

Analysis of Challenges to Food Security and Its Recommended Strategies

August 28, 2014

Xin Shi (Iris)

Abstract

Food security is a global challenge embedding complexities including social, economic and environmental fronts. Food security has to be achieved on the quantitative and qualitative level reflected by food availability, food access, food use and their stability. As a result, food security is overlapped to agricultural systems including food production, processing, distribution, retails, delivery to households and consumption of customer. Also food insecurity can be examined by three gaps which are status quo gap, nutrition gap and distribution gap. Land loss, scarcity of freshwater, climate change pose large threats on the food availability. In terms of developing countries, especially Sub-Saharan Africa, poverty and unequal human's rights inseparably caused food insecurity, while population growth has a globally negative influence on food security, which affects developing nations the most considering demographics and birth rates. On the arena of economic considerations, food security is subjective to income levels within countries, uneven distribution of economic growth as well as soaring food price. In order to counteract this global crisis, two international strategies should be supplemented by initiating an international food aid organization, as well as a research and education centre to improve food accessibility, food production and to address food waste. To narrow the

scale down to developing countries, crop intensification can cut down capital investment associated with providing more local job opportunities considering poverty and population expansion. Another strategy can be adopting the agro-forestry as one form of sustainable agricultural systems. This, to some extent, provides some resilience to climate change and also increases the diversity of income, particularly targeting small scale farmers who are the major components of agricultural production in Africa.

Introduction

Food security is an existing global challenge to allow everyone to have stable access to an adequate quantity of nutritious and affordable food supply, subject to both quantitative and qualitative requirements (Capone et al. 2014). Food security relies on four constitutors including food availability, food access, food use and stability in the former three items(Capone et al. 2014). Food availability, which is defined as the availability of a sufficient amount of food supplies, can be impacted by production, distribution and exchange. Food access, which refers to appropriate methods of acquiring enough food, is influenced by affordability, allocation and preference. Food utilization, which means proper consumption of food in terms of knowledge of nutrition and care, is determined by nutritional value, social value and food safety(Ericksen, 2008). Stability of former three components is the last stage to ensure the consistency of this whole food system. Moreover, food security is tied to “the diverse set of institutions, technologies and practices that govern the way food is marketed, processed, transported, accessed and consumed(Capone et al. 2014).” As a result, maintaining food secure is inextricably interlinked with agricultural systems.

Food insecurity can be examined by several food gaps with emphasis on different aspects. The first one is the status quo gap focusing on quantitative level which displays the difference between essential food supplies per capita and food supplies in the reality over the same duration(Shapouri&Rosen, 2001, Food security assessment: regional overview). On the other hand, the nutrition gap is based on the difference of nutrition intake between reality and expected needs to meet basic standard(Shapouri&Rosen, 2001, Food security assessment: regional overview.). The last important indicator is the distribution gap, which targets at the extra amount of food needed to meet minimum nutritional standards for each income groups (Shapouri&Rosen, 1999). During the period from 1998 to 2008, the incremental of 36 percent on the distribution gap was a more serious problem compared to the increasing 3% percent nutritional gap (Shapouri&Rosen, 1999). This implies that food insecurity is less likely to affect the countries without severely food insecure problem, whereas the problem is prone to exaggerating in the affected regions.

Statistics

Global food resources are adequate to support the collective population for the next couple of decades(Shapouri&Rosen, 2001, Food security assessment: regional overview). Unfortunately in reality, food insecurity happens to both developed countries and developing countries. According to the Economic Research Service, especially in 67 low-income countries, the developing countries would suffer from escalating food gaps in the next decade, predominately in Sub-Saharan African and South Asia(Shapouri&Rosen, 2001, Food security assessment: regional overview).

The most severe region experiencing food insecurity is Sub-Saharan Africa, which occupies only roughly 25 percent of the total collective population of 67 countries but should be responsible for a staggering 65 percent for nutritional gap amidst all 67 countries(Shapouri&Rosen, 2001, Food security assessment: regional overview).

Based on FAO's newly released statistics on Hunger Portal in 2013, 12 percent of the world's population (842 million people) are estimated to be undernourished in terms of energy intake, yet this figure represent only a tip of iceberg considering the global burden of malnutrition(Food and Agriculture Organization of United Nations, 2013, Hunger Portal). "An estimated 26 percent of the world's children are stunted or underweight, while 2 billion people are bearing one or even more micronutrient deficiencies and 1.4 billion people are overweight, of whom 500 million are obese" (Food and Agriculture Organization of United Nations, 2013, The state of food and agriculture).Majority of countries are suffering from more than one type of malnutrition, which might reflect on the stage of individuals, households, or even the community(Food and Agriculture Organization of United Nations, 2013, The state of food and agriculture).

