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Impact of access to Improved Water Source on Agricultural Labor Productivity: Case Study of Asian Developing Countries

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Abstract: Access to improve water source has become a vital element of basic social infrastructure of countries around the world even in Asian developing countries. Accordingly, this study empirically test the influence of access to safe drinking water on agriculture labor productivity for a panel of 19 Asian developing countries. The data set of 12 years (2002-2013) shall be taken from World Development Indicators (WDI) and United Nations Development Program (UNDP). Using fixed effects with Driscoll and Kraay (1998) standard errors, agriculture labor productivity positively influenced by access to improved source of water and statistically significant. Variables are taken for this study are agriculture labor productivity, access to safe water source in rural areas, access to better sanitation facilities in rural areas, age dependency ratio, agriculture land, human development index and consumption of fertilizer. The results shall try to draw the attention of the authorities of developing countries towards the issue of insufficient investment in basic social infrastructure i.e. access to improved water source while making development policies, especially in rural areas.

Keywords: Agriculture labor productivity, Access to improved source of water, fixed effect estimation with Driscoll and Kraay standard errors, Panel data, Consumption.
JEL Classification: Q18, L95, J43, C23, E21.

1. Introduction

Every year, lack of safe water for drinking and unimproved sanitation facilities jointly kill above 1.6 million children whose age is less than 5 years globally. Universally, provision of access to safe water for drinking and better facilities for sanitation caught importance, about 2.6 billion and 2.1 billion of people have increased access to safe water source for drinking and sanitation facility respectively since 1990.

In 2015, 663 million people still used unimproved source of water for drinking globally (WHO, 2015). Although gaining access improved for

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both water and sanitation but still, eight people out of ten survived without improved water sources while seven people out of ten survived without sanitation facilities in rural areas.

As the issue is crucial, the world has acknowledged that unsafe water for drinking can harm people health, lower the productivity level and living standards. Officially, first time the UN declared the ten year time period (1981-1990) as the Water Decade and acknowledged the importance of improved water for drinking and adequate sanitation facilities. This declaration has been varying time to time since 1990 and later UN announced time span from 2005 to 2015 as “Water for Life”. Access to improved water for drinking and fundamental sanitation facilities recognized clearly in the seventh MDG.

Gaining access to safer water for drinking and better sanitation supposed to be crucial in rural areas where possibility of access to infrastructure limitedly exist. Historically, access to improved source of water and satisfactory facilities for sanitation in rural areas of Asian developing countries has recorded low as compared to advanced countries. According to Rosen and Vincent (1999), time can be saved by reducing the distance for water collection. Woman, children, and peasants still have to cover long distances to gather the drinking water on foot.

The limited facilities can be explained by the lack of investments for infrastructure of providing better water supply and sanitation facilities. Generally, issue of repairing and maintaining the infrastructure exist even in the zones where these investments have been in sufficient amount.

Nankhuni and Findeis (2004) has initiated that time spent by children for water and wood collection have negative impact on school presence. Besides, Jabeen et al. (2011) scrutinized the influence of poor situation of water and sanitation facilities on health and argued that in rural areas the situation of water and sanitation is worse. Furthermore, by providing the access to safe water and better sanitation help to decrease the problem of diarrhea. Since, attendance of children in school, health of people and women income generating activities have increased by providing safe drinking water. Therefore, investments is required for providing safe water in rural areas helps to promote agricultural labor productivity.

According to Ruttan (2002) productivity in agriculture is the measure of efficiency through which inputs used in agriculture to produce specific level of output. When the combination of inputs provides maximum level of output then this productivity is supposed to be an optimal. Planning and development decision-making measurement of productivity is considered as a vital tool (Dayal 1984). It indicates the features of present performance as well as future tendencies.

A hundred years back, population of the whole World was not more than 2 billion while current population of the World is more than 7.5 billion. Asia is most crowded region as more than 4.4 billion people lived in this largest continent of the World. Most of developing countries of Asia are crowded and to feed this huge population, sufficient food is required. These developing countries rely mainly on agriculture sector.

