The Impact of Agricultural Land and Labor Productivity on Poverty: The Case of Rice Farming Households in Cambodia

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Abstract

Using the data from the Cambodia Socio-Economic Survey (CSES) 2009, the study examined the impact of agricultural labor and land productivity on poverty among Cambodian rice farming households. The results showed that improving productivity of land and, especially, that of labor reduced poverty in two of Cambodia's rice producing regions, the Tonle Sap and the Plain. There was no evidence of such impact in two other regions, the Mountain and the Cost. When the productivity of the less productive farming households were raised up to the mean level of productivity, only labor productivity was found to have an impact on poverty reduction in the Tonle Sap and the Plain, indicating that improving agricultural labor productivity is the key to poverty reduction. In Cambodia, improving rice productivity in the Tonle Sap and the Plain region is the most poverty reducing.

Keywords: Land productivity, labor productivity, Cambodia, rice production, rural poverty

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1. Introduction

Cambodia is one of the poorest countries in Southeast Asia. In the last decade, Cambodia's economy has been performing impressively. Growth rate[1] was among the best performance; as a result, per capita income has increased substantially and the number of people living below poverty line has been reduced significantly. According to the recent World Bank report, the national poverty head count has been reduced from 53.2% in 2004 to 20.5% in 2011 (Sobrado et al., 2013).

The speed of poverty reduction has been astonishing; however, because in the early period of growth, Cambodia's poverty rate was very high, thus although there has been significant reduction, poverty is still not a trivial problem as significant number of the poor still subsists below and close to poverty line (Beresford, Sokha, Roy, Sisovanna, & Namazie, 2004; Sobrado et al.,2013). A reduction of only 1,200 Cambodian Riel (KHR)[2] of consumption expenditure will double the number of people living under poverty line (Sobrado et al.,2013). What is more striking about Cambodian poverty is the difference between the poverty headcount rate in the rural areas, and that in the capital Phnom Penh and other urban areas. Poverty rate in rural area was more than ten times higher than the Phnom Penh poverty rate and almost double that of other urban poverty rate. While the poverty rate in Phnom Penh was merely 1.53% and in other urban, it was 16.10%, the rural poverty rate was 23.72% (Sobrado et al.,2013). Given the fact that around 90% of the Cambodian population resides in rural areas, the numbers suggest that several

[1] From 2000 to 2012, the rate of GDP growth was 8.0 %, and four consecutive years from 2004 to 2007, the rate was over 10%; nevertheless, in 2009, due to the global financial crisis, the rate dropped to 0.1% (ADB, 2013).

[2] Riel is Cambodian currency. In March 2014, the official exchange is around 4,000KHR/USD, so 1,200KHR is about 0.30 USD.

millions of rural dwellers are living below poverty line and that poverty in Cambodia become a rural phenomenon (ADB, 2011).

It is commonly understood that, in order to alleviate poverty, pro-poor policies aiming at raising the employment or income of the poor should be directed towards the sectors which the poor are well endowed. In the case of Cambodia, it is obvious that poverty is hurting the rural poor more severely and that it must be alleviated. Unlike the urban poor who depend on informal jobs in the city, the rural poor in dependents on agricultural activities, largely rice cultivation and livestock raising. Rice is not the only crop that Cambodian farmers produce but it is the main crop and many farming households have devoted most of their resources, land and labor, to rice cultivation. In general, the rural poor households are endowed with a small plot of land for rice cultivation and their household labors. If the productivity of these two resources improves, it is undeniable that the poor will be benefited.

Although rice is a lifeline of many of the rural poor, still rice industry has not satisfactorily developed. At the micro level, many farmers are still producing at subsistent level and practicing tradition cultivation. According to the World Bank's estimate, as cited in USDA (2010), only 40% of the farming households are capable of producing rice surplus to sell at the market. At the macro level, there are many constraints to rice production including the shortage of funding for extension work and crop research, the low yield due to the unavailability of good seed, the destruction of irrigation system during the war and the inaccessible to commercial credit by farmers (ADB, 2011; USDA 2010; Ngo and Chan 2010; Chea, Cramb &Fukai, 2004).Because of these constraints in production, the yield of Cambodian rice is one of the lowest among rice producing countries in Southeast Asia (Ngo &Chan, 2011:11).

Rice industry shall play more important role in rural poverty reduction if adequate resources are mobilized to support the industry. In its poverty assessment, the World Bank reported that rice was one the main driver of poverty reduction in Cambodia (Sobrado et al.,2013); in addition, Engvall et al. (2008) suggested that agricultural development, meaning improvement in rice productivity in Cambodia, is one of means of increasing rural income. According to Yu &Fan (2011), Cambodia still has a substantial potential to improve rice productivity. In this connection, the objective of this study is to examine the impact of land and labor productivity on poverty among the Cambodian rice farming households. The remainder of the study is organized as follows: the next section, Section 2, discuss the previous literature on the relationship between agricultural productivity growth and poverty reduction. Section 3 will present the data and the scope of the study. Section 4 will explain the analytical procedure. The empirical results will be presented in Section 5. Finally, Section 6 will summarize the findings and conclude the study by providing the policy implications and suggesting direction for future study.

2. Agricultural Productivity Growth and Poverty Reduction

The growth of agricultural productivity benefits all relevant stakeholders, from the consumers who will be able enjoy cheaper foods to the government whose tax revenues will substantially increase, and the farmers themselves from the increase of employment and income. Almost all countries in East and Southeast Asia have gone through growth in agricultural productivity before industrializing, except for few small island countries and territory such as Brunei, Hong Kong and Singapore.

With the growth of agricultural productivity, farmers are able to generate higher income, and more employment is available on the farm. The incremental income will allow them to spend on nutritious foods, which enable them to work more productively and to spend on other products from the non-agricultural sectors, which will benefit the rural economy as a whole. The government, at local and central level, is able to obtain extra tax revenue from the increased agricultural production. The local government may

spend the additional tax collected to finance infrastructure development in their locality such as building irrigation, canal, and road, which will further increase the productivity of the agricultural sector. Also, if agricultural products are exported, foreign currency will be augmented so that there are more funds available for purchasing agricultural machinery, which many developing countries usually are not able to produce and have to import. Eventually, the growth of agricultural productivity will continue to spiral through the benefit from improvement of infrastructure, more investment on capital goods, and better food intake resulted from the initial impact. This process will continue and sustain the economic growth to ultimately achieve the goal of the poverty reduction.