The regional difference of food insecurity shows high variety of population standing with chronic hunger issue which is defined as the inability to obtain enough food for at least 1 year, consisting of 578 million in the Asia Pacific region; 239 million in sub-Saharan Africa; 53 million in both Latin America and the Caribbean; 37 million in North America; and 19 million in other countries(Sasson, 2012). These astonishing statistics are expected to climb attributing to the rising prices of commodity and food. With regards to the investigation by the World Bank, 44 million people, who were

intensively susceptible to food insecurity, had been driven to extreme poverty in early 2011 due to the increase in food prices(Sasson, 2012).

Identifiable challenges of food security

There are three primary types of challenges on the way to achieving food security. The environmental aspects have more influence on agricultural production which goes hand in hand with food availability. The social influence covers all components of food security. From the economic perspective, the challenges of food security tend to get attached to food access. To be specially, agricultural production, directly linked with food availability, is constrained from environmental conditions, including land resource, freshwater resource as well as the global problem-climate change.

Agricultural productivity, as an index of agricultural production, is one of the most crucial components to achieving food security. On the one hand, the sustained increase in agricultural production leads to growth of food availability due to cheaper purchase to consumers and increasing food supplies (Wiebe, 2001). On the other hand, in most developing countries, the food-insecure population is basically comprised of farmers or people living in the rural area. Consequently this population can benefit from more profits or food surplus to better sustain and accommodate their living(Wiebe, 2001).Especially in Africa,some 80 percent of the population with food insecurity problems appears to live in the countryside, whereas the scattered farmers constitute roughly 50 per cent of the food insecure population attributed to poverty and their living condition (Mwaniki, 2006). To follow up this conclusion, concerning the statistics across the developing nations, agricultural industry only contributes to roughly 9 percent of the GDP, while the occupied labor force is more than 50 percent

(Mwaniki, 2006).

Environmental considerations

Land, as the basic source for food production, is closely related to agricultural productivity. When fierce competition occurs among land uses, the expanding scales of energy sectors, industrialization as well as urbanization, the bulk of arable land gives its way to the new trend of industrial and economic development and urbanization (Nellemann et al. 2009). Other than pressure from development, land degradation gives rise to lessen the available agricultural use of existing land. Initially, the inappropriate measures in irrigation and production aggravated three fundamental forms of degradation including salinizing soil, soil fertility depletion and erosion (Nellemann et al. 2009). Approximately 950 million hectares of land, which occupies virtually 33 per cent of potential agricultural land, is estimated to be arid or semi-arid areas (Nellemann et al. 2009). According to Nellemann et al. (2009), globally around 20 percent of irrigated land suffers from increased salinization along with production loss at the rate of 2500 square kilometers to 5000 square kilometers annually (UENP, 2008). The agricultural productivity has dropped up to 50 per cent owing to the soil erosion and desertification. Generally speaking, this issue has the great impact on the African region (Nellemann et al. 2009). Specifically, another 12 million hectares of agricultural land will be lost and built upon the capacity of the degraded land next year, which is likely to destroy the existing land used for 20 million tonnes of grain production every single year (Wiebe, 2001). From 1979 to 1995, over 36 million hectares of agricultural land had been completely replaced in China alone (Nellemann et al. 2009). The land loss amplifies the problem of food

insecurity. Besides, the agriculturally favorable cropland appears to be distributed unevenly worldwide via satellite imagery which is shown in Appendix A(Wiebe, 2001). The lower quality of agricultural land is typically in Latin America, Asia and Africa, where the low-income developing countries are situated and also the countries that are suffering most from food insecurity. The poor condition lead to higher costs for production and lower overall productivity. The lowest quality of cropland is in Sub-Saharan Africa that occupies just 6 percent of cropland can be classified as the favorable, while there are 16 percent in Asia, 27 percent in Latin America(Wiebe, 2001). On the contrary, based on the classification from the World Bank, the developed countries possess 29 percent of high quality cropland; extraordinarily more than fifty percent in Eastern Europe belongs to the top three land-quality classes(Wiebe, 2001).

Freshwater scarcity is another segment of environmental challenges, as agriculture will be accountable for 70 percentages of global freshwater consumption just in the form of irrigation(Nellemann et al., 2009). As the large demand comes from the agricultural sector, the groundwater cannot avoid withdrawal resulting from the discrepancy between irrigation rates and recharge rates from precipitation. Subsequently, water tables are dropping even among nations, which rely heavily on agriculture, especially Indian and China(Nellemann et al., 2009). What is worse, 40 percent of food production stems from 17 percent of irrigated land on the global scale(Nellemann et al., 2009). Some parts of the world, including Central Africa rely on glacier or snow as the primary water source for irrigation(Nellemann et al., 2009). Inasmuch as climate change will pose an inextricably threat on water source by eventually dying out from melting (Nellemann et al., 2009). The more compelling

prediction is that by 2050, the water demand is projected to double and water scarcity will more or less strike 1.8 billion people(Nellemann et al., 2009).

