Influence of Climate and Non-Climatic Factors on Global Food Security Index: A Cross-Sectional Country-Wise Analysis

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Abstract

The present study estimates the influence of climatic and non-climatic factors on global food security (GFSI) for 103 across countries. It also identifies that which group of countries is highly vulnerable in food insecurity due to climate change and variability in socio-economic variables. For this, global food security index (GFSI) which is created by Economist Intelligence Unit (EIU) considers as a dependent variable, that is regressed with climatic factors (i.e., annual mean temperature and annual precipitation) and non-climatic variables (i.e. cereal yield, per capita land under cereal production, population growth rate, consumer price inflation and forest area) using linear regression model. Estimates indicates that climatic factors (i.e., mean temperature and precipitation) show a negative and statistically significant influence on GFSI. Furthermore, empirical results based on ordinary least square (OLS) model shows that GFSI may be decreased by 1.70% with 1% increase in mean temperature. GFSI has also negatively influenced with rising population growth rate and inflation. Lower and low-income group countries are most vulnerable as compared to high income group countries. The major findings of this study suggested that price inflation and high population growth rate are most responsible variables for food insecurity in most developing countries like India.

Keywords: Climatic And Non-Climatic Factors, Global Food Security Index; Developed And Developing Economies.

JEL Classification: Q18, Q54 and P36

1. Introduction

Existing studies about climate change and its impact on various sectors of the economy shows that climate change has a negative and significant impact on all sector of the economy (e.g., Kumar et al., 2016; Singh et al., 2016). Numerous of studies have provided empirical evidence that agricultural productivity and food security have negatively affect due to climate change across economies (e.g., Kumar et al., 2016; Singh et al., 2016). Most of studies have examined the economic impact of climate change on agriculture (e.g., Kumar et al., 2015; Kumar et al., 2016). Few studies included food security with agricultural productivity in different regions of the world (e.g., Kumar et al., 2015; Kumar et al., 2016). In some of studies of agricultural productivity of two or three crops was taken as a proxy for food security in developing economies (e.g., Kumar et al., 2014; Kumar et al., 2017). And based on these crops earlier studies conclude that climate change has negative impact on food security for a place/region/country in the world. Studies also predicted that climate change would be serious threat for food security especially for developing countries. However, studies based on two or three crops cannot provide the actual situation of food security and its impacting factors in developed and developing economies. Since food security is not only linked with food crop only; some other factors and production of cash crops also may affect the food security in developing economies (e.g., Kumar and Sharma, 2013; Kumar et al., 2014; Kumar et al., 2015; Kumar et al., 2016; Singh et al., 2016; Kumar et al., 2017; Singh et al., 2017; Singh, 2017; Singh and Sharma, 2018; Singh et al., 2018). After that there are many complementary factors which have significant association with food security like yield of cereal production, per capita availability of arable land, population growth, consumer price inflation, forest area and other (e.g., Kumar and Sharma, 2013; Kumar et al., 2015; Singh, 2017; Singh and Sharma, 2018). Thus, these studies did not empirically estimate the influence of climatic factors on overall food security. Overall food security is a parameter that covers all the variables of the food security which are given as food security index (FSI) (e.g., Demeke et al., 2011; Ismali, 2012; Kumar and Sharma, 2013; Belloumi, 2014; Wineman, 2014; Badolo and Kinda, 2015; Kumar et al., 2015; Ahmed et al., 2016; Singh, 2017; Singh and Sharma, 2018). Food security index is powerful tool to justify the real situation of food security of any region. This index is also useful to increase the awareness to policy makers or economic agents for respective place to take initiative for policy purposes or target interventions to sustain food security ((e.g., Demeke et al., 2011; Kumar and Sharma, 2013; Belloumi, 2014; Wineman, 2014; Badolo and Kinda, 2015; Kumar et al., 2015; Singh, 2017; Singh and Sharma, 2018). This index also provides the comparison between more than two countries or regions or individuals (e.g., Kumar et al., 2015; Singh, 2017; Singh and Sharma, 2018).