In most developing countries, especially in rural parts, the rate of access to safe water for drinking and better services for sanitation are historically low. Access to safe drinking water have positive relationship with health of people, children attendance to school and women income generating activities. As these variables can affect the labor productivity so, trying to investigate how to access improved source of water in rural areas are influenced agricultural labor productivity of developing countries in Asia. The main objective of this research is to investigate the relationship of access to improved water source in rural areas and agricultural labor productivity level in developing regions of Asia.

2. Theoretical Framework

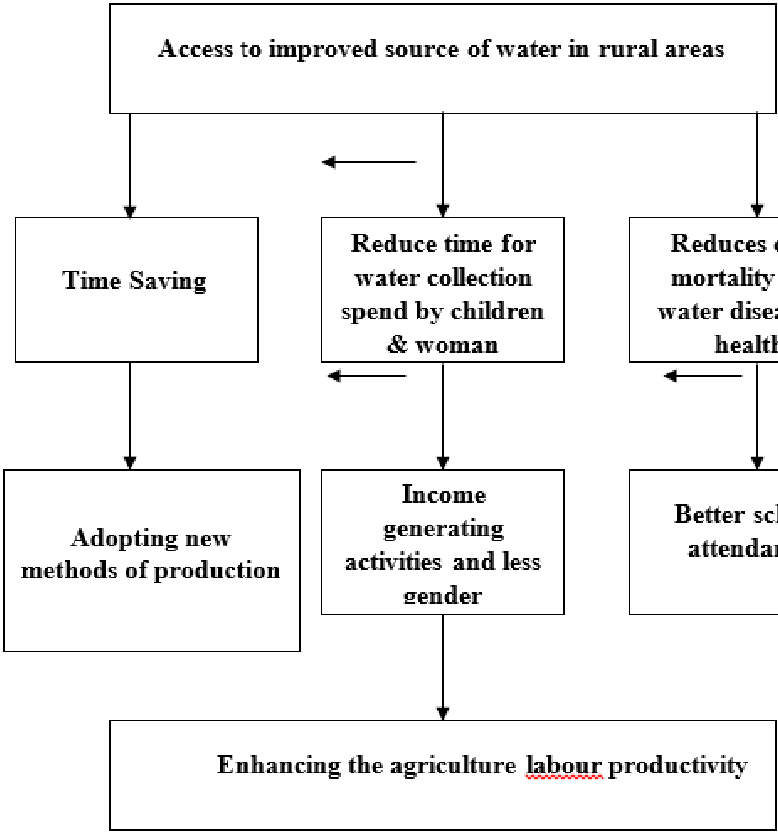
According to world health organization and UNICEF joint monitoring program (2015), children and women spend 125 million hours for collecting water daily and it is the prime responsibility of women and children in the household. Access to safe water for drinking is one of the most significant goal and assumed that it will be encouraged to execute the other MDG targets.

UN Human Rights Council has announced that the access of safe drinking water and sanitation is the human right on the basis of resolution A/HRC/RES/16/2 passed in 2011. The theoretical framework of this study which is shown figure 1, first discuss that by providing access of safe water for drinking directly helps to save time Rosen and Vincent (1999). This additional time save permits farmers to expand their activities in farms and increase production by adopting new production techniques. Women can also utilize this additional time by working in farms, this will lead to increase the agriculture production in rural areas of Asian developing countries.

Second, by providing access to improved water source leads to decrease the water collection time for children and woman as well. It will helpful to increase the school attendance of children. Women will also spend their time in income generating activity instead of spending long hours for gathering water. Furthermore, it will also reduce the gender inequality by lessen the condition on women to collect water and provide opportunity to take part in other productive activity for generating income (Koolwal and Van De Walle, 2013). According to Noga and Wolbring 2012, founded that lack of access to safe water and sanitation have negative impact on education and ability to work.

