

Food Insecurity and Gender Inequality: A Panel Data Analysis of Sub-Saharan Africa

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This paper focuses on the two key global issues of food insecurity and gender inequality. The paper tries to study the impact of various forms of gender inequality on magnitude of food insecurity in the developing region of Sub-Saharan Africa. FAO's food security indicators are combined with gender gap indexes of Global Gender Gap Reports and World Bank, for undertaking a panel data analysis for a set of 20 Sub-Saharan countries over two separate time period of 6 years and 22 years, respectively. The econometric analyses undertaken clearly provide support to the underlying hypothesis. A decrease in gender gap in employment and economic participation has a significantly positive impact on the level of food security, both in the short run and in the long run. Results relating to the gender gap in wage/salaries also provide support to our argument. In the long run, reproductive rights of women become equally important for ensuring food security of the growing population. Hence, the paper concludes by asserting that any policy or legislation which lacks gender dimension will be ineffective in controlling the growing magnitude of hunger in the conflict prone region of Sub-Saharan Africa.

Key Words: Food Insecurity; Gender Inequality; Sub-Saharan Africa; Education; Employment; Maternal Mortality

1. Introduction

Food is the most basic of human needs for productivity, health and survival. It is the foundation for human development and economic growth of any nation. Many of the world's poorest countries will see their populations double in the years from 2000 to 2050, with Africa climbing from 820 million to 2 billion (FAO, 2010). Farmers in Africa and other developing nations will, therefore, need to produce more than twice the current amount of food in order to meet this challenge. However, it is being recognized that success can be attained only if the contribution of women farmers to agricultural production and their enormous (present and future) potential is fully tapped.

Globally, women constitute 43 percent of the agricultural labour force, producing a large portion of the world's food crops (FAO, 2013a). In their role as food producers, women face overt and implicit discrimination in access to productive assets like land, credit, technology, and livestock. They receive lower wages than their male counterparts in the labour market and work without remuneration as unpaid contributing workers on family farms. Such disparities reduce women's agricultural productivity, affecting not only their own well-being, but also imposing high costs on the economy through poverty and deprivation.

Available statistics indicate that if women had the same access to productive resources as men, they could increase yields on their farms by 20 percent to 30 percent. This could raise the total agricultural output in developing countries by 2.5 percent to 4 percent, which could,

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in turn, reduce the number of hungry people in the world by 12 percent to 17 percent (ADB, 2013).

Females worldwide face many inequalities and constraints, often embedded in established norms and practices, limiting their access to education, employment and health care facilities, within households. They lack autonomy and representation in decision making processes and are the worst sufferers of political conflicts and violence. Besides, legislative measures such as those governing land inheritances include exclusionary provisions for women. Thus, gender bias prevails not only at the household level but also at the community and national level, impairing the life of women and girls inter and intra-generationally.

Gender equality is central to FAO's mandate to achieve food security, which can be reached only if nations simultaneously work towards removing all forms of discrimination against women at individual, household, community and national level. Global comparisons show a strong correlation between hunger and gender inequalities. Countries ranking highest on the index of global hunger are also those where such inequalities are more severe. Sub-Saharan Africa is one such example and is the region of study in this paper.

In this context, the paper tries to capture the menace of gender inequality in the region of Sub-Saharan Africa and determine its impact on the magnitude of food insecurity through panel data analysis. The paper is organised as follows: section 2 is literature review; section 3 is on magnitude of food insecurity in Sub-Saharan Africa; section 4 is on prevalence of gender inequality in Sub-Saharan Africa; section 5 is on theoretical and statistical dependence of food insecurity on gender inequality in Sub-Saharan Africa; section 6 is results of econometric analysis; section 7 is key findings and finally last section is on conclusions. There is Appendix 1 which contains econometric results.

2. Literature Review

There have been a number of theoretical and empirical studies which have shown that gender inequality adversely affects economic growth of a country.

The most widely quoted paper is that by Dollar and Gatti (1999), which points out that "gender differentials in education and health are not an efficient economic choice. Societies that under-invest in women pay a price for it in terms of slower growth and lower income". Using data for 100 countries for a time period of 30 years and dividing the countries based on their 1990 per capita income, the paper shows that the gender differences between the poorest quartile and the richest quartile are striking. In the poorest quartile of countries, only 5 percent of adult women had any secondary education, which was one-half of the level for men. On the other hand, in the richest quartile, 51 percent of adult women had at least some secondary education, which was 88percent of the level for men.

Klasen (1999), in his paper takes the argument a step forward by making a cross-country and panel regression analysis to investigate the extent to which gender inequality in education and employment reduces growth and development. His results indicate that a gender balanced growth in education in South Asia and Sub-Saharan Africa in 1960, could have resulted in faster economic growth by up to 0.9 percent per year. The paper also discusses the direct and

indirect impact of inequality in education on economic growth. Direct impact is through reduction in the average quality of human capital, while, indirect is through the impact on investment and population growth.

Klasen (2003), in another paper with Abu-Ghaida estimates the losses that countries are likely to suffer if they do not meet the MDG of equity in primary and secondary education by 2005. It asserts that the countries failing to meet the goal will indeed suffer significant losses in terms of foregone economic growth, as well as, smaller progress in reducing levels of fertility, child mortality, and under-nutrition. Estimates suggest that the countries that are currently off-track might lose 0.1 percent to 0.3 percent points in annual economic growth between 1995 and 2005, and an average of 0.4 percent points between 2005 and 2015. In addition, failing to meet the goal would lead to 0.1 percent to 0.6 percent more children per woman by 2015 and to higher child mortality of up to 32 per 1000 depending on how far the countries are from meeting the target.

Going beyond gender inequality in education and employment, a paper by Osmani and Sen, (2003), focuses on gender inequality in terms of health facilities. The basic message of the paper is that woman's deprivation in terms of nutrition and healthcare rebounds on the society as a whole in the form of ill-health of their offspring (males and females alike), both as children and as adults. In other words, undernourishment of the mother adversely affects the health of the foetus, which in turn leads to long-term health risks that extend not just into childhood but into adulthood as well. The paper is based on the experience of South Asia, where gender inequality finds expression in high rates of female mortality, which is the result of a widespread neglect of health, nutrition and other interests of women.

More interestingly, a paper by Ferrant (2011) doesn't segregate gender inequality in terms of education, employment and health. Rather, it uses a multi-dimensional concept of gender inequality in terms of a composite index called "Gender Inequality Index (GII)". It assumes that gender inequality hinders economic and human development, such that a one standard deviation change in GII increases long term per capita income by 9.1 percent and human development index (HDI) by 4 percent. Based on two-stage and three-stage least square methods with data for 109 developing countries, the author concludes that countries with the same characteristics of investment, human capital, and labour force could have different growth paths due to differences in the extent of gender inequality.

Although discrimination of women, whether covert or overt, is acknowledged in literature and its impact on growth is debated and analyzed over decades, little rigorous work has been done on studying its impact on the problem of food insecurity.

Agarwal (2012) examines the relationship between gender inequality and food security, with focus on women as food producers, consumers, and family food managers. She examines the constraints women face as farmers in terms of access to land, credit, production inputs, technology, and markets. Such inequalities which women face as producers, reduces the potential productivity of agriculture and overall food availability.

Asian Development Bank's Report (2013) analyzes gender inequalities that constrain woman's roles in agriculture and food production, and in the long run undermine

achievement of food and nutritional security. In the same report, a cross-country study of developing countries covering the time period 1970–1995 found that 43 percent of the reduction in hunger that occurred was attributable to progress in women’s education and an additional 12 percent reduction was attributable to increased life expectancy of women. Thus, almost 55 percent of the gains against hunger in these countries were due to improvement in women’s situation within the society. The paper re-affirms the above findings through panel data analysis for a set of 20 countries of Sub-Saharan Africa.

3. Magnitude of Food Insecurity in Sub-Saharan Africa

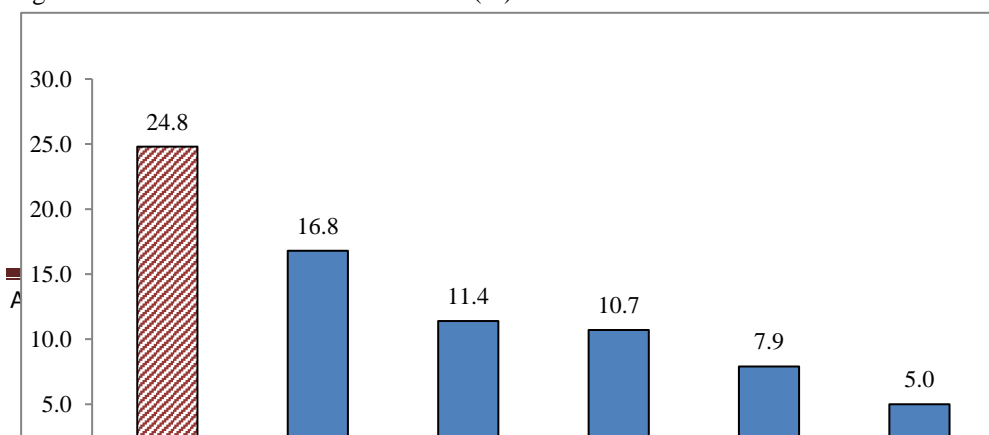
Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. (FAO, 2014).

