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Impact of Irrigation on Agriculture Productivity: Evidence from Sri Lanka

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***Abstract** – Asian countries have invested heavily on irrigation projects, partly because its food staple crop, rice, needs a sizable amount of water. Sri Lanka has a long history in irrigation activities, and it embarked on a number of major irrigation projects during the post-independent period. Most of such projects were financed through external borrowings. However, impact of irrigation on agricultural productivity has limitedy been investigate in Sri lanka, and the existing studies also focused on crop productivity differential in tank-specific locations. Addressing this research gap, present study aims at investigating the irrigation-productivity nexus for the study period of 2007-2019. Speficically, by employing a multiple regression framework, this study examined the impact of irrigation on selected agricultural crops, namely Paddy and Maize. Data for the study were extracted from secondary sources published by the Department of Agriculture. Our findings indicate that there is a strong positive relationship between irrigation and crop productivity. For instance, crop productivity in irrigated areas is around 30-40 per cent higher compared to that of in the rain-fed areas. The findings imply that irrigation contributed, among others things, to sustainable development via reducing the need for additional lands for aheivving domestic demand for foods.*

Keywords: *Irrigation, Agriculture, Productivity, Paddy, Maize, Sri Lanka.*

I. INTRODUCTION

Over the decades, both developed and developing countries have invested heavily on irrigation infrastructures to provide water to, among other things, agricultural activities. In particular, Asian countries have embarked on major irrigation projects as their main staple crop, paddy, requires a sizable amount of water for maturing. According to Shand (2002), one school of thought argues irrigation started in Sri Lanka dating back to 500 BC or even before. Some of the complex system of ancient irrigation include; Kalawewa-Youda-Ela system the Angamedilla-Parakama Samdra System and the Elahera-Minneriya-Kantalai System. According to Shand (2002), under the Colonial Rule, investment in irrigation development started in a small way primarily due to personal interests of colonial rulers. Nevertheless, restoration of major irrigation works started in the 1920s and became an integral part of government's activity in the 1930s. The major break-through with respect to irrigation happened during 1970s where government embarked on its most ambitious programme, the Mahaweli Development Programme for irrigation and power. According to Shand (2002), the proportion of public investment allocated for irrigation varied from 9 per cent to 40 per cent in the 1960-87. In addition to various extension to Mahavali Development Programme, the successive government embarked in a number of trans-basin diversions in recent years.

According to Food and Agriculture Organization (FAO), around 20 per cent of irrigated agricultural lands contribute over 40 per cent to the world's production of cereal crops. A comprehensive review on irrigation projects in Asia and in other countries has confirmed the significant role that irrigation plays in crop yields, poverty reduction, and economic growth (Lipton et al. 2003). Nevertheless, previous studies have found that the impact of irrigation on crop yields vary across irrigation systems, quality of water supply (sufficiency and time accuracy), and size and distribution of land holdings. How large is the productivity differential between irrigated and rain-fed agricultural systems in Sri Lanka[1]? Or what would be the productivity gains due to irrigation in Sri Lanka? In the context of Sri Lanka, a few studies have been conducted in investigating the returns to irrigation investment (Aluwihare and Kikuchi, 1991; Kikuchi, *et. al.*, 2002; Weligamage, 2012; Thusaar, *et al., 2013;* Abeysekara, *et. al.*, 2015). Nevertheless, none of such studies aimed at investigating the impact of irrigation on agricultural productivity. This study aims at addressing the above research gap. Specifically, the study aims at analyzing the productivity differentials between rain-fed and irrigated agricultural systems.

II. Literature Survey

Crop yields everywhere in the developing world are consistently higher in irrigated areas than in rainfed areas (Rosegrant *et al.*, 1997; Hussain and Hanjra 2004; Lipton et al. 2003). About 17% of global agricultural land is irrigated contributing about 40% to the world's production of cereal crops (WCD 2000). A comprehensive review of World Bank-

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[1] Broadly speaking, there are two agricultural systems in Sri Lanka; namely rain-fed and irrigated systems.

