policies. Second, the article demonstrates the usefulness of conducting detailed budget analysis of rice farming (Timmer et al., 1983), combined with counterfactual simulations based on agricultural household models (de Janvry et al., 1991; Singh et al., 1986). The different contribution of price and non-price factors in each study region can be explained by the microeconomic mechanism of these models.

The remainder of this article proceeds as follows. The next section provides background of the study areas. It is followed by a description of the data and empirical methodology used in the analysis. Section 4 presents the quantitative results. To understand the contrast found in the quantitative analysis, we qualitatively explore the contrast in policy interventions in section 5. The last section concludes the article.

2. Context

Rice has played a significant role in Kerala's society and culture. It has been cultivated historically in the State and has remained as a dietary staple for the population. The evolution of rice cultivation in Kerala has resulted in the development of specific rice agro-ecosystems, which combine unique rice varieties (with distinct medical and aromatic properties), cultivation practices, and crop cycles. At present, the income from rice cultivation is relatively high in Kerala. According to the cost of cultivation surveys, it stood third among all States in terms of farm business income from rice in 2018-19 (CCPC, 2021). Over the last four decades, however, there has been a consistent decline in area under rice cultivation and production of rice, and stagnation in yield (Johnson, 2018). From around 900,000 hectares in 1975-76, the area under rice cultivation fell to 200,000 hectares in 2016-17.

This loss of rice-cultivating lands has been a matter of concern in Kerala due to ecological, cultural, and economic reasons. Preservation of rice cultivation at present effectively means preservation of low-lying areas, some of which are also ecologically sensitive wetlands. The widely cultivated red-rice varieties (*matta* rice) are nutritive and consumed by a large section of the population. Although food security and employment generation in agriculture are not immediate concerns at the local level, rice cultivation can contribute to some production and employment. As a result, various State Governments have intervened by means of direct and indirect measures to arrest the decline in area under rice cultivation (Government of Kerala, 1999; Harilal and Eswaran, 2016; Nair, 1981; Thomas, 2011).

The state policy has responded by providing (1) special infrastructure and marketing support for development of rice cultivation, (2) cash incentives and price support for both inputs and output, and (3) other institutional measures. In the recent period, the Government of Kerala has provided an additional incentive (termed the State Incentive Bonus (SIB)) over the Minimum Support Price (MSP) provided by the Central Government for procurement of rice. The development plans have also allocated higher funds to rice than coconut, the crop with largest area under cultivation in Kerala (Figures A-3 and A-4, Appendix A). The institutions of *padasekharam* (Malayalam term for collective groups of rice-cultivating farmers) and *Kudumbashree* (self-help groups of women that have played an instrumental role in poverty eradication plans in Kerala) have been assisted by government in extending rice cultivation (Alex, 2013; Thomas, 2011). In addition to these, several local governments such as village panchayats have also devised their own programmes to revive rice cultivation.

In sharp contrast, the Mekong Delta Region of Vietnam, expanded its area under rice cultivation, registered impressive improvements in rice production and yields, and became a leading rice exporter in the world market after the mid-1970s (OECD, 2015). At present, rice is planted on around 4.0 million hectares with a production of 24.5 million tonnes and a yield of around 6 tonnes per hectare in the Mekong Delta Region of Vietnam (General Statistics Office, 2019). Vietnam has a history of investment in rice cultivation, particularly in irrigation development, and in enacting *Doi Moi* reforms that had a profound impact on rice production in the Mekong Delta (Kien et al., 2020; OECD, 2015; Pingali and Xuan, 1992; Sanh et al., 1998).

Both Kerala and the Mekong Delta are characterised by tropical climate with high rainfall and alternating dry and wet seasons (Table A-1, Appendix A for some statistics). In terms of institutional set-up, small farm size, market-oriented farming, high literacy rates of farmers, and a history of land reforms are characteristic to both regions. However, there are some differences. The Mekong Delta is a flat, low-lying region with an average altitude of two metres above mean sea level. While Kerala is characterised by an undulating topography, major rice-cultivating area are low-lying, wetland-like rice ecosystems. The scale of cultivation and the nature of market orientation are also different — Kerala's rice production mainly caters to the domestic demand whereas the Mekong Delta's major production is for exports (Anh et al., 2020). The population density is very high in Kerala compared to the Mekong Delta. There are variations in migration patterns and non-farm employment opportunities. However, despite these differences, there are areas within these two regions that are known for high productivity and profitability, making them highly comparable in settings. For this study, we selected such regions intentionally, as our motivation was to understand what could be achieved at the frontier of rice production in tropical Asia.

3. Data and Methods

3.1. Selection of Study Areas and Sample Households

We use primary data collected in 2018-19 through sample surveys of selected farmer households in Adat village panchayat, Thrissur district in the *kole* wetland region, and Dinh Thanh commune, An Giang province of the Mekong Delta Region in this article.

The *kole* wetland region is characterized by high productivity and profitability in Kerala. According to the statistics released by the Department of Economics and Statistics, Government of Kerala, average yield of rough rice in the *kole* wetland region for 2011-16 was 5.2 tonnes per hectare, the highest among all rice agro-ecosytems in Kerala. The average yield of rough rice in Kerala for the same period was 4.2 tonnes per hectare. The data from cost of cultivation surveys showed that the level of farm business incomes for 2014-17 in the *kole* wetland region was second highest among all rice agro-ecosystems in Kerala.

Within the *kole* wetland region, we chose Adat village panchayat for the study of economics of rice cultivation (Figure A-1, Appendix A).[1] Agricultural land in the *kole* wetland region is owned by individual farmers but for operational purposes cultivators are organized as joint-farming societies or *padasekharams*.[2] Adat village panchayat is one among the top five village panchayats with the largest number of *padasekharam* (numbering 13) and had the largest number of farmers within these five village panchayats. From the list of farmers in each *padasekharam*, we selected 65 farmer households through a random sampling procedure and interviewed them for the survey. The total number of farmers as per the lists of *padasekharam* was 2708 in 2018-19.[3]

The Mekong Delta region had an average rice-planted area of 4.2 million hectares in 2015-18. During this period, it accounted for around 55 per cent of the total rice-planted area and total production of rice in Vietnam. An Giang province within the Mekong Delta had the highest yield of rough rice across all season (6.2 tonnes per hectare) along with two other provinces (Dong Thap and Hau Giang). It had the second largest area under cultivation and production of rice among all the provinces in the Mekong Delta. Within An Giang province, Thoai Son district had the largest area and production of rice. Since commune-wise information was difficult to obtain, Dinh Thanh commune was selected as the site for fieldwork based on the discussions with agricultural officials (Figure A-2, Appendix A). According to the officials, Dinh Thanh was one of the best-performing communes in terms of rice production. The final sample had 60 households, selected at random, from two hamlets in Dinh Thanh commune.

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1 Village panchayat or Gram Panchayat, is a basic village-governing institute in rural India, covering several villages. It is a political institute, whose council members are elected directly by villagers.

2 A *padasekharam* oversees collective management of irrigation and may sometimes be involved in the land lease contract with outsiders and marketing. However, each *padasekharam* member maintains the independent responsibility of farm management of his/her plots. Therefore, we treat each farmer as the unit of paddy production, not *padasekharam*.

3 There are issues with this database as the *padasekharam* uses land records to determine the status of farmer. Any person who owns a plot of cultivating land is part of that *padasekharam*. To capture tenant farmers, who are excluded by this definition, we have interviewed lessee farmer than farmer who has leased-out land. The sample of 65 farmers capture one pure tenant, i.e. who did not own any land and had cultivated only leased-in land.

Dinh Thanh commune has three seasons of rice cultivation in a year and Adat village panchayat has a single season of rice. The cropping season in Adat began in November 2018 and extended up to May 2019. Among the three seasons in Dinh Thanh commune, the Winter-Spring season, from December 2018 to March 2019, coincided with the crop season in Adat. Some basic descriptions of both the study areas are in Table 1. On average, the farmers in Dinh Thanh, Vietnam operated double the rice-cultivating land than in Adat, Kerala. The household sizes are similar. The average yield in Dinh Thanh was higher than in Adat. The yields in both the locations were higher than the averages for the regions as a whole: Adat's average yield of 6.5 tonnes per hectare was higher than the yield of 5.2 tonnes per hectare for the *kole* wetland region in 2011-16 and Dinh Thanh's yield (for Winter-Spring season) higher than the average yield for An Giang province in 2018 (7.6 tonnes per hectare; which was the highest among all provinces in the Mekong Delta).

Table 1 *Descriptive statistics for land operated in Adat and Dinh Thanh, 2018-19*

Sl. No.	Indicators	Adat, Kerala				Dinh Thanh, Vietnam			
		Mean	Median	Max	Min	Mean	Median	Max	Min
1	Operated area under rice per household (hectares)	1.3	0.7	7.0	0.1	2.7	2.0	18.0	0.5
2	Household size (numbers)	4.6	5.0	9.0	1.0	5.0	5.0	11.0	2.0
3	Yield of rough rice (tonnes per hectare)	6.5	6.5	9.7	3.3	7.9	8.0	10.0	5.0

Source: Household Survey 2018-19.
Notes: The yields are averaged for land parcels and only Winter-Spring season was considered for Dinh Thanh.