Third, it improves the health of country's people by reducing the child mortality, diarrhea, and other water related diseases. According to World Health Organization and UNICEF joint monitoring program (2015), a child dies due to water related disease in every 90 seconds. Jabeen et al. (2011) argued that situation of health has been worse in rural areas due to lack of improved water and sanitation. Improvement in health promotes better school attendance of children especially in girls and natural productivity of labor. Both of these effects help to minimize the inequality gap between women and men and this will lead to rise productivity of labor.

Figure 1: Theoretical Link between Access to improved water source and Agriculture labour productivity



Source: Author's own compilation.

3. Literature Review

Rosen and Vincent (1999) discovered that the decline in the distance covered for water collection benefits in terms of time saving. The issue of long distance covered is more important for women as she have to look after the education of children and household work. They scrutinized 12 studies and from their result, they conclude that each daytime spent for household work and time spent for each water carrier is 134 minutes and 60 minutes respectively.

Khan et al., (2001) tried to explain the effect of developed watercourses in the upper Chenab canal system of Punjab, Pakistan and for this purpose, data was collected through a survey about socio-economic condition of farmers in the district of Gujranwala and Sheikhupura. It was concluded that after improvement in watercourses increased 20% cropping strength, to irrigate a hectare 1 hour and 33 minutes saved, cropping pattern changed and farmers concerned to grow crops which require more water.

Hussain and Hanjra (2003) inspected the impact of irrigation water on alleviation of rural poverty in south-east and South Asia. The occurrence and severity of poverty falls with more access to irrigation water, influence of irrigation water on poverty is at peak where the equitable landholding distribution exist, poor communities should be targeted for the improvement of irrigation to reduce the rural poverty, discriminatory distribution of agricultural water leads to unequal distribution of land.

Nankhuni and Findeis (2004) examined the impact of children time spend for natural resources like fuel wood and water collection on children schooling in Malawi. In this analysis, data collected from 1997 to 1998 through a survey, which was conducted by MNSO and concluded that environment degradation have negative impact on children education. Study also suggested that to improve the negative effect of deforestation on education in Malawi, environment programs should be encouraged and primary school scholarship given to children in concerned areas.

Ahmad et al. (2005) examined the factors affecting the profitability of carrot cultivation and variation in its yield, during 2002 to 2003 data was collected from two districts of Punjab province. Out of total 100 farmers, 50 from each district were interviewed and Cobb Douglas production function technique applied. Study revealed that the factors i.e. seed, fertilizer, and sowing of carrot in September and October have positive impact on carrot yield as compare to the factors like input high prices, lack of financial resource and insufficient accessibility of labor during peak season.

Bakhsh et al. (2006) determined the indicators of higher yield in radish cultivation. During July-August 2003, data was collected through purpose sampling technique from Sheikhupura and Sahiwal districts in Punjab province, Pakistan where total 97 radish growers, 50 from Sheikhupura district and 47 from Sahiwal district were interviewed. The outcome of study revealed that seed, use of fertilizer nutrients, Labour used for weeding, educating the farmers, good quality seeds and measures for plant protection have positive impact on radish production and these all found to be crucial factors which affecting the radish crop.

Damisa and Yohanna (2007) studied the role of females in farm management decision making in rural areas of Chikum and Lgabi of Kaduna State. A double stage random sampling was employed in attaining the desired sample for the study. Four villages were randomly selected out of which 50 women were selected randomly from each village to form the required sample size of 200. The response collected on age in years, wealth status, education level, land holding size, and religion. Likewise, 10 aspects of decision-making were also recorded in this study to conclude the role of rural women in decision making in agriculture sector.

Okoye et al. (2008) explored the determinants of labor productivity of small cocoyam farmers in Anambra State, Nigeria. In 2005 data was collected from 120 cocoyam farmers belongs to three out of four agriculture regions in the state through a multi stage random sampling method and to explain the labour productivity log linear model derived from Cobb-Douglas function used in this study. The study suggest policies with targeted to raise planting materials, fertilizer, capital inputs, inspiring experienced growers to remain in production, measures for birth control and access to productive resources to small farmers of cocoyam.