This widely accepted definition points at four main dimensions of food security, namely,

1. *Food availability*: the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).
2. *Food access*: access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet.
3. *Food utilization*: utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met.
4. *Food stability*: includes vulnerability and shock dimensions of food security. It measures the extent and exposure to risk, particularly those pertaining to food supply and food price stability.

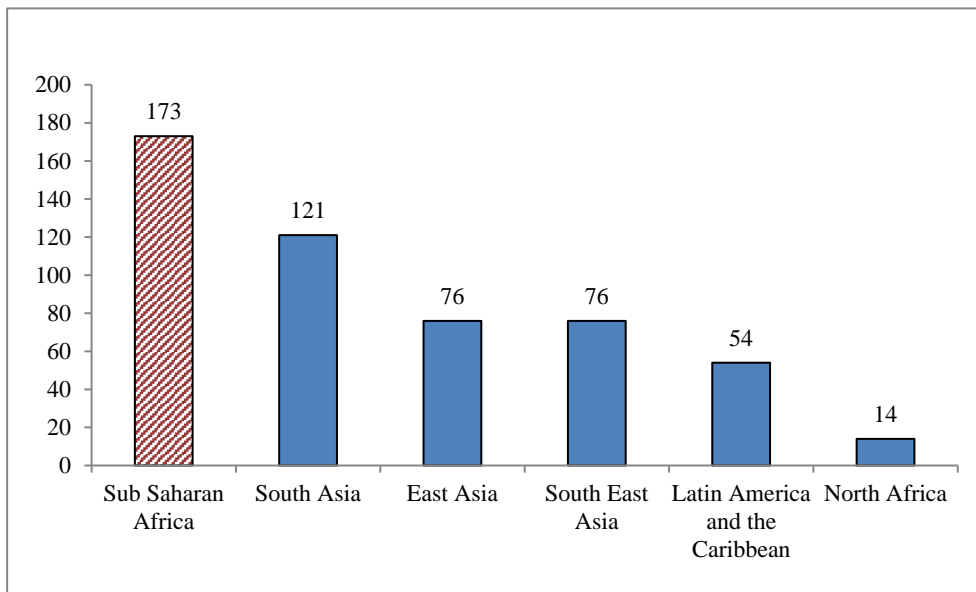
FAO’s annual report on the State of Food Insecurity in the World (FAO 2013b), indicates that globally there has been a progress in hunger reduction, with a 17 percent fall in the total number of people undernourished, between 1990-92 and 2011-13. However, majority of hungry people (98 percent of the overall undernourished population) still continue to live in the developing region. Sub-Saharan Africa remains the region with highest prevalence of undernourishment and maximum depth of food deficit, despite 8percent and 20 percent fall in the two parameters, respectively, during the 22 year time period. (Figure 1 and 2). Also, in contrast to the global trend, the number of undernourished people has been rising in this region - from 173 million in 1990-92 to 223 million currently. (Figure 3).

Figure 1: Prevalence of Undernourishment (%) in 2011-13



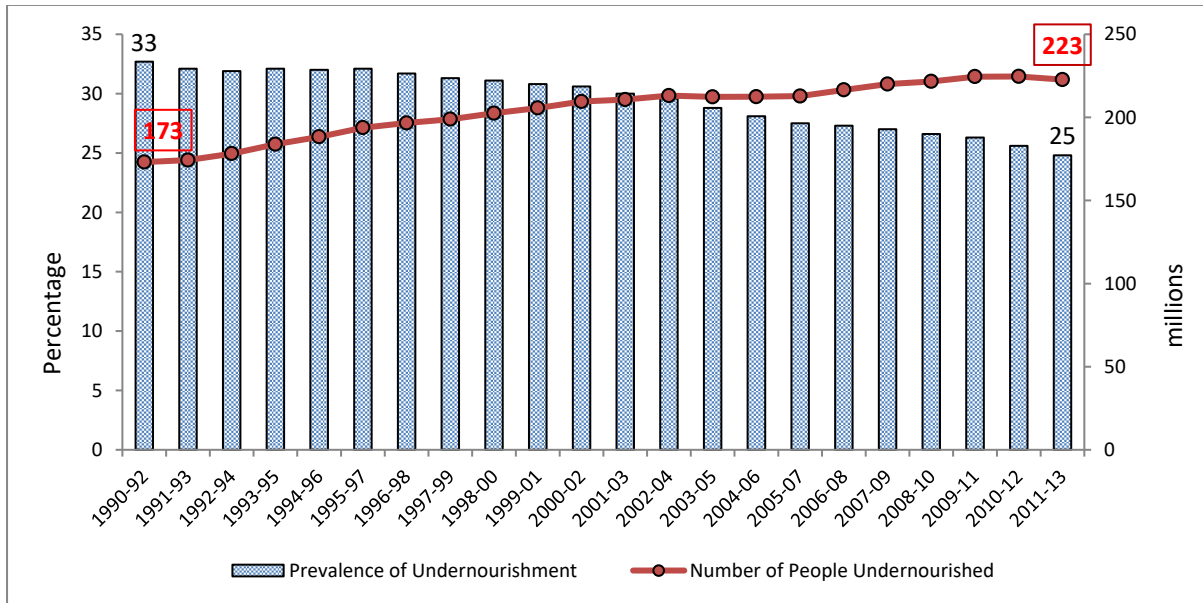
Source: FAO, 2013b

Figure 2: Depth of Food Deficit (kcal/caput/day) in 2011-13



Source: FAO, 2013b

Figure 3: Undernourishment in Sub-Saharan Africa



Source: FAO, 2013b

A further point of concern and discussion is the increasing trend in both – the percentage of undernourished population and depth of the food deficit, over the two decades from 1990-92 to 2011-2013 in several countries of Sub-Saharan Africa. For instance, in Burundi, undernourished population has increased from 44 percent to 67 percent and in Comoros from 41 percent to 65 percent. In Swaziland this percentage has more than doubled during the study period. Comoros also shows maximum kilocalorie deficit of 655 in 2011-13, which has increased by more than 90 percent from 344 in 1990-92.

In the following paragraphs, we analyze the extent of food insecurity in the study region, on the basis of each of the four FAO indicators.

3.1 Food Availability

Agricultural production determines food availability or supply of food to the growing population of a nation. It is the first link in the food security chain. World Bank data indicates that regionally, agricultural productivity is the lowest in Sub-Saharan Africa (SSA) at just 396 US\$, which is not even half the global average of 1077 US\$ in 2011. Besides, productivity itself is showing a declining trend over the years, which questions the regions capacity to supply food to its growing population.

Now, given the low level of agricultural productivity, high annual population growth rate at 2.7 percent in 2011, which is almost double that for most other regions, can partly explain the food deficit situation in the region. As per Africa Human Development Report (*UNDP 2012*), SSA will have the fastest growing population in the world for decades to come. In the years after 2050, its population is likely to reach 2 billion. By then, 1 in 5 people on the planet will be African and the extent of hunger will increase beyond control.

In a scenario of high population growth, calorie availability per capita also declines, resulting in a steep increase in malnutrition. Adequacy of average dietary energy supply or the ratio of dietary energy supply and average dietary energy requirement indicates this aspect of food insecurity. In several countries of SSA, the average energy requirement is exceeding energy supply, implying inadequacy of food supply and also the ratio has declined over the study time period, to worsen the situation. For instance, Swaziland has moved from a region of dietary adequacy (110) in 1990 to dietary inadequacy (92) in 2011. In Burundi and Comoros, it is 76 and 78, respectively in 2011, declining from above 90 in 1990.

In terms of diversity of food, cereals, roots and tubers still represent more than 60 percent of the total energy supply in the African region. Even the quality of diet measured by the daily amount of protein available per person is the lowest at average level of 59 grams of protein per person per day in 2008-10 as compared to 73 grams of protein per person per day for the developing region as a whole. The amount is seen to be as low as 38 grams in Liberia with no increase over the 20 year period from 1990-92.

Hence, there is a clear indication of presence of food deprivation in several countries of this region. As per Kidane et al, (2006), SSA is the only region of the world where hunger is projected to worsen over the next two decades unless some drastic measures are taken to reverse the current trend.

