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# 191. Inverse Relationship between Poverty and Willingness to Pay for Sustainable Environment

"Shah Muhammad Kamran[a], Fan Hongzhong[b], Israr Ahmad [c]*, Shafie Moiz Hali[d]" ,

, [a,b] School of Economics, Wuhan 430074, China ,[c] School of Management, Wuhan 430074, China
,[d] Collage of Public Administration, Wuhan 430074, China
Huazhong University of Science & Technology, 1037 Loyuo Road, Wuhan, 430074, China
E-mail address: israrahmad.dir@gmail.com

## Abstract

Personal interest is prime interest; except some exceptional cases mostly people around the world always pursuit for their own (and family) concerns first and letter for rest of the world. It was tried to determine the relationship between poverty and willingness to pay for a better and sustainable environment. Panel data model and techniques were used for the econometric analysis. Hypothesis was developed and tested for the whole panel data and then for different regions of the world with high/low income groups and developed and developing countries. Results of the study support the hypothesis “more the poverty, less the willingness to pay”; there is inverse relationship between poverty and willingness to pay for the sustainable development and eco-friendly and sustainable environment. The dream of sustainable development cannot be fulfilled without the measures for the alleviation of poverty at minimum possible level.



***Keywords:*** *"deforestation; poverty; sustainable development; willingness to pay"*

## 1. Introduction

Sustainable development is commonly used phrase in research and planning, hence generate many responses. Generally, the concept of sustainable development is an initiative to combine efforts for environmental issues with socio-economic matters. Economic growth, social equality and environmental protection are three main parts of sustainable growth, many researchers agree that these three ideas are the overall concept of sustainability.

The most quoted definition was coined by Brundtland [1] "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. According to this definition sustainable development can further be divided in two concepts;

- The essential **needs** of the world especially of the poor, to which extra priority should be given,
- **Limitations** of the environment’s ability to meet the needs of present and future, imposed by the level of technology and social structure.

With the first concept, it can be derived that without the fulfillment of the needs the goal of sustainable development cannot be achieved. Not only the needs but with special emphasize on the needs of the poor people living in the world who are not even able to think about the world and development no matter sustainable or unsustainable, their first priority is to fight with poverty.

Poverty is generally the scarcity of necessities, or simply a lack of necessary amount of material possessions or money to accomplish daily needs. It is a complex concept including, social, political and economic origins. Poverty can be

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defined as absolute; which refers to the lack of necessary means to meet basic needs such as clothing, shelter and food, whereas, the relative poverty refer to social and economic condition of individual with compared to rest of the society [2], [3]. In economics, income poverty means a family is unable to meet federally recognized standard that vary across the nations. Experts often seek to characterize the families whose economic positions do not meet the minimum acceptance level.

The international standard of extreme poverty is set to the possession of less than 1$ a day [3]. The World Bank, set two different standards for poverty headcounts, World Bank measures the poverty on the basis of individuals instead of family income poverty. It revised the standards in 2011 and the new levels are $1.9 a day and $3.10 a day.

Any society or country is a subsystem of a huge global system of the world and life on earth, every individual in this system plays its role to upgrade or degrade it. Individuals and societies consume the resources they already have or they buy on a price they can afford, to fulfil their needs. One of the most important resource the world and human being have are the trees and the reserves of trees namely forests. Forests have a pivotal role in minimizing the threat of natural disaster e.g. droughts, floods, landslides and other extremely perilous events. At universal level, forests diminish climate change by carbon sequestration, balancing oxygen, carbon dioxide and humidity in the air, they also shield watersheds, which provide 75% of freshwater globally. Forests are the most diverse ecosystem, cradle about 80% species of animals, insects and plants, and also provide jobs, security and shelter to the forest-dependent communities. Around 1.6 billion people - including more than 2,000 indigenous cultures - depend on forests for their livelihood. More than 13 million people across the world are directly employed in the formal forest sector [4], [5].

Despite the importance of forests for the survival of life on earth human activities are still making them to disappear. Human activities are one of the biggest or can be said that the biggest cause of deforestation. Most of the land occupied by human has faced deforestation and it is an ongoing process. During 1990 to 2015 world has lost around 129 million hectare of forests, and it is not only the forests lost but the degradation of whole ecosystem, with terrible consequences[4].