3.2. Key Variables and Methodology

The key variables of interest are the incomes from rice production and the contribution of different agricultural policies in realising the observed incomes. We use the measures of value added and incomes for studying the returns from rice cultivation, based on the standard technique of farm budget analysis (Timmer et al., 1983). More specifically, our study adopts the costs concepts devised for the Comprehensive Scheme for Calculation of Costs of Cultivation/Production for Principal Crops in India (CCPC). We use the cost calculations based on Government of India (2008) and Foundation for Agrarian Studies (2015), and adopt Cost A2, which stands for all paid-out costs incurred by the producer, as the measure of cost of cultivation.[4] The costs of cultivation are subtracted from the output revenue or the gross value of output (GVO) to obtain the farm business income (FBI) from rice cultivation. The GVO is obtained by adding the value of main product and by product. We also define Rice Income, as a different income concept, which is FBI *plus* all income transfers received on account of rice cultivation. The contribution of support is defined as the difference between actual rice income and the rice income earned in the absence of different government support measures.

For comparing incomes and costs across countries, we have employed the purchasing power parity (PPP) method. First, the consumer price indices for Kerala (for agricultural labourers) and Vietnam were used to adjust current values (2018-19) to the price level of 2017. We then used the "Households and Nonprofit Institution Serving Households (NPISHS) Final Consumption Expenditure" deflators from the International Comparison Programme 2017 (World Bank, 2020) to convert values in domestic currency units to United States Dollars (USD). As per this method, 1 USD at 2017 prices is equal to Vietnamese Dong (VND) 8,272 and Indian Rupees (INR) 20 at 2018-19 prices. In this article, estimates of incomes and costs are reported in USD purchasing power parity 2017 levels (USD PPP 2017). [5]

To evaluate the role of different support measures on rice incomes, we disaggregate the earnings from rice cultivation across different components of revenue and costs. When the support price by the government is changed, for example, it is likely that farmers adjust their input and output quantities in paddy production. As a starting point, we show a counterfactual rice income without these changes in production. We also simulate counterfactuals without the support policy in various ways, according to agricultural household models (de Janvry et al., 1991; Singh et al., 1986). The specific simulation model is adapted from the one used in Kurosaki (2001), allowing for the missing market of management labor.

[4] The CCPC provide various other cost concepts, including Cost A2+FL, which includes the imputed value of family labour, and Cost C2, which is roughly the economic cost of cultivation (Government of India, 2008). Table A-3, Appendix A reports costs based on these concepts.

[5] The alternative is using currency exchange rates (eg. Bordey et al. 2016). The exchange rates for 1 USD in 2018-19 were INR 70 and VND 23,005. Therefore, values in USD arrived using exchange rate conversions will be lower than those arrived by the PPP method. For Dinh Thanh, the values from PPP method were 2.8 times the values arrived by exchange rate conversion, and it was 3.5 for Adat.

4. Crop Incomes and Government Support

4.1. Crop Incomes for a Single Season

We start the presentation of the quantitative results at the level of a land-parcel in one cropping season of rice. The mean GVO, value added, Cost A2, and FBI in Adat were significantly higher than the corresponding values in Dinh Thanh (Table 2). The mean paid-out cost (Cost A2) was USD 4,200 per hectare in Adat and USD 2,572 per hectare in Dinh Thanh. The mean FBI was USD 3,948 per hectare for Adat and USD 1,851 per hectare for Dinh Thanh. The mean rice income, inclusive of government transfers, was USD 4,131 per hectare in Adat while it was the same as the FBI in Dinh Thanh. A combination of price, yield, and cost factors accounts for this difference in incomes between two regions.

Table 2 *Average incomes and costs of cultivation for one season, Adat and Dinh Thanh, 2018-19* in USD PPP 2017 per hectare

Sl. No.	Measure	Adat, Kerala (n=102)		Dinh Thanh, Vietnam (n=108)		Mean difference	t-statistic
		Mean	Std. dev.	Mean	Std. dev.		
1	Gross value of output (GVO)	8,148	1,517	4,423	773	3,725	22.2 (***)
2	Intermediate consumption	1,539	502	1,723	435	-184	-2.8 (**)
3	Value added	6,609	1,480	2,700	867	3,909	23.5 (***)
Costs and Incomes							
4	Cost A2	4,200	1,592	2,572	616	1,628	9.7 (***)
5	FBI (GVO – Cost A2)	3,948	2,034	1,851	964	2,097	9.5 (***)
6	Rice income (FBI + transfers)	4,131	2,083	1,851	964	2,280	10.1 (***)
7	Rice income at GoI support (only for Adat, Kerala)	1,351	1,895	1,851	964	-500	-2.4 (**)
Yield and Price							
8	Yield (t/ha)	6.4	1.2	7.9	1.1	-1.4	-8.7 (***)
9	Price (USD/qtl)	126	9	56	4	70	69.4 (***)

Source: Survey data, 2018-19.
Note: Significance level in parenthesis for Independent samples t-test; *** = significant at 1 per cent and ** = significant at 5 per cent.

The biggest difference between the two regions comes from differences in gross value of output (GVO), determined in turn by yields and prices received by farmers. Both yield and price differences were statistically significant. As stated earlier, the yields among farmers in Adat were lower than among farmers in Dinh Thanh. The variability in yields, as measured by coefficient of variation, was lower in Dinh Thanh (15 per cent) than Adat (18 per cent). The farmers in Adat obtained more than double the price received by farmers in Dinh Thanh. The average price received by farmers in Adat was USD 126 per quintal in 2018-19, with almost all farmers receiving the government procurement price of USD 125 per quintal. In Dinh Thanh, farmers sold their produce to private traders for a price ranging from USD 48 to USD 69 per quintal (with the mean being USD 56 per quintal). There was no direct price support, like in Adat, for farmers in Dinh Thanh in 2018-19.

There were several government support measures in Adat (Table A-2, Appendix A). Most of the cultivators received some form of government support. The Government of Kerala offered the SIB, and both the Government of Kerala and the local government offered input subsidies and direct benefit transfers to farmers. If the rice income was calculated without the support measures offered by the Government of Kerala and the local government, that is keeping the support level like the other regions in India, the rice income in Adat becomes USD 1351 per hectare, 27 per cent lower than the rice income in Dinh Thanh.

There were also differences in costs between the regions. The major differences are explained by three factors. First, the peculiar nature of operations accounts for some differences such as the practice of manuring and liming, which is present in Adat but not in Dinh Thanh. Secondly, there are technological differences between the two regions. Thirdly, the use of inputs was different due to climatic and cultural factors. Finally, differences in wages and prices influenced costs of cultivation. A detailed discussion on cost components is provided in Appendix B.

4.2. Crop Incomes for Households

Turning to annual household crop incomes, the picture changes. Annual household crop income in Adat was USD 5,557, lower than in Dinh Thanh at USD 10,331 (Table 3).[6] The difference between two regions were statistically significant. At the per capita level too, mean annual crop income in Adat is significantly lower than in Dinh Thanh.

As there are three crops in Dinh Thanh, the annual crop income per hectare was USD 4,072, which was not significantly different from that of Adat (USD 4,044). This implies that while the farmers in Dinh Thanh cultivate three crops, their annual rice income per hectare is like the level

[6] See Figure A-5, Appendix A for a graphical distribution of rice incomes in both regions.

of returns from land for one season in Adat. Since the household size did not differ much between Adat (4.6 members) and Dinh Thanh (5.0 members), the difference in the size of farm is the key factor in resulting in differences in incomes per capita from rice cultivation.

Table 3 *Mean household rice income, Adat and Dinh Thanh, 2018-19* in USD PPP 2017 per hectare

Sl. No.	Measure	Adat, Kerala (n=65)		Dinh Thanh, Vietnam (n=60)		Mean difference	t-statistic
		Mean	Std. dev.	Mean	Std. dev.		
1	Rice income per hectare (single season; n=102/108)	4,131	2,083	1,851	964	2,280	10.1 (***)
2	Rice income per hectare (annual)*	4,044	1,710	4,074	2,296	-28	-0.8
3	Rice income per household (annual)	5,557	7,277	10,331	11,790	-4,774	-2.8 (***)
4	Rice income per capita (annual)	1,340	1,908	2,295	2,728	-955	-2.3 (**)

Source: Survey data, 2018-19.
Notes: 1. * Rice income per hectare (annual) in Adat is different from rice income per hectare (single season) as household crop incomes are aggregate of 120 land parcels (as opposed to 102 land parcels in rice income per hectare for one season).
2. Significance level in parenthesis for Independent samples t-test; *** = significant at 1 per cent and ** = significant at 5 per cent.

In both regions, households with 2 hectares or less (“smallholder”) had lower rice incomes per capita than households that cultivated larger holdings. While the difference in rice income per capita was not statistically significant among larger households between Adat and Dinh Thanh, it was statistically significant for smallholders between two regions (Table A-4, Appendix A). Rice income per capita for smallholders in Adat was USD 613, significantly lower than USD 1,160 in Dinh Thanh. Most of the smallholder households in Adat had marginal holdings (less than 1 hectare) with an average size of 0.6 hectares compared to 1.1 hectares in Dinh Thanh.