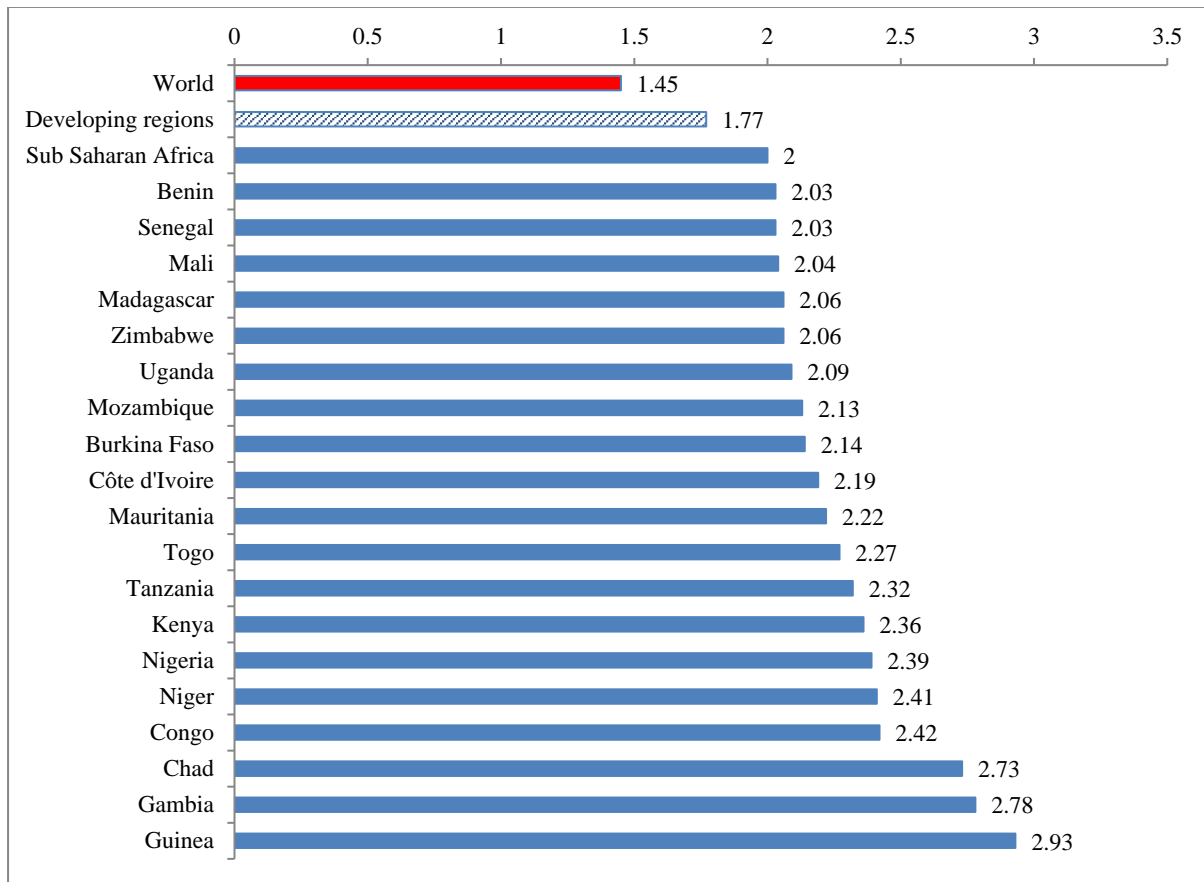
3.2 Food Access

Available food is ineffective in reducing hunger, if it is not supplemented with adequate means of food distribution among the population, both in terms of economic and physical access.

The scarcity of data on infrastructure does not allow computation of regional aggregates on availability of means of physical access. Considering road density (ratio of total road network over total land area) statistics of FAO as a proxy indicator, it is found that there is severe lack of road network in the Sub-Saharan region. In comparison to the global average of 24.7 km per 100 square km of land area, it is just 7.9 km in this region. Besides, in several countries such as Angola, Burkina Faso, Cameroon, Central African Republic, Madagascar and Namibia, road infrastructure is less than the national average and has also declined over past two decades.

Finally, even if food is physically accessible, the high food price level index of 2 and above in the region, much higher than the global average of 1.4, is an indicator of poor economic access, particularly in countries like Guinea, Gambia and Chad, where the index is 2.9, 2.8 and 2.7 respectively. (figure4).

Figure 4: Domestic Food Price Level Index in 2011 (base year = 2005)



Source: Food and Agriculture Organization, 2013b

Lack of economic access to food is also indicated by high poverty levels in the region. Poverty forms the basis of hunger. Working poor or share of employed people living below the poverty line is globally the highest in SSA at 42 percent in 2011. According to human development indicators of 2010, it has the highest incidence of multidimensional poverty, with considerable variation across the 37 African countries from a low level of 3 percent in South Africa to a high of 93 percent in Niger—while the average share of deprivation ranges from about 45 percent (in Gabon, Lesotho and Swaziland) to 69 percent (in Niger) (FAO 2012).

3.3 Food Utilization

Nutritional security or proper utilization of the available and accessible food is an important aspect of the food security concept. It may be adversely affected by lack of access to clean drinking water, unhygienic environment, lack of a balanced diet, as well as, prevalence of diseases.

Based on FAO statistics, it is found that on an average 37 percent of the population in this developing region doesn't have access to improved drinking water sources. However, the figures are much higher in several countries of the region. For instance, in Congo, Mozambique, Madagascar and Ethiopia, more than 50 percent of the population lack access to improved water sources.

Available statistics for the region are further disturbing, as far as hygiene is concerned. Almost 70 percent of the population, which is double the global average (36 percent), lack access to sanitation facilities. This implies that more than 80 percent to 85 percent of the population in several countries of the region live in extremely unhygienic conditions with inadequacy of even the excreta disposal facilities (Table 1).

Table 1: Percentage of Population with Access to Sanitation Facilities (%)

REGIONS	1990	2011
World	48	64
Developing regions	36	57
Sub-Saharan Africa	26	31
Countries of Sub-Saharan Africa		
Benin	5	14
Burkina Faso	8	18
Chad	8	12
Ghana	7	14
Guinea	10	19
Madagascar	8	14
Mozambique	9	19
Niger	4	10
Sierra Leone	11	13
Togo	13	11
United Republic of Tanzania	7	12

Source: Food and Agriculture Organization, 2013b

Diseases and epidemics like HIV/AIDS, malaria, tuberculosis which plague the continent have further worsened the nutritional security in the region. SSA remains the most heavily affected region in the global HIV epidemic. In 2011, an estimated 23.5 million people living with HIV resided here, representing 69 percent of the global HIV burden (UNAIDS, 2012).

3.4. Food stability

Economic, social and political stability is also a necessary aspect of the overall food security of a nation. FAO captures it through two separate set of indicators, namely vulnerability and shocks, which are a combination of natural and man-made factors.

Vulnerability of agricultural farmers to changes in weather patterns limits their food production ability. This situation is particularly troublesome in SSA because 93 percent of the agriculture is rainfed and it is the world's second most severely affected region for climatological disasters like extreme temperatures, droughts and wildfires (UNDP, 2012). A further support to this is provided by the FAO statistics, which indicate that just 3.6 percent of the arable land in the region is equipped for irrigation. The percentage is even less than 1 percent for several countries in the region (Table 2).

Table 2: Arable Land Equipped for Irrigation (%)

REGIONS	1990-92	2009-11
World	18.8	22.7
Developing regions	24.9	29.7
Sub Saharan Africa	3.9	3.6
Countries of Sub-Saharan Africa		
Benin	0.6	0.5
Botswana	0.4	0.7
Burkina Faso	0.6	0.5
Cameroon	0.4	0.5
Comoros	0.2	0.2
Congo	0.4	0.4
Ghana	0.2	0.7
Togo	0.3	0.3
Uganda	0.2	0.2

Source: Food and Agriculture Organization, 2013b

Political instability and violence is rampant in Africa. Since the early 1960s, when most of the African countries began to achieve independence, more than fifty coups have taken place in the continent. In the past ten years, the number of wars and internal conflicts have escalated, nearly a third of the forty-five countries in this region are embroiled in international or civil wars today. (Victor & Ombati, 2012).

The FAO “*Index of Political Stability and Absence of Violence/Terrorism*” tries to capture this aspect of food insecurity. Its value varies from **-2.5** (weak stability) to **2.5** (strong stability). For 70 percent of the Sub-Saharan nations, this index is negative.

Conflict severely disturbs the food security chain in a nation by adversely affecting both supply and access to food. It disrupts agricultural production and distribution, renders land unusable, displaces populations, and affects their livelihoods. It damages the available physical and social infrastructure, all of which have a long term impact on the region.

4. Prevalence of Gender Inequality in Sub-Saharan Africa

Women are the cornerstone of the economy of SSA, performing essential economic functions and undertaking agricultural production activities. However, they face several forms of discrimination manifest in the low literacy and higher unemployment rates; high fertility rates; unacceptably high maternal mortality ratio; high prevalence of HIV/AIDS; female genital mutilation; early marriages; polygamy, exclusion of women from land ownership; lower representation in decision-making position; etc.

Even though, exact quantitative assessment of the extent of discrimination women face is difficult, World Economic Forum has been quantifying the magnitude of gender disparities through its Global Gender Gap Report series, being published since 2006. The “Global Gender Gap Index” in the report seeks to measure one important aspect of gender equality - the relative gaps between women and men, across a large set of countries and across four

fundamental categories or subindexes - *Economic Participation and Opportunity; Educational Attainment; Health and Survival and Political Empowerment.*

The sub-sections below provide an analytical discussion on each of these aspects of gender inequality based on statistics from gender gap reports, World Bank and ILO.