Many empirical researches have been conducted to prove the pro-poor impact of agricultural productivity growth, and although the results, generally, support the role of agriculture in reducing poverty, the impact is not consistent in that different impact has been observed in different locality and agricultural setting. There is a consensus that agricultural growth is more effective in reducing poverty in countries where agriculture's share in the economy is relative large and the sector is more labor intensive, which means that the poor can participate and benefit directly from growth. De Janvry and Sadoulet (2009) examined the impact of agricultural growth on poverty in three regions, namely East Asia, South Asia and South America, and concluded that agricultural growth contributed more to poverty reduction in East Asian countries than their South Asian and South American counterparts because in the former the agricultural sector was more labor intensive and farmers operated in smaller scale. A cross-country study by Irz et al. (2001) using agricultural productivity as an independent variable in poverty regression showed strong correlation between agriculture and poverty reduction regardless of the use of different types of poverty indices.

Besides cross-country studies, sectoral comparison of the contribution of agriculture and other sectors to poverty reduction also suggests the important role of agriculture. In Southeast Asia, the study by Warr (2002) supported the premise that agriculture contribute to poverty reduction; however, its role was less significant than the growth of service sector. In a country context, Thorbecke &Jung (1996) studied the sectoral impact on Indonesian poverty alleviation, and suggested that agricultural and service sectors contributed more to poverty reduction than the industrial sector. In South Africa, Khan (1999) found that agriculture, mining and services were the sectors which contributed most to the poverty reduction due to their high direct linkages to poor households.

In a longitudinal study in India, Ahluwalia (1978) found that agricultural growth contributed to poverty reduction in aggregate; nonetheless, when examining each Indian state separately, some states showed the importance of agriculture in reducing poverty; while in other states, the results were reversed. The poverty reducing effect of agricultural growth in India was later also supported by Datt &Ravallion (1998) whose study suggested that higher farm yield reduced absolute poverty, and the effect was not confined to the farmers close to poverty line; the poorest of the poor were also benefited. However, using the same data set as Ahluwalia (1978), Saith (1981) found that actually agricultural growth did not reduce rural poverty because the positive effect of poverty reduction was smaller than the negative effect of price rise. In other words, agricultural growth reduced poverty of the farmers but it raised the agricultural price, the food price in particular, which made the poor who were net food consumers worse off. Therefore, inflationary pressure is one of the main causes of rural poverty, according to Saith (1981). The opposite conclusion of Ahluwalia (1978) and Saith (1981) encouraged Mathur (1985) to investigate the causes, and as a result, Marthur (1985) suggested that the main reason for the difference in conclusions was the use of different specification to estimate the equation. Ahuwalia (1978) used value added, while Saith (1981)

used gross output as an indicator of agricultural growth. In addition, Mathur (1985) supported the finding of both researches: agricultural growth reduced poverty, where price rise increased poverty, which is supported by the longer time series data by Bell &Rich (1994).

Beside India, Indonesia and South Africa, studies in other countries showed inconclusive result on the relationship between agricultural growth and poverty reduction. In Indonesia, Suryahaid et al. (2012) examined the role of sectoral growth on poverty reduction and found that agriculture contributed to the poverty reduction in post Asian financial crisis only in rural areas and the impact was lagged behind the contribution of service sector. This indicated that agricultural growth contributed to poverty reduction differently in different time period. The study in Pakistan by Malik (2005) found no evidence of poverty reduction attributable to agricultural growth, indicating not all countries benefited from agricultural growth. As a suggestion, Malik (2005) proposed that the use of aggregate agricultural data to examine its poverty reducing effect was unreliable, and that the poverty reducing effect of agriculture should be examined in disaggregate manners, i.e study had to incorporate the fact that different crops were grown by different group of farming households in different regions.

In conclusion, although theory proposes that agricultural growth reduce poverty, empirically, there is no conclusive finding. Agriculture contributed to poverty reduction differently in different time period and different localities. Moreover, it should be noted that the use of aggregate agriculture data to examine its poverty reducing role may produce unreliable finding due to the fact that farmers produce different crops in different agro-climatic regions. Therefore, the growth of some crops may benefit a group of farmers but not necessarily all farmers. Based on the review, this study attempts to fill the literature gap by examining the impact of the growth of land and labor productivity on poverty reduction among Cambodian rice farming households in different agro-climatic regions. The analytical procedure will be presented in the next section.

3. Data and Scope of Study

3.1 Data

Data applied in this study was obtained from the Cambodia Socio-Economic Survey (CSES) of 2009, hereafter referred to as CSES 2009. The Cambodia's Ministry of Planning's National Institute of Statistics (NIS) is responsible for conducting the survey and publishing its results. The survey was conducted from January to December 2009. It is a nationwide survey covering the sample of 12,000 households with 720 villages, which are divided into 12 monthly samples of 1,000 households in 60 villages.

3.2 Scope of the Study

The study focuses on the direct impact of the increase of land and labor productivity on consumption expenditure of rice farming households. The consumption expenditure will be used to calculate its impact on the poverty among farming households. Rice farming households were chosen for the study owing to the fact that rice was cultivated by 85% of the rural households in 84% of the 3 million hectare of cultivated land in Cambodia (Sobrado et al.,2013). Diversified farming households and households cultivating other cash crops or vegetable were excluded from the sample.

Land and labor productivity raise household consumption expenditure through the direct and indirect channel including the surge of produce price and farm wage, the increase of farm and non-farm employment. For this reasons, there is study which apply the simultaneous equation to examine both the direct and indirect impact such as the study by Datt &Ravallion (1998). However, due to data availability, I

will apply a single equation to assess only the direct impact of the improvement of land and labor productivity on the consumption expenditure of the Cambodian rice farming households.