Climate change is amplified due to the accumulative concentration of greenhouse gases, stemming from deforestation, extraction and consumption of fossil fuels, production of daily essentials such as agricultural products, etc. Regarding the information provided by the Intergovernmental Panel on Climate Change, the greenhouse gas emission would lead to the average temperature including all the continents and oceans to increase another 1.4-5.8 centigrade at the end of the 21st century (Darwin,2001). The rising global temperature will exert enormous influence on the food production including crop production. The first and foremost consideration should be the growing season of crops due to the affected soil conditions such as temperature, precipitation. Besides, availability of arable land is gradually submerged by the escalating sea level. According to the indicative model in the U.S. Department of Agriculture's Economic Research Service, climate change is estimated to alter the growing season of crops by the varying temperature, precipitation, and regional differences(Darwin,2001). For instance, once the average global temperature increased 1.8 centigrade, the growing season would become shorter near the equatorial area; while the growing season in higher latitudes will extend to a longer period(Darwin,2001). It will also increase the severity of storms and produce more frequently prolonged drought periods as well as a higher likelihood of floods as a whole impeding the progress from agricultural productivity. In addition, increasing certain types of greenhouse gases including sulfur dioxide and ozone in the atmosphere will be detrimental to crop growth and counteract the

benefits brought on by a higher concentration of CO₂(Darwin,2001). Last but not least, climate change can bring about a higher probability of infestations such as foreign species which invade and thrive due to a lack of natural predators and so forth(Darwin,2001).

Converging the agreement of conclusions from 6 climate models and 2 crop modelling methods, the consensus indicates that the agricultural products will most likely decline worldwide by 6 percent with fertilizers and 16 percent without fertilizers, assuming the temperature goes up 4.4 centigrade accompanied with an additional 2.9 percent moisture content(Nellemann et al. 2009). What if climate change is not alleviated? By 2080, in certain African countries, the potential of agricultural production might lead to a maximum of 60 percent, whereas the mean declining rates of production will be around 16 per cent to 27 per cent depending on the performance of fertilization, difference of precipitation pattern, availability of freshwater resource (Nellemann et al. 2009).

Social Considerations

In spite of pressure from the agricultural sector including the limited existence of cropland, climate change and interactions with limited resource, food security generates a social challenge in both the developed nations and the developing world. The root causes of the same issue are different between developing countries and developed countries based on its prevalence and severity amidst the affected population(InterAcademy Council Board Meeting, 2004). Food insecurity strikes the developing countries the most due to a lack of food access resulting from

poverty(InterAcademy Council Board Meeting, 2004). As a result, food security and poverty alleviation routinely are two inseparably mutual effects. The whole world except for Africa has made great strides towards the combined issue(Sasson, 2012). Specifically, Sub-Saharan Africa keeps fallen behind and has a high risk of a worse situation unless certain actions are conducted(Sasson, 2012). Enormous social segments have a negative influence on the big picture of achieving food security and mitigating poverty, including health status, etc.

The global population is estimated to explode up to 9.6 billion by 2050(Mwaniki, 2006). This population expansion will happen dramatically in Asia and Africa which are the two most vulnerable regions stemming from food insecurity(Mwaniki, 2006). The preliminary characteristic of the population explosion is that urbanization is urgent to support the growing population. Approximately 60 percent of the population is projected to sustain a living in the urban regions by 2035(Mwaniki, 2006). To manage the expanding urban areas puts more stress on the available cropland and sustainable environment, which calls into question the achievable level of food availability. In sub-Saharan Africa, birth rates per capita is exceedingly high and is over twice of the world average; simultaneously nearly 40 percent of the national population is under 15-years old which have not reached the age of giving birth to newer generations (Bremner,2012). Thus, by 2050, the population is likely growing up to 2 billion in Sub-Saharan Africa,even people there are willing to lower their birth rates(Bremner,2012). This casts a huge influence on food supplies for the long run. The secondary attribute is the predicted trend of demographics. Although the young population, of those below 28 years old, dominates the overall demographics today, they are all prone to approaching 60-year old(Mwaniki, 2006).

By 2050, one third of the population in developing nations will be over 60 years old. Particularly this implies that around 80 percent of the old will be in the developing world which will lead to a seriously declining labor force to maintain food secure (Mwaniki, 2006).