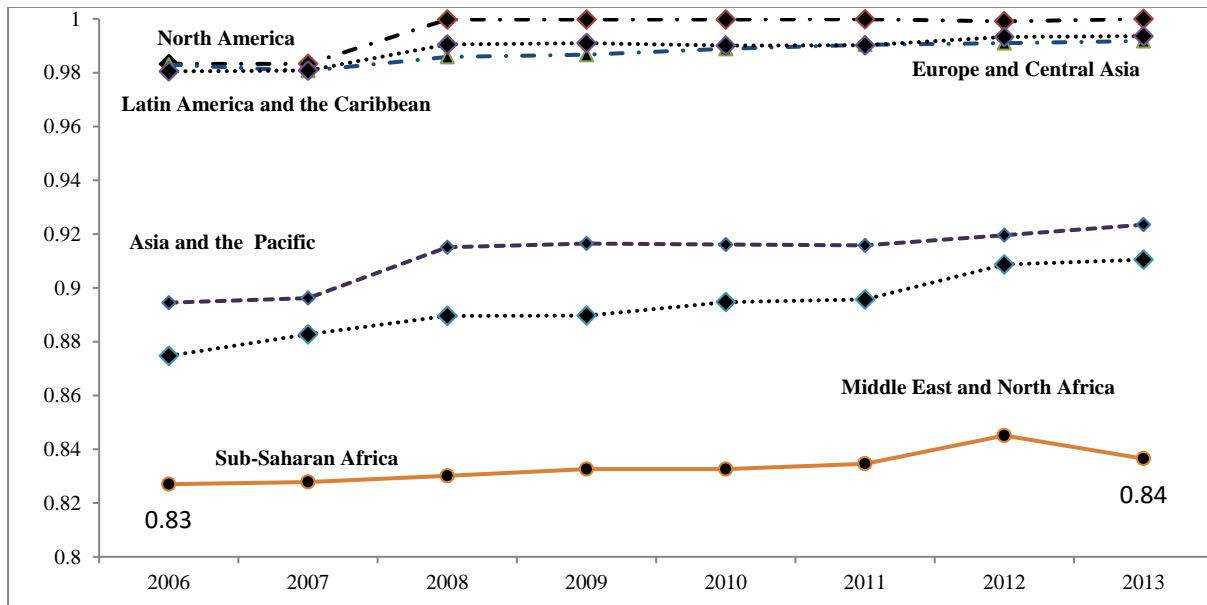
4.1 Education

Traditionally, all societies have given preference to males over females when it comes to educational opportunities. In today's globalised world, despite increasing concern and commitment, gender inequalities in literacy rates and education level remain a challenge. Right to education is still denied to many girls across the globe. As per UNICEF statistics for 2011, an estimated 31 million girls of primary school age and 34 million girls of lower secondary school age have no school enrolment. (UNICEF, 2014).

The *Educational Attainment Subindex* of gender gap report takes into account the parameters of literacy rate as well as enrolment in primary, secondary and tertiary education for assessing gender inequality in the field of education. As far as literacy rate is concerned, 13 Sub-Saharan countries (out of a total of 24 countries covered in the report) are among the bottom 20 countries in global ranking. Gender parity in literacy is as low as 45 percent in Benin, 54 percent in Mozambique and 56 percent in Chad. In case of enrolment ratios, statistics indicate that just 60 percent gender equity is attained by the countries of this region in primary education, which reduces to 30 percent in secondary and 20 percent in tertiary education.

An analysis of the trends over the 8 year time period (2006 to 2013) indicates that regionally, SSA has continuously occupied the last position with highest gender gap (Figure 5). It can also be seen that the region has made only a marginal progress from 0.83 in 2006 to 0.84 in 2013 in reducing gender inequality in education. Again, Benin, the globally lowest-ranking country on this subindex has closed only about 51 percent of its gender gap.

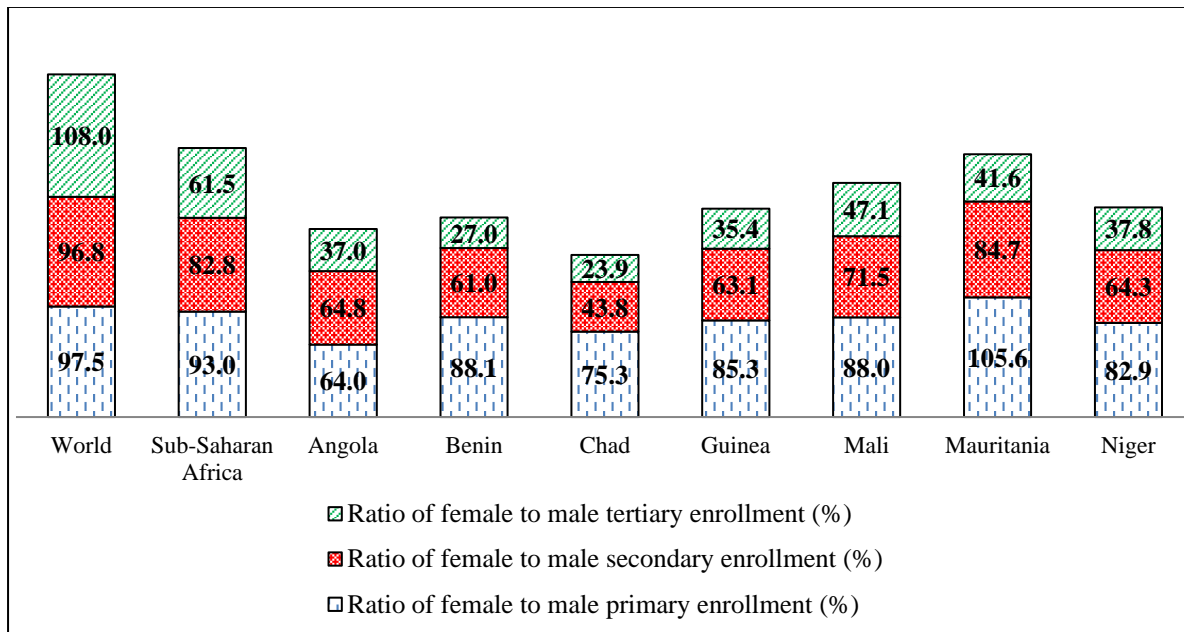
Figure 5: Regional Trends in Educational Attainment Subindex



Source: Global Gender Gap Report 2013

A similar picture comes out from the analysis of World Bank statistics. Although the developing world on average looks likely to hit the UN’s gender inequality target, in most of the countries of SSA, all education indicators are below global statistics. The region has one of the world’s lowest female adult literacy rates, with only 51 percent of the female population (15 and above) being able to read and write in 2011, well below the world average of 80 percent. Also, unlike general trend, in most of the countries of the region, the education pyramid is much narrower at higher levels with bigger gender disparities. Female access to secondary and tertiary education in the region as a whole is still limited with gross enrolment rates of 37 percent and 6 percent respectively. The ratio of girls enrolled at the secondary and tertiary levels is as low as 44 per 100 boys and 24 per 100 boys respectively, in countries like Chad (Figure 6).

Figure 6: Ratio of female to male - primary, secondary and tertiary enrolment in 2011



Source: World Development Indicators, 2013

This contrary situation of SSA can partly be explained by the high female dropout rates in the region, which by definition have a negative impact on school completion rates. Hence, by lowering the number of female students who drop out at the primary level, countries in this African region can set the stage for their progression to secondary and tertiary education. Accordingly, in our paper, due to non-availability of sufficient data on primary completion rates, we are using the statistics on primary and secondary enrolment ratios (female-male) for making the econometric analysis.

4.2 Health

Women live longer than men, across all regions. But, this is not an indication of absence of gender disparity in access to healthcare facilities and related parameters. *Health and Survival Subindex* of gender gap report brings forth the gender based differences in health, through two set of indicators, namely, *sex ratio at birth* and *gap between women's and men's healthy life expectancy*.

Regionally, SSA continues to hold the second last position (just before Asia and the Pacific) in this subindex, with no improvement since 2006. If we consider the values of its two components for 2013, it is found that the sex ratio at birth is above the equality benchmark of 0.944 for all the countries covered in the report (except Nigeria). Similarly, in terms of healthy life expectancy, all countries (except Botswana) have nearly reached the gender equality benchmark of 1.06.

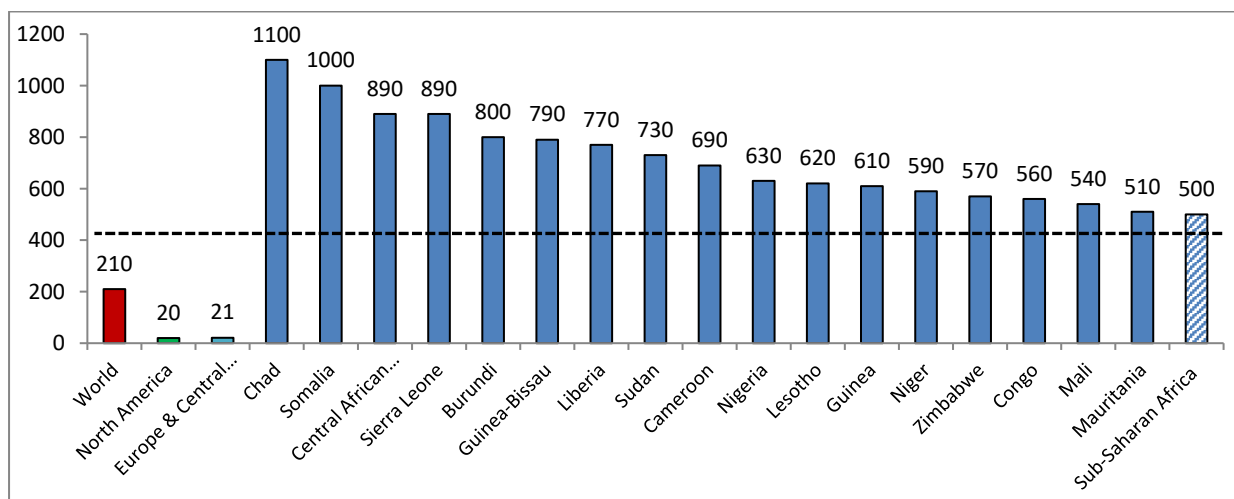
However, this subindex of gender gap report doesn't explicitly reveal the magnitude of gender biasedness in terms of reproductive health, which is the most important component of the overall health of a woman. For instance, globally in 2010, 37 percent of the women were lacking access to voluntary family planning and 33 percent of the pregnancies each year were

unattended by skilled health staff, particularly affecting marginalised young women and girls. These figures were as high as 76 percent and 50 percent, respectively, for SSA.