4. Analytical Framework

This section presents the analytical procedure applied to compute the impact of land and labor productivity on poverty. I began by calculating poverty indices of rice farming households in four agro-climatic regions from the CSES 2009. Subsequently, I regressed the per capita consumption expenditure of rice farming households on land and labor productivity, and other explanatory variables. The regression coefficients of land and labor productivity were then used to compute their impact on the change of poverty indices. There are two regression scenarios to be examined; in the first scenario, I assumed 10% increase of land and labor productivity for all rice farming households regardless of their productivity status, while in the second scenario, I raised the land and labor productivity of less productive farming households to the mean level.

4.1 Poverty Measurement

In Cambodia, poverty lines are calculated differently for three designated regions: Phnom Penh, other urban areas, and rural areas[3]. In this study, for only rice farming households will be included in the analysis, I assumed that all sample are all rural inhabitants. Therefore, the rural poverty line was used to construct poverty indices for the Plain, Tonle Sap, Mountain and Coast agro-climatic regions. The new poverty line redefined by Cambodia's Ministry of Planning (MoP) in 2013 includes the consumption expenditure of food, non-food allowance, and the expenditure for clean water; the rural poverty line was set at 3,503 Cambodian Riel (KHR)[4], 290 KHR higher than the previous rural poverty line which was only 3,213 KHR (MoP, 2013).

Using the MoP's rural poverty line, three different poverty indices, namely poverty headcount, poverty gap and poverty severity, were computed by applying the formula proposed by Foster, Green and Thorbeke (1984). The formula is expressed in the following equation:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^\alpha \qquad (1)$$

Where,

N is total population

q is number of the poor

z is poverty line

y is per capita consumption expenditure

Equation (1) can be interpreted as follows: If $\alpha = 0$, P_0 becomes poverty headcount ratio ; if $\alpha = 1$, P_1 become poverty gap and if $\alpha = 2$, P_2 become poverty severity index.

4.2 Regression Analysis

[3] Among the three poverty lines, rural poverty line is the smallest reflecting the higher cost in urban are and the capital Phnom Penh. Included in poverty line is the allowance for food, non-food and clean water which is highest in rural are because significant number of rural households have no access to clean water, an indicator of their poverty. For more detail see MoP (2013).

[4] In March 20141 USD is equal to around 4,000 KHR.

The rice farming households' per capita consumption expenditure was regressed on two main variables, land and labor productivity, and other independent variables.

The regression equation is in the following form:

$$\mathbf{y_i} = \boldsymbol{\beta_0} + \mathbf{X_i}\boldsymbol{\beta_1} + \boldsymbol{\varepsilon_i} \quad (2)$$

Where,

$\mathbf{y}$ is per capita consumption expenditure

$\mathbf{X}$ is a vector of independent variables

$\boldsymbol{\varepsilon}$ is an error term

Several definition of labor and land productivity were applied in the literature. Land productivity was defined as crop yield or gross crop value per acre (Datt &Ravallion(1998); Sarris et al. (2006); and de Janvary &Sadoulet (2009)), while Irz et al. (2001) used the gross output net of the intermediate input cost to reduce the effect of input intensification during production. Labor productivity was defined by Irz et. al (2001) and de Janvary &Sadoulet (2009) as per worker average value added. I followed the definition of land productivity by Irz et al. (2001) and labor productivity by Irz et al. (2001) and de Janvary &Sadoulet (2009).

Ordinary Least Square (OLS) and Instrumental Variable (IV) Regression methods were employed to analyze the impact of land and labor productivity on per capita consumption expenditure.

5. Results and Discussion

5.1 Rice Farming Households and Their Poverty Status

As aforementioned, in Cambodia, rural poverty rate is much higher than that of urban areas. According to the World Bank report, about 80% of the Cambodian population resides in rural area. Among the rural dwellers, 90% of them are poor and 85% of them are rice farmers (Sobrado et al.,2013). Hence, it is irrefutable that large proportion of the poor rural households is rice farming households.

Using the rural poverty line as a benchmark and the data from CSES 2009, poverty indices among rice farming households in four agro-climatic regions was calculated and reported in Table 1.

Table 1 Poverty rate among Cambodian rice farming households, 2009[5]

	Cambodia	Plain	Tonle Sap	Mountain	Coast
Poverty Headcount P(0)	0.163	0.155	0.169	0.196	0.113
Poverty Gap P(1)	0.029	0.027	0.030	0.035	0.020
Poverty Severity P(2)	0.008	0.007	0.008	0.009	0.006
Mean Cons.	5456.994	5610.060	5385.787	5159.899	5487.158

Source: Author, based on CSES 2009

Table 1 shows that the average per capita consumption of rice farming households is about 5,456 KHR per day. Households in Plain region have highest average per capita consumption of 5,610 KHR followed by 5487 KHR in Caost, 5385 in Tonle Sap and 5159 KHR in Mountain region. With regard to poverty, rice farming households in Mountain region are the poorest followed by households in Tonle Sap, Plain and Coast.

Cambodian rice farming households hold small plot of land and are still producing at subsistent level mainly for household consumption. Only 37% of them are net rice producers; 17 % to 41% others are

[5] In 2009, the national poverty headcount rate is 23.9% (World Bank, 2009). Poverty headcount rate among rice farming households in 2009 is lower than the national headcount rate because the rural poverty line was used and rice farming households are not the poorest of the poor. In Cambodia, the poorest of the poor are landless households.

net rice consumers and the remaining are producing only for own consumption. Table 2 reports the summary statistics of the variables to be used in the analysis as well as the characteristics of rice farming households. Based upon the table, an average holding size of rice cultivated area is 1.3 hectares per households. The average households head are in their middle age, the means age is 42.8 years old, completed only around 5 years of schooling which is slightly lower than primary school completion. In average, there are 5 members in the household, and only small portion of the households have access to productive infrastructures such as irrigation and electricity. The rate of the possession of modern capital goods such as hand tractor is very low.