Discrimination of gender and age is the other key factor contributing to this issue in Africa. It means food insecurity wreaks havoc on the health status of females and the new generation by less food provision particularly when extreme events occur. Besides, the female teenager receives less amount of food compared to the male teenager even in the same household (Bremner, 2012). In order to track the progress of reaching the Millennium Development Goals' target, a survey was conducted by assessing the proportion of 5-year old or younger children that were underweight. From 1990 to 2000, the ratio has declined from 27 percent to 22 percent in sub-Saharan Africa (Bremner, 2012). Regrettably, this is only part of the story. Hence, concerning the exact figure of children's population, additional 50 percent of children are born in contrast with the population 20 years ago (Bremner, 2012). This indicates 5.5 million more children are underweight now than in 1990 (Bremner, 2012).

Economic Considerations

In terms of the methods adopted by the United States Department of Agriculture, food gap amid different countries is measured by the distribution gap. This takes into account calorie intake with diverse levels of income in the same nation so as to estimate the population which is not able to meet basic levels of nutritional requirements in order to measure the population who failed to meet nutritional intake

by indicative consumption levels(Shapouri&Rosen, 2001, Effects of income distribution on food security). The income groups are categorized into five groups. The national distribution gap was greater than 25 million tonnesto meet food nutrition requirement for all income groups in 67 low income countries at 2000(Shapouri&Rosen, 2001, Effects of income distribution on food security). This, which became 50 percent more than the average nutritional gap, was predicted to surpass 30 million tonnes by 2010(Shapouri&Rosen, 2001, Effects of income distribution on food security). After observation of consumption statistics of different levels of income group in different areas, Asia is more promising for mitigating the distribution gap through 2010. On the other hand, Sub-Saharan Africa is the most fragile even in terms of distribution gap. Only the top two income groups were able to meet the nutritional requirements in 2000(Shapouri&Rosen, 2001, Effects of income distribution on food security). If the consumption ratio continued dropping by the following decade following projection, food security of this area would be deeper damaged (Shapouri&Rosen, 2001, Effects of income distribution on food security). As a result, the population suffering from hunger is predicted to grow another 20 percent over the following decade(Shapouri&Rosen, 2001, Effects of income distribution on food security). The food insecurity would be amplified by the faster growing rate of the distribution gap on the benchmark of the number of hungry people.

Table 1. Percentage of population living on less than 1 dollar per day

Regions Time	Sub-Saharan Africa	Southern Asia	Eastern Asia	Latin America& the Caribbean	South-Eastern Asia
1990	46.8%	41.1%	44%	10.3%	20.8%
2004	41.1%	29.5%	9.9%	8.7%	6.8%

(Source: The Millennium Development Goals report 2007)

Even as the urge for poverty elimination and food security increases, developing countries are desperate for economic development in the forms of altering farm land into real estate. Unfortunately, the benefits resulting from economic growth have been unevenly distributed within and among nations (United Nations, 2007). Based on historic records of Table 1 (The Millennium Development Goals report 2007), there were 980 million people, who relied on less than 1 dollar per day trying to support subsistence, falling in extreme poverty without the guarantee the food security in 2004 (United Nations, 2007). Compared to 1.25 billion in 1990, the number of people bearing extreme poverty has already reached a significant drop to 980 million (United Nations, 2007). However, the major contributor to this achievement is from fast economic growth in Asia, especially in Eastern and Southeastern Asia. Thanks to great efforts made by India, Southern Asia, as a whole, will be motivated to mitigate hunger and poverty (United Nations, 2007). On the other hand, Western Asia has not made any progress but instead has doubled the size of its population over the period from 1990 to 2005 (United Nations, 2007). In Sub-Saharan Africa, citizens living under the extreme poor condition used to occupy 46.8 percent of the overall population, while in 2004, this figure declined to 41.4 per cent under the Millennium Development Goal (United Nations, 2007). Not only does the proportion keep becoming smaller, but the population living on less than 1 dollar has also gradually started to get under control regardless of rapid population expansion. Besides the mean annual income per capita in 7 sub-Saharan countries had more than a 3.5 percent increase, meanwhile that of other 27 countries grew up over 2 percent from 2000 to 2005 (United Nations, 2007). However, this progress falls behind the target in

the Millennium Development Goals which aims at cutting down half extremely poor population by 2015, as poverty is the primary contributor to lacking of access to food supplies in developing countries.

In early 2011, food prices worldwide had been soaring over the summit which swept the global economy in 2008. In particular, the general prices of maize and wheat worldwide doubled in May 2011 (Sasson, 2012). This emerged phenomenon started in June 2010, mainly derived from growing demand due to population growth, especially in developing countries, as well as the low agricultural productivity owing to unconventional weather changes including unexpected droughts in Russia, North China, and other parts of the developing world (Sasson, 2012). At the time, considering a lack of food supplies, this high food price drove poor groups among nations to fight against the governments for their lives in developing nations; cropland in poor countries relying on agricultural export had been taken by rich countries which survive on import of agricultural products (Sasson, 2012); also over this special period, vulnerable agricultural countries have been experiencing “export bans, food riots, panic buying and emergency price controls” (Sasson, 2012). This reached the peak in February 2011, a spike that had more potential to have more significant influence than that of 2008 based on the food price index conducted by FAO (International Food Policy Research Institute, 2011). Owing to the corresponding regulation of the international inflation, the level of rising price in 2011 has not surpassed the severity of 2008 (International Food Policy Research Institute, 2011). Overall, this aggravates uncertainty and complexity of difficulties in achievement of food security.