Hence, in our paper we take into consideration trends in two important parameters relating to reproductive and sexual rights of women, for analysing health related disparities.

Maternal Mortality: ratio is very high in SSA. It stands at 500 per lakh live births, which is more than double the global average of 210. Within this region, it is as high as 1100 in Chad and 1000 in Somalia, and is higher than the national average in majority of the countries (figure 7). World Bank statistics also indicate that almost 57 percent of the global maternal deaths in 2010 took place in SSA, which is more than double (36 percent) in 1990. The challenging situation here can further be justified by comparing the regional statistics for lifetime risk of maternal deaths. The risk is less than 1 percent in almost all parts of the world, except SSA, where it is 2.6 percent in 2010, down from 5.3 percent in 1990.

Figure 7: Maternal mortality ratio (modelled estimate, per 100,000 live births) in 2010



Source: World Development Indicators, 2013

Adolescent Fertility: reproductive health problems including HIV menace is particularly critical for adolescent girls because they have the highest levels of unmet needs for contraception and are the most vulnerable to forced marriage and sexual exploitation. Most of the world's births to adolescents — 95 percent occur in the developing region, and nine in 10 of these births occur within marriage or a union. About 70,000 of such girls die annually of causes related to pregnancy and childbirth. (UNPF, 2013).

Again, adolescent fertility rates are the highest in the countries of SSA and have declined by just 19 percent from 136 in 1990 to 110 in 2011, making the current rates much higher than the global average of 46 births per 1,000 women in the age group of 15-19 years.

HIV Epidemic: continues to affect SSA in intolerable proportions. As per World Bank statistics, woman's share of population (in the age group of 15 and above) living with HIV was 58 percent in 2011 and has increased from 54 percent in 1990. The percentage was as

high as 68 percent in Gabon, 65.5 percent in Senegal, 64 percent in Ethiopia and higher than 50 percent in several other countries.

All such information about the region simply makes us infer that even if more females are born and they have higher life expectancy than men, gender inequality will persist as long as woman's sexual and reproductive rights are violated.

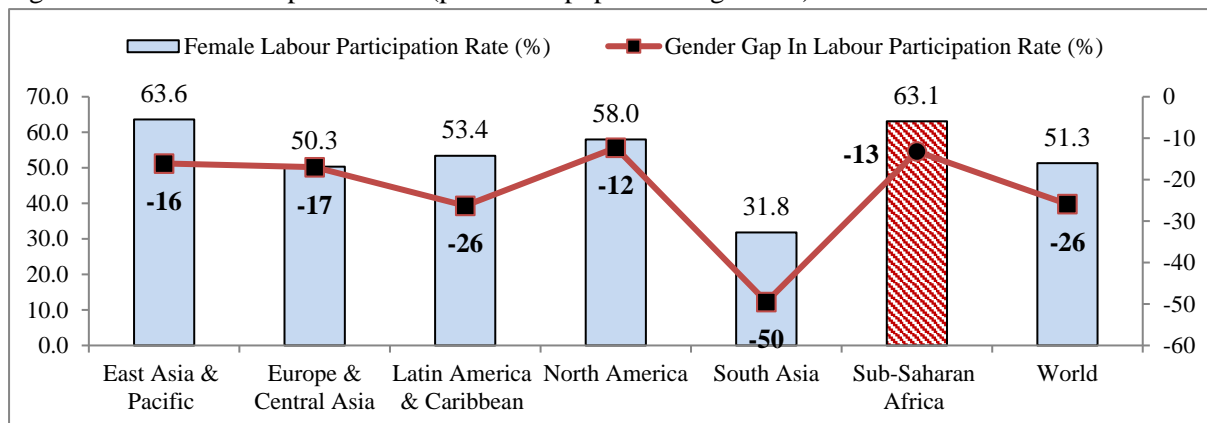
4.3 Employment

Higher educational attainment rates of women have facilitated their entry into the labour market and the current decreasing trend in the gender gap of labour force participation rate is a clear indication of this phenomenon. However, persisting discrimination in the form of wage inequalities have virtually nullified the effects of their increased economic empowerment. *Economic Participation and Opportunity Subindex* of gender gap report captures this aspect of gender inequality through its remuneration gap component.

Regionally, SSA has been the third best performer in this subindex since 2006 (positioned behind North America and Europe and Central Asia), mainly due to high labour force participation rates. But, the statistics for wage equality indicates that this has not been accompanied by higher female-male wage ratios. For instance, in Malawi, Mozambique and Burundi, female labour force participation is exceeding male labour force participation, but, female wages are just 64 percent to 74 percent of men's wages.

Similarly, *World Bank statistics* shown in figure 8 indicate that in SSA, female labour force participation rate at 63 percent and gender gap in it at 13 percent, places it at a much better position if compared with global averages of 51 percent and 26 percent, respectively. Despite such progress, 39 percent of the women fall into the category of unpaid contributing family workers and only 16 percent of the employed females earn wages/salaries, while on the contrary, almost double this percentage of men are in the category of wage/salary earners.

Figure 8: Labour Participation Rate (percent of population ages 15+) in 2011



Source: World Development Indicators, 2013

Women are the key food producers in SSA. Almost 60 percent of the employed women work in agriculture, and the female share of the agricultural labour force is almost 50 percent (FAO, 2011). Nevertheless, men represent 85 percent of agricultural landholders, while the

remaining 15 percent of the land is held by women. As per Africa Human Development Report (UNDP, 2012), men own more than twice the units of livestock that women own in Ghana, Madagascar and Nigeria. Similar gaps exist for fertilizer, mechanical equipment, new technologies, extension services and access to credit.

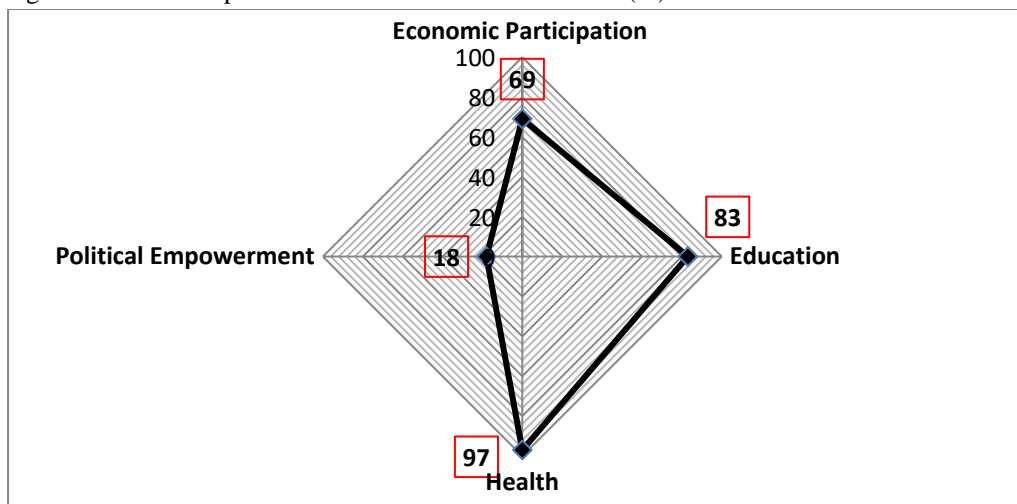
All such gender biased practices in the labour market are manifestations of the persisting forms of discrimination in the arena of economic participation and amounts to a virtual denial of equal “rights at work” to women.

4.4 Political Representation

A critical aspect of promoting gender equality is to identify and redress power imbalances in the political arena. Women are still far more likely than men to be politically inactive. They lack participation and are widely under-represented in the decision-making processes. Gender gap report captures this aspect of gender disparity through *Political Empowerment subindex*, which measures the gap between men and women at the highest level of political decision making.

Global patterns for 2013 indicate that among all the four subindexes of gender inequality considered by the gender gap report, the level of gender parity attained is the least in case of political empowerment. Regionally, SSA also shows a similar pattern, as pointed out by the cobweb diagram in figure 9. It has closed just 18 percent of its gender gap, which implies that 82 percent of the females face gender discrimination in political participation.