In terms of household incomes, we can see that households in Adat obtain a large share of their incomes from non-agricultural sources (Table 4). This is not the case in Dinh Thanh, where 57 per cent of the average household income is provided by rice cultivation. While both regions have households engaging in non-farm sectors, the nature of engagement is different with farmers in Adat being more part-time than farmers in Dinh Thanh. The number of households that did not have any other source of income than rice cultivation was 14 in Dinh Thanh. This was zero in Adat; implying all households had used different means of livelihood to augment their income than rice cultivation.

Table 4 *Mean household income and sources of incomes, Adat and Dinh Thanh, 2018-19* in USD PPP 2017

Source	Adat, Kerala			Dinh Thanh, Vietnam		
	Number of hhs#	Average income#	Share# (%)	Number of hhs#	Average income#	Share# (%)
Income from rice cultivation	65	5,557	26	60	10,331	57
Private salaries	29	5,702	26	18	1,953	11
Government salaries and pensions	20	4,586	21	10	1,129	6
Business/other self-employed activities	24	2,772	13	9	790	4
Rental income	7	437	2	10	3,184	18
Labouring out - non-agricultural	23	1,458	7	6	316	2
Income from animal resources	23	65	0	16	387	2
Labouring out - agricultural	8	244	1	1	45	0
Remittances	9	635	3	-	-	-
Others	8	92	0	-	-	-
Total	65	21,549	100	60	18,135	100

Source: Survey data, 2018-19.
Notes: Non-rice crop incomes and welfare pensions/assistances were not considered for this table.
"Number of hhs" reports the number of sample households who reported a positive value of income from the source. "Average income" is the average over all sample households (65 for Adat and 60 for Dinh Thanh). "Share" shows the composition percentage of "Average income" thus calculated.

The mean household income for Adat is USD 21,549, about 19 per cent more than the average income in Dinh Thanh (USD 18,135). The mean support (that is the support from the Government of Kerala and the local government) received by rice-cultivating households in Adat was USD 3,419. This is about 16 per cent of the household income. In other words, while agricultural support is a significant contributor to ensure profitability of farming in Adat, its contribution to household incomes is much lower.

4.3. Estimates of Support under Different Scenarios

The previous subsections highlighted the contribution of support to rice incomes in the absence of any supply response among farmers. To examine the alternate scenarios when farmers respond in their input use towards the changes in price, we run a simulation in the tradition of agricultural household models. Since output price is the major component of the support in Adat, Kerala, we calculate the support received by farmers in the effect of a supply response. To simulate this response, we take the output price without the SIB as the alternate price. For Dinh Thanh, we take a different scenario into consideration. The major form of support impacted the household rice income through cultivation of rice in three seasons. We thus calculate the household rice income in the absence of third crop (Autumn-Winter crop), which was made possible by the government intervention, and compare it with the current situation. It is possible that farmers in Dinh Thanh adjust their rice production in the other two rice seasons with the absence of the Autumn-Winter crop. However, as this is a between-season adjustment, we expect such response to be highly limited. Therefore, we ignore this possibility in the counterfactual calculation.

In the case of Adat, the rice area of the sample farmers is almost fixed, with very little possibility of area response through substitution with other competing crops in the short run. We thus calibrate a model of an agricultural household as a farm producing two outputs of rice and non-agricultural self-employment activities from two variable inputs of management labour and monetary capital (with rice area fixed), simultaneously as a consumer obtaining utility from consuming food (i.e., rice), leisure, and manufactured consumption goods (see Appendix C for details). In other words, farmers can hire labour for different operations in rice cultivation or non-agricultural activities but may use their own labour for management of both sets of activities. The division of this time between the activities change with relative prices of outputs, and create subjective equilibrium effects through the change of its shadow wage when the management labour market is completely missing (de Janvry et al., 1991; Kurosaki, 2001). From a survey of recent studies on supply response in the Indian agriculture, we calibrate the model assuming the supply elasticity of 0.15 of rice yield in response to an increase in rice price under the complete market scenario.[7] Table 5 reports the simulation results for supply responses when the rice price is reduced by 31 per cent (that is the price without the SIB) for rice in Adat.

Table 5 *Response of rice farmer to 31 per cent decrease in rice price, Adat* in per cent

Changes in production/wage/costs	Complete market	Missing management labour market
Rice output	-4.03	-3.41
Capital input	-7.13	-8.06
Management labour input	-4.34	1.86
Management labour wage	0.00	-11.78
Management labour cost	-4.34	-9.92

Note: Elasticities arrived using the literature survey of supply response in India and Kurosaki (2001).

Table 5 implies the following situations. In the complete market situation, that is if the management labour could be hired from the market, the reduction of rice price by 31 per cent

[7] Marginally changing this value does not change the results reported in this article qualitatively.

would result in the reduction of rice yield by 4.03 per cent, capital input by 7.13 per cent, and the management labour cost (and input) by 4.34 per cent. In the case of missing management labour market, the own management labour input increases. But as the (reserve) wage sees a large reduction, the management labour cost is lower than the complete market scenario. However, these differences in management labour cost are not captured in the total paid-out costs (or Cost A2), as this does not consider the imputed value of family labour. The changes in rice yield and capital affect the rice incomes received by farm households.

Table 6 *Mean gross value of output, costs, and incomes from rice cultivation, Adat, 2018-19* in USD per hectare

Sl. No.	Variable	Actual	Without State and local govt. support	Complete market	Missing manageme nt labour market
At the level of land parcels (n=102)					
1	Yield (kg/ha)	6,448	6,448	6,197	6,228
2	Price (USD/kg)	1.26	0.88	0.87	0.87
3	GVO	8,148	5,685	5,403	5,430
3	Cost A2 (paid-out costs)	4,200	4,443	3,901	3,872
4	FBI (GVO – Cost A2)	3,948	1,242	1,502	1,558
5	Direct transfer	183	109	183	183
6	Rice income (FBI + Transfer)	4,131	1,351	1,685	1,741
7	Support (difference from actual)	-	2,780	2,446	2,390
8	Share of support (% of actual)	-	67	59	58
At the household level (n=65)					
9	Household rice income	5,557	2,138	2,667	2,755
10	Support (difference from actual)	-	3,419	2,890	2,802
11	Share of support (% of actual)	-	62	52	50

Note: The numbers in "2 Price (USD/kg)" for three alternative scenarios are almost 31% lower than the actual case, but not exactly the same across the three scenarios. The major difference is in the column "Without State and local government support." For this column, we simulated the change in the rice procurement price, which is reduced by 31%, assuming no change in price and quantities of rice marketed in other outlets, and then calculated ex post the effective price of rice, which is reported in the table.

The mean gross value of output, costs, and incomes calculated according to the two counterfactuals are given in Table 6. In Table 6, the column "Without State and local government support" shows the scenario without supply response — that is the values obtained by only removing the support from the Government of Kerala (State) and local government. The two counterfactuals, complete market and missing management labour market scenarios, represent supply response to only a reduction in output price, that is all other support in terms of income transfers and input subsides remain as usual. The two counterfactual scenarios give slightly lower measures of support — 59 and 58 per cent of mean actual rice incomes. These correspond to a share of 52 and 50 per cent of support in mean household rice incomes. The share of these counterfactual support measures is about 13 per cent of household income (fall from the earlier 16 per cent).

The cultivation of Autumn-Winter season is a recent phenomenon in Dinh Thanh, enabled by construction of dykes in the 2000s. To examine the alternative without this additional season, we calculate the household income without the crop incomes from the Autumn-Winter season for Dinh Thanh. All four scenarios (three counterfactuals for Adat and one for Dinh Thanh) are presented in Table 7 along with the actual incomes.

Table 7 *Mean rice income by different scenarios, Adat and Dinh Thanh, 2018-19* in USD per hectare

Sl. No.	Measure	Adat, Kerala (n=65)				Dinh Thanh, Vietnam (n=60)	
		Actual	C 1	C 2	C 3	Actual	C 4
1	Rice income per hectare (single season; n = 102/108)	4,131	1,351	1,685	1,741	1,851	1,851
2	Rice income per hectare (annual*)	4,044	1,323	1,650	1,704	4,074	2,972
3	Rice income per household (annual)	5,557	2,138	2,667	2,755	10,331	7,537
4	Rice income per capita (annual)	1,340	516	643	664	2,295	1,674

Notes: 1. C 1 = Counterfactual 1, i.e. without State and local government support and without supply response; C 2 = supply response with complete market scenario; C 3 = supply response with missing management labour market; and C 4 = without Autumn-Winter crop income in Dinh Thanh and without supply response in the other two crop seasons.
2. Winter-Spring season is taken in Dinh Thanh for comparison of rice incomes for Rice income per hectare (single season).

The comparison of different counterfactuals provides two interesting insights. First, even if we account for supply response in Adat, the resultant rice incomes are only marginally higher than the alternate scenario without supply response (C 1). These are much lower than the actual rice income in Adat. These are also lower than the average rice income in Winter-Spring season in Dinh Thanh. Secondly, even when there is no Autumn-Winter season, the larger operated area in Dinh Thanh ensures that the mean household rice income in Dinh Thanh is higher than Adat.

The counterfactual scenarios show that the farmers in Adat would face a very sharp reduction in rice incomes if the price support provided by the Government of Kerala (the SIB) is removed.