In continent Africa, annual deforestation reached at 650 ~~million~~ thousand hectares. Increasing demand of agriculture land, grazing fields and infrastructure, growing need of energy products (charcoal and firewood) and construction inputs are the basic cause of this severe deforestation [6]. Americas loss the forests at an average rate of 0.4% annually in 1990s [7]. Situation in continent Asia is not much different, for instance Thailand lost 28% forests during 1976 and 1989 [8]. Indonesia due to its wood based products trade, deforested 300 thousand hectares/year of its land in 1970s, while this figure reached to 600 in 1980s and it was not the end in 1990s deforestation rose to one million hectare annually [9].

Keeping in view the importance of forests and the poor around the world, it can be stated that the concept of sustainable development cannot be achieved without considering the poverty and forests as the determinants of development. In this study it was tried to find the relationship between these two determinants. This study also made significant contribution to the literature on the determinants of deforestation. Deforestation~~Forest~~ have never been used before as the indicator of willingness to pay for the better and sustainable environment and growth.

Willingness to pay is the maximum price at/or below which a consumer will definitely buy one unit of product, while in economics some researchers theorize it as a range not as a fix point [10]. If sustainable development and environment is considered as commodity and poor as buyer then this research circled the behaviour of buyer to purchase sustainable environment and development.

## 2. Research Methodology

Instrumental Variable technique with panel data estimation is used for the analysis in this study.

Instrumental Variable (IV) technique established by Philip G. Wright and Sewall Wright and further developed by Olav Reiersøl [11]–[13]. IV technique allow for consistent estimation when the independent variables are correlated with the error terms in the model, this correlation occur when changes in the dependent variable change the value of one or more than one of the covariates in the regression. Omitted variables also effect the independent as well as dependent variables, or in other case the covariates are subject to measurement errors. These issues are referred to endogeneity problem. With the presence of endogeneity, OLS produces inconsistent and biased estimates [14]. Simply an IV is a variable that does not belong to the explanatory equation but is correlated with the endogenous explanatory variables, conditional on the

value of other covariates.

However, there are some problems associated with Instrumental Variables., Bound et al (1995) stated that IV generally produce inconsistent estimates, if they are correlated with error term and problem of weak instrument is also an other serious issue. Results with weak instruments will be poor and predicted values will have very little variation [15].

IV strength can assessed directly as the instruments and endogenous covariates both are observable. A normal rule of test is to check whether the omitted instruments are irrelevant in the first stage regression [16]. Relationship of instruments with the error term in the regression can't be measured in exactly identified models. But, if the there is an over identified model then over identification can be used to test the correlation. And the assumption is that, the residual should not be correlated with the exogenous variable if the instruments are really exogenous [17].

### 2.1. Empirical Model and Data Description

The selection of the sample countries for the empirical analyses are based on the previous studies of Palo et al (1987) and Scrieciu (2007) that they conducted to assess the reasons of deforestation [18], [19]. They include 68 and 50 countries respectively in their research. Initially 20 countries are selected on the basis of high population from each continent, North America was not included in the analysis as there are three big countries are highly populated e.g. Canada, Mexico and US and rest of the countries are so small in respect of population. Same is the case with the continent Australia. Nigeria is excluded from the Africa while China, India, Pakistan and Indonesia was also excluded from the countries in Asia ,Russia from Europe and Brazil from the South America were excluded for same reasons.. These countries from the respective continents were eliminated to avoid the outlier following the practice of Palo et al (1987) and Scrieciu (2007). North Korea for typical reasons, whereas Iraq, Syria, Afghanistan, Yemen from Asia and many highly populated countries form the Africa were also eliminated from the sample as they are war torn states, so the respective data was not available for at least one modelled variable throughout the whole period analysed. Therefor the final dataset includes 70 countries.