Figure 9: Gender Gap Index for Sub-Saharan Africa 2013 (%)

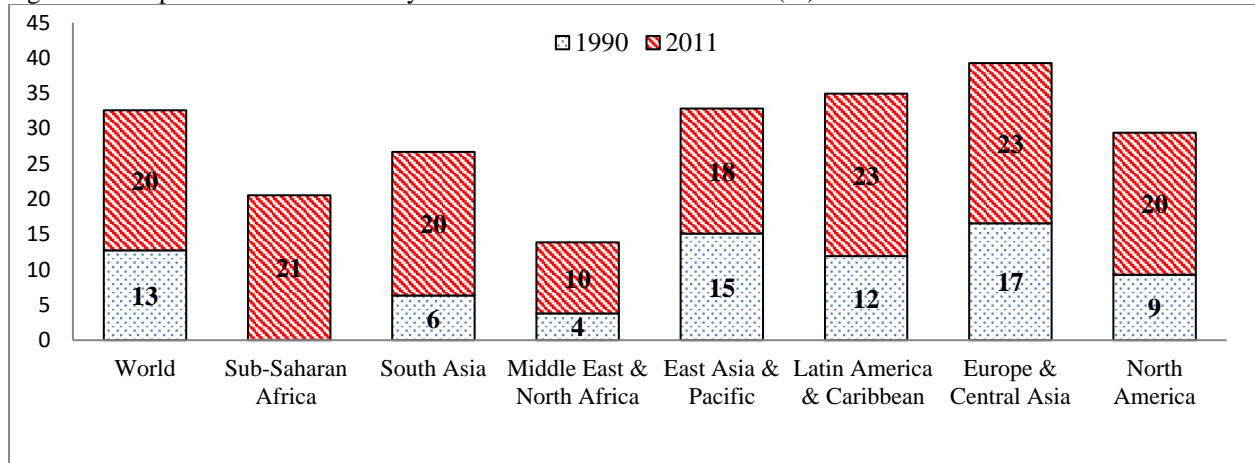


Source: Gender Gap Report - 2013

A clearer picture can be obtained if we consider the World Bank statistics on percentage of seats held by women in national parliaments. Globally, just 20 percent of the seats were held by women in national parliaments in 2011. Nevertheless, women’s parliamentary representation of 21 percent in SSA is comparable to that of the developed world at 23 percent in Europe and 20 percent in North America (figure 10). This shows that achievements on this indicator are related more to political will than to the level of development. Rwanda, for instance, was the first country in the world to elect more women parliamentarians than

men in 2008, and now has 56.3 percent of female parliamentarians. (United Nations Development Group, 2010).

Figure 10: Proportion of Seats Held by Women in National Parliaments (%)



Source: World Development Indicators, 2013

However, the real effects of political empowerment of women on food security are difficult to analyze because of the magnitude of political instability and the resulting atrocities against women, in most of the countries of this African region.

5. Link between Food Insecurity and Gender Inequality in Sub-Saharan Africa

The paper first tries to establish a general theoretical dependence of food insecurity on gender inequality and then develop this link for Sub-Saharan Africa through econometric analysis.

5.1 Theoretical Link between Gender Inequality and Food Insecurity

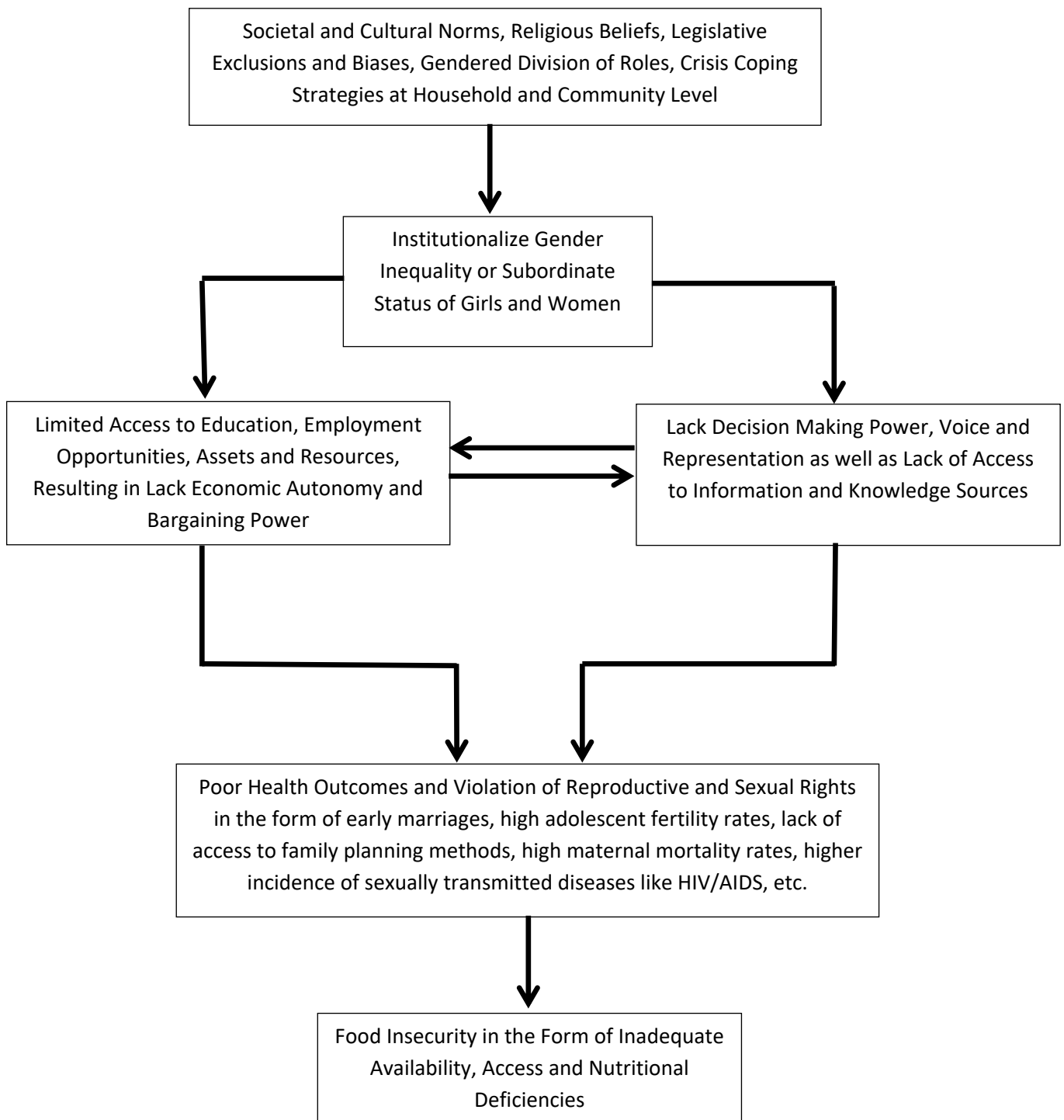
Gender inequality in our society has been institutionalized by a combination of factors, namely, societal and cultural norms; religious beliefs; legislative exclusions and biases; gendered division of roles; crisis coping strategies at household and community level; etc. For instance, illegal practice of sex-selective abortions and female infanticide is rooted in the social norms that favour sons' over daughters'. Sons' are viewed as the breadwinners who will carry on the family name and perform the last rites of the parents. Similarly, legislative measures such as those excluding daughters and widows from inheriting land as well as those permitting a second marriage for the husband when there is no son from the first marriage, cultivate a notion of male superiority. Traditional norms that support patriarchal dominance have resulted in acceptance of domestic violence by women at large.

Vulnerability of women increases many fold during economic (food, fuel and financial shocks), political and ecological crisis. They are assumed to take the responsibility of acting as safety nets of last resort and sacrifice in every possible manner for ensuring survival of the family under such circumstances. They are amongst the first to lose their jobs during economic downturn. Girls are removed from school first in order to reduce education related

expenses. During crisis, when prices rise, women and girls in the family are forced to reduce their food intake and suffer from nutritional deficiencies.

All such norms and practices have generated unconscious gender biasedness in the thinking pattern of the society, which is manifest in the form of the persistent gender gap in education, employment, asset ownership, decision making power, political participation and representation as well as in access to knowledge and information.

Figure 11: Theoretical Link – Flowchart





Education: illiteracy or lack of adequate education is one of the causes of early marriage of young girls, resulting in adolescent pregnancy, increased risks of maternal death and infant mortality, higher prevalence of infectious diseases like HIV/AIDS, etc. Besides, poor education of young mothers has adverse impact on nutrition and health of the foetus and infants.

Employment: lower levels of education of girls in comparison to boys result in fewer employment opportunities and gender based discriminations in the labour market. It is widely known that income in the hands of women yields benefits for the entire family, particularly in terms of food, health, clothing and education of the children. But lower purchasing power of women restricts their ability to ensure food security of their family member, both in terms of access and utilization.

Asset ownership and control: unequal access to and control over productive resources undermines economic performance of women. It erodes their autonomy and bargaining power both within and outside households. Evidence also suggests that countries where women lack land ownership rights or access to credit have on average 60 percent and 85 percent more malnourished children, respectively (*United Nations Human Rights Council, 2012*). This is because improving women's access to and control over financial resources leads to higher investment in children's health and nutrition.

Decision making power: women's limited access to education and employment opportunities curtails their economic autonomy and weakens their bargaining position, which translates into little or no voice in household decisions. In certain regions, intra-household allocation of food discriminates in terms of quality and quantity required by male and female members of the household. Women even tend to eat the least, or to eat leftovers after other family members have consumed their food. Such nutritional discrimination against pregnant women, women of child-bearing age as well as girls in early childhood may have adverse consequences on the foetus and future babies. Thus, disadvantage of poor nutrition is carried over from one generation to the next. Studies have also found that in the households where women determine what the family eats, children have higher birth weights and are better nourished.