This simulation analysis must be seen as responses in the short-term. Given that the reduction in price is large (31 per cent) and it leads to a very big reduction in incomes even with supply response, it is possible that farmers are discouraged from rice farming in the long term.

5. Price and Non-Price Factors

As shown in the previous section, the difference in crop incomes between Adat and Dinh Thanh reflects their contrasting experiences, and in particular differences in policy approaches followed by the governments in Vietnam and Kerala, India. To deeply understand the contrast found in the quantitative analysis, we further explore the contrast in policy interventions in this section in a qualitative way. More concretely, we briefly discuss the nature of price support in both countries and the factors that enable the cultivation of Autumn-Winter crop in Vietnam. How have price and non-price factors influenced rice cultivation in Adat and Dinh Thanh?

5.1. Price Support and Procurement

The implementation of a public price support and procurement policy was very critical in Adat. In Adat, rice was procured at a pre-announced procurement price — the MSP declared by the Government of India with an additional price (SIB) provided by the Government of Kerala. The SIB equaled 31 per cent of the procurement price in Kerala in 2018-19. All but a few farmers sold their produce to government procurement agencies in Adat in 2018-19.

The Government of India formally instituted a system of foodgrain procurement and public distribution system in the mid-1960s to ensure remunerative prices for farmers and food security for the nation (Venkateswarlu, 2021). Rice has been covered under this price policy from the beginning and currently the government procurement of rice happens at MSP across India, with bonuses paid by a few States. After 1991, the costs of production have risen due to various factors, such as low yield growth (Dev and Rao, 2010) and increased input prices (Raghavan, 2008; Srivastava et al., 2017), which have led to increase in MSP in response to farmers' demands.

In the Mekong Delta Region of Vietnam, 30 per cent of the rice produced enters into the domestic value chain and 70 per cent to export value chain (Anh et al., 2020). Farmers sold rough rice to traders and aggregators in Dinh Thanh. The traders usually market rough rice to local millers or to exporters through intermediaries. While there is no direct procurement by state from rice producers, the government in Vietnam has exerted considerable influence on rice value chain through export controls (quotas or targets) and "directed paddy price" policy (Cramb, 2020).

The Vietnam Food Association (VFA), consisting of mostly state-owned millers and polishers, functions as the agency for coordinating exports in the Mekong Delta Region.[8] This near total control over exports by state-owned enterprises allows the state to boost prices for the local producers during low-price events and reduce prices in domestic markets for consumers when prices are high (Hai and Talbot, 2013). The government has invested in enhancing storage space and funded the purchase of rice by SOEs from the traders in the past to regulate the farm-gate prices of rice (Cramb, 2020).

The Vietnamese government has also taken steps through a resolution to ensure at least 30 per cent profit over production costs to farmers from 2010 (Cramb, 2020). Although a floor price (directed paddy price) is announced by Ministry of Finance in consultation with Ministry of Agriculture and Rural Development (MARD) and provincial governments, who provide estimates of production costs, this policy has had minimal effect in the Mekong Delta Region.

As is clear from the discussion above, the alternative level of rice prices used in the simulation in the previous section was not the international rice price evaluated within each country. In both Adat and Dinh Thanh, trade distortions existed for the rice price. In this sense, we did not wholly quantify the implicit income transfer through the wedge between domestic and international prices of rice. Full analysis of this is left for further research.

5.2. Irrigation

In Vietnam, the intensification of rice cultivation and consequent increase in household crop incomes was made possible by public investments in irrigation infrastructure. The policy of improving rice incomes in the Mekong Delta Region of Vietnam through expansion of irrigation and drainage systems from the mid-1990s have enabled farmers to raise a third crop in flooded Autumn-Winter season (Kien et al., 2020; Le Coq and Trebuil, 2005). The construction of dykes was undertaken primarily to prevent the flooding of the Mekong River Delta and to improve the

[8] Of the various state-owned enterprises (SOEs), Vinafood 2 is the most prominent exporter. The other prominent members of VFA are either subsidiaries of Vinafood 2 or provincial exporters. More than half of the exports from the Region are government-to-government contracts, which is currently a monopoly of Vinafood 2 (Cramb, 2020).

livelihood security of farmers (Government of Vietnam, 1996). This was followed by reclaiming land for cultivation and intensification of rice production (OECD, 2015).

The major public investment in Dinh Thanh has been the construction of dykes to protect fields from floodwaters. The construction of the dyke surrounding the study area was completed in 2007. This enabled sample farmers in Dinh Thanh to transition from a previous two-crop-based to three-crop-based rice production system. All sample households had a cropping intensity of three. The control of flood waters and irrigation is difficult in the Autumn-Winter season as compared to the Winter-Spring and Summer-Autumn seasons. Yields are also lower in the Autumn-Winter season. But price of rough rice realised by farmers has been the highest in this season, due to low supply. Overall, cultivation of rice in the Autumn-Winter season has been profitable (at the level of paid-out costs) in Dinh Thanh and has provided farmers an additional source of income after the mid-2000s.

The *kole* wetland region has seen public investments from the 1950s to improve irrigation systems. These included projects initiated in the late 1970s for constructing permanent outer bunds for *padasekharam*s (equivalent to a dyke) and construction of a dam to irrigate the crop in months preceding the monsoon (Kannan, 1979). These projects were introduced with the objective of raising a second crop in the *kole* wetland region. Adat had permanent outer bunds at the time of the survey but ongoing attempts to increase the cropping intensity have not yet materialized.[9]

5.3. Agricultural Research and Extension

The availability of suitable short-duration rice varieties was an important factor that aided intensification of rice cultivation in Dinh Thanh. On average, a farmer grows rice for 283 days per year in Dinh Thanh. The average crop duration for a single crop is 94 days. However, the average number of days for which rice is grown in Adat is 134 days (Table A-5, Appendix A). The *kole* wetland region permits a crop calendar of 200–215 days, the time between October and May every year, when draining the low-lying wetland region becomes possible. But this duration does not allow for more than a single crop of the currently available varieties.

[9] A specific scheme for the *kole* wetland region, "Kole Double" project, initiated by the Department of Agriculture, Government of Kerala, to raise a second crop in at least 10,000 hectares of the *kole* wetland region began in 2018 for a period of three years (Government of Kerala, 2018). This plan specifically involved modernization of irrigation equipment and extension support. The intended outcome of this project was to raise a second crop with a yield of 3.5 tonnes per hectare.

Between 1980 and 2009, a total of 226 rice varieties were released in Vietnam, averaging around 8 varieties per year. The rice varietal improvement programme was highly influenced by the International Rice Research Institution (IRRI) and of the total number of rice varieties released in this period, 177 had links to IRRI (Brennan and Malabayabas, 2011). The increased yield level associated with new varieties contributed to increased rice production and incomes in Vietnam (Ut and Kajisa, 2006).

In Kerala, between 1974 and 2018, 64 rice varieties were released by the Kerala Agricultural University (KAU) system, averaging around 1.4 varieties per year (Kerala Agricultural University, 2019). Among the two varieties cultivated in Adat, the variety Jyothi was released in 1974 and the variety Uma in 1998. A new variety, named Manuratna with a crop duration of 95-99 days and average yield of 6.5-7 tonnes per hectare, has been released by KAU in 2018 for the *kole* wetland region (The Hindu, 2019). This variety was tested by a few *padasekharam*s in Thrissur district at the time of the survey; but it was not adopted in the survey area.

The relatively slow development of new varieties and slow adoption have been largely a feature of agricultural research and development after 1991 in India. The national government has initiated a gradual withdrawal from agriculture, including research and extension services after liberalization and globalization reforms began in 1991 (Bhalla, 2006; Ramachandran and Rawal, 2010). Public investments in agriculture slowed down during this period and this had adverse impacts on capital formation and technological growth (Bisaliah et al., 2013; Chand et al., 2012; Srivastava et al., 2017).

From 2000 to 2017, the total spending on agricultural research stagnated at 0.3 per cent of agricultural gross domestic product in India, with the number of full-time-equivalent researchers in agriculture falling from 4.7 to 4.0 per 100,000 farmers (International Food Policy Research Institute, 2021). Agricultural research and education have remained underfunded at the level of State governments, having obtained only 2 per cent of total expenditure for the rural economy (Jha and Acharya, 2011). Kerala's situation has been only slightly better: the share of agricultural research and education in expenditure on rural economy was 3.3 per cent in the 1990s and 3.6 per cent in the 2000s.

While the budgetary provision for agricultural research has remained stagnant (at 0.2 per cent of agricultural GDP) in the 2000s, Vietnam has increased the number of full-time-equivalent researchers in agriculture from 7.8 per 100,000 farmers in 2000 to 13.6 per 100,000 farmers in 2017 (International Food Policy Research Institute, 2021). Through international collaborations with countries with an established national agricultural research system including India, Vietnam has been able to add more scientists to agriculture (Janaiah and Mohanty, 2018).

The situation is similar with respect to extension services in India. In addition to inadequate funding, public extension services are only used by a small section of the population at the national level and have remained inaccessible to smallholders and other vulnerable populations (Krishna et al., 2019; Sajesh and Suresh, 2016). While Kerala has a been a better performer than other States, there remains several inadequacies.