Existing literature about climate change and its impacts on different sector of the economy showed that it has a negative impact on all the sector of economy in developing economies (e.g., Gadgil, 1995; Gbetibouo and Hassan, 2005; Greg et al., 2011; Ahmad et al., 2011; Ajetomobi et al., 2011; Gupta et al., 2012; Kumar et al., 2016; Kumar et al., 2017; Singh, 2017; Singh and Issac, 2018). Numerous of studies have provided empirical evidence that agricultural productivity and food security have negatively affect due to variability in climatic factors. Many studies investigate the impact of climatic factors on gross domestic product (GDP) like Greg (2011); Masters et al. (2010); Gbetibouo and Hassan (2005); Zhai and Zhuang (2009); Zhai et al. (2009); Horowitz (2009) etc. Most studies have examined the economic impact of climate change on agriculture. Few studies included food security with agricultural productivity in different regions of the world such as Gupta et al. (2012); Kurukulasuriya and Mendelsohn (2008); Deressa et al. (2005); Seo and Mendelsohn (2008); Yu et al. (2010); Ajetomobi et al. (2011); Mendelsohn et al. (2011); Kumar et al. (2016); Kumar et al. (2017) etc. In some of studies of agricultural productivity of two or three crops was taken as a proxy for food security; and based on these crops they conclude that climate variability has negatively affected food security for a place/region/country in the world. These studies have also predicted that climate change and it variability would bring negative implication on food security especially in developing countries.

However, above-mentioned studies did not empirically estimate the influence of climatic factors on overall food security. Overall food security is a parameter that covers all the variables of the food security which are given as food security index (FSI) by different international organizations like International Food Policy Research Institute (IFPRI), Economic Intelligence Unit (EIU), and Food and Agriculture Organization of the United Nations (FAO). FSI is significant tool to justify the real situation of food security level for any region (Ye et al., 2013; Kumar and Sharma, 2013; Kumar et al., 2015; Sharma and Singh, 2017; Kumar et al., 2017; Singh et al., 2017; Singh, 2017; Singh and Sharma, 2018). It is useful to increase the consciousness to policy makers or economic agents in a respective place to take initiative or target interventions to increase food security (Kumar and Sharma, 2013; Kumar et al., 2015; Singh et al., 2017; Kumar et al., 2017; Singh, 2017; Sharma and Singh, 2017; Singh and Sharma, 2018). Hence it is very interesting to assess that whether climate variability has any significant influence on FSI or not. Due to this drawback the main aim of this study is to assess the influence of climatic and non-climatic factor on global food security index across countries. Another objective of this study is to identify that which group of countries is more vulnerable in term of food security due to variation in climatic factors or other variables.

1.1. Brief Overview on Climate Change and Agriculture

Climate change is not a new phenomenon and it is changing in ancient era in the world. Most scientific studies show that weather mechanisms are changing due to rising GHG emission in atmosphere (Gadgil, 1995; and Mall et al., 2006). Human and natural activities are the responsible for GHG emission and climate variability. Human activities have increased the possibilities of climate change due to growing population, rapid urbanization, higher industrialization, modern technology, innovation, higher economic development, transport, building construction, reduction in forest area (Ahmad et al., 2011). Natural and human activities have increased high quantity of greenhouse gases (GHGs) especially carbon emissions in atmosphere and GHGs emissions brought several problems for humanity such as rise in temperature of the earth surface and in atmosphere, fluctuation in rainfall, declining ground water, flooding due to high rainfall, drought, soil erosion, heavy wind, rising sea level due to melting of glacier, cyclone, wind speed, hail storm, fog, earthquake and landslide all are the clear evidence of climate change related phenomenon.