Besides, lack of education and bargaining power is responsible for women having restricted access to sources of knowledge and information. Lack of employment opportunities restricts their mobility and exposure to new ideas, latest happenings and innovations. They are often debarred of understanding and awareness relating to their legal rights. For instance, financial illiteracy, lack of information on agricultural innovations and policy support of the government to farmers, may limit the ability of the female food producers to increase their farm yield. Also, women being primarily responsible for food preparation within a household, may adversely affect the food security of the family members due to poor nutritional knowledge and unhygienic dietary practices.

5.2 Econometric Analysis

The main hypothesis of the paper is that gender inequality adversely affects the level of food security in the region of Sub-Saharan Africa, which implies that a decrease in gender gap (female – male) in the key areas of education, employment, and reproductive health, results in a decline in prevalence of undernourishment and depth of the food deficit. It also leads to an increase in the average dietary energy supply level of the region.

Data Sources

The paper is based on data from three main sources, namely, Food and Agriculture Organization (FAO), World Economic Forum and World Bank.

Food Insecurity Data

Food insecurity is being measured in terms of three food security indicators of FAO – “Prevalence of Undernourishment”, “Depth of the Food Deficit” and “Average Dietary Energy Supply Adequacy”.

1. The prevalence of undernourishment expresses the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life. This is the traditional FAO hunger indicator, adopted as one of the official millennium development goal indicators.
2. The depth of the food deficit indicates how many calories would be needed to lift the undernourished from their status, everything else being constant. It is the average intensity of food deprivation of the undernourished.
3. The average dietary energy supply adequacy is the ratio of dietary energy supply and average dietary energy requirement and indicates the calorie availability per capita aspect of food security. Analyzed together with the prevalence of undernourishment, it allows discerning whether undernourishment is mainly due to insufficiency of the food supply or to particularly bad distribution. It thus provides an indicator of structural food supply adequacy.

Gender Inequality Data

There are two different datasets for measuring gender inequality – one is generated from the global gender gap reports and the second from the world development indicators.

1. Dataset from gender gap reports includes data on two subindexes (Educational Attainment Subindex and Economic Participation Subindex), measured over a short time period (2006 to 2011), across 19 countries of Sub-Saharan Africa. In the case of the two subindexes, the highest possible score is 1 (equality) and the lowest possible score is 0 (inequality). In addition, enrolment in primary education and earned income are the two other separate parameters used.
2. Dataset from World Bank includes data on three parameters of gender inequality, measured over a longer time period (1990 to 2011), across 20 countries of Sub-Saharan Africa. *The Ratio of Female to Male Labour Force Participation Rate*

expressed in percentage, is a parameter which is used to measure the extent of gender inequality in employment. The higher this percentage, the lesser is the magnitude of gender inequality. *The Ratio of female to male secondary enrolment* expressed in percentage is a parameter which is used to measure the extent of gender inequality in education. Two separate parameters are being used for measuring gender inequality in health. *Maternal mortality ratio (modelled estimate, per 100,000 live births)* is an important indicator of lack of access to adequate medical facilities to pregnant women and represents the risks associated with each pregnancy. *Adolescent fertility rate (births per 1,000 women ages 15-19)* measures gender inequality in terms of lack of reproductive rights of women.

Data for control variables

The three control variables used in the paper are - *GDP per capita (constant 2005 US\$)* from World Bank, and *Change in Domestic Food Price Level Index, and Road Density (per 100 square km of land area)* from FAO.

Methodology

In case of both the datasets, panel regression analysis using fixed effects model (as suggested by the Hausman test) has been undertaken. Two separate models have been fitted into the data. The models differ in respect of the variables used to measure gender inequality as an explanatory variable, keeping the dependent and control variables unchanged. Additionally, the time period of study varies in the two models, depending upon the availability of data. It is 6 years from 2006 to 2011 for first model, and 22 years from 1990 to 2011 for second model. Also, due to a small time period of 6 years, in the first model, all independent and control variables are placed at a one-time period lag. Further, the lists of Sub-Saharan countries covered in the two models also differ.

MODEL 1

It is based on the data collected from gender gap reports and includes three sets of regression equations, depending on the dependent variable. The equations analyze the impact of a reduction in the gender gap on under-nutrition, food deficit and average dietary energy supply, across a dataset of 19 Sub-Saharan countries:

Set of Regression Equations 1

$$\begin{aligned} \text{Under Nutrition}_{i,t} \\ = \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 GDP_{PC\ i,t-1} + \alpha_3 \Delta FPI_{i,t-1} + \alpha_4 \text{Road Density}_{i,t-1} + \varepsilon_{i,t-1} \end{aligned}$$

Set of Regression Equations 2

$$\begin{aligned} \text{Depth of Food Deficit}_{i,t} \\ = \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 GDP_{PC\ i,t-1} + \alpha_3 \Delta FPI_{i,t-1} + \alpha_4 \text{Road Density}_{i,t-1} + \varepsilon_{i,t-1} \end{aligned}$$

Set of Regression Equations 3

$$\begin{aligned} \text{Avg Dietary Energy Supply Adequacy}_{i,t} \\ = \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 \text{GDP}_{PC\ i,t-1} + \alpha_3 \Delta \text{FPI}_{i,t-1} + \alpha_4 \text{Road Density}_{i,t-1} + \varepsilon_{i,t-1} \end{aligned}$$

Where:

- X is the explanatory variable (Educational Attainment Subindex; Enrolment in Primary Education; Economic Participation Subindex and Earned Income) for country i at time t-1;
- Subscripts 'i' and 't' represent country and time respectively; i = 1 to 19 and t = 2006 to 2011;
- Under Nutrition: Prevalence of Undernourishment;
- GDP_{PC}: GDP per capita;
- ΔFPI: Change in Food Price Level Index;
- All Variables are in Logarithm Form;
- All explanatory and control variables are at a one-period time lag;

MODEL 2

This set of regression equations analyze the panel dataset generated from world development indicators, across a set of 20 Sub-Saharan countries.

Set of Regression Equations 1

$$\text{UnderNutrition}_{i,t} = \gamma_0 + \gamma_1 X_{i,t} + \gamma_2 \text{GDP}_{PC\ i,t} + \gamma_3 \Delta \text{FPI}_{i,t} + \gamma_4 \text{Road Density}_{i,t} + \eta_{i,t}$$

Set of Regression Equations 2

$$\begin{aligned} \text{Depth of Food Deficit}_{i,t} \\ = \gamma_0 + \gamma_1 X_{i,t} + \gamma_2 \text{GDP}_{PC\ i,t} + \gamma_3 \Delta \text{FPI}_{i,t} + \gamma_4 \text{Road Density}_{i,t} + \eta_{i,t} \end{aligned}$$

Set of Regression Equations 3

$$\begin{aligned} \text{Avg Dietary Energy Supply Adequacy}_{i,t} \\ = \gamma_0 + \gamma_1 X_{i,t} + \gamma_2 \text{GDP}_{PC\ i,t} + \gamma_3 \Delta \text{FPI}_{i,t} + \gamma_4 \text{Road Density}_{i,t} + \eta_{i,t} \end{aligned}$$

Where:

- X is the explanatory variable (Ratio of female to male labour force participation rate; Ratio of female to male secondary enrolment; Maternal mortality ratio; and Adolescent Fertility Rate) for country i at time t;
- Subscript 'i' and 't' represent country and time respectively; i = 1 to 20 and t = 1990 to 2011;
- Rest of the Variables are same as in Models 1;
- All Variables are in Logarithm form;

6. Results

Econometric results are given in the tables 1 and 2 in Appendix 1.

Model 1

Educational Attainment Subindex: a decline in the gender gap in education in one time period, indicated by an increase in the value of this subindex, results in a decline in the level food insecurity in the following time period. The coefficients indicate that a 1percent increase in gender equality in the field of education leads to a decline in undernourishment by 0.3 percent and in food deficit by 0.02percent. However the impact on dietary energy supply is insignificant

Enrolment in Primary Education: the impact of primary education on reducing the extent of food insecurity is high and significant with respect to all the three indicators, though it is much higher in case of average dietary energy supply adequacy ratio. A 1percent increase in gender equality in the field of primary education leads to an increase in dietary energy supply by more than 70 percent.

Economic Participation Subindex: a decline in the gender gap in economic participation in one time period, indicated by an increase in the value of this subindex, results in a decline in the level food insecurity in the following time period. A 1 percent increase in gender equality in the field of economic participation leads to a decline in undernourishment by 0.1 percent and food deficit by 0.01 percent. Again the impact is insignificant on dietary energy supply of the population.

Earned Income: a reduction in gender gap in earned income has a significantly positive impact on the extent of food security in terms of its all the three indicators. It is maximum in the case of dietary energy supply level, where a 1 percent increase in gender equality in the field of primary education leads to an increase in average energy supply ratio by 9.4 percent.

GDP per capita: has a highly significant impact on reduction in the level of food insecurity in the region. On the other hand, *Change in Food Price Level Index* or inflation seems to have a statistically insignificant impact on the extent of food insecurity.

Road Density Index: Infrastructure has a positive impact on the level of food security in the region, but this is statistically significant only in the case of enrolment in primary education.