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assisted irrigation projects during 1994-2004 (IEG 2006) and a review of irrigation projects in Asia that received assistance from the International Water Management Institute (ADB/IWMI 2005) confirmed the significant role that irrigation plays in poverty reduction and economic growth. Access to irrigation water is widely credited to be one of the major underlying factors for the substantial productivity gains obtained during the Green Revolution in Asia in the 1960s and 1970s (Pingali *et al.* 1997). In light of the recent rises in food prices and increasing demand for non-agricultural use of land, raising agricultural productivity is more important than ever. Will improvements in irrigation be able to contribute to further gains in crop productivity? If so, to what extent and how can we maximize the potential of irrigation? Some recent studies based on regional or state-level data suggest that further investments in irrigation would make only a moderate contribution to agricultural production and agricultural GDP (Fan *et al.* 2000; Fan and Chan-Kang 2004, Jin *et al.*, 2012). At the same time, however, others claim that the economic gains from further improvements in irrigation are potentially large (Sombilla *et al.*, 2002; Hussain and Hanjra 2004). There exist a large number of reports and research papers that analyze the economic impact of irrigation. However, the issues being analyzed as well as the data and methods being used suffer from various limitations including aggregation bias, small sample problems and inability to establish the true causal relationship between irrigation and impact of irrigation. In this paper we review some of the existing methods that have been used to evaluate the economic returns of access to irrigation water. Below we review some of the main methods used in these studies, especially in some of the more recent ones.

The overall objective of this study is to examine the impact of irrigation on agricultural productivity. In this context, this study consider the impact of irrigation on selected crops, namely paddy and maize. Lack of data prevents us from investigating the impact of irrigation on other field crops.

III. Methodology and Data

This study estimates following Cobb-Douglas production function to understand the relationship between yields and various agricultural inputs, the following was estimated.

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{u} \qquad (1)$$

All, except dummy variables, are in natural logarithm form. Our dependent variable (vector y) is yield (kg/acre) and X is a matrix of variables and it contains following variables;

X_1: pre-harvest labor (SLRs/acre)
X_2: pre-harvest machinery (SLRs/acre)
X_3: seed (kg/acre)
X_4: phosphorous applied (kg/acre)
X_5: nitrogen applied (kg/acre)
X_6: potassium applied (kg/acre)
X_7: average farm size (in perches)
D_1: irrigation (dummy variable: 1=irrigated, 0=rain-fed)
D_2: water stress reported (dummy variable: 1=yes, 0=no)

In the above model, β is a vector of parameters and u is the vector of disturbance term which is assumed to be independently and identically distributed.

The Department of Agriculture conducts bi-annual surveys (one in Maha and another in Yala) on the cost of cultivation of major agricultural crops. Each survey covers several hundreds of farmers and collects detailed information on yields, type of irrigation, input costs and farm gate prices. The summarized data by area (or district) are reported in Cost of Cultivation of Agricultural Crops Handbook in each season. This study extracted data from the Handbooks for the period of 2008 Maha-2017 Yala seasons. This regression model was run for Paddy and Maize. For paddy, sample size is around 300 while the sample of Maize consists of 47 observations. No of observations for paddy per year is around 30 while for Maize it is just 4 observations.

IV. Results and Discussion

Irrigation Investment

During the first few years of the independent Sri Lanka, then government spent around 5-7 per cent of total government budget on irrigation and this share declined gradually in subsequent years till 1980s (Kikuchi, *et.al.*, 2002). With the initiation of Accelerated Mahavali Development Programme, government expenditure on irrigation jumped nearly 5 per cent of its total budget. The above project made a huge impact on today's irrigation infrastructures in the Dry Zone of Sri Lanka. With the completion of its major components, public investment on irrigation declined gradually and around 1 per cent of the total government budget allocated for irrigation development by the end of 1990s. Limited availability of public funds as well as the completion of major irrigation projects were the main reasons for the decline in public investment in irrigation in early 2000. Nevertheless, a number of new irrigation shemes were initiated since 2005 and accordingly a sizable share of public investment channeled into the irrigation sector in subsequent years.