Agriculture is only one sector that most vulnerable due to climate variability; and negative effects on food security level in any region. At present agricultural is in highly vulnerable position due to degradation of natural resources (i.e., land and water) and climate change (Paroda and Joshi, 2017; Singh and Issac, 2018). It is evident that climate variability is also likely to affect the agricultural productivity and food security in many parts of the world. It becomes especially more serious concern for developing countries because they do not have enough resources to mitigate these adverse effects of climate change vis-a-vis developed countries (Greg et al., 2011). The present day developing world has nearly one billion people who are undernourished[1]; more than one sixth population (900 million) of the world faces chronic hunger (Johnson, 2009). Furthermore, one child dies every five second somewhere (Ramasamy and Moorthy, 2012); and around 8 million populations die every year due to hunger-related causes, which count more than 50% world's children (Johnson, 2009). Around 3.1 million children under age of five die each year due to poor nutrition and every 3.5 second, a child lost their life due to poverty at global level (Paroda and Joshi, 2017). Hence, above statistics increases the several problems for global and national policy makers, and development organizations to resolves the aforesaid issues to maintain the food security at global level.

2. Brief Review of Literature

A numerous of researchers have assessed the influence of socio-economic variables on estimated food security index (FSI) in different countries like India, Nigeria, China, Bangladesh, Ethiopia based on secondary and primary data. Adenegan et al. (2004); Arene and Anyaeji (2010); Babatunde et al. (2007); Omotesho et al. (2006); Omotesho et al. (2007); and Ibrahim et al. (2009) has used FSI as dependent variable for empirical work in Nigeria. Faridi and Wadood (2010) also used FSI as dependent variable for empirical analysis in Bangladesh. Ye et al. (2013) also used to investigate the impact of various factors on estimated FSI based on secondary data in China. These all studies mostly investigate the influence of socio-economic variables on constructed FSI. But there is no extensive evidence on climate variability and its influences on FSI in existing literature. Most probably, Demeke et al. (2011)'s study tried to investigate the influence of rainfall on constructed FSI in Ethiopia. Thereafter, Kumar and Sharma (2013) used estimated state-wise FSI for empirical investigation in India. The study assesses the impact of climatic and non-climatic factors on created FSI using state-wise panel data in India. Belloumi (2014) also assess the impact of climatic factors on estimated FSI in ESA economies. Kumar et al. (2015) have created global food security index (GFSI) for selected economies and it assessed the impact of several socio-economic indicators on GFSI. Kumar and Sharma (2017) also develop an empirical model which assess the climatic and non-climatic factors on FSI in India. Singh et al. (2017) also applied an empirical model to investigate the implications of socio-economic indicators on estimated GFSI in selected developed and developing economies.

3. Material and Methods

3.1. Descriptions and Sources of Data

[1] http://www.timesunion.com/business/press-releases/article/World-Scientists-Define-United-Approach-to-3440641.php#ixzz1uf81t663

The present study includes 103 cross economies, whereas it covers one-year data (i.e. 2011) on global food security index (GFSI) and other socio-economic factors. The detail of selected economies is given in Appendix: A. Country-wise information on GFSI is derived from Economist Intelligence Unit (EUI), which was published in 2012. Per hectare cereal yield (in Kg), per capita land under cereal production (in hectare), population growth rate (in %), consumer prices inflation (in %) and forest area (% of total arable area) are taken from World Bank; Food and Agriculture Organization of the United Nations (FAO); World Meteorological Organization (WMO); and other international organizations like United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC). The average annual temperature (in ^{0}C) and average annual precipitation (in mm) are taken from Little Data Book on Climate Change: Supplemental Data published by the World Bank in 2011. This spreadsheet contains historical averages for the time period 1961-1990, based on gridded climatologies; and average annual temperature and average annual precipitation are used as proxy for climatic factors in regression analysis.

3.2. Formulation of Empirical Model

To investigate the influence of climatic and non-climatic factors on GFSI, simple multiple linear regression models is applied using country-wise cross-sectional data in this study. The model is adopted from existing studies i.e. Demeke et al., 2011; Kumar and Sharma (2013); Wineman (2014); Kumar et al. (2015); Kumar et al. (2017); Sharma and Singh (2017); Singh et al. (2017); Singh and Sharma (2018). This model assumes that GFSI is a function of various socio-economic and climatic factors like annual mean temperature, annual precipitation, cereal production per hectare, per capita land, inflation, forest area, population growth rate and others (e.g., Wineman, 2014; Kumar et al., 2015; Kumar et al., 2017; Sharma and Singh, 2017; Singh et al., 2017; Singh and Sharma, 2018). In mathematically, aforementioned relation may be written as:

$$GFSI_i = f\,(AMEANT_i, APRE_i, CYPH_i, PCLUCP_i, PGRA_i, CPI_i, FA_i) \quad (1)$$