The Government of Vietnam established a national agricultural extension system in Vietnam in the early 1990s and it has been increasing the number of extension professionals over years (Bo, 2012; Poussard, 1999). A study estimated that nearly half of the households accessed extension services between 2010 and 2016 (Thiep and Nhung, 2018). During our field visit, the extension worker of Dinh Thanh commune said that around nine classes were organized in 2018-19 to answer queries by farmers. Around 40 per cent households had participated in training programmes, mainly regarding the use of fertilizers and pesticides, in the previous year. Most of the advice sought from other extension sources were also about plant protection chemicals and pests on rice.[10]

In comparison, a fewer number of farmers (28 per cent of households) attended training programmes in Adat in 2018-19. Farmers approached the Agricultural Office in Adat village panchayat for advice on other crops such as vegetables and tree crops but only rarely for rice cultivation. The role of extension workers and the agricultural university system were less prominent in Adat than what we found in the Mekong Delta region of Vietnam.

6. Conclusion

The comparative study of rice cultivation in two best-performing villages in different Asian regions (Adat village panchayat in the *kole* wetland region, Kerala, India and Dinh Thanh commune, Mekong Delta, Vietnam) involved an examination of rice incomes and various factors

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[10] Vietnam in partnership with IRRI organized training sessions on "1 Must Do, 5 Reductions" (1M5R) technique that focuses on use of certified seeds ("must do") and reduced seed rate, fertilizers, pesticides, water, and post-harvest losses from 2017 to 2020 (International Rice Research Institute, 2020). Some sample households reported that they have attended training programmes on 1M5R technique.

contributing to the observed income levels. The mean rice income was estimated to be USD 4,131 (2017 PPP) per hectare in Adat for a single season. For a comparable single season (the Winter-Spring) in Dinh Thanh it was USD 1,851 per hectare. However, given the three seasons of cultivation and higher operated area, households in Dinh Thanh (USD 10,331) had higher average rice income than households in Adat (USD 5,557). The higher rice income per hectare in Kerala was mainly the result of State and local government support for rice cultivation. The State Incentive Bonus (SIB), which improved the output price for farmers, was the major component of support in Kerala. The counterfactual analysis, by considering supply responses in the absence of additional support for output price, showed that the public support was crucial in maintaining the observed levels of income from rice cultivation in Adat, Kerala. The article thus demonstrated the usefulness of budget analysis of rice farming, combined with counterfactual simulations based on agricultural household models.

The qualitative analysis brought out the relative role of price and non-price factors in agricultural development in both regions, thereby providing important implications to rice policies in tropical Asia. The policy of providing additional price support in Kerala, India, has been the main instrument for enhancing incomes from rice cultivation in the *kole* wetland region of Kerala. While the *kole* wetland region saw investments in irrigation, there was no increase in cropping intensity. There has been an inadequate emphasis on research and extension services in agriculture in India, which has hampered the technological progress and modernisation of farming practices. But given the enormous importance of price support, abandoning it would lead to a sharp reduction in farm incomes in short term, especially in the frontier rice-production areas like the *kole* wetland region.

In comparison, public investment in dyke infrastructure has enabled intensification of rice production in Dinh Thanh. Availability of suitable short-duration rice varieties developed in Vietnam and other parts of Asia was a crucial factor that helped multiple cropping. Price measures were not used much in the Mekong Delta region of Vietnam, as shown by the absence of a direct procurement system, although the government has intervened in terms of export controls. The advancement in research and the emphasis given to extension services in the Mekong Delta is a model that needs to be considered for India, especially in the context of increasing the contribution of non-price factors in agricultural development.

Although the support provided by each government to rice farmers is important for profitability of rice cultivation in Kerala and Mekong Delta, the contribution of rice income to the household income is not very high and has been declining over time due to the increase of non-agricultural activities. This is especially so in Adat, Kerala. Assessing the rice policies in the whole context of rural livelihood with the rising importance of non-agricultural income is left for further research.