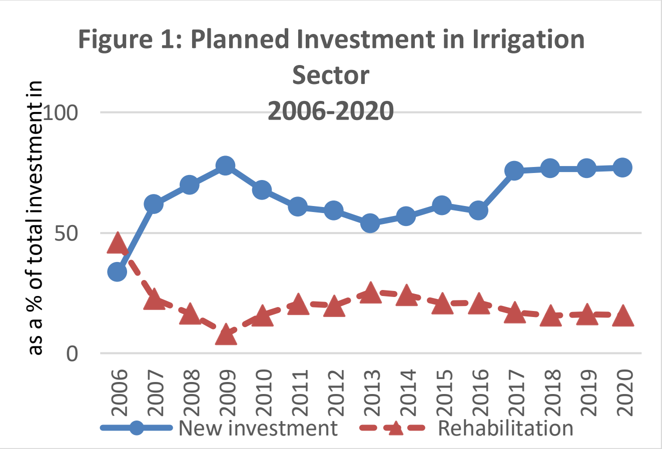


Figure 1: Planned Investment in Irrigation Sector 2006-2020

Source: Public Invesment Programmes (various issues), Department of National Planning, Sri Lanka

For instance, the share of public investment on new construction increased from 30 per cent in 2006 to 80 per cent in 2009 (see Figure 1). The end of the civil war in 2009 paved the way for new irrigation investment and remaining components of the mega Mahavali projects were started with the Asian Development Bank funds during the post 2010 period. In addition, government secured finances through bi-lateral sources in engaging in mega irrigation projects such as Moragahakanda. As a result of those initiatives, irrigation water is available to many parts of the Dry Zone in Sri Lanka. An increase in cropping intensity of paddy and its total production is the provision of water through irrigation shcemes (Kikuhci *et. al.*, 2002).

Productivity Differentials

In Sri Lanka, there are two seasons of cultivation, namely Maha Season (September-March) and Yala Season (May-August). Cultivation during the Maha Season is mainly through rain water where Monsoon seasons are in operation. During the Yala Season, farmers depend on irrigation systems for cultivation, mainly for paddy cultivation.

Figure 1: Paddy Productivity Differentials: Irrigated Vs. Rainfed

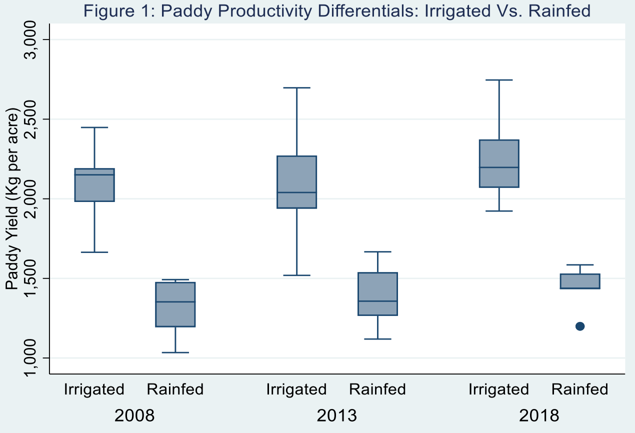
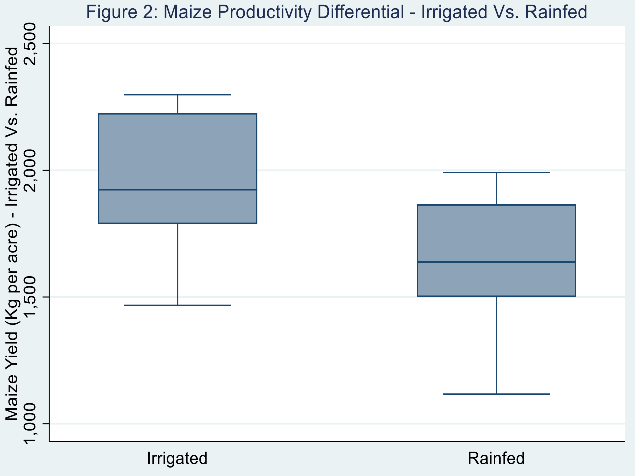