Here *GFSI* is global food security index for i^{th} country; *AMEANT,* and *APRE,* are that the average annual temperature (in ^{0}C), and average annual precipitation (in mm) respectively for. *CYPH, PCLUCP, PGRA, CPI,* and *FA* are cereal yield on per hectare land, per capita land under cereal production, population growth rate, consumer price inflation and forest area respectively. In case of multiple linear regressions model, equation (1) would be as:

$$GFSI_i = \beta_0 + \beta_1 (AMEANT)_i + \beta_2 (APRE)_i, + \beta_3 (CYPH)_i, + \beta_4 (PCLUCP)_i + \beta_5 (PGRA)_I + \beta_6 (CPI)_i, + \beta_7 (FA)_i + \delta_8 D_1 + \delta_9 D_2 + \delta_{10} D_3 + \mu_i \quad (2)$$

Here β_0 is constant coefficient or intercept term; and β_1, β_2, β_3, β_4, β_5, β_6 and β_7 are regression coefficients of associated variables. D_1, D_2, and D_3 are dummy variables for high, upper middle and lower income group countries respectively, which are incorporated to identify the impact of climatic and non-climatic factors in group-wise economies. δ_8, δ_9 and δ_{10} are regression coefficients for respective dummy variables which estimate that whether climatic and non-climatic variables have similar influence on GFSI or not in all income group countries. Demeke et al. (2011) also used multiple linear regression model to assess the influence of annual rainfall and other socio-economic variables on constructed food security index in Ethiopia. Aforementioned regression model is run through STATA and SPSS statistical software to estimate the regression coefficients of explanatory variables in equation (2).

4. Results and Discussion

4.1. Discussion on Descriptive Results

Table 1 shows the brief description of average values of different variables for different income group countries which are undertaken in this study. The average value of mean temperature in lower and low income countries are higher as compared to high and upper middle income countries. Therefore, it is a major concern for lower and low income group countries. Lower and low income group countries are very serious position in food security as the average values of global food security index for lower and low income group countries are lower as compared to high and upper middle income countries. Average cereal production on per hectare arable land is major determinant for food security but this is low in lower and low income group countries due to this reason these countries are lower position in GFSI. High population growth rate is another harmful factor for low value of global food security index in these countries since high population growth rate will increase more food demand but these countries are not in a position to improve cereal productivity, resulting in more food insecurity; again this turn in low value of global food security index. As high inflation reduce purchasing power of the population, thus high inflation is also an injurious factor for food security in lower and low income countries. These economies are unable to access the food, therefore these economies are in food insecurity trap.

Table 1: Descriptive results

Country Groups	Factors	*GFSI*	*AMEANT*	*APRE*	*CYPH*	*PCLUCP*	*PGRA*	*CPI*	*FA*
All Countries	*Mean*	53.67	18.17	1102.33	3236.77	0.18	1.41	6.97	29.07
		(20.2)	8.32	717.00	1942.37	0.51	0.95	6.89	19.06
High Income	*Mean*	80.52	10.28	817.68	5225.52	0.13	0.63	3.02	33.08
	SD	5.71	6.60	363.63	1833.71	0.17	0.59	1.21	18.51
Upper Middle Income	*Mean*	58.25	17.04	1124.52	3260.11	0.32	0.97	7.24	30.04
	SD	7.65	8.09	889.87	1413.43	0.97	0.66	9.45	20.05
Lower Income	*Mean*	42.76	23.18	1236.8	2443.23	0.10	1.83	8.11	28.80
	SD	8.47	4.18	791.15	1467.61	0.07	0.90	4.14	18.52
Low Income	*Mean*	29.67	23.09	1257.54	1799.78	0.14	2.35	9.91	23.75
	SD	5.46	6.21	664.56	970.41	0.13	0.75	7.82	19.01

Source: Estimated by Author.