The 70 countries from the four continents (Africa=16, South America=18, Asia=16 and Europe=20) were repeatedly observed over 13 years from 2001 to 2013. The dataset employed in the regression analysis fetched from the World Bank, World Development Indicators online database 2016. The GDP per capita is constant at 2011 US dollars. The poverty measure is the headcount index of international poverty line at US$3.1 per day. However, there were some missing values in the dataset, to avoid an unbalanced panel dataset that may complicates the estimation, and missing values were extrapolated by fitting a trend for each country to the existing values. This results in 871 observations and 75 parameters (70 countries plus 5 modelled independent variables), rendering 796 degrees of freedom. Table 1 presents the descriptive statistics of variables.

### 2.2 Econometric Model

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$$lnForest_{it} = \beta_0 + \beta_1 lnPoverty_{it} + \beta_2 lnPopulation_{it} + \beta_3 lnAgriLand_{it} + \beta_4 DumYear_2 \ldots\ldots\ldots \beta_{16} DumYear_{13} + \eta_i + \lambda_t + \mu_{it} \quad (1)$$

In above models, i and t denote country and time, respectively; $\beta_0$ is a constant; $\beta_1 - \beta_{16}$ are the coefficients of the respective variable to be estimated; $\eta_i$ and $\lambda_t$ stand for the place and time-specific effects, respectively; and $\mu_{it}$ refers to a random disturbance term. The variables in the model are as follows:

Explained variable *lnForest* is the natural logarithm of forest covered area of the particular country in square kilometres. This is used as the proxy for the willingness to pay. It is hypothesized that it has an inverse relationship with the poverty, forest area will be reduced with the increase in the poverty headcount.

Explanatory Variables:

*lnPoverty* is the natural logarithm of the population living below the international poverty line in particular country at that specific year.

*lnPopulation* is the natural logarithm of the overall population of the particular country at that specific year. It is used as the control variable. Many researchers argued that increasing population is one the major cause of the deforestation in the world [20], [21].

*lnAgriLand* is the natural logarithm of the area for agriculture use including cultivation and graze land of the particular country at that specific year. Lot of previous studies concluded that increasing use of land for the agriculture purposes cause the decrease of forest area [22], [23], it is also used as the control variable.

**Table 1: Variable Descriptive Statistics**

| Variable Category | Variable | Description | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|---|---|
| Dependent Variable | *lnForest* | Area of Country Covered with Forests | 871 | 4.777 | 0.646 | 2.994 | 6.196 |
| Independent Variable | *lnPoverty* | Poverty headcount | 871 | 6.364 | 1.109 | 1.135 | 8.071 |
| Control Variables | *lnAgriLand* | Land for Agriculture use | 871 | 5.016 | 0.566 | 3.582 | 6.337 |
| | *lnPopulation* | Population of Country | 871 | 7.302 | 0.415 | 6.416 | 8.196 |
| Instrumental Variables | *lnAgriLabor* | Labor engaged with agriculture activity | 871 | 6.035 | 0.919 | 0.723 | 7.539 |
| | *lnUnemployment* | Unemployment in the country | 871 | 5.748 | 0.487 | 3.887 | 6.790 |
| | *lnRurPopulation* | Rural population | 871 | 6.863 | 0.533 | 5.233 | 8.024 |

Instrumental Variables
*lnAgriLabor*, is the natural logarithm of labor force engaged with agriculture and associated sector of the particular country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model. Geda et al (2001) states that engagement of labour in the agricultural activities is one of the main cause of relative poverty in a society [24].

*lnUnemployment* is the natural logarithm of the unemployed labor force of the particular country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model. Rate of unemployment in a country is one of the important determinants of poverty, it is not only a problem in the developing world but it also effect the most advance democracies in the west [25].

*lnRurPopulation* is the natural logarithm of the population living in rural areas in the particular country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model. Ratio of urban and rural population in the country effect the relative poverty [26].