Ogunlela and Mukhtar (2009) examined the issue of gender and role of women in agriculture and rural development in Nigeria. The authors are off the view that most of the farmers in Nigeria work at the survival and they are smallholder of agricultural land in large agricultural system while security of food for the country and development of agriculture chiefly depend on them. It is further founded that the rural women take the lead in agricultural activities than their male counterparts. The ratio of participation of men and women in agriculture sector 60-80 percent of labour total force.

Geere et al. (2010) analyzed the domestic water carrying and its consequences on health in Limpopo province of South Africa. In this study, data was collected from six rural villages of province through semi-structured interview, observations and measurement to discover water carrying done by people. To identified the significant relationship between potential risk factors and self-reported pain linear regression models was used and results revealed that water container lifted mostly by women or children on their head and 69 % spinal (neck or back) pain reported. Study concludes that water carrying effect the health through musculoskeletal disorders like neck or back pain and linked disability.

Boone et al. (2011) discovered the effects of household characteristics and distance travel to water on the water source choice, and the factors of time spend in water collection in the household by different persons. Study used detail survey data on the characteristics of household individuals, information on household wealth and assets from 73 rural and urban communities across Madagascar. It usually consist of 2190 households, which concluded that woman and girls spend more time to collect water. The response of reducing the distance travel to water source changed with gender, age of household individuals also differs in case of rural and urban areas.

Noga and Wolbring (2012) examined the benefit and cost of accessing safe water and better sanitation for the disable persons. The study concluded that isolation of safe drinking water, cleanliness and sanitation have inverse influence on health of persons, education, working ability and ability to take part in social events. It generates a conceptual framework that providing the infrastructure of safe water and sanitation for disable persons, where it is not available, may result in social and economic benefits like regained gross domestic product, decrease unemployment, improved the productivity and these benefits offset the cost associated with provision of clean water as well as sanitation for disable individuals.

Mkondiwa et al. (2013) attempted to establish a relationship between poverty and lack of access to sufficient safe water in rural areas of Malawi. Data was collected through a survey of randomly selected 1,651 households and applied Canonical Correlation Analysis technique. Finding of study revealed that there is positive correlation present among the poverty and lack of access to safe and adequate water. Accordingly, study suggest that Integrated Rural Water Resources Management should intervene to encounter the problems of poverty and lack of access to safe water in rural areas of Malawi.

Steve et al. (2014) attempted to explain the influence of adult education on the agricultural productivity of small-scale female farmers in Nigeria. The data for the study was collected from randomly selected 60 female participating in farming activities and 60 nonparticipants. Multiple regression analysis revealed that age, education level, experience of farming and extension contact significantly associated to output. There was statistical difference exist between the output and earnings of participant and non-participant females. The study concludes that there is a positive impact of education on the agricultural productivity of small-scale female maize growers.

Hauff and Mistri (2015) checked the relation of EKC with safe drinking water, ground water and waterborne diseases in India. In this study log-log, quadratic and cubic models used to investigate the income and five environmental indicators relationship for data set of 11 years (2001-2012) taken from the 32 Indian states. It is concluded that from the panel data analysis there is no EKC relation occur with environmental indicators. Moreover, income growth is present but there was no significant effect found on all environmental indicators.

4. Methodology and Data Sources

4.1. Model

In order to determine the empirical relationship between the variables, the following functional form has been used.

$$ALP = f\ (IWSR, ISFR, LAND, ADR, FC, HDI)$$

Here the agriculture labour productivity which is a function of improved water source in rural area (IWSR), other controlled variables like improved

sanitation facilities in rural area (ISFR), agricultural land (LAND), age dependency ratio (ADR), consumption of fertilizer (FC) and index for human development (HDI) which are expected to be linked to agriculture labour productivity. All the variables used in this analysis are in the form of natural log except IWSR, ISFR, and HDI. HDI is an index and its value ranges from 0 to 1 while IWSR and ISFR are already in percentage.
Econometric specification of above function is as follows:

$$(lnALP)_{it} = \beta_0 + \beta_1 (IWSR)_{it} + \beta_2 (ISFR)_{it} + \beta_3 (lnLand)_{it} + \beta_4 (lnADR)_{it} + \beta_5 (lnFC)_{it} + \beta_6 (HDI)_{it} + \mu_i + V_t + {}_{it} \ldots\ldots (1)$$