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Appendix A

Additional Figures and Tables

Figure A-1 *Map of Adat village and the* Kole *Wetland Region*

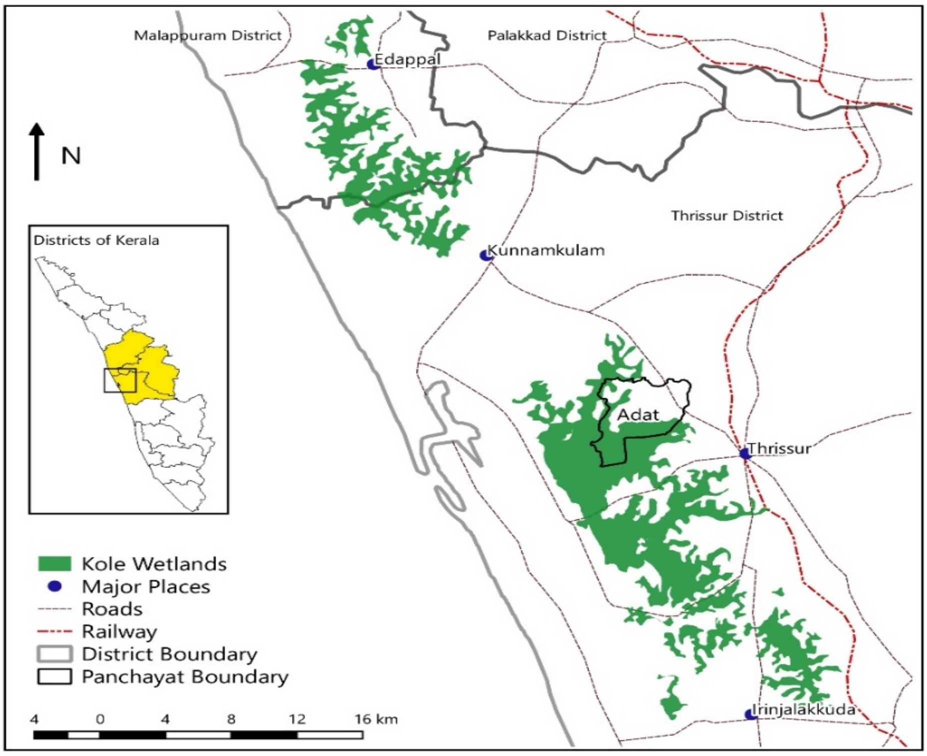


Figure A-2 *Map of Dinh Thanh commune and An Giang*

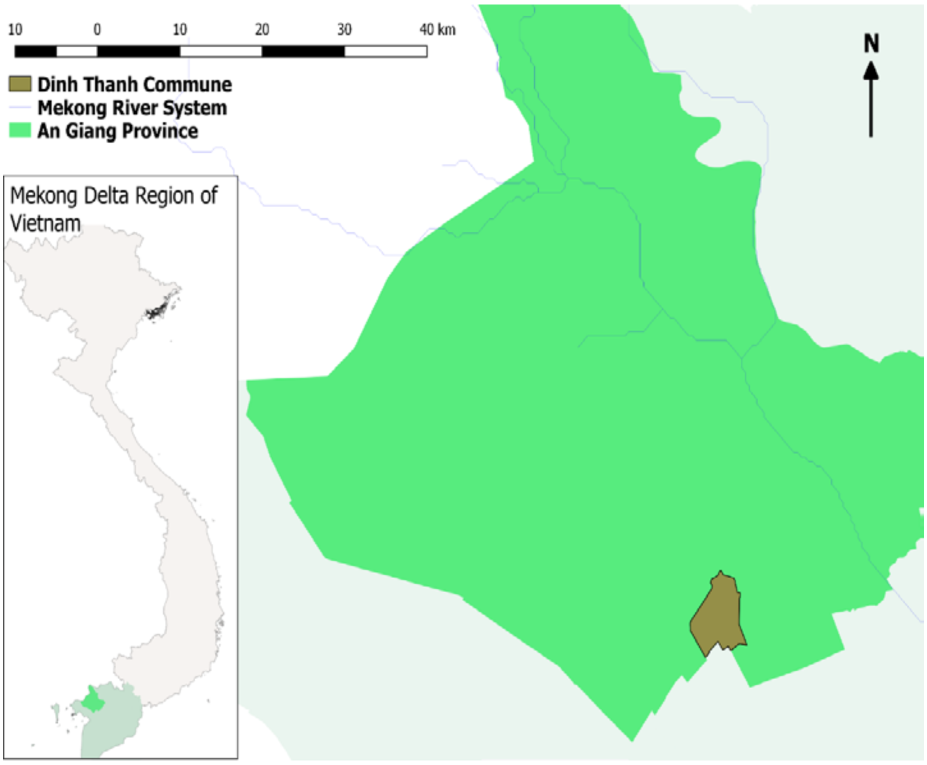
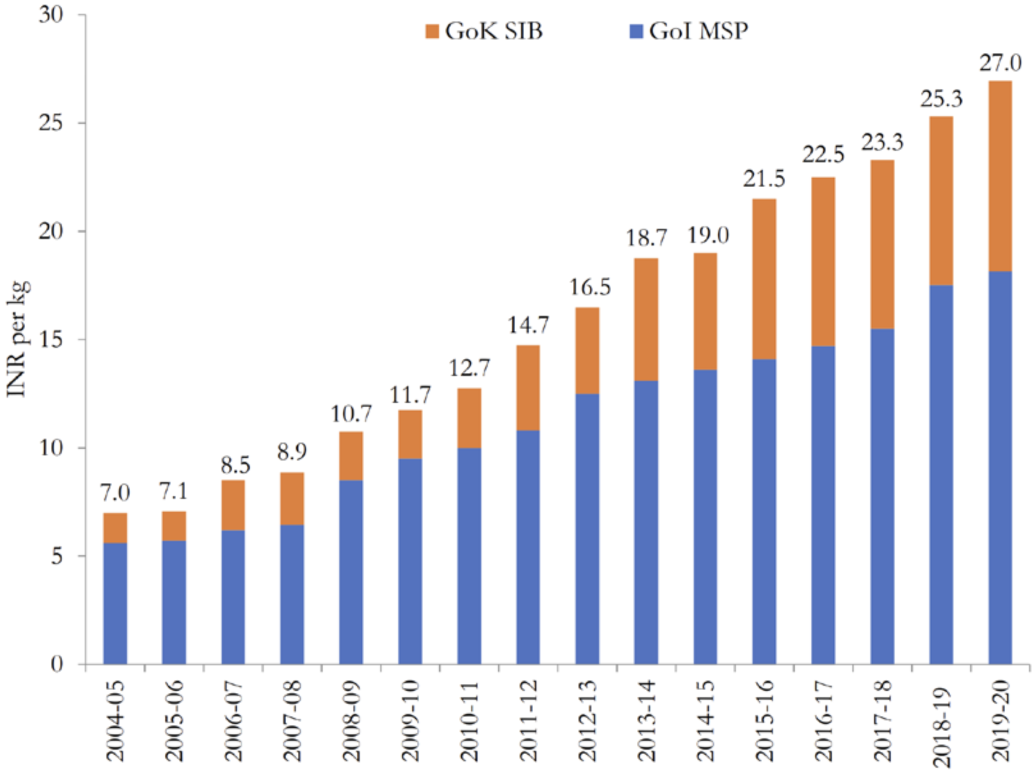
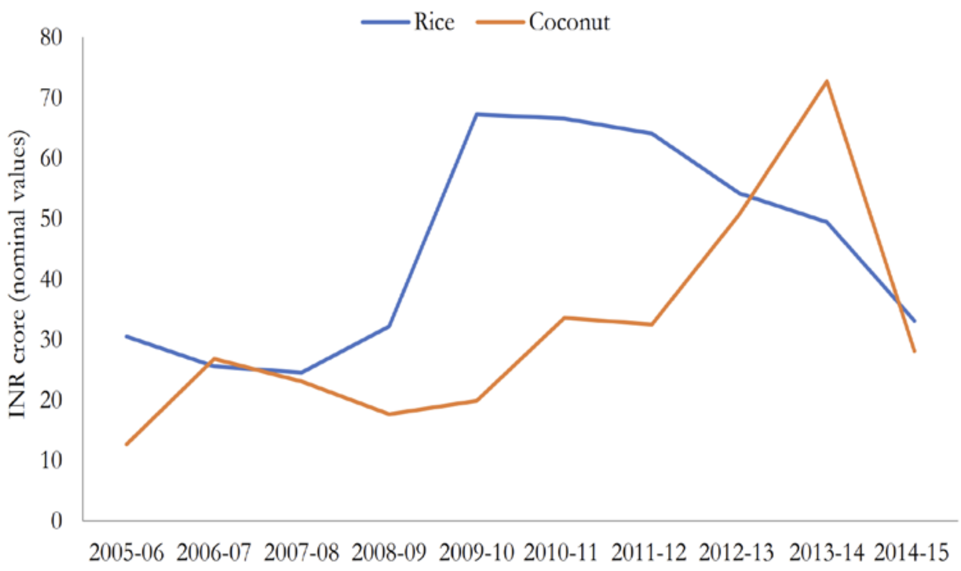


Figure A-3 *Procurement price for rough rice, 2004-05 to 2019-20* in INR per kg



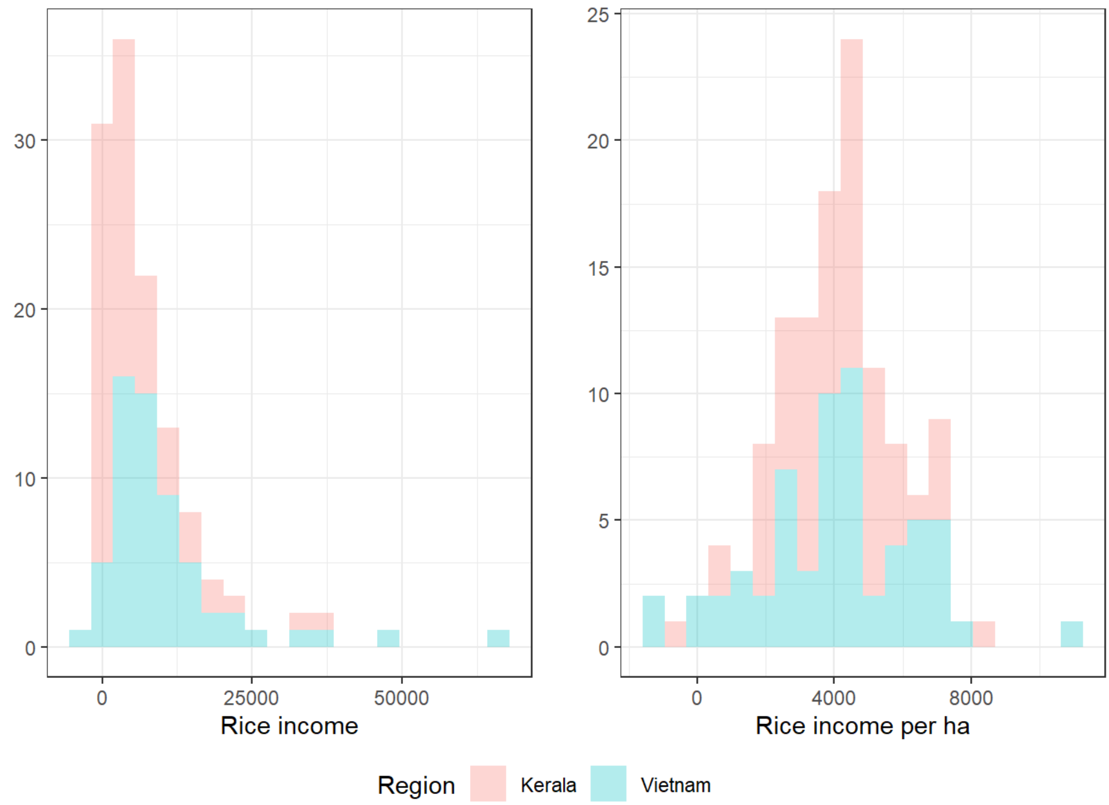
Source: Received in personal communication from SUPPLYCO.
Note: GoI MSP = Government of India Minimum Support Price; GoK SIB = Government of Kerala State Incentive Bonus.

Figure A-4 *Plan fund utilisation by crops, 2005-06 to 2014-15* in INR crore



Source: Calculations from GoK (2016).
Notes: 1. The expenditure on schemes concerning multiple crops is not considered for this graph.
2. Plan fund implies the expenditure set aside by the government for specific planning purpose. It includes funds allocated for the State development plan, funds devolved from the Central Government to the States (as per the Centrally Sponsored Schemes and Central Sector Schemes).

Figure A-5 *Distribution of rice incomes at the level of households and land parcels (per ha), Adat and Dinh Thanh, 2018-19* in USD PPP 2017



Source: Survey data, 2018-19.

Table A-1 *Some selected indicators of climate, agriculture, and population of Kerala and the Mekong Delta region of Vietnam*

Sl. no.	Indicators	Kerala	Mekong Delta
1	Total geographical area (sq. km.)	38,863	40,816
2	Geographical location (latitudes)	8° 17' N and 12° 47' N	8° 30' N and 11° 00' N
3	Mean temperature	27 °C	27.8 °C
4	Average rainfall (mm)	2924	2182
5	Population (thousand persons)	33,406	17,282
6	Population density (persons/sq. km.)	860	426
7	Net sown area (thousand hectares)	2040	2616
8	Gross cropped area of rice (thousand hectares)	194	4146
9	Total irrigated area in rice (share of gross cropped area)	76	91
10	Average size of operational holdings per household (hectares)	0.18	1.4

Sources: GSO (2019), Kien *et al.* (2020), GoI (2020).

Notes: 1. Average rainfall is the normal rainfall received in Kerala (long-term average) and mean temperature for Kerala is the normal temperature recorded in Thiruvananthapuram district in 2011. The mean rainfall and temperature for the Mekong Delta region is the average recorded in Ca Mau weather station for 2011-18.

3. Statistics for irrigated area is for 2016-17 in Kerala (GoI 2020) and for the Mekong Delta is from 2002 as cited in Kien *et al.* (2020). Even at present, more than 90 per cent of crop area is irrigated in the Mekong Delta region.

4. Population for Kerala is according to 2011 census. For the Mekong Delta region, it is the population estimate is for 2018.