## 3. Results and Discussion

Stata12 statistical software package was used to perform the regressions and to perform the model estimation by employing static panel and instrumental variable regression. There is huge difference between the development levels of continents, in order to avoid estimation bias regressions were conducted separately for all four continents. Static panel and instrumental variable regression was conducted. Table 2 lists the regression results for the effects of economies of poverty (*lnpoverty*) and other control variables agriculture land and population (*lnAgriLand* and *lnPopulation*) on the deforestation. All the results of the joint significance test (F test) with the model indicate that the model is generally effective. When statistic panel and instrumental variable estimations are conducted, we use the p value accompanied in the Hausman test to determine whether to choose a fixed or random effect model, the test statistic of weak instrumental variable is the minimum eigenvalue statistic; if the p value of Hausman (FE vs RE) test for all regressions is larger than 0.1; the results of the stochastic effect is analysed. If not, the result of fixed effect is analysed and used for the discussion and conclusion. Severe endogeneity may result in the deviation or inconsistency of OLS estimation results, that's why instrumental variable method (IV) for the estimation is used while *lnAgriLabor*, *lnUnemployment* and *lnRurPopulation* were used as instrumental variable and *lnPoverty* was instrumented. Instrumental Variable technique is also used for robustness check, regression results are presented in Table 2 and Table 3 for fixed effect and random effect respectively. The results showed that overall model fitness is good (Prob. F-stat 0.00).

**Table 2. Regression results showing that Poverty affects the forest differently in different parts of the world (2001–13)**

| | 1-World | 2-World | 3-Africa | 4-America | 5-Asia | 6-Europe | 7-Non-OECD | 8-OECD |
|---|---|---|---|---|---|---|---|---|
| | FE | FE-IV | FE-IV | FE-IV | FE-IV | FE-IV | FE-IV | FE-IV |
| *lnPoverty* | -0.00584*** | 0.0113 | -0.605* | -0.164*** | 0.0274 | 0.0107*** | -0.129** | 0.01635 |
| | (-0.00221) | (-0.012) | (-0.32) | (-0.0423) | (-0.0282) | (-0.0036) | (-0.0549) | (-0.00951) |
| *lnAgriLand* | -0.289*** | -0.266*** | -0.690** | -0.500*** | -0.0608 | -0.0987* | -0.0678 | -0.1560*** |
| | (-0.0299) | (-0.0305) | (-0.272) | (-0.123) | (-0.0548) | (-0.0527) | (-0.106) | (0.06024) |
| *lnPopulation* | -0.154*** | -0.218*** | 1.456 | -0.193 | -0.0713 | -0.123** | 0.402 | 0.50220*** |
| | (-0.0238) | (-0.0407) | (-1.084) | (-0.223) | (-0.0686) | (-0.062) | (-0.253) | (0.09788) |
| *lnAgriLabor* | -0.0137* | | | | | | | |
| | (-0.00731) | | | | | | | |
| *lnUnemployment* | 0.00021 | | | | | | | |
| | (-0.0058) | | | | | | | |
| *lnRurPopulation* | -0.1348*** | | | | | | | |
| | (-0.0244) | | | | | | | |
| Constant | 7.463*** | 7.623*** | 2.411 | 9.571*** | 5.303*** | 5.990*** | 3.084 | 1.6524 |
| | (-0.22) | (-0.284) | (-5.047) | (-1.412) | (-0.538) | (-0.417) | (-1.913) | (0.911) |
| $\eta_i$ | No | No | No | No | No | No | No | No |
| $\lambda_t$ | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ Sqr | 0.4397 | 0.4221 | 0.0009 | 0.661 | 0.1019 | 0.5009 | 0.0001 | 0.5994 |
| N | 871 | 804 | 192 | 216 | 192 | 204 | 612 | 192 |

Note: *, ** and *** indicate that estimates are at the 10%, 5% and 1% significance levels, respectively, bracketed value is the standard error of the corresponding test statistics. The estimations reported in this table include year dummies.

Analysis presented in this study proposed that it would not be fair to present a generalized macroeconomic explanation of deforestation, because results are varying from region to region and the results for the global data are not statistically significant and effective. But the results of the regional data along with group of countries on the basis of development showed efficient and significant estimates.

In both regression (Table 2 regression 1 and Table 3 regression 1), random and fixed effect poverty is significant at 1% with negative sign which was expected, and this support the hypothesis of this study, that poverty has an inverse relationship with the forestation‡. However, the regressions with the instrumental variables (Table 2 regression 2 and Table 3 regression 2), poverty show direct relationship with forestation but the results are not statistically significant at any level. Increment in the agriculture use of land, rural population and engagement of labor in agricultural activities all variables have negative and significant effect on forestation, both with random and fixed effect models. While, unemployment shows positive but statistically insignificant effect, which is irrelevant in the regression, but it shows good results to be used as instrumental variables.