Table 2 Summary statistics of the variables

	Unit	Mean	Std. Dve.	Min	Max	Obs
Household Charaterirsitcs						
Harvested area	ha	1.3	1.2	0.0	15.0	2713
Household size	persons	5.0	1.7	1.0	13.0	2713
Head of household age	year	42.8	13.2	15.0	87.0	2713
Head of household education	year	5.4	6.0	0.0	16.0	2713
Gender of head of household	dummy	0.8	0.3	0.0	1.0	2713
Non-agricultural income	000 KHR	1206.6	3360.0	0.0	24600.0	2713
Dependency Ratio	ratio	0.4	0.2	0.0	0.8	2713
Fertilizer	dummy	0.7	0.4	0.0	1.0	2713
Percapita consumption	KHR	5457.0	1897.1	1450.5	10152.9	2713
Infrastructure						
Phone	dummy	0.3	0.5	0.0	1.0	2713
Irrigation	dummy	0.4	0.5	0.0	1.0	2713
Electricity	dummy	0.1	0.3	0.0	1.0	2713
Productivity						
Land productivity	ratio	14.3	1.3	7.5	19.5	2606
Labor productity	ratio	13.3	1.1	7.7	16.9	2485
Land endowment	ratio	-1.0	0.9	-5.3	2.2	2587
Rice Production Factors						
Hand tractor	dummy	0.1	0.3	0.0	1.0	2713

Source: CES 2009

In general, many rice farming households have more than one job. Besides cultivating rice, during the off farm season, many of them commute to the city to find temporary employments in labor intensive sectors such as construction and other informal jobs (Solocomb, 2010).

5.2 Regression Note and Results

The regression analysis was carried out using STATA. Initially, the OLS was computed. Also I checked the endogeneity problem of the land and labor productivity variables and confirmed that the endogeneity problem exists. In the study of agriculture and poverty in Tanzania by Sarris et al. (2006) using similar econometric technique, the problem of endogeneity was also found. When the independent variables are endogenized, their OLS coefficients are no longer reliable; the coefficients become biased; therefore, OLS cannot be a reliable tool for the analysis in this case. The endogeneity problem was corrected by applying the IV regression analysis. I tested the validity of the instruments and performed the IV regression. The results will be reported in Table 3. In addition, the results of the OLS were also presented to visualize the difference between the coefficients of IV and OLS. The implication of the policy will be based on the result of the IV regression.

As aforementioned, the dependent variable is the per capita consumption expenditure of the rice farming households and the explanatory variables are the household and farm characteristics, infrastructure,

and productivity variables. Two models were formulated. In Model 1, the main independent variable is land productivity, while Model 2's main variable is labor productivity. Other independent variables are basically the same for both models.

The sample was disaggregated into four samples: Plain, Tonle Sap, Mountain and Coast samples. Including the aggregated Cambodian sample, five regressions were estimated for Model 1 and Model 2.

Both the OLS and IV regression result supported the hypothesis that improving land and labor productivity will increase the per capita consumption of the rice farming households in Cambodia in general. When disaggregated into different regions, basically there was evidence of significant relationship between productivity variables and per capita income in only the Plain and the Tonle Sap. Meanwhile, the relationship between productivity and per capita consumption expenditure cannot be confirmed in the case of the Mountain region ; while in the Coast, only labor productivity had a significant impact on per capita consumption expenditure but the magnitude is very small, only 0.04, in OLS model.

The coefficient sizes of the OLS regression results are much smaller than those of the IV regression results due to the biasness of OLS results because land and labor productivity are endogenized. The interpretation will be only on the results of the IV regression in the aggregated Cambodian sample, the Plain and the Tonle Sap regions since hypothesis of the impact of productivity on per capita consumption cannot be strongly supported in other regiones.

Because the productivity and dependent variables are in natural logarithm, the coefficient of the variables can be interpreted as elasticity. Therefore Table 3 shows that, in Cambodia, on average, an increase of land productivity by 10% will raise the household per capita consumption expenditure by 2%, while in Plain and Tonle Sap region, the per capita consumption expenditure will increase by 2.2% and 4.9% respectively. The variables are significant at 1% level in all cases.

Table 3. Impact of land and labor productivity on per capita consumption expenditure scenario 1