Model 2

Ratio of female to male secondary enrolment: increase in this ratio has a significant impact on reduction in the level of food insecurity in the region in terms of all the three indicators. A 1percent increase in enrolment ratio leads to a decline in undernourishment by almost 0.3percent, food deficit declines by 0.01percent and dietary energy supply increases by 0.2 percent.

Ratio of female to male labour force participation rate: increase in this ratio also has a statistically significant impact of all the three indicators of food insecurity. The impact is statistically significant in raising the dietary energy supply (0.4 percent), followed by reduction in under-nutrition (0.3 percent) and food deficit (0.02 percent).

Maternal mortality ratio (modelled estimate, per 100,000 live births): also has a highly significant impact on the level of food security in the region. A 1 percent decrease in maternal mortality ratio leads to a decline in undernourishment by almost 13 percent, increase in dietary energy supply by 11 percent and food deficit declines by 0.5 percent.

Adolescent fertility rate: a 1percent decrease in adolescent fertility rate leads to a decline in undernourishment by almost 22 percent, increase in dietary energy supply by 18 percent and food deficit declines by more than 1 percent.

GDP per capita: again has a highly significant impact on reduction in the level of food insecurity in the region, in terms of all the three indicators of food insecurity. However, *Change in Food Price Level Index* or inflation seems to have a statistically insignificant impact on food security.

Road Density Index: infrastructure too has a significant impact on reducing food insecurity in the region. The impact is most visible for extent of under nutrition, in case of secondary enrolment ratio. It is also significant for depth of food deficit and dietary energy supply ratio, in case of maternity mortality and adolescent fertility rates.

7. Key Findings

On the basis of econometric analysis and interpretation of its results, we find that gender disparities prevailing in Sub-Saharan Africa in areas of education, economic participation and reproductive health clearly have an adverse impact on the level of food security in the region. This impact is manifest both in the short run (6 year time period) and in the long run (22 year time period). In the long run, adolescent fertility and poor maternal health has an adverse effect on dietary energy supply or calorie availability per capita in a significant manner.

Gender inequality in education is also an important factor affecting the level of food insecurity in the region, both as composite subindex and as individual parameters of primary enrolment ratio and secondary enrolment ratio.

Similarly, increase in economic participation of women, both as a composite index of gender gap report and as separate parameter of labour force participation rate has a positive effect on the level of food security in the region. It may also be noted that labour market discrimination in the form of wage/income disparities too has a significant impact on all the food security indicators used in the paper for analysis.

Besides, it was found that GDP per capita was the most important control variable across all regressions in both the models. This implies that '*Access to Food by all*' is the necessary condition for ensuring food security. Infrastructure assessed in terms of road density is also affecting food security levels, particularly in the cases where the impact of disparities in education, maternal health and adolescent fertility rate is being assessed.

8. Conclusion

The paper through its panel data analysis tends to support the hypothesis that gender inequality in Sub-Saharan Africa has adverse effect on the level of food security in the region. Indisputably, women play a key role in a nation's food economy, not only as food

producers and income earners, but also as food distributors and consumers. Nevertheless, better educated and economically empowered women have more control over their life and are able to exercise their choices with greater autonomy. They are better informed to take their decisions relating to marriage, family planning, nutritional requirements as well as balanced diet for a healthy living. In addition, mandatory provisions which guarantee sexual and reproductive right can play a very important role in providing women a respectable and dignified life. It is a well-known fact that empowered mothers' have a strong positive influence on the education, health and nutrition of their daughters'. Hence, any policy or legislation which lacks gender dimension will be ineffective in controlling the growing magnitude of hunger in the conflict prone region of Sub-Saharan Africa.

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Appendix 1

Table 1: MODEL 1 (All explanatory and control variables are at a one time period lagged)

Dependent Variables		Prevalence of Under Nutrition		Depth of Food Deficit		Average Dietary Energy Supply Adequacy	
Explanatory and Control Variables							
Educational Subindex	Attainment	-0.314(p-value = 0.177)	= 0.082)	-0.0240(p-value = 0.097)(0.0142)	=	0.415(0.262)	
GDP per capita(constant 2005 US\$)		-10.91*(4.657)		-0.733(p-value = 0.374)	= 0.055)	16.20*(6.901)	
Inflation(Change in Food Price Level Index)		3.865(2.830)		0.0983(0.227)		-2.149(4.193)	
Infrastructure(Road Density)		-2.378(1.721)		-0.190(0.138)		3.966(2.550)	
_cons		127.4*** (32.67)		12.11*** (2.621)		-41.90(48.41)	
<i>N</i>		76		76		76	
<i>R</i> ²		0.177		0.143		0.167	
Enrolment in Education	Primary	-31.89* (15.55)		-3.727** (1.187)		71.21** (21.69)	
GDP per capita(constant 2005 US\$)		-9.608* (4.748)		-0.510(0.362)		11.70(p-value = 0.083) (6.625)	
Inflation(Change in Food Price Level Index)		4.245(2.828)		0.199(0.216)		-4.265(3.947)	
Infrastructure(Road Density)		-3.290(p-value = 0.087)(1.887)	=	-0.352*(0.144)		7.258** (2.633)	
_cons		124.6*** (31.64)		12.52*** (2.415)		-52.16(44.15)	
<i>N</i>		76		76		76	
<i>R</i> ²		0.192		0.239		0.275	
Economic Subindex	Participation	-0.0779 (p-value = 0.097) (0.0461)	=	-0.00627(p-value = 0.095) (0.00369)	=	0.0932(0.0686)	
GDP per capita(constant 2005 US\$)		-12.23** (4.570)		-0.832* (0.366)		18.00* (6.795)	
Inflation(Change in Food Price Level Index)		2.084(2.736)		-0.0395(0.219)		0.157(4.067)	
Infrastructure(Road Density)		-1.214(1.545)		-0.102(0.124)		2.401(2.296)	
_cons		112.0*** (31.15)		10.94*** (2.492)		-21.16(46.32)	

<i>N</i>	76	76	76
<i>R</i> ²	0.173	0.144	0.157
Earned Income	-7.802*(3.142)	-0.524*(0.256)	9.432(p-value = 0.051)(4.717)
GDP per capita(constant 2005 US\$)	-12.02**(4.441)	-0.824*(0.361)	17.74*(6.666)
Inflation(Change in Food Price Level Index)	1.698(2.667)	-0.0602(0.217)	0.628(4.003)
Infrastructure(Road Density)	-1.019(1.496)	-0.0857(0.122)	2.168(2.245)
_cons	109.7*** (30.23)	10.75*** (2.461)	-18.47(45.38)
<i>N</i>	76	76	76
<i>R</i> ²	0.219	0.163	0.189

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: MODEL 2

Dependent Variables → Explanatory and Control Variables ↓	Prevalence of Under Nutrition	Depth of Food Deficit	Average Dietary Energy Supply Adequacy
Ratio of Female to Male Secondary Enrolment	-0.253*** (0.0369)	-0.00952*** (0.00159)	0.224*** (0.0313)
GDP per capita(constant 2005 US\$)	-13.95***(1.463)	-0.613***(0.0630)	12.73***(1.240)
Inflation(Change in Food Price Level Index)	-0.0584 (1.169)	-0.00842 (0.0504)	0.311 (0.991)
Infrastructure(Road Density)	6.984** (2.279)	-0.0485(0.0982)	-1.071(1.932)
_cons	120.4*** (10.00)	9.812*** (0.431)	7.289(8.479)
<i>N</i>	372	372	372
<i>R</i> ²	0.346	0.368	0.401
Ratio of Female to Male Labor Force Participation Rate	-0.316*** (0.0719)	-0.0213*** (0.00284)	0.358*** (0.0590)
GDP per capita	-11.35*** (1.489)	-0.495*** (0.0589)	10.66*** (1.221)
Inflation	-0.288(1.285)	-0.0199(0.0508)	0.521(1.054)

Infrastructure(Road Density)	0.652(2.288)	-0.148(0.0905)	2.907(1.877)
_cons	122.8*** (10.49)	10.16*** (0.415)	1.386(8.606)
<i>N</i>	386	386	386
<i>R</i> ²	0.214	0.349	0.316
Maternal Mortality Ratio	13.31*** (1.532)	0.512*** (0.0643)	-11.79*** (1.269)
GDP per capita	-2.832(1.761)	-0.198** (0.0739)	3.383* (1.459)
Inflation	0.196(1.200)	0.00300(0.0504)	0.0559(0.994)
Infrastructure(Road Density)	1.477(2.025)	-0.238** (0.0850)	3.213(p-value = 0.056) (1.678)
_cons	-41.49* (20.57)	3.644*** (0.864)	148.6*** (17.05)
<i>N</i>	386	386	386
<i>R</i> ²	0.315	0.360	0.391
Adolescent Fertility Rate	22.66*** (2.324)	1.012*** (0.0941)	-18.52*** (1.962)
GDP per capita	-8.092*** (1.413)	-0.374*** (0.0572)	8.340*** (1.193)
Inflation	-0.260(1.173)	-0.0153(0.0475)	0.452(0.990)
Infrastructure(Road Density)	-0.761(1.920)	-0.307*** (0.0778)	5.386*** (1.621)
_cons	-25.43(17.35)	3.384*** (0.703)	124.7*** (14.65)
<i>N</i>	386	386	386
<i>R</i> ²	0.344	0.430	0.395

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$