Assessing the Pillars of Sustainable Food Security

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Abstract
There has been a vast array of work undertaken to assess the factors of sustainable food security. The purpose of this study is to examine the role of four independent variables in respect to sustaining Global Food Security: Food Availability, Access to food, Nutrient Utilization, and food stability, which are usually referred to as the Pillars of Food Security. A comprehensive literature review on Food Security was conducted; a model is presented to illustrate the relationship between Food Security several specific factors that determine its sustainability. The model shows that while Availability, Access, Utilization, and stability are the four main factors that are essential to ensure Food Security, several other sub-factors are involved. These sub-factors and their roles in Food Security must be considered in developing a sustainability strategy.
Several relevant publications from within the particular subject of interest form the scope of this empirical research.

Keywords: Food Security, Food Availability, Nutrient Utilization, Food Stability, Nutrient Bioavailability

1. Introduction

There have been many discussions about food security, (Christopher B Barrett, 2010), (Swaminathan, 2003), (Conceição & Mendoza, 2009), (Christopher B. Barrett, 2001),(Lutz, Scherbov, Prskawetz, Dworak, & Feichtinger, 2002), (Schmidhuber & Tubiello, 2007), (Rosegrant & Cline, 2003), (Chen, 2007), (Godfray et al., 2010),(Farre, Twyman, Zhu, Capell, & Christou, 2011), (Townsend, Peerson, Love, Achterberg, & Murphy, 2001). "The term food security was originally used to describe whether a country had access to enough food to meet dietary energy requirements. (Pinstrup-Andersen, 2009)". "The most widely accepted

definition of food security derives from the 1996 World Food Summit Plan of Action, which describes food security as a state in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Coates, 2013)".

"The right to food is one of those most consistently mentioned in international human rights documents, but it is the one most frequently violated in recent times. Targets set by the World Food Summit in 1996 for the reduction of hunger have largely failed, despite food production having grown faster than world population.(Clover, 2003)"."In July 2002, during the next summit of the Food and Agriculture Organization of the UNO (FAO), it was admitted that the world community was losing the battle with hunger and that the food problem is a global one. (Kormishkina, Krutova, Sausheva, & Semenova, 2013)"

Several factors have been identified as critical to food security. "Food security is contingent on three basic parameters - availability, accessibility and affordability. Availability comes from production and related aspects of productivity that sustain a desired level of production, accessibility is about distribution(Krishnaraj, 2005)". "Food security depends not only on the availability of food but also its nutritional quality(Farre et al., 2011)."If global food security is to be attainable and sustainable, a multidimensional approach must be used in formulating and implementing an appropriate strategy. "The reasons why action plans to address food security have continued to fall short can be attributed to faulty analysis and faulty actions (Clover, 2003)". Several factors which contribute to food security must be thoroughly examined and action plans need to be targeted at ensuring that these factors are well considered in designing a sustainable global food security framework.

Achieving sustainable food security will require more than improving farm productivity and profitability while minimizing environmental impacts. The concept is broader than sustainable agriculture: it fuses the goals of household food security and sustainable agriculture. It requires both. It requires that we look not only at the aggregate supply of food but also at income and land distribution, at household livelihoods and dietary needs, at food distribution and waste, at women's status and their opportunities, at fertility and population issues, and at the protection and regeneration of the resource base for food production - terrestrial, aquatic, and climatic. "Achieving food security needs policy and investment reforms on multiple fronts, including human resources, agricultural research, rural infrastructure, water resources, and farm- and community-based agricultural and natural resources management. Progressive policy action must not only increase agricultural production, but also boost incomes and reduce poverty in rural areas where most of the poor live. (Rosegrant & Cline, 2003)."
This paper examines with the basic pillars of food security, and a model is developed that inter-relate various sub-factors which affect these pillars of food security.

2. Research Method

Attaining sustainable Food Security is anall-encompassing process that involves several factors. The research presented in this paper focus on global food security and four factors that affect its sustainability. The four factors in relation to sustainable food security that were examined are food availability, access, utilization and stability. The review-centric approach is used in this paper, several published works were reviewed and a new insight into the subject matter is contributed. The literature review serves as a solid theoretical background for assessing these factors, thereby generating clues for a new insight into the subject matter.

3. Pillars of sustainable Food Security

Sustainable food security is a broad phenomenon that requires a wide range of factors which must be well considered in designing a strategy to that end. The major pillars of food security that practitioners believed are critical to achieving its sustainability include food Availability, Access, Utilization and Stability. (Coates, 2013), (Christopher B Barrett, 2010), (Pinstrup-Andersen, 2009), (Kannan et al., 2000)

3.1 Additional factors

During the course of the literature review, other additional factors which have significant effects on sustaining food security were identified. These additional factors as shown in table 1 were grouped into corresponding sub-factors as they inter-relate with each of the primary pillars of food security. Figure 1 shows a pictorial representation of the relations.