	Dependent Variable: Logpc_cons											
	Cambodia				Plain				Tone Sap			
	OLS		IV		OlS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics												
Age	0.00	0.01**	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
	(1.56)	(1.96)	(1.29)	(1.08)	(0.21)	(0.45)	(0.52)	(0.18)	(1.10)	(1.30)	(0.87)	(0.37)
Age^2	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(-1.31)	(-1.72)*	(-0.80)	(-0.57)	(-0.20)	(-0.43)	(-0.34)	(-0.01)	(-0.82)	(-1.03)	(-0.58)	(-0.04)
Gender	-0.02	-0.01	0.01	0.02	-0.04	-0.03	-0.03	-0.03	-0.02	-0.01*	0.13	0.07
	(-0.99)	(-0.61)	(0.44	(0.62	(-1.28)	(-1.20)	(-0.82)	(-0.95)	(-0.48)	(-0.21)	(1.23)	(0.98)
Lognon_agr_inc	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.00	0.00
	(6.06)	(6.00)	(5.05)	(4.66)	(4.36)	(4.35)	(3.81)	(3.84)	(4.34)	(4.13)	(0.58)	(0.60)
Hh_size	-0.07***	-0.08***	-0.07***	-0.01***	-0.06***	-0.06***	-0.06***	-0.06***	-0.07***	-0.08***	-0.05***	-0.05***
	(-16.58)	(-16.92)	(-11.52)	(-10.11)	(-8.66)	(-8.91)	(-6.60)	(-6.22)	(-9.99)	(-10.14)	(-3.25)	(-2.85)
Dep_ratio	-0.17***	-0.16***	-0.21***	-0.22***	-0.23***	-0.22***	-0.25***	-0.26***	-0.09	-0.08	-0.04	-0.10
	(-4.58)	(-4.25)	(-4.46)	(-4.32)	(-3.87)	(-3.72)	(-3.40)	(-3.60)	(-1.38)	(-1.18)	(-0.34)	(-0.87)
Fertilizer	0.03**	0.04***	0.03*	0.03	-0.02	-0.01	0.02	-0.00	0.06**	0.08***	0.18**	0.09**
	(2.14)	(2.77)	(1.86)	(1.50)	(-0.60)	(-0.24)	(0.40)	(-0.03)	(2.32)	(3.06)	(2.39)	(2.12)
Infrastructure												
Phone	0.12***	0.13***	0.08***	0.07***	0.14***	0.14***	0.10***	0.09***	0.12***	0.12***	0.00	-0.02
	(8.13)	(8.50)	(3.80)	(2.82)	(6.07)	(6.16)	(2.97)	(3.11)	(4.30)	(4.47)	(0.04)	(-0.24)
Electricity	0.13***	0.14***	0.09***	0.08**	0.12***	0.12***	0.01	0.01	0.14***	0.14***	0.05	0.05
	(5.44)	(5.57)	(3.19)	(2.44)	(2.81)	(2.80)	(0.21)	(0.26)	(3.68)	(3.36)	(0.53)	(0.62)
Productivity												
Logland_prod	0.01*		0.20***		0.02*		0.22*		0.01		0.49**	
	(1.88)		(3.34)		(1.93)		(1.92)		(1.15)		(2.20)	
Loglabor_prod		0.02***		0.25***		0.02**		0.22***		0.02		0.46***
		(2.69)		(3.90)		(2.57)		(3.24)		(1.82)*		(2.72)
Logland/labor ratio	0.05***		0.19***		0.05***		0.18*		0.04		0.36**	
	(5.27)		(4.08)		(3.33)		(2.33)		(2.79)***		(2.41)	
Constant	8.63***	8.49***	5.96***	5.38***	8.68***	8.54***	5.76***	5.93***	8.49***	8.34***	1.64	2.39
	(74.04)	(75.08)	(7.01)	(6.27)	(45.92)	(47.91)	(3.48)	(6.55)	(39.31)	(41.11)	(0.51)	(1.05)
Number of Obs	2484	2484	2484	2484	1081	1081	1081	1081	754	754	754	754
Adjusted R^2	0.20	0.20			0.16	0.16			0.22	0.22		
GMM C statistic												
Chi-sqr			14.87	21.96			4.62	11.23			16.28	22.75
P-value			0.00	0.00			0.03	0.00			0.00	0.00
Hansen's J												
Chi-sqr			0.57	3.16			2.65	2.40			0.23	0.33
P-value			0.45	0.21			0.10	0.30			0.63	0.85

Table 3. Impact of land and labor productivity on per capita consumption expenditure scenario 1 (cont.)

	Dependent Variable: Logpc_cons							
	Mountain				Coast			
	OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics								
Age	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
	(1.01)	(1.19)	(1.21)	(1.30)	(1.06)	(1.08)	(1.37)	(1.48)
Age^2	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(-0.78)	(-0.99)	(-0.99)	(-0.58)	(-0.91)	(-0.97)	(-1.27)	(-1.41)
Gender	0.05	0.05	0.05	0.05	-0.05	-0.01	-0.11	-0.03
	(0.92)	(0.99)	(0.82)	(0.90)	(-0.70)	(-0.12)	(-1.36)	(-0.50)
Lognon_agr_inc	0.01*	0.00	0.01	0.01	-0.00	-0.00	-0.00	-0.00
	(1.78)	(1.63)	(1.16)	(1.59)	(-0.67)	(0.25)	(-1.07)	(-0.80)
Hh_size	-0.09***	-0.09***	-0.09***	-0.09***	-0.09***	-0.10***	-0.09***	-0.11***
	(-8.61)	(-8.65)	(-7.77)	(-7.97)	(-6.10)	(-6.56)	(-4.77)	(-4.96)
Dep_ratio	-0.19**	-0.16*	-0.12	-0.18	-0.12	-0.09	-0.13	-0.08
	(-2.05)	(-1.77)	(-0.65)	(-1.07)	(-1.03)	(-0.78)	(-1.11)	(-0.71)
Fertilizer	0.05	0.05	0.07	0.05	-0.06	-0.05	-0.04	-0.04
	(1.60)	(1.51)	(1.19)	(0.79)	(-1.13)	(-0.82)	(-0.69)	(-0.70)
Infrastructure								
Phone	0.06	0.07*	0.09	0.07***	0.15***	0.17***	0.13***	0.19***
	(1.55)	(1.91)	(1.13)	(1.06)	(3.31)	(3.79)	(2.88)	(4.25)
Electricity	0.16***	0.16***	0.15**	0.18***	0.09	0.10	0.09	0.10
	(2.91)	(2.94)	(2.56)	(3.04)	(0.98)	(1.06)	(1.22)	(1.52)
Productivity								
Logland_prod	-0.02		-0.03		0.01		-0.09	
	(-1.18)		(-0.16)		(0.73)		(-1.11)	
Loglabor_prod		-0.02		-0.01		0.04*		-0.03
		(-1.57)		(-0.09)		(1.95)		(-0.30)
Logland/labor ratio	0.04		-0.08		0.11***		0.05	
	(1.57)		(-0.52)		(4.11)		(0.89)	
Constant	8.95***	8.93***	9.69***	8.79***	8.71***	8.27***	10.18***	9.06***
	(32.66)	(32.28)	(5.22)	(5.18)	(23.62)	(22.97)	(8.62)	(7.89)
Number of Obs	424	424	424	424	225	225	225	225
Adjusted R^2	0.23	0.22	0.23	0.23	0.26	0.22	0.20	0.22
GMM C statistic								
Chi-sqr			0.17	0.01			2.23	0.75
P-value			0.67	0.93			0.14	0.39
Hansen's J								
Chi-sqr			0.00	0.73			0.15	8.44
P-value			0.98	0.69			0.70	0.01

Note:- Instrumented Variables:

Logland_prod (instruments: irrigation, household head education)

Loglabor_prod (instruments: irrigation, household head education, hand tractor)

-*,**&*** significant at 10%, 5% and 1% respectively.