4.1. Discussion on Empirical Findings

Table 2 reveals the regression results which estimate the influence of various variables on GFSI. Annual mean temperature show a negative and statistically significance influence on GFSI. It implies that GFSI is negatively affected due to variability in mean temperature across economies. Here, it can be predicted that 1% increase in mean temperature, the value of GFSI may decline by 0.53% in undertaken economies. As annual precipitation has a positive association with GFSI, thus annual precipitation would be useful to increase GFSI. Although, regression coefficient for annual precipitation is not statistically significant but its positive sign shows that precipitation would be helpful to improve the value of GFSI in undertaken economies. Cereal yield on per hectare land is found crucial factor to improve the value of GFSI. Cereal yield on per hectare land has a positive and statistically significant association with GFSI. As GFSI is positively associated with forest area, therefore increment in forest area would be beneficial to maintain the value of GFSI. Population growth rate and consumer price inflation are more detrimental factors, both have negative and statistically significant association with GFSI. The value of GFSI may be declined by -6.01% and 0.49% as 1% increase in population growth rate and consumer price inflation respectively.

Table 2: Influence of climatic and non-climatic factors on global food security index (GFSI)

No of Obs.	103		*F*(7, 95)		70.72	
R-squared	0.7608		*Prob>F*		0.0000	
Exp. Variables	*Reg. Coefficient*	*Std. Err.*	*t-Value*	*P>|t|*	*95% Conf. Interval*	
AMEANT	-0.53207*	0.23011	-2.31	0.023	-0.98889	-0.07525
APRE	0.00322	0.00215	-1.49	0.139	-0.00749	0.00106
CYPH	0.00437***	0.00061	7.18	0.000	0.00316	0.00558
PCLUCP	1.73444	1.08043	1.61	0.112	-0.41049	3.87937
PGRA	-6.01241***	1.59955	-3.76	0.000	-9.18792	-2.83690
CPI	-0.48754***	0.14760	-3.30	0.001	-0.78056	-0.19452
FA	0.11643*	0.05927	1.96	0.052	-0.00124	0.23410
Con. Value	60.9484***	4.96762	12.27	0.000	51.08644	70.81036

Source-Estimated by Author; and *P <0.05, **P <0.01 and ***P <0.001 indicate the statistical significance level for respective variables.

Table 3 and 4 show the regression results which estimate the influence of only climatic factors on GFSI. Annual mean temperature has negative and statistically significant association with GFSI. Here, this regression model assumes that if other factors are constant than value of GFSI may be declined by 1.70% as 1% increase in annual mean temperature in these economies. GFSI is positively influenced with rising annual precipitation. All regression coefficients for included dummies for respective income group economies have a positive and statistically significant association with GFSI. It suggests that there are no significant different in influence of climatic variables on GFSI among the high, upper, lower, and low income groups countries. Here, it may be concluded that value of GFSI is similarly influenced due to climate variability in all income group nations. It also provide an evidence that climatic variables have a negative influence on food security in most economies.

Table 3: Influence of climatic factors on global food security index (GFSI)

No of Obs.	103	*F(2, 100)*	34.85

R-squared	0.4363		*Prob > F*		0.0000	
Exp. Variables	*Reg. Coefficient*	*Std. Err.*	*t-Value*	*P>|t|*	*95% Conf. Interval*	
AMEANT	-1.70019***	0.20747	-8.19	0.000	-2.11181	-1.28857
APRE	0.00351	0.00200	1.76	0.082	-0.00046	0.00748
Con. Value	80.68471***	4.1668	19.36	0.000	72.41789	88.95152

Source-Estimated by Author; and *P <0.05, **P <0.01 and ***P <0.001 indicate the statistical significance level for respective variables.