Recommended Strategies

In 1996 the World Food Summit asked for international attention including political awareness of the hunger challenge. It also reiterated human's right to avoid hunger and set the target "to reduce the number of undernourished people to half their present level no later than 2015". Making a target was quite important to help achieve international food security instead of only counting and recording number of affected people. Also in 2007, the first goal in the Millennium Development Goals is to eliminate extreme poverty and hunger, which are two major issues directly related to food security. The first target is to cut the proportion of people who rely on less than \$1 a day for living by half (United Nations, 2007). As the significance of food security draws global attention, it is necessary to come up recommended strategies starting with global scale.

The global strategy against food insecurity can be achieved by building an initiative named World Food Preservation Centre for the sake of reducing food loss during the production process in developing countries(Wilson, 2013). Its major duties are to learn from worldwide modern postharvest technology on food preservation and sustainable technology during food productions and to do research on technology innovation or adaptability of technologies to accommodate these technologies to the developing nations. Considering the fact that smallholder farmers are the majority of victims suffering from food insecurity in low-income countries, the increment of food production will generate an instantaneous and expressive advantage to improve their

lives.

To make this feasible, the first step could be to initiate a website as the virtual organization associated with some experts on food conservation(Wilson, 2013). This platform offers several features laying the solid foundation before the physical one exists, including a virtual library on given fields by reserving relevant resources as well as updating the newest reports; an online learning center that carries online courses and education programs on sustainable food production and food preservation; a communication platform for solving problems and sharing experiences; and a research centre that develops accustomed technologies to the crop growing circumstances in developing nations which also meets the national requirements of food(Wilson, 2013). Solar powered tractors and food transporters exemplify some of the available options to the World Food Preservation Centre, which is favorable to make full use of local weather, since a large proportion of low-income is situated near the equator which has substantial exposure to solar energy(Wilson, 2013). Apart from high-tech alternatives, low-tech strategies will also be displayed for choices. For example, introducing either the integrated pest management, pure biological control, or manure is instrumental in preventing agricultural loss in a more tenable, environmental-friendly and safer method compared to chemicals. Compared to vast application of chemicals, these approaches have more benefits and less investment for a long run.

International food aid is to address food insecurity by supplementing the limited access to the availability of food due to fluctuations in domestic food supplies

specifically targeting the low-income nations especially targeting at Asia and Sub-Saharan Africa (Shapouri&Rosen, 2011). These countries generally go through the similar problems of inadequate food stock and a lack of capital accumulation to import(Shapouri&Rosen, 2001, Food security and food aid distribution). This program was firstly initiated by the United States to share the surplus of grain to these low income countries in 1950(Shapouri&Rosen, 2001, Food security and food aid distribution). In the beginning of 1970, the whole world was experiencing the depression of grains' production; the entire quantity reached the lowest records for food aids over these years- 6 million tons in 1973 (Shapouri&Rosen, 2001, Food security and food aid distribution). As a result, international food aid can only be conducted sustainably to keep enough food quotas from donors. Despite a strong start, the fact is that the United States, staying the position of the consistently largest donor, has already decreased the amount devoted to food aid in the last 30 years resulting from the development of a globalized market and change of emphasis on U.S. policy (Shapouri, S. &Rosen, S., 2011). Between 1995 and 1999, the participants of food aid donors were mainly from North America, the European Union, Australia, and Japan(Shapouri&Rosen, 2001, Food security and food aid distribution). In terms of cereal donation, the rate from the United States took up 52 percent compared to the total amount received for food aid(Shapouri&Rosen, 2001, Food security and food aid distribution).The following which the European Union and Canada occupied 16 per cent and 5 per cent, respectively(Shapouri&Rosen, 2001, Food security and food aid distribution).