4. Discussion

4.1 Food security

Food security is primarily concern with constant availability and access of people in the appropriate quantity and quality of food needed for a healthy life. According to Coates (2013) the FAO in the World Food Summit of 1996 gave the most widely accepted definition of food security as the state in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (Coates, 2013) This position is also reiterated by Swaminathan (2003) that At the World Food Summit in 1996, Food security was defined as "physical and economic access, at all times, to sufficient, safe and nutritious food (for people) to meet their dietary needs and food preferences for an active and healthy life.(Swaminathan, 2003)". Clover (2003) however identified Availability, access and affordability as elements of food security.(Clover, 2003). Conceicao and Mendoza (2009) also identified the role of food crises, Biofuel and Climate change in sustaining global Food Security (Conceição & Mendoza, 2009). While Choudhary and Parthasarathy (2007) focus on measuring the role of women in the operationalization of Food Security (Choudhary & Parthasarathy, 2007), Crush and Frayne (2011) believe that the lack of access to food is a key determinant of Food Insecurity. (Crush & Frayne, 2011).

4.2 Availability

Availability of food is an essential factor to be considered in ensuring a sustainable food security system. According to Barrett (2001) even though aggregate food availability is insufficient to ensure either access to proper utilization of nutrients to achieve food security, aggregate availability is however a necessary condition for food security. Food insecurity is inevitable within an economy lacking enough food to satisfy all of its population's nutritional needs (Christopher B. Barrett, 2001). Lutz at al., (2002) pin pointed increase in population, poverty, education and gender inequalities as critical factors that reduce food production thereby leading to a decline in food availability and invariably resulting in food insecurity. (Lutz et al., 2002). An earlier study by Pingali et al., (2008) emphasized the effect of biofuel production on food availability and other pillars of food security. According to the study, Biofuels affect the availability of food by competing directly for commodities and with productive resources, the diversion of food crops for biofuel production lead to a consequent rise in food prices thereby creating growing concerns about food security since access to food is determined primarily by incomes and food price levels (Pingali, Raney, & Wiebe, 2008). Schmidhuber and Tubiello (2007) assessed the effect of changes in agro-ecological conditions such as changes in temperature and precipitation associated with continued emissions of greenhouse gases and the increase in atmospheric carbon dioxide (CO_2) concentrations on alteration in land suitability, potential yields, and food production (Schmidhuber & Tubiello, 2007). Rosegrant and Cline

(2003) studied the impact of the HIV/AIDS epidemic on food security. According to the study, Adult labor is often removed from affected households, and these households will have less capacity to produce or buy food, as assets are often depleted for medical fees, also the agricultural knowledge base will deteriorate as individuals with farming and science experience succumb to the disease (Rosegrant & Cline, 2003). Chen (2007) identified accelerated urbanization as a factor that not only reduce agricultural land but also increase soil pollution through waste disposal and acid deposition derived from urban air pollution(Chen, 2007).

4.3 Access

Pinstrup-Anderson (2009) argued that food availability alone is not enough to determine food security; rather the individual access to available food should also be taking into consideration. According to the author, availability does not assure access, and enough calories do not assure a healthy and nutritional diet. If food security is to be a measure of household or individual welfare, it has to address access. The author believes that the same sentiment is shared by FAO in defining food security as situation when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (Pinstrup-Andersen, 2009).

Godfray et al., (2010) examined the role of price in determining access to food. According to these authors, patterns in global food prices are indicators of trends in the availability of food. Poor transport and market infrastructure raise the prices of inputs, such as fertilizers and water, and increase the costs of moving the food produced into national or world markets (Godfray et al., 2010).

An earlier study by Kennedy and Peters (1992) pinpoint household income as a major factor in determining access to food (Kennedy & Peters, 1992). Smet et al., (2013) establish that that armed political conflict has a detrimental effect on food security and household welfare: conflict induces food insecurity by reducing own food production and access to food (Smets, Tusiime, & Renard, 2013). Del Ninno et al (2007) elucidate the significance of Food aid, both for short-term emergency relief and as program food aid that helps address medium-term food "deficits", is often a major component of food security strategies in developing countries. The study also reveals that numerous concerns have been raised, however, about the efficiency of food aid – supported programs in meeting their objectives. Problems identified include minimal impact on development, high cost of procurement of tied aid, and poor targeting. Moreover, along with food-assisted programs in general, food aid resourced programs often involve high administrative costs within-country (due in part to leakages) lack of timeliness (late arrival or even cancellation) and the high cost of delivery to the recipient country were also identified as part of criticisms of food aids. These limitations notwithstanding, emergency food aid according to the study has often been effective in addressing short-term relief needs(Del Ninno, Dorosh, & Subbarao, 2007).