Where,

ALP = Agriculture value added per worker inconstant 2010 US$
IWSR = Improved water sources in rural area (Percentage of rural population with access)
ISFR = Improved sanitation facility in rural area (Percentage of rural population with access)
LAND = Agricultural Land (Percentage of land area)
ADR = Age Dependency Ratio (Percentage of working age population)
FC = Consumption of Fertilizer (Kg per hectare of arable land)
HDI = Human Development Index
U_i = Unobserved individual effect
V_t = Time specific effect
$\mathcal{E}_{it}$ = Error term that differs both over time and across individuals

4.2. Data

The data set of 19 Asian developing countries consist of Azerbaijan, Armenia, Bangladesh, China, Cambodia, Indonesia, India, Jordan, Kazakhstan, Malaysia, Mongolia, Maldives, Philippines, Pakistan, Sri Lanka, Saudi Arabia, Turkey, Thailand and Vietnam has been taken over the period of 2002-2013 from World Development Indicators (WDI) and United Nations Development Program.

4.3. Methodology

Panel data set consists of both cross section and time series data. To determine the link between variables by using panel data allow us to capture the changes of cross section in one time along with same cross section in different period of time. Larger number of observations in panel data gives more precise estimated results and greater degree of variability in panel data reduces multi-collinearity problem which leads to get better results of estimation. In this investigation, we used variables of 19 developing countries of Asia having the 12 year time span from 2002 to 2013.

Therefore, to estimate the relationship between the stated variables the panel data techniques for the estimation of micro panel has been applied namely the fixed effects and random effects models were used to determine the relation. The other issues of the panel data models namely panel heteroscedasticity and serial correlation has also been addressed by the technique which is robust to this estimation problems. As for the estimation procedure concerns, the data over time which covers the twelve years represents the micro panel, therefore the desired estimation technique here is the fixed and random effects estimation. The estimation procedure under the fixed effects model is carried out by the use of least square dummy variable technique (LSDV), within estimation or the transformation or the maximum likelihood technique.

A test for the presence of the individual effects can be constructed as a simple F-test comparing the pooled OLS and the fixed effects estimates. And to choose between the fixed effects and random effects the Hausman test has been applied. Under the null hypothesis of the Hausman test, the random effect model is consistent and efficient but the fixed effect model is consistent only but not the efficient.

As it can be seen from the Pesaran cross sectional dependence test in the results section that the model is facing with the problem of the cross sectional dependence. Therefore, relying on the results obtained from the fixed and random effects would be totally misleading. In this context, the Driscol and Kraay (1998) standard errors were applied to obtain the consistent and robust errors. Driscol and Kray (1998), proposed that the standard non-parametric co-variance matrix can be modified in such a way that it is robust to the very general form of the cross sectional dependence. Adjusting the standard errors in this way guarantees the consistent covariance matrix, independent of the cross sectional units even when the$N \rightarrow \infty$. Thus, the problem faced by the PCSE was resolved.

5. Estimation Results

For the estimation of panel data, various tests are conducted and the detail is given below.

5.1 Test for Multi-Collinearity

Initially, the study check the presence of multi-collinearity among the regressors with the help of Variance inflation factors (VIFs). Generally, if the VIF of variables is greater than 10 then it indicates the problem of multi collinearity present..

Table 2: Test for Multicollinearity

Variable	VIF	1/VIF
IWSR	3.00	0.332991
ISFR	6.30	0.158811
LAND	1.83	0.546902
ADR	1.80	0.556969
FC	1.98	0.505169
HDI	4.66	0.214591
Mean VIF	3.26	

Source: Author's own Compilation

As VIF of all the independent variables are less than 10 reported in table 4.1which concludes that there is no multi collinearity exist in our analysis

In case of heterogeneity present among the cross sections due to dissimilar traits like social, cultural and other aspects then Fixed or Random effect model should be used instead of OLS because of incomplete specification problem in OLS model. In panel data analysis following are two test are used as instrument to decide about the appropriate estimation technique.