The challenge for implementing international food aid is the well-balanced and effective pattern between demand and supply. Simultaneously the quantity of food

aid does not remain the same amount of available food every single year within and out the countries. In 1981 and 1983, these low income countries received twice the resources from food aid, nevertheless the delivered food cut down less than 50 per cent of the demand(Shapouri&Rosen, 2001, Food security and food aid distribution). In the 20th century, the mean food source is allocated 30 per cent to low-income countries in both Africa and Asia, and 11 per cent for Latin American nations(Shapouri&Rosen, 2001, Food security and food aid distribution). However, this only makes up for 60 percent of the consumption shortfall (Shapouri&Rosen, 2001, Food security and food aid distribution). Another drawback of current food aid program is the motivator, which is mainly referred as humanitarian relief based on the donors, whereas economic and political goals are indispensably paramount in distribution of sources. The common agreement is that it generates more light on mitigating the temporary food insecurity, including counteraction of consumption shortfall and emergency response to disasters such as sudden droughts which some low-income countries are the most vulnerable to(Shapouri&Rosen, 2001, Food security and food aid distribution). This conclusion is drawn by the facts that food aid contributes to alleviating the pressure for survival after some serious catastrophes in Sudan, Somalia and Haiti(Shapouri&Rosen, 2001, Food security and food aid distribution). Over 1982 to 1999, 62 developing countries, as food aid recipients, were not able to produce enough food to support their domestic population, while this food shortfall was bridged by food aid from donors accounting for roughly 92 percent(Shapouri&Rosen, 2001, Food security and food aid distribution).

Since food aid program is necessary to keep going, there are several difficulties towards the existing organization. Initially, effectiveness of allocations on resources is

the crucial element of success, as recent investigation shows that the allocation of food aid does not always bring out the best of results concerning satisfying the needs (Shapouri&Rosen, 2001, Food security and food aid distribution). The improved aspect of the instrument should put into account objectives of both donors and recipients and be involved with a broader range of participants and more various methods to take part in. As long as more countries take part in food aid and creating rules of allocation, the political and economic consideration will play a less important role(Shapouri&Rosen, 2001, Food security and food aid distribution). For those high-income countries without commodity surplus, the fine global atmosphere can spur them to donate money in order to dwindle the sole reliance on food surplus by introducing a more flexible mechanism of international aid to food security(Shapouri&Rosen, 2001, Food security and food aid distribution).More importantly, food aid program lacks of a centralized system to oversee the operations. World food preservation center can monitor all the statistics for food aid from each donors and recipients. This combination of strategies aims at allocation of resource more effectively. Since food aid is more efficient towards transitory and emergency food insecure issues, employing the credit system based on different countries works as an incentive to encourage more participants which gives stakeholders priority to access to food aid program when emergency issue strikes them.

Since exceeding 90 percent national food consumption is attributed to domestic food production in the majority of food-insecure regions, poor nations should focus on convenient and cost-effective strategies to address food insecurity for the long term (Shapouri&Rosen, 1999). Some sustainably effective measures are needed to be in

place as diverse available agricultural practices and technologies, with emphasis on food security, at the perspective of more sustainable and vibrant agriculture system(Beddington et al. 2012). Given a key finding from FAO, it reveals that approximately 325 million tonnes of food are able to mitigate the hunger issue from 870 million people(Food and Agriculture Organization of United Nations, 2013, Save food: global initiative on food losses and waste reduction). Sustainable agricultural systems gain popularity due to multi-benefit outcomes. Agro-ecological process, agro-forestry, diversified rotations and food intensification by efficient allocation of resources, such as land, water and nutrient, belong to sustainable agricultural practices. However, the same sets of practice in different locations show the high variety of outcomes even when dealing with the same agricultural practice. The most compelling examples are that cereal in Asia at 2001 increase 240 per cent of yields in 1961 associated with minor change in land use(Beddington et al. 2012). In contrast, using the same benchmark, sub-Saharan Africa's yield only accomplished a moderate growth coming from additional 80 per cent land use over the exact same duration(Beddington et al. 2012). Consequently, strategic decision has to be made by putting into consideration every single factor which affects the agricultural productivity, including lacking of land, water and soil. Then what is the way forward?

Here comes to the agricultural measures of crop intensification which directly contribute to climate adaption and increased crop productivity for addressing food insecurity. The system of rice intensification is the cornerstone of crop intensification which is further developed for a wider range of crops' adaptability typically applied in certain Asian and African nations. The key point for successful crop intensification

can be concluded into well establishment of young and healthy plants with care, paying attention to offering adequate nutrition in the form of organic matter, sufficient space, aeration as well as irrigation in a proper manner, for this makes sure individual plants take full advantage of growth above and below the ground without concerns about the generation of adverse microorganisms(Abraham et al,2014).

India, as one of the developing nations, achieves a meaningful milestone in this area. Based on records of the World Bank, the state of Bihar with 0.35 million population of farmers employed the system of crop intensification exceeding 50,000 hectares of land(Abraham et al,2014). As a result of boosted productivity, the final outcomes displayed that 86 percent increment for rice, 72 percent more of wheat, additional 56 percent for pulses, 50 percent for oilseeds and 20 percent in vegetables(Abraham et al,2014). The escalation of profits based on above were estimated to be around 250 percent, 86 percent, 67 percent, 93 percent, and lastly 47 percent, respectively(Abraham et al,2014).