Source: Author

In the case of labor productivity, 10% increase in productivity will raise consumption by 2.5%, 2.2% and 4.6% in Cambodia, Plain and Tonle Sap regions respectively, and like the case of land productivity, the coefficient of labor productivity are significant at 1% level in all cases. It should be noticed that in the Tonle Sap region, the improvement of both land and labor productivity will contribute more to the increase in per capita consumption expenditure, which can be explained by the fact that in Tonle Sap, farm land are more abundant due to relatively sparsely populated, and farming households depend largely on rice cultivation, while, in the Plain region, farming households generally possess smaller cultivated land size but have better access to off farm employment since the zone is in close proximity to big cities like the capital Phnom Penh and Kampong Cham.

To examine the impact of an improvement of land and labor productivity on poverty reduction, two scenarios were formulated; in the first scenario, land and labor productivity of all rice farming

households were assumed to increase by the same rate, 10%. Using the elasticity of the coefficients from the IV regression result in Table 3, the increase in per capita consumption expenditure due to 10% improvement of land and labor productivity was calculated. And this increase in per capita consumption expenditure was used to calculate the new poverty indices. The result of poverty reduction is presented in Table 4.

Table 4. Impact of 10% increase in land and labor productivity on poverty reduction

	Cambodia				Plain				Tonle Sap			
	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)
Base	5456.994	0.163	0.029	0.008	5610.060	0.155	0.027	0.007	5385.787	0.169	0.030	0.008
Land	5566.134	0.153	0.026	0.007	5733.481	0.148	0.024	0.006	5649.691	0.142	0.024	0.006
Labor	5593.419	0.148	0.025	0.007	5733.481	0.148	0.024	0.006	5633.533	0.143	0.024	0.011
Change												
Land	2.0%	-6.1%	-9.0%	-10.6%	2.2%	-4.8%	-10.0%	-12.0%	4.9%	-16.3%	-20.1%	-23.8%
Labor	2.5%	-8.8%	-11.1%	-13.1%	2.2%	-4.8%	-10.0%	-12.0%	4.6%	-15.6%	-19.0%	41.0%

Source: Author

In Table 4, 10% increase in land productivity will raise the mean per capita consumption expenditure from to 5,456 KHR to 5,566 KHR per day and reduce poverty head count ratio by one percentage points, from 16.3% to 15.3% in Cambodia's sample. In the Plain region, 10% increase in land productivity will bring the mean per capita consumption to 5,733 KHR from its base value of 5,610 KHR and reduce poverty head count ratio by 0.7 percentage point, from 15.5% to 14.8%. The Tonle Sap region saw the largest increase in per capita consumption expenditure as well as the drop of poverty headcount ratio rate. 10% increase in land productivity raised the mean per capita consumption expenditure from 5,385 KHR to 5,649 KHR and poverty head ratio was dropped by larger margin, from 16.9% to 14.2%.

Labor productivity showed the same pattern as that of land productivity in the three cases. 10% increase in labor productivity in Cambodia and Plain region will result in similar rate of increase in per capita consumption expenditure and poverty reduction, that is mean per capita consumption was raised to 5,593 KHR and 5,733 KHR, and poverty headcount ratio was reduced to 14.8% both in Cambodia and Plain region respectively. Whilst, in the Tonle Sap region, the magnitude of the impact of the improvement in labor productivity on mean per capita consumption expenditure and poverty reduction was slightly smaller than that of land productivity; that is, 10% increase in labor productivity raised the mean per capita consumption expenditure to 5,633KHR and reduced poverty head count ratio by 2.6 percentage points, from 16.9% to 14.3%. Other two poverty indices, the poverty gap and the poverty severity, of the three cases were also improved.

The first scenario above assumed that all the productivity of all rice farming households was increased by 10% across the board and the results showed that farming households in the Tonle Sap region benefited most from increase in productivity as evidenced by the increase in mean per capita consumption expenditure and poverty reduction followed by farming households in the Plain region. We could not find any evidence of the impact of the productivity improvement on per capita consumption expenditure and poverty reduction in the Mountain and Coast regions.

In the second scenario, only the productivity of the rice farming households whose land and labor productivity were below average was elevated to the mean level. With this assumption, new regression coefficients were calculated and the results are presented in Table 5.

Like the results of the first scenario, the second scenario found the significant relationship between land and labor productivity, and per capita consumption expenditure in only the aggregated Cambodia's sample, the Plain and the Tonle Sap agro-climatic regions. Still there was no significant relationship between the land and labor productivity, and per capita consumption in Mountain and Coast regions. Therefore, in the same manner, only the three cases, Cambodia, Plain and Tonle Sap, will be analyzed. We performed the endogeneity test and used valid instruments in the IV regression. The results of the OLS and IV regression were presented and only IV regression results was examined for policy implications. The results of the second scenario will be reported in Table 5.

Table 5. Impact of land and labor productivity on per capita consumption expenditure scenario 1