Regression results for the effect of poverty on the forestation in Africa (Table 2 regression 3 and Table 3 regression 3) show negative coefficient of poverty with 5% and 10% significance in fixed and random effect models respectively. Addition in the agriculture land also have a negative effect on the forestation in Africa and these results are significant at 5% in both fixed and random effect estimation. Whereas, population shows positive but statistically insignificant results.

Regression results for the effect of poverty on the forestation in America (Table 2 regression 4 and Table 3 regression 4) show negative coefficient of poverty with 1% significance in both fixed and random effect models. Addition in the agriculture land also have a negative effect on the forestation in America at 1% significant level with fixed effect estimation but agriculture land is not significant with random effect model. Whereas, population shows negative but statistically insignificant results.

Regression results for the effect of poverty on the forestation in Asia (Table 2 regression 5 and Table 3 regression 5) show positive but statistically insignificant with both fixed and random effect models estimation. Addition in the agriculture land have a negative but statistically insignificant with both fixed and random effect on the forestation in Asia. Whereas, population shows negative but statistically insignificant results.

Regression results for the effect of poverty on the forestation in Europe (Table 2 regression 6 and Table 3 regression 6) show positive at 1% significance with both fixed and random effect models estimation. Addition in the agriculture land have a negative and significance effect on forestation with fixed effect estimation, while negative and insignificant results with random effect model on the forestation in Europe. Whereas, population have negative and significance effect on forestation with fixed effect estimation, while negative and insignificant results with random effect model on the forestation in Europe.

**Table 3. Regression results showing that Poverty affects the forest differently in different parts of the world (2001-13)**

| | 1-World | 2-World | 3-Africa | 4-America | 5-Asia | 6-Europe | 7-Non-OECD | 8-OECD |
|---|---|---|---|---|---|---|---|---|
| | RE | RE-IV | RE-IV | RE-IV | RE-IV | RE-IV | RE-IV | RE-IV |
| *lnPoverty* | -0.00622*** | 0.0171 | -0.662** | -0.118*** | 0.0361 | 0.0102*** | -0.135** | 0.0173 |
| | (-0.00233) | (-0.013) | (-0.307) | (-0.0431) | (-0.0317) | (-0.0037) | (-0.0577) | (0.0097) |
| *lnAgriLand* | -0.211*** | -0.191*** | -0.556** | -0.106 | -0.0127 | -0.0535 | 0.104 | -0.131** |
| | (-0.0304) | (-0.0316) | (-0.253) | (-0.113) | (-0.0585) | (-0.0535) | (-0.0826) | (0.0587) |
| *lnPopulation* | -0.132*** | -0.205*** | 1.596 | 0.1 | -0.0536 | -0.0992 | 0.490** | 0.516*** |
| | (-0.0249) | (-0.0434) | (-0.977) | (-0.211) | (-0.077) | (-0.0635) | (-0.246) | (0.0962) |
| *lnAgriLabor* | -0.0146* | | | | | | | |
| | (-0.00768) | | | | | | | |
| *lnUnemployment* | 0.00364 | | | | | | | |
| | (-0.00617) | | | | | | | |
| *lnRurPopulation* | -0.1405*** | | | | | | | |
| | (0.0258) | | | | | | | |
| Constant | 6.906*** | 7.118*** | 1.068 | 5.322*** | 4.876*** | 5.595*** | 1.62 | 1.4263 |
| | (-0.233) | (-0.304) | (-4.491) | (-1.243) | (-0.599) | (-0.43) | (-1.696) | (0.8935) |
| $\eta_i$ | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $\lambda_t$ | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-Sqr | 0.3625 | 0.4068 | 0.0086 | 0.515 | 0.0639 | 0.2925 | 0.1759 | 0.1982 |
| Observations | 871 | 804 | 192 | 216 | 192 | 204 | 612 | 192 |

Note: *, ** and *** indicate that estimates are at the 10%, 5% and 1% significance levels, respectively, bracketed value is the standard error of the corresponding test statistics. The estimations reported in this table include year dummies.