This new system is highly suitable for those vulnerable countries considering the poverty and population growth, since it asks for enormous labor force and much less capital investment. The generated benefits go beyond just profits which pay back the labor intensive approach. Also the efficient usage of water, land and aeration makes the special sets of cultivation resilient with climate change and various soil conditions. In addition, national strategies can be supplemented with global strategies. For example, through world preservation center, those countries either can participate the food aids program or exchange their latest progress and technology with other developing countries. So they can start on a small scale in order to test the

feasibility of crop intensification and also send back feedback to do more research to better accustomed and refined strategies.

Another form of sustainable agricultural systems is agro-forestry which embeds nitrogen-fixing trees to secure nutrition into the agricultural system from a perspective of sustainability(Nellemann et al. 2009). This practical strategy, to some extent, protects crop system from reduction of agricultural productivity induced by climate change. The majority of vulnerable people in the developing world are subsistence farmers, most of which rely on regular rainfall pattern to support irrigation for agriculture in order to produce enough food (Nellemann et al. 2009). Besides, their investment into other adaptive measures is absent due to the shortage of budget.

As a matter of fact, agroforestry projects are applied to some sustenance farming in Kenya which is one low-income country in sub-Saharan Africa. Only 12 percent of famers are willing to adopt the agroforestry, as this unique strategy is too young to predict the long term result (Nellemann et al. 2009). Although the assessment has been conducted for merely 2 to 4 years, the outcomes so far have beneficially contributed to household food security in local areas. The first good sign is the increasing productivity which is achieved by decreasing soil erosion and securing nutrients in soil. Among the same type of trees, mature stands are prone to pose a more prominent effect on improvement compared to seedlings. Until now, the evolving aptness of productivity is equal to average additional 20 to 35 percentages of maize yields in terms of different locations (Nellemann et al. 2009). Furthermore, once most planted trees have grown for 4 years, 87.5 percent small scale farmers

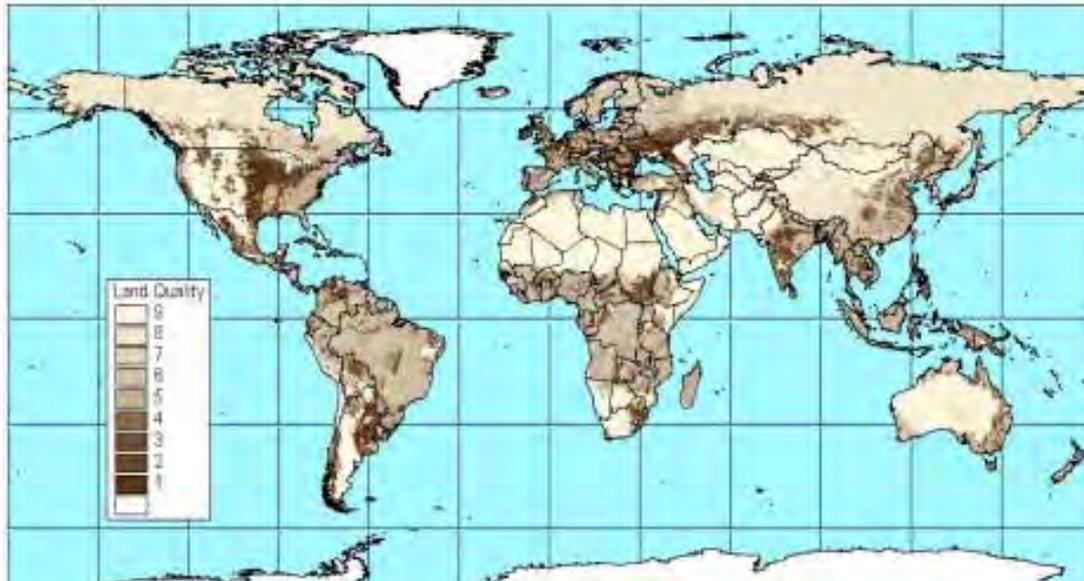
claimed income went up for the sales of products on the trees, such as fruit, seedling, and timber and via the decreasing needs for food purchase (Nellemann et al. 2009). Other than this, comparing with deforestation of natural forests, non-timber agroforestry products inspire the conservation of trees in agroforestry system (Blackman et al. 2008). Accordingly, agroforestry projects not only provides a feasible solution of food security by diversified and resilient agriculture systems, but it also improve farmers' wellbeing and alleviate the poverty which indirectly generates more room for food security.

Conclusion

The low income developing countries are hard to maintain food secure without intervention from developed nations regarding multifaceted challenges on poverty, less favorable cropland, more population base and more growing population. It is necessary to emphasize more on international strategies at the start, but developing countries have to learn both basic and the advanced technology from developed countries and customized them to fit their own needs. Hopefully developing countries eventually can catch up with the world's pace and successfully shift the focus to sustain themselves.