	Dependent Variable: Logpc_cons											
	Cambodia				Plain				Tone Sap			
	OLS		IV		OlS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics												
Age	0.01	0.01*	0.00	0.00	0.00	0.00	0.00	-0.00	0.01	0.01	0.01	0.00
	(1.56)	(1.95)	(0.76)	(0.77)	(0.19)	(0.40)	(0.18)	(-0.19)	(1.08)	(1.30)	(0.48)	(0.36)
Age^2	-0.00	-0.00*	-0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00
	(-1.33)	(-1.70)	(-0.08)	(-0.16)	(-0.18)	(-0.36)	(0.12)	(0.45)	(-0.82)	(-1.03)	(-0.06)	(0.05)
Gender	-0.02	-0.01	0.01	0.02	-0.04	-0.03	-0.00	-0.02	-0.02**	-0.01	0.21	0.05
	(1.09)	(-0.60)	(0.39)	(0.81)	(-1.28)	(-1.16)	(-0.02)	(-0.64)	(-0.55)	(-0.25)	(1.07)	(0.70)
Lognon_agr_inc	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01	0.01***	0.01***	0.01***	-0.00	0.00
	(6.08)	(5.97)	(4.42)	(3.74)	(4.34)	(4.29)	(1.28)	(3.23)	(4.18)	(4.15)	(-0.12)	(0.39)
Hh_size	-0.07***	-0.08***	-0.07***	-0.07***	-0.06***	-0.06***	-0.07***	-0.06***	-0.07***	-0.08***	-0.06***	-0.07***
	(-16.67)	(-17.03)	(-9.90)	(-11.01)	(-8.70)	(-8.97)	(-3.63)	(-6.61)	(-10.07)	(-10.30)	(-2.62)	(-4.71)
Dep_ratio	-0.17***	-0.16***	-0.20***	-0.20***	-0.23***	-0.22***	-0.21	-0.23***	-0.09	-0.07	0.00	-0.05
	(-4.52)	(-4.21)	(-3.25)	(-3.87)	(-3.84)	(-3.69)	(-1.51)	(-3.24)	(-1.39)	(-1.15)	(0.03)	(-0.42)
Fertilizer	0.03**	0.04***	0.03	0.01	-0.02	-0.01	-0.10	-0.02	0.06**	0.08***	0.18*	0.06
	(2.14)	(2.69)	(1.16)	(0.22)	(-0.77)	(-0.32)	(-0.93)	(-0.56)	(2.23)	(3.01)	(1.69)	(1.21)
Infrastructure												
Phone	0.12***	0.13***	0.08***	0.06**	0.15***	0.14***	0.09	0.09***	0.12***	0.12***	0.01	0.01
	(8.29)	(8.54)	(2.67)	(2.50)	(6.19)	(6.11)	(1.22)	(2.68)	(4.40)	(4.58)	(0.07)	(0.18)
Electricity	0.14***	0.14***	0.10**	0.08**	0.13***	0.12***	-0.09	0.02	0.15***	0.14***	0.14	0.06
	(5.54)	(5.60)	(2.55)	(2.40)	(2.91)	(2.79)	(-0.33)	(0.32)	(3.76)	(3.70)	(1.47)	(0.70)
Productivity												
Logland_prod	0.00		0.60**		0.03		1.22		0.01		1.16	
	(0.08)		(2.40)		(1.58)		(0.93)		(0.29)		(1.62)	
Loglabor_prod		0.03***		0.50***		0.05***		0.42***		0.03		0.86***
		(2.71)		(3.51)		(3.11)		(2.97)		(1.38)		(2.60)
Logland/labor ratio	0.04***		0.13***		0.03***		0.09		0.04**		0.23**	
	(4.95)		(3.18)		(2.87)		(1.31)		(2.55)		(1.77)	
Constant	8.78***	8.32***	0.14	1.88	8.51***	8.15***	-9.04	3.03***	8.61***	8.24***	-7.96	-3.06
	(53.45)	(50.18)	(0.04)	(0.97)	(28.71)	(31.21)	(-0.47)	(1.54)	(28.50)	(27.28)	(-0.78)	(-0.68)
Number of Obs	2484	2484	2484	2484	1081	1081	1081	1081	754	754	754	754
Adjusted R^2	0.2	0.2			0.16	0.16			0.22	0.22		
GMM C statistic												
Chi-sqr			15.04	19.46			4.08	10.23			17.48	22.38
P-value			0.00	0.00			0.04	0.00			0.00	0.00
Hansen's J												
Chi-sqr			0.72	4.27			0.97	2.79			0.02	0.73
P-value			0.39	0.12			0.33	0.25			0.89	0.69

Table 5. Impact of land and labor productivity on per capita consumption expenditure scenario 1 (cont.)

	Dependent Variable: Logpc_cons							
	Mountain				Coast			
	OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics								
Age	0.01	0.01	0.01	0.01	0.01	0.14	0.01	0.02
	(1.13)	(1.22)	(1.17)	(1.22)	(1.13)	(1.24)	(1.03)	(1.55)
Age^2	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(-0.92)	(-1.02)	(-0.96)	(-1.00)	(-0.98)	(-1.15)	(-0.95)	(-1.49)
Gender	0.05	0.05	0.05	0.06	-0.05	-0.01	-0.10	-0.02
	(0.95)	(0.98)	(0.93)	(0.93)	(-0.82)	(-0.14)	(-1.32)	(-0.23)
Lognon_agr_inc	0.01*	0.00	0.01*	0.01*	-0.00	-0.00	-0.00	-0.00
	(1.86)	(1.64)	(1.91)	(1.85)	(-0.74)	(-0.34)	(-1.02)	(-0.73)
Hh_size	-0.09***	-0.08***	-0.09***	-0.09***	-0.09***	-0.10***	-0.09***	-0.10***
	(-8.72)	(-8.64)	(-7.39)	(-8.42)	(-6.09)	(-6.66)	(-4.45)	(-5.16)
Dep_ratio	-0.19**	-0.16*	-0.16	-0.20	-0.12	-0.08	-0.19	-0.08
	(-2.11)	(-1.80)	(-1.33)	(-1.47)	(-1.04)	(-0.67)	(-1.33)	(-0.66)
Fertilizer	0.05	0.05	0.06	0.04	-0.06	-0.05	-0.03	-0.05
	(1.60)	(1.54)	(1.43)	(0.64)	(-1.08)	(-0.86)	(-0.43)	(-0.84)
Infrastructure								
Phone	0.06	0.07*	0.07	0.06	0.14***	0.17***	0.12**	0.19***
	(1.57)	(1.90)	(1.33)	(1.03)	(3.27)	(3.77)	(2.31)	(4.41)
Electricity	0.16***	0.16***	0.16**	0.17***	0.09	0.09	0.10	0.09
	(2.95)	(2.94)	(3.31)	(3.36)	(0.96)	(1.05)	(1.13)	(1.43)
Productivity								
Logland_prod	-0.05**		-0.13		0.00		-0.21	
	(-2.34)		(-0.50)		(0.12)		(-0.93)	
Loglabor_prod		-0.04		0.02		0.06*		0.02
		(-1.57)		(0.10)		(1.72)		(0.13)
Logland/labor ratio	0.05**		0.03		0.10***		0.12***	
	(2.40)		(0.39)		(4.17)		(4.18)	
Constant	9.43***	9.17***	10.50***	8.36***	8.84***	7.98***	12.08***	8.41***
	(26.35)	(23.03)	(2.95)	(3.16)	(14.83)	(15.22)	(3.55)	(3.85)
Number of Obs	424	424	424	424	225	225	225	225
Adjusted R^2	0.24	0.22	0.24	0.23	0.27	0.22	0.18	0.25
GMM C statistic								
Chi-sqr			0.10	0.01			1.05	0.73
P-value			0.75	0.76			0.31	0.78
Hansen's J								
Chi-sqr			0.02	0.73			0.61	8.97
P-value			0.87	0.69			0.44	0.01