Figure 2: Maize Productivity Differential - Irrigated Vs. Rainfed



Source: Author's construction. Data from the Cost of Cultivation of Agricultural Crops (*various issues)*, Department of Agriculture

During Figure 1 & 2 report average yield data on paddy and maize for irrigated lands and rainfed lands. Yield is measured, in terms of kilogram, per acre. Paddy yield has consistently been higher than in irrigated lands than that of the rainfed land during the selected years. For instance, median paddy yield in irrigated lands has been over 2000Kg whereas this figure for rainfed lands has been below 1500. It is interesting to note that, in year 2013, some irrigated areas had reported low yields than some rainfed areas. Similarly, maize productivity in irrigated lands had been higher than that of the rainfed lands. It is quite clear that this productivity differentails could be attributed to a number of factors, including the availability of water. In such a context, it is useful to examine whether it is possible to figure out any systematic differences with respect to unput use between the two agricultural system.

Table 1: Input Use - Irrigated Vs. Rainfed (per acre) - 2017

	Paddy		Maize	
Inputs	Irrigated	Rainfed	Irrigated	Rainfed
labour (LKR)	10,728	13,642	26,346	17,157
Capital(LKR)	8,059	7,799	5,932	6,480
Seeds (Kg)	50	42	6	5
TSP (kg)	39	32	55	28
Urea (Kg)	86	53	131	110
MOP (Kg)	24	30	51	38

Note: TSP=Triple Super Phosphate and MOP=Muriate of Potash
Source: Cost of Cultivation of Agricultural Crops, Department of Agriculture, 2017.

Table 1 reports data on input use by respective agriculture system for year 2017. For both Paddy and Maize, use of fertilizer was somewhat higher in irrigated lands compared to that of the rainfed lands. For instance, on average, farmers in irrigated lands used 39Kg of TSP and 86Kg of Urea for per acre of paddy while farmers in rainfed lands utilized 32Kg of TSP and 53Kg. Nevertheless, farmers in rainfed lands utilized much higher amount of MOP (24Kg per acre of paddy) than that of farmers in irrigated lands. With respect to labour and capital inputs, farmers in irrigated lands used less labour for paddy whereas use of labour for Maize production is much higher in irrigalated lands compared to that of rainfed lands.

Are productivity differentials, discussed above, attributed to the differences in input use? However, it is quite difficult to answer this question using simple descriptive statstices. In order to solve this puzzle, we control input variables in our regression analysis.

Table 1: Effect of Irrigation on Paddy Productivity

Dependent Variable: Paddy yield (log(kg/acre)