5.2 Breusch and Pagan (LM) Test for Panel Effects or OLS

LM test allow us to decide whether the panel effects (fixed or random effects) or simple OLS model is suitable. Results of LM test illustrated in table 5.2 indicates the low p-value as 0.000 which leads to rejection of null hypothesis at 1% level of significance and concludes that the panel effects are present.

Table 3: Breusch-Pagan Lagrange Multiplier (LM)

H_o: Var (u) =0 or No panel effect.	
chibar2(01)	1053.18
p-value>chibar2	0.000

Source: Author's own compilation

5.3 Hausman Test: Choice between FE and RE regressions

To decide whether fixed or random effect regression suitable and for this purpose Hausman test is applied after estimating both the regressions. The results of Hausman test described in table 5.3 suggests null hypothesis of preferring RE rejected at 1% level of significance.

Table 4: Hausman Test

Ho: Preferred random effects	
Value	Decision
p-value>χ^2 =0.0002	Reject H_o and preferred fixed effect

Source: Author's own Compilation

5.4 Fixed Effects Estimates

As the result of Hausman test suggested that fixed effect are suitable and results of fixed effect estimation illustrated in table 5 showed that the variables IWSR, LAND, HDI, and ISFR are statistically significant at 1% level of significance. P-values of these explanatory variables smaller than 0.01 but ADR and FC are not statistically significant even at 10% due to their high p-value as 0.128 and 0.518 respectively.

Table 5: Fixed Effects Estimation

Independent Variables	Fixed Effects Estimation (Ordinary Least Square, OLS)	Remarks

	ALP as Dependent Variable	
	Coefficient	p-value
Improved Water Source in Rural Areas (IWSR)	0.0072** (0.0028)	0.011
Improved Sanitation Facilities in Rural Areas(ISFR)	-0.0160*** (0.0024)	0.000
Agriculture Land (LAND)	0.3905*** (0.1181)	0.001
Age Dependent Ratio (ADR)	-0.4082*** (0.1408)	0.004
Fertilizer Consumption (FC)	-0.0153 (0.0160)	0.341
Human Development Index (HDI)	4.8326*** (0.4991)	0.000
Constant	5.3542***	0.000

	(0.8629)	
	R^2	0.7667
	F(6, 203)	111.17
	p-value > F	0.000

Parentheses contain standard errors., *** Shows 1% level of Significance.,** Shows 5% level of Significance.

Access to improved water source in rural areas (IWSR) positively affect the agriculture labor productivity as the value of its coefficient 0.00723 explained that against 1 unit increase in improved water source in rural areas will lead to increase labor productivity by 0.00723% and its coefficient is statistically significant at 5%. Result of our study are consistent with the past study Noga and Wolbring (2012) and Kiendrebeogo (2012).

Sign of coefficient of agriculture land in our analysis is positive and above table shows that 1% rise in agriculture land will lead to increase agriculture labour productivity by 0.3905622% and its coefficient is statistically significant at 1%. By increasing the relative areas of agricultural land in total land area increases the labour productivity. This result is consistent with Ahmad et al. (2005), Steve et al. (2014). As the people living in rural areas of developing countries are more attached to their land. They have affection for land people work hard on their piece of land that indicates increase in agriculture output while availability of more land for agriculture reduces the cost associated with new production techniques and machinery because mechanization on large holding results in more agriculture production.

Paradoxically, in our analysis, we note that better sanitation facilities in rural areas have negative impact on agriculture labor productivity as the results indicate that against 1 unit increase in improved sanitation facilities of rural areas leads to decrease the agriculture productivity by 0.0160353% and its coefficient is statistically significant at 1%. Definitely, without the awareness of campaign regarding sanitation facilities in rural areas if sanitation facilities like latrines, public and private waste bins, drainage system for sewage removal are provided than beneficiary inhabitants may be hesitant to use sanitation facilities. Due to their habits of using natural places as a wastebasket for their waste and excreta or because people are not properly aware of its utility.