Note:- Instrumented Variables:

Logland_prod (instruments: irrigation, household head education)

Loglabor_prod (instruments: irrigation, household head education, hand tractor)

-*,**&*** significant at 10%, 5% and 1% respectively.

Source: Author

Table 5 showed large increase in mean per capita consumption expenditure in all cases after the productivity of less productive farming households was raised to the mean level; however, it is worth noting that although the increase in labor productivity boosted up more per capita consumption expenditure than in the first scenario in all three cases, no evident was found to support the relationship between land productivity and per capita consumption expenditure in the Plain and Tonle Sap regions, suggesting clearly that improve labor productivity of the less productive farming households was beneficial in these two zones. Like the previous scenario, we could not find any evidence of significant impact of productivity improvement on per capita consumption expenditure in other two agro-climatic regions, the Mountain and the Coast.

As the World Bank (2013) suggested, labor is one of the main asset the Cambodian rural poor are endowed; thus, improving labor productivity is definitely pro-poor. Based on the result of the second scenario regression, 10% increase in land productivity will increase the per capita consumption expenditure by 6% and 10% increase in labor productivity will augment the per capita consumption expenditure by 5% in Cambodia sample. In the Plain and Tonle Sap regions, 10% increase in labor productivity will raise per capita consumption by 4.2% and 8.6% respectively. The coefficients are significant at 1% level. To examine the impact of productivity on poverty reduction, the increase in per capita consumption expenditure resulted from the 10% increase in the productivity was used to calculate the new poverty indices, which is presented in Table 6.

Table 6. Impact of 10% increase in land and labor productivity on poverty reduction when less productive farming households was raised to the mean level

	Cambodia				Plain				Tonle Sap			
	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)
Base	5456.994	0.163	0.029	0.008	5610.060	0.155	0.027	0.007	5385.787	0.169	0.030	0.008
Land	5784.414	0.153	0.021	0.005	-	-	-	-	-	-	-	-
Labor	5729.844	0.148	0.022	0.006	5845.682	0.148	0.022	0.005	5848.965	0.143	0.020	0.009
Change												
Land	6.0%	-6.1%	-26.3%	-28.5%	-	-	-	-	-	-	-	-
Labor	5.0%	-8.8%	-21.6%	-24.5%	4.2%	-4.8%	-18.9%	-21.7%	8.6%	-15.6%	-34.0%	9.7%

Source: Author

Table 6 presents the poverty indices computed from the 10% increase of land and labor productivity based on the IV regression results with the assumption that the less productive farming households' productivity was raised to the mean level. 10% increase in land productivity raised the mean per capita consumption expenditure from 5,456 KHR to 5,784 KHR in Cambodia's case and reduced poverty headcount ratio by one percentage points, from 16.3% to 15.3 %, while the 10% increase in labor productivity raised mean per capita consumption expenditure to 5,729 KHR and reduced poverty headcount ratio by 1.5 percentage points, from 16.3% to 14.8%. There was no significant relationship between land productivity and per capita consumption expenditure in Plain and Tonle Sap region. For the impact of labor productivity, 10% increase in labor productivity raised the mean per capita consumption expenditure from 5,610 KHR to 5,845 KHR in Plain region. In the Tonle Sap region, the mean per capita consumption expenditure increased from 5,385 KHR to 5,848 KHR. Regarding poverty reduction, the poverty headcount ratio in the Plain fell from 15.5% to 14.8 %, and in theTonle Sap, it fell from 16.9% to 14.3%.

6. Conclusion and Policy Implications

This study contributed to the literature of the impact of agricultural growth on poverty reduction by examining the impact of land and labor productivity improvement on the poverty reduction of rice farming households in Cambodia. Malik (2005) proposed that to clearly see the impact of agricultural growth on poverty, researches must examine the impact of different crop that farmers cultivate. The study examined rice production and confirmed that rice productivity plays significant role in poverty reduction. In addition, it was found that in one country, crop productivity did not contribute to poverty reduction in different agro-climatic regions. Therefore, productivity improvement policies should be focused on regions where productivity improvement contributes the most to poverty reduction. Due to data availability the single equation approache to examine only the direct impact of productivity growth on poverty reduction

was applied. In the future, if data are available, there should be a study to also examine the indirect as well as the longitudinal impact of productivity growth on poverty reduction.

In the Cambodian context, rice is important because significant number of households have been cultivating rice as a source of food as well as source income generation. Although the magnitude is different from one agro-climatic zone to the other, the study found significant impact of increasing labor and land productivity of rice cultivation in reducing poverty in Cambodia's Tonle Sap and Plain regions, where crop cultivation is concentrated largely in rice production. In particular, the findings in the two scenarios provide strong evidence in support of labor productivity.

Cambodia is unique in the sense that farmers mainly cultivate rice, especially for those residing in the Tone Sap and the Plain region, where the landscape is more suitable for rice production; therefore, rural poverty reduction in those shall begin with the improvement in productivity, land and labor, in these two agro-climatic regions. Besides, there is evidence that labor productivity will contribute more considerably to poverty reduction in both regions. Specifically, labor productivity enhancement should be directed towards farming households who have been cultivating less productively, that is having labor productivity less than average. The increase in productivity will contribute to the increasing of their per capita consumption more markedly and eventually will improve their poverty status.

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