Variable	(1) Without de-trending - Both season	(2) Adjusted for time trend - Both seasons	(3) Fully adjusted for time Both seasons	(4) Fully adjusted for time Maha Season	(5) Fully adjusted for time Yala season
Constant	5.612***	4.873***	4.466***	3.902***	4.995***
	(0.321)	(0.366)	(0.506)	(0.798)	(0.611)
Pre-harvest labor costs (log(LKR/acre))	-0.0383	0.0187	0.0286	0.0819	-0.0689
	(0.0312)	(0.0338)	(0.0344)	(0.0518)	(0.0447)
Pre-harvest machinery costs (log(LKR/acre))	0.118***	0.158***	0.183***	0.179***	0.198***
	(0.0371)	(0.0376)	(0.0461)	(0.0660)	(0.0594)
Seed(log(kg/acre))	0.160***	0.158***	0.178***	0.124***	0.264***
	(0.0301)	(0.0294)	(0.0307)	(0.0432)	(0.0410)
Phosphorus applied(log(kg/acre):TSP	-0.0504**	-0.0690***	-0.0384	-0.0712	-0.0239
	(0.0234)	(0.0233)	(0.0295)	(0.0491)	(0.0379)
Urea applied(log(kg/acre))	0.118***	0.108***	0.0981***	0.176***	0.0877**
	(0.0346)	(0.0339)	(0.0340)	(0.0582)	(0.0385)
Potassium applied(log(kg/acre)):MOP	0.00582	-0.0153	-0.0280	-0.0313	0.0112
	(0.0245)	(0.0245)	(0.0251)	(0.0390)	(0.0312)
Average size of the farmland(log)	-0.00954	0.0125	0.0129	0.0355	-0.0376
	(0.0183)	(0.0187)	(0.0190)	(0.0272)	(0.0258)
Irrigation (1=Irrigated, 0=Rainfed)	0.423***	0.429***	0.425***	0.386***	0.438***
	(0.0245)	(0.0240)	(0.0245)	(0.0376)	(0.0309)
Water-stress (1= if drought/flood/lack of water)	-0.251***	-0.255***	-0.250***	-0.270***	-0.207***
	(0.0200)	(0.0196)	(0.0209)	(0.0472)	(0.0253)
Time Trend/dummies	No	Yes	Yes	Yes	Yes
Observations	300	300	300	161	139
R-squared	0.860	0.867	0.874	0.864	0.921

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; LKR=Sri Lankan Rupees

Table 2: Effect of Irrigation on Maize Productivity

Dependent variable: Maize yield (log(Kg/acre)

	Model 1	model 2	model 3
Constant	6.502***	5.388***	5.707***
	(0.635)	(0.944)	(1.152)
Pre-harvesting labour costs(log(SLRs/acre))	0.0285	0.0709	0.0336
	(0.0672)	(0.0713)	(0.0834)
Pre-harvesting capital costs(log(SLRs/acre))	0.124**	0.153***	0.139**
	(0.0505)	(0.0528)	(0.0575)
Volume of seeds (log(Kg/acre)	0.0410	0.144	0.238
	(0.200)	(0.207)	(0.226)
Urea applied(log(kg/acre))	-0.0951	-0.0171	-0.0631
	(0.0600)	(0.0770)	(0.0944)
Irrigation (1=irrigated, 0=Rainfed)	0.148***	0.124***	0.125***
	(0.0399)	(0.0420)	(0.0434)
Water-stress (1=drought/flood/lack of water, 0=otherwise)	-0.257***	-0.233***	-0.214***
	(0.0366)	(0.0392)	(0.0479)
Time Trend/Dummies	No	Yes	Yes
Observations	47	47	47
R-squared	0.730	0.746	0.812

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; LKR=Sri Lankan Rupees

Determinants of Paddy Productivity

Table 1 reports the estimated results related to the determinants of paddy productivity. Paddy yield (number of Kg per acre) is the dependent variable and the variable is enters into the model in its logarithem form. Similarly, all the variables, except dummies, enter into A number of explanatory variables were considered in explaning the variation in paddy yield. These included, pre-harvest labour, pre-harvest capital, amount of seeds, amounts of TSP, Urea, and MOP. All variables are measured per acre basis and transformed into logarithm form. One of the advantage of this transformation is that the estimated coefficients could be interpreted as elasticities. In other words, the estimated coefficient states the responsiveness in paddy yield to one percentage change in the control variable. Average size of the farmland was also introduced as an explanatory variable to account for any economies of scale effect. Our variable of interest, irrigation status, entered into model as a dummy variable. It takes 1 for irrigated agriculture system and, otherwise 0. In addition, water-stress (experiencing drought/flood conditions) dummary variable was introduced to capture any extreme events related to lack of water or abundance of water due to extreme whether conditions. Agriculture yield could be affected if the water levels declines to extremely low or reach extremely high. Water-stress dummy takes 1 if the particular year witnessed drought/flood in a given locality, and otherwise 0. As described in the methodology section, sample contains data from year 2008 to 2018, and it is possible that data may contain some time effect. Within a regression framework, the time effect could be isolated in two ways, either through an inclusion of time dummies or time trend. In our regression analysis, the time effect is treated employing both time dummies and time trend variable in alternative models.