The human development index has significant and positive association with agriculture labour productivity. Result is also consistent with the study of Steve et al. (2014), Sapkota (2014), Harvey (2008), and Nadeem et al. (2011). Result indicates that one unit increase in HDI will cause 4.673976 % increase in agriculture labour productivity and its coefficient is statistically significant at 1%.

The age dependency ratio has inverse relation with agriculture labour productivity as the result of above table showed that against 1% rise in this ratio will lead to fall the agriculture productivity by 0.4082421% and its coefficient is statistically significant at 1%. Accordingly, the greater this ratio means household has non-active members as compared to active members, which results in lower agricultural productivity of household. This result is also consistent with the finding of Kiendrebeogo (2012).

The coefficient of fertilizer consumption is negative which showed that fertilizer consumption has negative impact on agriculture productivity, although it is not statistically significant. Result showed that 1% increase in fertilizer consumption would cause decrease in the agriculture productivity by 0.0153208%, although its coefficient is not statistically significant. Result of our study is not consistent with finding of past studies of Ahmad et al. (2005), Ahmed and Heng (2012). This negative sign of coefficient of fertilizer consumption is the outcome of extreme use of fertilizer on fields, which may decreased production because of damage caused to yields.

Coefficient of determination of model is 0.7667 explain that 76.67 % variation in agriculture labor productivity is due to independent variables included in our model. Over all the model of fixed effect, estimation is founded to be statistically significant at 1% significance level as F statistic value is very high. Moreover, other diagnostic test are applied and their results are discussed below in subsections.

5.4.1 Model Specification Test

As R^2 is 0.7667 indicates that 76.67 % of total variation in the agriculture labour productivity is due to explained variables included in the model while remaining 23.33% variation due to other factors that are not incorporated in the model. Ramsey test is used to investigate for probably omitted variables from model and results show that the test is insignificant by accepting the null hypothesis although for single equation model link test is applied. It revealed that estimated hat square of link test is insignificant at 1%. As both the test are insignificant which lead to conclude that the model is correctly specified. Results of both the test are tabulated below.

Table 6: Ramsey test and Link Test

Model Specification Tests	Ramsey Test H_0: Model has no omitted variables	F(3, 218) = 1.15	p-value > F = 0.3303
	link test (Single-equation estimation)	_hat	p-value =0.426> 0.000
		_hatsq	p-value = 0.457> 0.000

Source: Author's own compilation.

5.4.2 Test for Serial Correlation

As we are working with micro panel data where the periods are less than 20, this alleviates the possibility of serial correlation. For the sake of precision, we applied Wooldridge test to investigate the problem of serial correlation. Results illustrated in table 5.6 show that the value of F statistic is 2.755 p-value is above 0.05, which leads to accept the null hypothesis that there is no serial correlation present in data.

Table 7: Wooldridge Test for Serial Correlation

Wooldridge Test.	
H_0: There is no first order serial correlation present in data.	
F(1, 18)	2.755
p-value> F	0.1143

Source: Author's own compilation.

5.4.3. Test for Heteroscedasticity

If heteroscedasticity present in the model this will lead to wrong standard error of the regression coefficients as well as wrong t-values. To investigate the group wise heteroscedasticity we applied Modified Wald test. Results reported in table 5.7 indicates the rejection of null hypothesis as p-value is below 0.05 and it can be easily concluded that errors are heteroscedastic in our analysis.

Table 8: Modified Wald Test for Group Wise Heteroscedasticity

Modified Wald Test	
H_0: Residuals are homoscedastic	
$\chi 2$ (19)	1157.00
p-value > $\chi 2$	0.000

Source: Author's own compilation.

5.4.4. Test for Cross Sectional Dependence

To check the dependency across the countries we applied Pesaran CD test where the null hypothesis suggest that there is no cross sectional dependence present. Results of this test are reported in table 5.8, here the minimum value of the probability indicates the refusal of the cross sectional independence and revealed that cross sectional dependence exist between the panel in our analysis.