To estimate the effect of poverty on the forestation or the relationship between deforestation and poverty results were also estimated differently for the highly developed (OECD) countries and for the countries those are not the member of the OECD. Results of the regressions (Table 2 regression 7 & 8 and Table 3 regression 7 & 8) in the OECD countries poverty has no significant effect on the forestation with both random and fixed effect model estimations, while the poverty has a negative and significant effect on the forestation in the less developed countries. These results are consistent with both random and fixed effect models. Increase in the land use for the Agricultural activities have varying effect on forestation, in case of OECD countries it has a negative and significant impact on the forestation with both fixed and random effect estimation. However, in non-OECD countries it has positive results with random effect and negative with fixed effect model estimation, but in both estimation the results are insignificant. Interestingly population has a positive and significant effect on the forestation and results with both fixed and random effect estimation shows that an increase in the population may increase the forest covered areas.

## 4. Conclusion

Based on panel data of 70 countries from 2001 to 2013, this study analysed the current determinants of deforestation. It examined how changes in major economic indicators may affect the deforestation in any country and region.

Population growth and deforestation in this study showed an inverse relationship for the whole sample, while the same population showing a significantly positive relationship with the forestation in the highly developed democracies around the world, it may be because of their awareness for importance of forests and technological advancement and it can also be the result of their dependence on the more sophisticated technologies and economic structures. These results are consistent with the study of Rupasingha and Stephan (2007) who stated that population growth rate are one of the main cause of deforestation around the world [27]. However, these results are in contrast with study of Angelsen & Kaimowitz (1999) who concluded their study by saying that population and deforestation thesis is based on the weak modeling and lack of accurate data [28].

Increase of land area being used for the agriculture activities have a significantly negative effect on the forest covered area, and this effect is same around the world even in the most developed countries with highly level of scientific technologies. These results are consistent with the previous studies of Karen (1998) and Sanjukta & Todd (2003), who argued that without adoption of more advanced and efficient scientific and productive technologies and serious research for more yield with less inputs including land the pressure on forest keep increasing by leads to more deforestation [20], [23].

Results of the estimation shows that poverty cannot be ignored in terms of sustainable environment, although these results are not consistent with the detailed study of Angelsen & Kaimowitz (1999), but they rejected this hypothesis on the basis of weak modeling and lack of appropriate data. But, many other researchers after the study of Angelsen & Kaimowitz (1999) used more filtered data and more sophisticated modeling techniques and find a positive relationship between determinants of poverty and deforestation [20], [23].

This study analyzed deforestation from the perspective of the poor who constituted nearly 35% of the world population (WDI, 2012). The poor makes their decision to deforest land based on the parameters of choice and alternates they have, such as the prices and accessibility to the fuel and irrigation facilities to the un-forested land able for agricultural activities. Behaviour of the poor is based on the fulfilment of basic needs, they will continue deforestation as long as they have unfavourable living conditions with their current income level. The adoption of any policy in favour of forestation could only make difference if it also consider the poverty as a cause of deforestation and make efforts for the alleviation of poverty. If poor don't have the basic needs fulfilled then they have no other way to fulfil but deforestation.

Results of this study support the hypothesis that poor people are less or almost no willingness to pay for the better and sustainable environment, as they are already suffering from lack of daily life necessities and they will go for the fulfilment of their basic needs no matter at what cost they are getting it. These results also leads to a broad spectrum of policy implications. Due to different conditions priorities may vary in countries, countries with high economic development, formulate their future polices with the environmental protection at priority, while a country already suffering from poverty and low per-capita income will not consider environment protection as a future policy goal. Most notably, deforestation can be taken as an endogenous economic course, compelled logical daily life decisions, made by the people living in the country or region. Therefore, government environmental and development policies should be derived on the basis of the fulfilment of the needs of the people and to control the elements that directly and indirectly affects deforestation, like education, unemployment, ratio of population engaged with agricultural activities and etc. in order to increase awareness and willingness to pay for a better future.

The Idea of sustainable development cannot be materialized until the alleviation of poverty from the world. Mahatma Gandhi once beautifully said "There are people in the world so poor and hungry, that God cannot appear to them except in the form of bread."

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