As against household food security, individual food security depends on various visible and invisible intra-household factors such as gender and age. According to Choudhary and Parthasarthy (2007), overall household food security may not be a guarantee for individual food security. Often, food available to a household is not equally accessible to the men, women and children of the household. (Choudhary & Parthasarathy, 2007).

4.4 Utilization

Barrett (2010) explained the importance of the dietary quality of available food. According to the author, "utilization reflects concerns about whether individuals and households make good use of the foodto which they have access". The author believes that the nutritional value of food in term of essential micronutrient and vitamins and the ability of the body to metabolize and absorb these nutrients is an essential factor of

food security (Christopher B Barrett, 2010). Townsend et al., (2001) believe that there is a correlation between food security and obesity. According to them, in a logistic regression analysis, mildly insecure women were 30% more likely to be overweight than those who were food secure. Thus, food insecurity had an unexpected and paradoxical association with overweight status(Townsend et al., 2001). Farre et al., (2011) elucidate on the potentials of Genetic Engineering as a strategy for tackling nutrient deficiency in food. They further explained that Genetic Engineering offer prospect of nutritionally complete staple crops that could realistically address malnutrition on a global scale(Farre et al., 2011).

According to Ivers et al., (2009) HIV infection reduces the efficiency of nutrient absorption and utilization due to compromised immunity. Malabsorption of fats and carbohydrates is common, which invariably affect the absorption and utilization of fat-soluble vitamins. They conclude that infections can lead to metabolic changes, including changes in insulin and glucagon levels, result from both reduced food intake and the immune response to infection.(Ivers et al., 2009). An additional, key issue according to Hall et al., (2008) is that an effective supply of micronutrients is dependent on their bioavailability, Metabolites present in food may inhibit or enhance absorption, especially of minerals. Metabolomics could provide a tool with which to study aspects related to potential remedies based on, e.g. food processing techniques and biofortification (Hall, Brouwer, & Fitzgerald, 2008). Dietary diversity can play a role in identifying the food-insecure. According to Hoddinott and Yohannes (2002), households with low levels of dietary diversity are likely to have low levels of consumption per person and low caloric availability (Hoddinott & Yohannes, 2002).

4.5 Stability

Kannan et al (2000) consider food security as a situation that ensure the ability of all the people to access food at all times (Kannan, Dev, & Sharma, 2000). Josling and Barichello (1984) identify world market stability as a factor to a sustainable food security. According to them world market stability is largely dependent upon the actions of major grain trading countries, improvement in the sensitivity of domestic storage and consumption to world conditions could increase their contribution to world food security(Josling & Barichello, 1984). Culture is connected to food security through the individual's access to formal education, cultural capital may amplify the benefits of formal education and other forms of human capital for food security (Molnar, 1999). Agricultural biodiversity is critical for food security; biodiversity provides valuable ecosystems services and functions for agricultural production. According to Thrupp (2000) there is an urgent need to adopt an agroecosytems approach, beyond a focus on genetic resource conservation alone, to implement other biodiversity-enhancing methods in farms, such as integrated ecological pest and soil management. (Thrupp, 2000). Ecological intensification provides a strategy based on local management interventions that can move crop production into the safe space globally, to meet increasing demands for food, ecological intensification has to be combined with other measures that dampen demands, such as reducing food loss across the supply chain and by stepping down the food chain in global consumption. (Bommarco, Kleijn, & Potts, 2013). Tweenten (1999) asserts that food security is best served when economic progress is broad-based, such development must also provide public goods and correct externalities for sustainable progress.(Tweeten, 1999).

5. Contribution and New Insight

Several research works have iterated the various component of global food security. However, none have taken a wide view at the broad factors that must be considered in ensuring its sustainability.

This paper has provided a new insight into the vast amount of factors necessary in sustaining food security by examining the effects that these factors have on the process.

A comprehensive review of some of the literatures available on the subject clearly reveals that the process required a vast amount of factors that if not taken into consideration will jeopardized any strategy aimed at sustaining food security.

The proposed model in this paper clearly shows the various factors that directly or indirectly affect the pillars of sustainable food security.

Research have shown that food availability is fundamental to ensuring food security.(Christopher B. Barrett, 2001). The proposed model however shows how population (Lutz et al., 2002), biofuel production (Pingali et al., 2008), climate change (Schmidhuber & Tubiello, 2007), HIV/AIDS epidemic (Rosegrant & Cline, 2003), and urbanization (Chen, 2007) directly affect the availability of food thereby invariably having effect in on the sustainability of food security.