Regression model (1) was estimated without controlling for time effect and in all other regression models, time effect was treated either using the time trend variable or year dummies. It is interesting to note that explanatory power, R^2, was above 0.80 in all the models indicating the estimated models were able to explain the variation in yield satisfactorily. The estimated models were examined against possible violation of Ordinary Least Square (OLS) assumptions by employing relevant diagnostic tests and appropriate treatments were made in addressing such violations. In particular, it was observed that all regression models violated the assumption of homocedasticity and accordingly robust standred errors were estimated.

In model (1), the estimated coefficient of irrigation dummy is positive and statistically significant at 1 per cent level of significance [0.42 (s.e.0.02)]. It implies that paddy yield is higher in irrigated lands by around 40 per cent compared to that in rainfed lands. This result is consistent across all models where time effect is treated as well as models which were estimated separately for respective agriculture seasons. Significantly positive result clearly demonstrate that irrigation has contributed immensely for productivity increase, hence, the total production. Between the two seasons, it is noticeable that productivity increase due to irrigation water is remarkable during Yala season compared to the Maha Season. For instance, productivity in irrigatae lands in Maha season is around 39 per cent where as in Yala season productivity differential is around 44 per cent. During the Maha season, water requirements remain somewhat low since Sri Lanka, both in Wet and Dry zones, receives rains through the Monsoon. Farmers heavily depend on irrigated water in the Yala season.

Among the other variables, pre-harvet machinery, seeds, amount of urea applied and water-stress variable were statistically significant in the model implying that those variables are critical in determining the paddy productivity both in Maha and Yala seasons. For instance, the estimated coefficient of pre-harvest machinery is positive and statistically significant in Model (1) through Model (5). The estimated coefficient varies from 0.16 in Model (1) to 0.20 in Model (5). This implies that 1 per cent increase in pre-harvest machinery investment leads to 0.15-0.20 per cent increase in paddy yield. This conveys a message that there is a room for improving productivity in paddy through further mechanization. Though machinery (or capital) investment significantly improves paddy productivity, our results suggest that an increase in labour does not make an impact on paddy productivity. This implies that additional labour does not play a role in improving productivity in paddy cultivation. This is a case of labour abundance in agriculture areas, as argued in Lewis two-sector model (Lewis, 1954). Amount of seeds also makes a positive contribution on paddy productivity. However, amount of seeds does not necessarily reflect the quality of seeds which is cruicial in productivity improvement. It is possible that the amount of seeds may partly reflect the changing agricultural practices adopted by farmers, such as high density farming. In such as scenario, an increase in amount of seeds used is positively relate with the productivity. Amount of TSP (Triple Super Phosphate) applied was negative and statistically significant in Model 1 & 2. Nevetheless, the estimated coefficient was not statistically significan in Model 3 though Model (5). Among the three different fertilizer types, application of Urea was significant across all the Models. It has been found that Urea is more efficient in paddy farming compared to its substitutes. The government of Sri Lanka provided part of the Urea requirements to paddy farmers under its fertilizer subsidy. Our results reaffairm that such assistance has contributed to increase paddy farming productivity. Average farm size is not statistically significant implying economies of scale is in in operation in paddy farming. This may be due to the fact the the average farm size does not vary much in data. This is because, in Sri Lanka, most of the paddy lands were distributed to farmers by the government under its Land Development Ordinance (LDO) and a farm family was granted a limited ownership, in the form of a permit to use the land, over 2-3 acres of land suitable for paddy farming. Under the LDO permit system, land ownership cannot be transferred to a person not belong to the family. Even in the case of within family ownership transfer, strict guidelines were adopted. Hence, with respect to paddy farming large and medium size farmlands are quite rare even in the Wet Zone where mostly lands are privately owned. In terms of sizes, there is a even distribution across all the districts and therefore variation in average farm size in the dataset is very much limited. The estimated coefficient of water-stress variable is negative and statistically significant at 1 per cent level of significance. The size of the estimated coefficient varies from 0.43 ri 0.39. It implies that extreme wheather condition, either drought or flood, could reduce paddy productivity by around 40 per cent regardsless of availability of irrigation water. It is interesting to note that the impact of extreme whether condition on paddy productivity is severe for farmlands cultivated under irrigation scheme compared to that of rainfed system.