Table 4: Influence of climatic factors on GFSI in group dummies for countries

No of Obs.	103		F(5, 97)		227.02	
R-squared	0.9027		*Prob > F*		0.0000	
Exp. Variables	*Coefficient*	*Std. Err.*	*t-Value*	*P>|t|*	*95% Conf. Interval*	
AMEANT	-0.37724***	0.09474	-3.98	0.000	-0.56527	-0.18921
APRE	0.00317***	0.00089	3.56	0.001	0.00140	0.00494
D_1	47.41481***	1.87260	25.32	0.000	43.69821	51.13141
D_2	26.72155***	1.86940	14.29	0.000	23.01131	30.43179
D_3	13.18835***	1.88928	6.98	0.000	9.43866	16.93804
Con. Value	34.39476***	2.30714	14.91	0.000	29.81573	38.97379

Source-Estimated by Author; and *P <0.05, **P <0.01 and ***P <0.001 indicate the statistical significance level for respective variables.

4. Viability and Consistency of Empirical Results

As this study is global level which includes 103 cross countries and before this limited studies to analyses the influence of climatic factor on estimated food security index at global level. Therefore, the empirical finding of this study may be consistent with earlier studies which are based on review and empirical work in different region/countries. The negative and statistically significant coefficient of annual mean temperature with global food security index could be correlated with earlier studies which estimate the climatic impacts on gross domestic product in different countries and global level like Greg et al. (2011); Masters et al. (2010); Gbetibouo and Hassan (2005); Zhai and Zhuang (2009); Zhai et al. (2009); and Horowitz (2009); Kumar et al. (2015); Singh et al. (2017). However, Ye et al. (2013) found positive influence of climatic factor on food security index in China. For this, there may be a one reason is that this study was included one country (i.e. China). Therefore, in China, temperature might have positive influence on food security index. Positive and statistically significant influence of annual precipitation on global food security index of this study may be consistent with existing study like Demeke et al. (2011). This study show that variability in rainfall have a statistically significant influence on household food security index in Ethiopia.

Regression coefficient of cereal yield has a positive and statistically significant influence on global food security index. This result is matching with most studies which are based on country-wise studies such as Prabha (2010); Salami (2011); Kumar and Sharma (2013); Kumar et al. (2015); Kumar et al. (2017); Singh et al. (2017); Sharma and Singh (2017); Singh and Sharma (2018). The negative and statistically significant influence of population growth rate on global food security index is similar to country-wise analysis like Helms (2004); Masters et al. (2010); Kumar and Sharma (2013); Kumar et al. (2015); Kumar et al. (2017); Singh et al. (2017); Sharma and Singh (2017); Singh and Sharma (2018). Consumer price inflation also has negative and statistically influenced on global food security index. This empirical result is consistent with many regional studies which also estimate the inflation effects on food security such as Adenegan et al. (2004); Isvilanonda and Bunyasiri (2009); Pandey (2009); Kumar and Sharma (2013); Kumar et al. (2015); Kumar et al. (2017); Singh et al. (2017); Sharma and Singh (2017); Singh and Sharma (2018). Regression coefficient of forest area has a positive and significant influence on global food security index. For this empirical result, this study predict that more forest area would be exogenous component to increase the productivity of agriculture, thus increase in forest area would be an ecosystem-based adaptation (EBA) to mitigate the adverse effect of carbon emission and to improve in level of food security (Pramova et al., 2012; Kumar and Sharma, 2013; Kumar et al., 2017; Singh and Sharma, 2017; Singh and Sharma, 2018; Singh et al., 2018).