Appendix A

Satellite Imagery (The cropland quality from low to high is corresponding to the assigned class from high to low)



Source:USDA/NRCS

Reference

1. Ericksen, P.J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18(1), 234-245.
2. Capone, R. et al. (2014). Food system sustainability and food security: connecting the dots. *Journal of Food Security*, Vol. 2, No. 1, 13-22. doi:10.12691/jfs-2-1-2
3. Shapouri, S. & Rosen, S. (1999). Food security assessment: why countries are at risk. Agricultural Information Bulletin No. 754. Economic Research Service, United States Department of Agriculture. Retrieved from: http://pdf.usaid.gov/pdf_docs/pcaaa880.pdf
4. Shapouri, S. & Rosen, S. (2001). Food security assessment: regional overview. Issues in Food Security. Agricultural Information Bulletin No. 765-1. Economic Research Service, United States Department of Agriculture.
5. Sasson, A. (2012). Food security for Africa: an urgent global challenge. *Agriculture & Food Security* 2012, 1:2. doi:10.1186/2048-7010-1-2
6. Food and Agriculture Organization of United Nations (2013), (1). The state of food and agriculture. Retrieved from: <http://www.fao.org/docrep/018/i3301e/i3301e.pdf>
7. Wiebe, K. (2001). Natural resources, agricultural productivity, and food security. Issues in Food Security. Agricultural Information Bulletin No. 765-3. Economic Research Service, United States Department of Agriculture.
8. Nellemann, C. et al. (2009). The environmental food crisis – The environment’s role in averting future food crises. A UNEP rapid response assessment. Retrieved from: http://www.grida.no/files/publications/FoodCrisis_lores.pdf
9. Darwin, R. (2001). Climate change and food security. Issues in Food Security. Agricultural Information Bulletin No. 765-8. Economic Research Service, United States Department of Agriculture.
10. InterAcademy Council Board Meeting (2004), Realizing the promise and potential of African agriculture: Implementation of recommendations and action agenda. Retrieved from: <http://www.interacademycouncil.net/File.aspx?id=27838>

11. Bremner, J. (2012). Population and food security, Africa's challenge. Retrieved from: <http://www.prb.org/pdf12/population-food-security-africa.pdf>
12. Mwaniki, A. (2006). Achieving food security in Africa: Challenges and issues. Retrieved from: <http://www.un.org/africa/osaa/reports/Achieving%20Food%20Security%20in%20Africa-Challenges%20and%20Issues.pdf>
13. Shapouri, S. & Rosen, S. (2001). Effects of income distribution on food security. Issues in Food Security. Agricultural Information Bulletin No. 765-2. Economic Research Service, United States Department of Agriculture.
14. United Nations (2007). The millennium development goals report. Retrieved from: <http://www.un.org/millenniumgoals/pdf/mdg2007.pdf>
15. International Food Policy Research Institute (2011). Global food policy report. Retrieved from: <http://www.ifpri.org/sites/default/files/publications/oc72.pdf>
16. Wilson, C. L. (2013). Establishment of a world food preservation center. Agriculture & Food Security, 2:1. Retrieved from: <http://www.agricultureandfoodsecurity.com/content/2/1/1>
17. Shapouri, S. & Rosen, S. (2001). Food security and food aid distribution. Issues in Food Security. Agricultural Information Bulletin No. 765-4. Economic Research Service, United States Department of Agriculture.
18. Beddington, J. R. et al. (2012). The role for scientists in tackling food insecurity and climate change. Agriculture & Food Security, 1:10 Retrieved from: <http://www.agricultureandfoodsecurity.com/content/1/1/10>
19. Abraham B. et al. (2014). The system of crop intensification: reports from the field on improving agricultural production, food security, and resilience to climate change for multiple crops. Agriculture & Food Security, 3:4
20. Food and Agriculture Organization of United Nations (2013). SAVE FOOD: Global Initiative on Food Losses and Waste Reduction. Key findings. Retrieved from: <http://www.fao.org/save-food/key-findings/en>
21. Shapouri, S. & Rosen, S. (2011). Global food security: prospects and the role of food aid. Food security assessment. USDA Economic Research Service, United States Department of Agriculture. Retrieved from: http://webarchives.cdlib.org/sw1bc3ts3z/http://ers.usda.gov/publications/GFA15/GFA15_b.pdf
22. Food and Agriculture Organization of United Nations (2013) Hunger portal, Retrieved from: <http://www.fao.org/hunger/en/>
23. UNEP (2008). In dead water. Merging of Climate Change with Pollution, Over-Harvest, and Infestations in the World's Fishing Grounds. UNEP/GRID-Arendal, Arendal, Norway. Retrieved from: http://www.grida.no/_res/site/file/publications/InDeadWater_LR.pdf