Determinants of Maize Productvity

Table 2 reports the estimated results on determinants of Maize productivity. Maize production per acre (in Kg) is the dependent variable and it entered into the model in logarithm form. A number of explanatory variables were considered in explaning the variation in Maize productivity. These included; pre-harvest labour cost, pre-harvest machinery cost, volume of seeds, and amount of Urea applied. All these variables were entered into regression model in logarithm form. These transformation allows us to interpret the estimated regression coefficient as elasticities. Our variable of interest, irrigation, entered into the models as a dummy variable. It takes 1 for an irrigated agriculture system and, otherwise 0. Broadly, there are two agricultural systems in which Maize is cultivated, namely irrigated and rainfed. In addition, a dummy variable was introduced into regression models to capture whether or not the agriculture system (area) witnessed some water-stress (drought or flood) during the given year. It takes 1 if the system witnessed some water-strees in the given year, and otherwise 0. As described in the methodology section, sample contains data from year 2008 to 2018, and it is possible that data may contain some time effect. Within a regression framework, the time effect could be isolated in two ways, either through an inclusion of time dummies or time trend. In our regression analysis, the time effect is treated employing both time dummies and time trend variable in alternative models.

It is interesting to note that explanatory power, R^2, was above 0.70 in all the models indicating the estimated models were able to explain the variation in yield satisfactorily. The estimated models were examined against possible violation of Ordinary Least Square (OLS) assumptions by employing relevant diagnostic tests and appropriate treatments were made in addressing such violations. In particular, it was observed that all regression models violated the assumption of homocedasticity and accordingly robust standred errors were estimated.

Model 1 was estimated without the time effect, while Model 2 & 3 were estimated by introducing time trend and year dummies, respectively, to capture any time dependent variation in Maize productivity. In all three models, the estimated coefficient of irrigation dummy is positive and statistically significant at 1 per cent level of significance. In Model (1), where time effect was not controlled for, the estimated coefficient of irrigation is 0.15 (s.e. 0.04) whereas in Model (2) and (3) the magnitude of the estimated coefficient is around 0.12. Accordingly, it could be concluded that Maize productivity is higher by around 12 per cent in irrigated system compared to that in rainfed systems. This 12 per cent incremental grain is due to availability of water through irrigation scheme. However, it is notable that productivity impact of irrigation water is relatively low in Maize cultivation compared to that in Paddy cultivation. This is due to the very fact that water requirement for Paddy farming is relatively much higher compared that for the Maize cultivation. In other words, Paddy is a water intensive crop than the Maize.

According to the reported results in Table 2, pre-harvest machinery expenditure is a significant factor in determining the Maize productivity. In all the models, the estimated coefficient of pre-harvest machinery expenditure is positive and statistically significant. For Instance, in Model 3, the estimated coefficient is 0.14 (s.e. 0.6). It implies that due to 1 per cent increase in pre-harvest machinery expenditure increases the Maize productivity by 0.14 per cent. As in the case of Paddy cultivation, amount of labour does not make a significant contribution towards Maize productivity. This certainly indicates a situation of higher use of labour compared to machinery. Hence, additional labour makes no contribution to Maize productivity. Water-stress dummy is negative and statistically significant in all the three model. The extreme whether conditions (drought or flood) could affect the Maize productivity as in any other agricultural crop.