Table 9: Pesaran CD Test

Pesaran CD Test	
H_0: Cross sections are independent	
Pesaran test of cross sectional dependence = 2.963	Pr = 0.0030
Average absolute value of the off-diagonal elements	0.436

Source: Author's own compilation

The study applied Driscoll and Kraay standard error with fixed effect estimation as the result of Table 5.7 and 5.8 indicates the presence of group wise heteroscedasticity and cross sectional dependence in our analysis. Result of estimation with Driscoll and Kraay are discussed below in Table 10.

5.5 Fixed Effects Estimation with Driscoll and Kraay Standard Errors

The test for group wise heteroscedasticity and Pesaran test for cross sectional dependence advocate that error structure is correlated and heteroscedastic among the countries and call for fixed effect estimation with Driscoll and Kraay (1998) standard error. Results reported in table 5.9 reveals that standard error of coefficients of improved water source, improved sanitation facilities, fertilizer consumption and human development index with Driscoll and Kraay (1998) technique reduced and agriculture land, age dependency ratio standard error increased as compared with fixed effect estimation whereas the estimates of coefficient of fixed effect remain same. Coefficient of Fertilizer consumption is statistically remain insignificant, moreover, improved water source, improved sanitation human development index are statistically significant at 1 % significance level. Age dependency ratio and agriculture land are significant statistically at 5 % significance level. The value of R^2 remain same as 0.7667 as it was in fixed effect estimation while large value of F= 435.07 suggest over all significance of model. From all this, we can conclude that access to improved water source in rural areas positively affect the agriculture labour productivity that is consistent with result of Kiendrebeogo (2012).

Table: 10: Estimation with Driscoll and Kraay standard errors

Dependent Variable is Agriculture Labour Productivity (ALP)		
Independent Variables	FE Estimates with Driscoll and Kraay standard errors	
	Coefficient	p-value
Improved Water Source in Rural Areas (IWSR)	0.0072*** (0.0017)	0.002
Improved Sanitation Facilities in Rural Areas(ISFR)	-0.0160*** (0.0019)	0.000
Agriculture Land	0.3905**	0.011

(LAND)	(0.1287)	
Age Dependent Ratio (ADR)	-0.4082** (0.1513)	0.021
Fertilizer Consumption (FC)	-0.0153 (0.01994)	0.459
Human Development Index (HDI)	4.8326*** (0.3125)	0.000
Constant	5.3542*** (1.212)	0.001
R^2	0.7667	
F(6,11)	435.07	
p-value > F	0.000	

Shows 5% level of Significance, * Shows 1% level of Significance, Parentheses contain standard errors.

6. Conclusions and Policy Recommendations

In order to discover the effect of access to safe drinking water on agriculture labor productivity, proxy of five variables as ISFR, LAND, ADR, FC, and HDI have been included in model to control the effect of these variables on labor productivity. We reached at the concluding remarks that access to improved water, human development index are positive whereas age dependency ratio founded to be negative, as the signs of these variables are according to theory and expectation. Improved sanitation facilities is negative and statistically significant It is known that in rural areas of developing countries awareness of sanitation facilities are historically remain very low as compared to developed nation and the habit of people to use open spaces as wastebasket responsible for its negative sign. Agriculture land is positive and significant as most of Asian developing economies are agrarian, people are attached to land, work hard on their land and here mostly land is fertile due to this its sign is positive. In a paradoxical way, fertilizer consumption has negative impact on agriculture labor force, although it is statistically insignificant. From the start of the analysis, we expect that the effect of access to safe water for drinking will be positive, so after applying the econometric techniques we conclude that its sign is positive and significant at 1% based on above results.

These outcomes have significant policy implications. Policies for rural sector progress and to cope with problem of poverty in Asian development countries are needed to stress on providing fundamental social infrastructure like facilitate people with improved water sources in these areas. Provision of safe drinking water can be done by setting up piped water into house, free water taps, tube well, protected dug well and rainwater collection in these areas. Government should encourage development programs regarding provision of improved water sources in rural areas, as it will helps to boost the labor productivity in these areas.

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