However it was revealed that availability of food does not guarantee access (Pinstrup-Andersen, 2009). It is evident form the model that food prices (Godfray et al., 2010), income (Kennedy & Peters, 1992), conflict (Smets et al., 2013), food aid (Del Ninno et al., 2007), gender and age (Del Ninno et al., 2007) all have a direct effect on the food security.

In the same vein, dietary diversification (Hoddinott & Yohannes, 2002) , nutrient bioavailability (Hall et al., 2008), HIV/other infections (Ivers et al., 2009), obesity (Townsend et al., 2001) and genetic engineering (Farre et al., 2011) are factors that affect the nutrient utilization of food thereby invariably affecting food security sustainability.

Furthermore, the model clearly shows that international market stability (Josling & Barichello, 1984), culture and education (Molnar, 1999), agricultural biodiversity (Thrupp, 2000), ecological intensification (Bommarco et al., 2013) and economic policy (Tweeten, 1999) are factors that determine stability and as such must be considered in ensuring sustainable food security.

Finally the model presented has made it clear that sustainable food security depends on a wide range of factors which must be painstakingly considered in formulating any strategic action plan to that end.

6. Conclusion

Food availability, access, utilization, and stability are integral parts of food security. Food security can therefore be imagined to a house having three pillars of availability, access and utilization but the ground on which these three pillars are standing for continuous support is the stability factor. We must address each of these factors in ensuring sustainable food security. Each of these factors is dependent on several other sub-factors or component which must all be taking into consideration in formulating a framework for sustainable food security globally.

Further research into the subject is therefore recommended to identify other pertinent factors and to gain more insight.

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Tables and Figure

Table1. Additional factors

Availability	**References**
Population	(Lutz et al., 2002)
Climate change	(Schmidhuber & Tubiello, 2007)
Urbanization	(Chen, 2007)
Biofuel production	(Pingali et al., 2008)
HIV/AIDS	(Rosegrant & Cline, 2003)

Access	**References**
Food prices	(Godfray et al., 2010)
Income	(Kennedy & Peters, 1992)
Political conflicts	(Smets et al., 2013)
Food aids	(Del Ninno et al., 2007)
Gender and age	(Choudhary & Parthasarathy, 2007)

Utilization	**References**
Dietary diversity	(Hoddinott & Yohannes, 2002)
Bioavailability	(Hall et al., 2008)
HIV and other Infection	(Ivers et al., 2009)
Obesity	(Townsend et al., 2001)
Genetic Engineering	(Farre et al., 2011)

Stability	**References**
International market	(Kannan et al., 2000)
Culture and Education	(Molnar, 1999)
Biodiversity	(Thrupp, 2000)
Ecological intensification	(Bommarco et al., 2013)
Economic policy	(Tweeten, 1999)

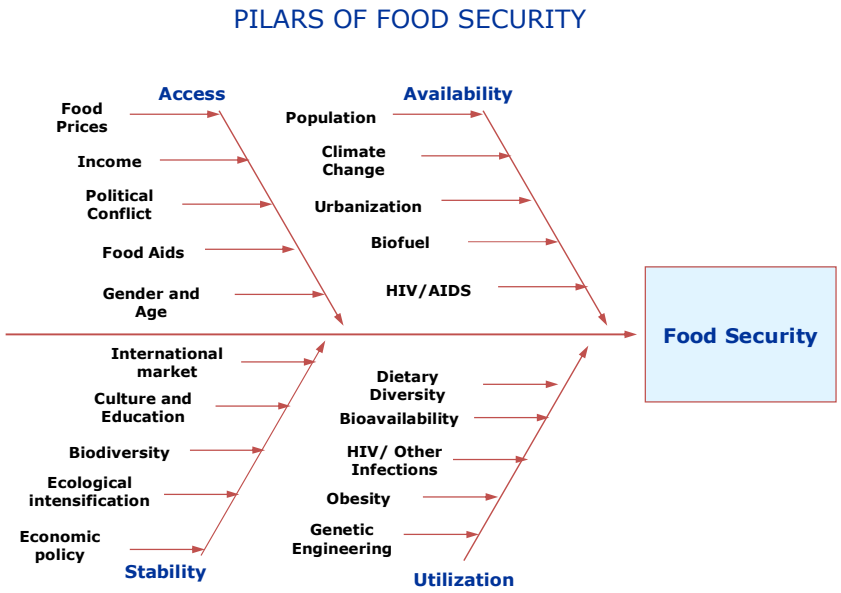

Figure 1 **Factors of sustainable Food Security**