In this study, two crops were seclected in examining the impact of irrigation water on agricultural productivity. The selection was largely done on the basis of data availability. However, the selected crops differ in terms of water requirements. Paddy is a water intensive crop whereas Maize required moderate level of water, in particular during its early stages of growing. Nevertheless, it was revealed that productivity, related to both the crops, is higher in irrigation system compared to that in rainfed system.

V. Conclusion

Both developed and developing countries have invested heavily on irrigation, among other things, to provide required water for agricultural activities. Sri Lanka has a history of engaging in irrigation for cultivation, mainly for Paddy cultivation since rice being Sri Lanka's staple food crop. According to historical records, Dry Zone of Sri Lanka consisted of a number of small, medium, and large tanks to store rainly water to for cultivation and domestic uses. Most of such tanks were an intragal part of a major system called cascade system. During the colonial periods, lasted over 200 hundred years, those tanks were largely neglected by the rulers. Nevertheles, Sri Lanka embarked on a number of new irrigation schemes and restored a number of old irrigation systems during the post-independence period. Accordingly, a sizable share of total public investment channeled into this sector by succcesive governments. Mahavali Accelerated Development Project lanched in early 1980s was one of the large scale projects to provide water paddy cultivation in the Dry Zone. In recent years, Sri Lanka lauched a number of projects with the assistance of foreign donors. Nevetheless, a limited attempt has been made in quantifying the impact of irrigation on agricultural productivity. This study made an attempt to quantify the impact of irrigation on agricultural productivity, namely Paddy and Maize productivity. Data for the study were extracted from Cost of Cultivation of Agricultural Crops, published by the Department of Agriculture. The Department of Agriculture conducts bi-annual surveys (one in Maha and another in Yala) on the cost of cultivation of major agricultural crops. Each survey covers several hundreds of farmers and collects detailed information on yields, type of irrigation, input costs and farm gate prices. The summarized data by area (or district) are reported in Cost of Cultivation of Agricultural Crops Handbook in each season. This study extracted data from the Handbooks for the period of 2008 Maha-2018 Yala seasons. Based on the previous literature, this study employs a multiple regression framework to examine the determinants of Paddy and Maize productivity.

There are a number of key findings. First, both Paddy and Maize productivity is higher in Irrigated agricultural system than that in rainfed system. Part of the productivity differentails are attributed to the availability of irrigation water. For instance, irrigation attributes to around 40 per cent of productivity gains while this figure for Maize is around 12 per cent. With respect to both crops, it could clearly be evident that irrigation water enhances agricultural productivity. At the same time it was found that drought/flood related events made a huge impact on agricultural productivity. According to our estimates, both in rrigated and rainfed systems, extreme whether condition reduces Paddy and Maize productivity by around 20 per cent. In addition, our regression results provide evidence on the productivity effect of mechanization. An increase in pre-harvest mechanization expenditure leads to enhance productivity. For instance, an increase of pre-harvest machinery expenditure by 10 per cent leads to 2 per cent increase in Paddy productivity. With respect to Maize productivity, 10 per cent increase in pre-harvest leads to 1.5 per cent increase in productivity. These results indicate that Sri Lanka can further improve both Paddy and Maize productivity through greater mechanization. It is also interesting to note that additional labour make no impact on Paddy or Maize produvtivity. An increased use of Urea generates productivity gains in Paddy farming while use of any type of fertilizer does not make any significant impact on Maize productivity.

In summary, our results suggest that irrigation could enhance environmental sustainability while achieving economic development through enhancing land productivity. Higher productivity implies that the country could meet her food requirements with less lands thereby reducing pressure on environment. Moreover, our results indicate that public funds invested in irrigation projects have contributed to the wellbeing of the general public.

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