5. The average size of operational holdings for Kerala is from the Agricultural Census of India, 2015-16 and for the Mekong Delta is from Rural, Agricultural, and Fishery Census 2016.

Table A-2 *Items of government support for rice cultivation and coverage among land parcels operated under* padasekharam*s within Adat village panchayat by level of government, 2018-19*

Sl. No.	Item of support	Amount, unit, and conditions	Number of households	Area (ha)
Government of India (GoI or Central Government support)				
1	Minimum Support Price (MSP)	INR 17.5 per kg	64	63
2	Cash transfer under *Rashtriya Krishi Vikas Yojana* (*RKVY*)	INR 3000 per hectare	64	53
3	Cash transfer under *Paramparagat Krishi Vikas Yojana* (*PKVY*)	INR 1000 per farmer (only for households engaged in organic farming)	6	6
Government of Kerala (GoK or State Government support)				
4	State Incentive Bonus (SIB)	INR 7.8 per kg	64	63
5	Subsidy for lime ($CaCO_3$)	INR 9 per kg (up to 600 kg lime per hectare for a land parcel)	60	62
6	Production incentive for rice farmers	INR 1000 per hectare	64	53
7	Production incentive for rice farmers under Sustainable Development of Rice Programme	INR 1000 per hectare	64	53
Adat village panchayat (AVP or local government support)				
8	Subsidy for seed	INR 31 per kg (up to 32 kg seeds per acre for a land parcel)	63	64
9	Incentive for organic farming	INR 6000 per farmer	6	6
All households			65	70

Source: Information on public support obtained from Agriculture Office, Adat and Survey Data 2018-19.
Notes: 1. The total number of land parcels considered here are 108 (out of 120 land parcels).
2. *Rashtriya Krishi Vikas Yojana* (*RKVY*), a centrally sponsored development scheme (CSS), is considered as part of the support offered by Government of India.

Table A-3 *Components of costs of cultivation, Adat and Dinh Thanh, 2018-19* in USD (PPP 2017) per hectare

Sl. No.	Component	Adat, Kerala (n=102)		Dinh Thanh, Vietnam (n=108)		Mean difference	t-statistic
		Mean	Std. dev.	Mean	Std. dev.		
(1)	(2)	(3)	(4)	(5)	(6)	(7 = 3 - 5)	(8)
Paid-out costs							
1	Hired human labour	1081	798	232	227	848	10.3 (***)
2	Plant protection chemicals	367	212	786	346	-419	-10.6 (***)
3	Machine labour	743	308	417	103	326	10.2 (***)
4	Rent paid for leased-in land	414	959	99	349	315	3.1 (***)
5	Fertilizer	673	379	552	170	121	3.0 (***)
6	Manure (including lime ($CaCO_3$))	116	193	0	0	116	6.1 (***)
7	Seed	119	67	206	84	-87	-8.3 (***)
8	Marketing	123	25	53	80	70	8.7 (***)
9	Irrigation	134	88	121	42	13	1.4
10	Others	323	174	10	17	313	18.0 (***)
11	Interest on working capital	96	40	42	12	54	13.0 (***)
12	Depreciation and maintenance	11	18	54	109	-43	-4.0 (***)
13	Cost A2 (sum of sl. no.s 1 to 12)	4200	1592	2572	616	1628	9.7 (***)
Paid-out costs and imputed value of family labour							
14	Family labour	531	752	254	226	277	3.6 (***)
15	Cost A2+FL (sl. no. 13+14)	4731	1894	2826	646	1905	9.6 (***)
Economic costs							
16	Interest on owned fixed assets	6	8	61	146	-55	-3.9 (***)
17	Rental value of owned land	2434	1132	1147	364	1286	11.0 (***)
18	Cost C2 (sl. no. 15+16+17)	7170	1665	4034	607	3136	17.9 (***)

Source: Survey data, 2018-19.

Notes: 1. Averages for Dinh Thanh commune are for the Winter-Spring season.

2. Significance level in parenthesis for Independent samples t-test; *** = significant at 1 per cent and ** = significant at 5 per cent.

Table A-4 *Rice income per capita and per hectare for small holders and others, Adat and Dinh Thanh, 2018-19*

Sl. No.	Measure	Adat, Kerala		Dinh Thanh, Vietnam		Mean difference	t-statistic
		Mean	Std. dev.	Mean	Std. dev.		
(1)	(2)	(3)	(4)	(5)	(6)	(7 = 3 - 5)	(8)
Smallholders (less than 2 hectare) (Adat n= 49; Dinh Thanh n =28)							
1	Rice income per capita	613	561	1160	925	-547	-2.8 (***)
2	Rice income per hectare	3914	1750	4645	2449	-731	-1.5
Others (2 hectares or more) (Adat n= 16; Dinh Thanh n =32)							
3	Rice income per capita	3568	2740	3289	3352	279	0.3
4	Rice income per hectare	4450	1567	3574	2063	876	1.5

Source: Survey data, 2018-19.
Note: Significance level in parenthesis for Independent samples t-test; *** = significant at 1 per cent and ** = significant at 5 per cent.

Table A-5 *Average crop duration (days), share in total planted area (per cent), and yield (t/ha) by varieties, Adat and Dinh Thanh, 2018-19*

Sl. No.	Region and variety	Average crop duration (days)	Share in total area (%)	Yield (t/ha)
1	*Adat, Kerala (all varieties)*	134	100	6.4
2	Jyothi	135	41	6.3
3	Uma	133	59	6.5
4	*Dinh Thanh, Vietnam (all varieties)*	97	100	7.9
5	IR 50404	97	77	7.9
6	OM 5451	98	17	7.8
7	Nang Hoa 9	90	6	7.1

Source: Survey data, 2018-19.
Note: Average crop duration in days is calculated by multiplying average crop duration in months with 30.

Appendix B

Costs for a Single Season

Costs of cultivation differ in the two regions (Table A-3, Appendix A). The results of statistical tests of the difference in means show that all cost components other than irrigation were significantly different between Adat and Dinh Thanh. Irrigation was from largely publicly funded canal irrigation in both regions. For most inputs, the average cost per hectare was higher in Adat than Dinh Thanh. The exceptions were plant protection chemicals, seed, depreciation and maintenance, and interest value of fixed assets. The structure of costs also differed between the two regions, especially at the level of paid-out costs. While expenditure on hired human labour, machine labour, and rent paid for leased-in land were the top three components of Cost A2 in Adat, expenditure on plant protection chemicals, fertilizers, and machine labour were the most important components of Cost A2 in Dinh Thanh.

Human Labour

At the level of paid-out costs, the largest difference between Adat and Dinh Thanh was accounted in respect of costs of hired human labour. The total labour use was higher in Adat at 46 days per hectare as compared to 25 days in Dinh Thanh (Table B-1). Of the total labour, hired human labour use was 31 days per hectare in Adat and 11 days per hectare in Dinh Thanh.

Table B-1 *Operation-wise mean labour use days (8-hour) per hectare, Adat and Dinh Thanh, 2018-19*

Sl. No.	Operations	Adat, Kerala			Dinh Thanh, Vietnam		
		Hired	Family	All	Hired	Family	All
1	Land preparation	-	-	-	0.0	0.7	0.7
2	Making field bunds	6.2	0.6	6.8	-	-	-
3	Sowing	1.2	0.6	1.8	0.8	0.9	1.7
4	Transplanting	1.9	0.0	1.9	-	-	-
5	Retransplanting	0.4	0.2	0.5	3.1	2.1	5.2
6	Applying fertilizers or manure	4.1	2.5	6.6	2.1	1.1	3.2
7	Applying lime	1.1	0.6	1.7	-	-	-
8	Spraying plant protection chemicals	3.1	1.3	4.4	4.8	1.0	5.8
9	Weeding	12.5	3.4	15.8	0.4	0.6	1.0
10	Irrigation	0.5	5.8	6.3	0.0	7.0	7.0
11	Harvesting	-	-	-	0.0	0.1	0.1
12	Total labour days	30.9	14.9	45.8	11.2	13.4	24.7

Source: Survey data, 2018-19.

Notes: 1. Land preparation and harvesting were undertaken by a few households using their own machines in Dinh Thanh, Vietnam.

2. Making field bunds in Adat was usually combined with sowing.

3. Averages for Dinh Thanh commune are for the Winter-Spring season.

Secondly, the modal wage rate for male labour varied between USD 15 and 27 per (8-hour) day and for female labour varied between USD 15 and 21 in Dinh Thanh (Table B-2). The average wage rate in Adat was higher, between USD 35 and 49 per day for men and USD 25 and 30 per day for women. Wage rates in Kerala are approximated twice those in Vietnam. Kerala also has the highest rural wage rates for male and female casual workers (including agricultural workers) across India (Jose, 2013).

Table B-2 *Operation-wise modal daily (8-hour) wage, Adat and Dinh Thanh, 2018-19* in USD PPP 2017

Sl. No.	Operations	Adat, Kerala		Dinh Thanh, Vietnam	
		Male	Female	Male	Female
(1)	(2)	(3)	(4)	(5)	(6)
1	Making field bunds	40	25	-	-
2	Sowing	39	28	27	21
3	Transplanting	35	25	-	-
4	Retransplanting	49	26	15	15
5	Applying fertilizers or manure	49	30	22	18
6	Applying lime	39	28	-	-
7	Spraying plant protection chemicals	49	30	22	18
8	Weeding	35	25	24	19
9	Irrigation	35	25	15	15

Source: Survey data, 2018-19.