5. Concluding Remarks and Future Research Direction

The main objective of this study was to assess that how global food security index (GFSI) is being influenced due to variation in climatic and non-climatic factors using simple multiple regression model for 103 cross-countries of different income groups. Empirical results based on ordinary least square (OLS) model shows that global food security index is negatively influenced due to increase in annual mean temperature. Based on empirical estimations, this study is predicted that the value of GFSI may be declined by 0.53%, if non-climatic factors are constant than the value of GFSI may be go down by 1.07% due to 1% increase in annual mean temperature. While, annual precipitation has positive and statistically significant association with GFSI. It indicates that the value of GFSI would be improved as increase in annual precipitation. Lower and low income group countries are most vulnerable as compared to high income group countries. As the regression coefficients of all dummies for different income groups have a positive and statistically significant association with GFSI. Estimates shows that all countries are similarly affected due to increase in annual mean temperature. GFSI is negatively influenced due to rapid population growth and increase in consumer price inflation in undertaken economies. There are many other factors which are responsible for food insecurity in lower and low income countries like low cereal productivity, rapid population growth, higher inflation as compared to high and middle income group countries. Increment in cereal yield and forest area; and to control population growth and price inflation would be crucial policy suggestion to improve the food security in low and lower income countries. In all economies, forest area may be an exogenous factor to maintain the environmental sustainability. Subsequently, forest area would be useful to maintain the sustainable food security in developing economies. Thus, it suggested that there must be effective policies to preserve the ecosystem services of forestry in developing and developed economies. As the present study is based on 103 countries of world due to this reason, empirical findings of this study may not be generalized for any region/country because every country does not have similar environment and other factors which are not included in this study. Hence, there is essential further research for a particular region/country to reach an appropriate policy implication and to check the reliability of empirical findings of this study.

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Appendix A: Group of cross countries **(**World Bank, 2011)

High Income	Upper Middle Income	Lower Middle Income	Low Income
Australia	Algeria	Angola	Bangladesh
Austria	Argentina	Cote d'Ivoire	Benin
Belgium	Azerbaijan	Bolivia	Burkina Faso
Canada	Belarus	Cameroon	Burundi
Czech Republic	Botswana	Egypt	Cambodia
Denmark	Brazil	El Salvador	Chad
Finland	Bulgaria	Ghana	Congo, Dem. Rep.
France	Chile	Guatemala	Ethiopia
Germany	China	Honduras	Guinea
Greece	Colombia	India	Haiti

Hungary	Costa Rica	Indonesia	Kenya
Israel	Dominican Republic	Morocco	Madagascar
Italy	Ecuador	Nicaragua	Malawi
Japan	Jordan	Nigeria	Mali
Netherlands	Kazakhstan	Pakistan	Mozambique
New Zealand	Malaysia	Paraguay	Myanmar
Norway	Mexico	Philippines	Nepal
Poland	Panama	Senegal	Niger
Portugal	Peru	Sri Lanka	Rwanda
Korea, Rep.	Romania	Sudan	Sierra Leone
Slovakia	Russian Federation	Syrian Arab Republic	Togo
Saudi Arabia	South Africa	Ukraine	Tajikistan
Spain	Thailand	Vietnam	Tanzania
United Kingdom	Tunisia	Yemen	Uganda
United States	Turkey	Zambia	
Sweden	Uruguay		
Switzerland	Venezuela		

Appendix B: Abbreviations

Global Food Security Index (*GFSI*) –Country wise global food security index data was taken from Economic Intelligence Unit (EIU) that is published in 2012. This index includes three major components of food security such as availability, stability and accessibility of food; and this is generated by 26 key variables of food security utilizing with simple descriptive method for 105 cross countries of the world (Economic Intelligence Unit).

Mean Temperature (*AMEANT*) – This is average annual temperature (in degrees Celsius) of maximum and minimum temperature. This spreadsheet contains historical averages for the time period 1961-1990, based on gridded climatologies from the Climate Research Unit (World Bank).

Precipitation (*APRE*) - This is average annual precipitation (in millimeters). This spreadsheet contains historical averages for the time period 1961-1990, based on gridded climatologies from the Climate Research Unit (World Bank).

Cereal Yield (kg/hectare) (*CYPH*)- This is output in kilograms on per hectare of harvested land, includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains (FAO).

Per Capita Land Under Cereal Production (*PCLUCP*) – This is estimated as arable land under cereal production (in hectare) divide by total population.

Population Growth Rate Annual (*PGRA*) - Population growth rate annual (in %) is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage (World Bank).

Consumer Prices Inflation (*CPI*)- Consumer price inflation annual (in %) as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly (International Monetary Fund).

Forest Area (*FA*) - Forest area (% of total land area) is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (World Bank).

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