Note: 1. Making field bunds in Adat was usually combined with sowing.

2. Averages for Dinh Thanh commune are for the Winter-Spring season.

In terms of labour operations, manual weeding, even though practiced in Adat and Dinh Thanh, used more labour per hectare in Adat than in Dinh Thanh. While some farmers used weedicides, most farmers in Adat relied on hired labour for weeding (12.5 days per hectare). Increase in prevalence of weeds was reported by cultivators in the aftermath of Kerala Floods of 2018 in Adat. In comparison, the extent of weeding in Dinh Thanh was minimal. The operation of making field bunds (which was usually combined with sowing) had 6.8 days per hectare in Adat, which was absent in Dinh Thanh. Making field bunds are important in Adat as fields are submerged during the rains.

The three common operations of rice cultivation are broadcast sowing, application of fertilizers (including manures in the case of Adat), and spraying plant protection chemicals. The total labour use per hectare for these operations are as follows: 1.8 days in Adat (excluding making field bunds) and 1.7 days in Dinh Thanh for broadcast sowing, 6.6 days in Adat and 3.2 days in Dinh Thanh for applying fertilizers, and 4.4 days in Adat and 5.8 days in Dinh Thanh for spraying plant protection chemicals. These operations together account for 27 per cent of total hired labour days in Adat and 69 per cent of total hired labour days in Dinh Thanh.

There were differences in average time taken for application of inputs (measured as kg/day; obtained on dividing mean usage by mean labour use). The amount of seed sown was 65 kg per day in Adat and 119 kg per day in Dinh Thanh. For fertilizer, it was 108 kg per day in Adat and 145 kg per day in Dinh Thanh. While the quantity of plant protection chemicals is not available, the number of sprays in Dinh Thanh (5-6 times) was higher than in Adat (3-4 times).

The lower labour absorption in Dinh Thanh is partly a consequence of technological innovation. Field workers for broadcast sowing, applying fertilizers, and spraying plant protection chemicals in Dinh Thanh use a multi-purpose sprayer fueled by petrol. The sprayer, which weighs about 20 kg, is carried by workers on their shoulders. In case of broadcast sowing, 20 – 25 kg of seeds is loaded into the drum of the sprayer. Interviews with experienced farmers in Dinh Thanh said that one litre of petrol can sustain the sprayer for 2 hours and up to one hectare of sowing seeds could be undertaken by some farmers in an hour (although in practice, the time taken differed from this best estimate and farmers were sowing manually in some cases). As opposed to this, broadcast sowing and application of fertilizers or manures were performed by manual labour and mechanical sprayers were largely used for spraying plant protection chemicals in Adat.

Other Inputs

The rental value of owned land was the largest contributor to economic costs in both regions. The number of leased-in land parcels in Adat was 18 (out of 102 land parcels), and the average rental cost was USD 2955 per hectare. In Dinh Thanh, only 9 plots (out of 108 land parcels) were leased-in land parcels and the average rental cost was USD 1258 per hectare for the comparable Winter-Spring season. Less leasing in of land and lower rental costs reduced this cost item in Dinh Thanh relative to Adat.

Another difference between the two regions was in the use of manures and application of lime ($CaCO_3$) that were present in Adat and absent in Dinh Thanh. Application of lime has been recommended by the Department of Agriculture, Kerala to regulate the pH value of acidic soils in the *kole* wetland region. It was applied on 96 per cent of the area operated in Adat, with the average application of 296 kilogram per hectare. Both home-produced and purchased manure was applied on 54 per cent of the total operated area in Adat.

Sample farmers in Dinh Thanh incurred a higher cost for plant protection than farmers in Adat. The average was USD 786 per hectare in Dinh Thanh, twice the amount in Adat. High application is a feature of the Mekong Delta Region of Vietnam due to various agro-ecological and cultural reasons. The seed rate was also higher in Dinh Thanh than in Adat, with the rates being 203 kg per hectare and 117 kg per hectare respectively (Table B-3). As opposed to this, the use of fertilizer was considerably higher in Adat than Dinh Thanh, probably on account of the different type of fertilizers used. The average fertilizer use was 713 kg per hectare in Adat compared to 463 kg per hectare in Dinh Thanh.

Table B-3 *Per hectare use of selected inputs in rice cultivation, Adat and Dinh Thanh, 2018-19*

Sl. No.	Measure	Adat, Kerala (n=102)		Dinh Thanh, Vietnam (n=108)		Mean difference	t-statistic
		Mean	Std. dev.	Mean	Std. dev.		
(1)	(2)	(3)	(4)	(5)	(6)	(7 = 3 - 5)	(8)
1	Fertilizer (kg/ha)	713	363	463	130	250	6.6 (***)
2	Seed rate (kg/ha)	117	32	203	46	-86	-15.8 (***)
3	Harvest machine labour (hrs/ha)	6	3	3	2	3	9.1 (***)
4	Land preparation machine labour (hrs/ha)	12	11	3	2	9	8.4 (***)

Source: Survey data, 2018-19.

Notes: 1. Averages for Dinh Thanh commune are for the Winter-Spring season.

2. Significance level in parenthesis for Independent samples t-test; *** = significant at 1 per cent and ** = significant at 5 per cent.

The hours of machine labour use were significantly higher in Adat than in Dinh Thanh (Table B-3). Land preparation and harvesting were fully mechanized operations performed with tractors or power tillers and combine harvesters in both Adat and Dinh Thanh. More time for land preparation is needed in Adat to make the land cultivable, as it is inundated for nearly six months every year before the start of the crop cycle. What explains the higher labour use in harvesting is the adverse conditions present in Adat during the period of harvesting. There were intermittent rains at the time of harvest in 2019, which led to lodging and damp soil in the fields, leading to significant delays in completion of harvesting.

Appendix C

Details of Simulation Analysis

Following the discussions in Kurosaki (2001) and Sadoulet and de Janvry (1995), the farmer's production technology for Adat, Kerala is modeled by the Generalized Leontief Profit Function as

$$\pi\ (p^*, z^q) = \sum_{(i,j)=(a,c,l,f)} b_{ij}\sqrt{p_i^* p_j^*} + \sum_{i=a,c,l,f} b_{iz} p_i^* z^q$$

where π is the total profit of the farm, p_k is the price (wage) of commodity (service) k, which could be a shadow price, and b_{ij} and b_{iz} are fixed parameters. As the interaction of the production side as a farm manager and the consumption side as a consumer/labourer is the key in agricultural household models (de Janvry et al., 1991; Kurosaki, 2001; Singh et al., 1986), the cultivating farmer is modeled as a consumer, obtaining utility from consuming food (i.e., rice, subscript a), leisure (subscript l), and manufactured consumption goods. We assume a Cobb-Douglas utility function whose budget shares are fixed.

For the simulation purpose, a set of b_{ij} and b_{iz} for the profit function and a set of budget shares are calibrated using mathematical planning using the software GAMS. The calibrated model, following from Kurosaki (2001), satisfies all restrictions required for a genuine profit function and minimizes the sum of squares of the distance of implied supply responses from those elasticities reported in the literature.

In the case of Adat, the rice area of the sample farmers is almost fixed, with very little possibility of area response through substitution with other competing crops in the short run. We consider the above model as a farm producing two outputs of rice and non-agricultural self-employment activities from two variable inputs of management labour and monetary capital. In other words, farmers can hire labour for different operations in rice cultivation or non-agricultural activities but have to use their own labour for management of both set of activities. The division of this time between the activities changes with relative prices of outputs.

A survey of recent studies on supply response in the Indian agriculture gives the supply elasticity to be between 0.01 and 0.41 (Ganesh-Kumar et al., 2012; Hazrana et al., 2020; Imai et al., 2011; Kozicka et al., 2015; Kumar, 2017; Mythili, 2008; Pandey, 2012; Sharma, 2016). We take the supply elasticity of rice production to rice price as 0.15 to be a reasonable estimate under the complete market scenario. The estimated parameters from Kurosaki (2001) are retained and adjusted with some assumptions for the missing management labour scenario. Appendix Table C-1 reports key parameters associated with the calibrated household model used in the simulation. Using the calibrated model, we simulate production and consumption under alternative scenarios when the rice price is reduced by 31 per cent. The resulting supply responses are reported in Table 5 and crop incomes are reported in Tables 6–7 of the article.

Table C-1 *Model parameters for the rice farmer in Adat, Kerala*

Production side: Elasticities implied by the generalized Leontief profit function				
	Non-agri price	Rice price	Capital price	Wage of management labour
Non-agri output	0.24	-0.12	-0.05	-0.06
Rice output	-0.09	0.15	-0.02	-0.03
Capital input	0.24	0.24	-0.54	0.05
Management labour input	0.10	0.14	0.05	-0.29
Consumption side: Budget shares implied by the Cobb-Douglas utility function				
	Food (rice)	Leisure		Manufacture goods
Budget share	0.27	0.48		0.25

Note: Elasticities are evaluated at the initial equilibrium.

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