International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET207625

Food Security and Renewable Energy : Insights

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Article Info
Volume 7 Issue 6
Page Number: 18-23
Publication Issue :
November-December-2020

Article History
Accepted : 01 Dec 2020
Published : 20 Dec 2020

ABSTRACT

The world's increasing population together with the amount of calories needed to meet dietary requirements has intensified food security concerns. As a result, the world's energy demand has correspondingly risen mainly due to the preference for sophisticated food production-(usually energy–demanding), as well as mechanization of the food supply chain. Renewable energy has been pivotal in meeting the above demands by means of energy for food processing, storage and transport.

The surge in food prices has gained widespread consideration. Many factors such as cost of farm inputs, climatic patterns and land tenure systems account for the food price increases observed in recent decades. Others perceive renewable energy, particularly –bioenergy as being a cause of the above. The quest for a safer energy against conventional fossil fuels has made first generation biofuels the go-to option resulting in competition for resources that would have otherwise been used to produce food or consumed as food. Hence the food price increments and food scarcity observed in some areas over the years.

Bioenergy production may have a variable effect on food prices. Whereas the cultivation of first generation bioenergy crops can increase food prices, it could also be the catalyst to induce investments in agriculture to increase crop yields that would ultimately stabilize prices. In the situation where resources for staple crops are shifted to bioenergy feedstock farming, staple food prices would soar due to shortages. This suggests many people are likely to remain in perpetual hunger unless crops yields are enough to meet the dimensions of food security –availability, access, utilization and stability.

Food security and bioenergy have positive synergies as alluded. For example, bioenergy demand may cause higher prices to boost local economies. It could lead to surplus food supply to ensure food security. Additionally, bioenergy could mitigate energy deficiencies, especially in the countryside. Proper management would be essential to ensure bioenergy production does not occur to the detriment of local livelihoods –notably food production and its consumption.

Keywords : Food Security, Renewable Energy, Bioenergy

I. INTRODUCTION

The need for food and energy to meet socio-economic development is increasing. While food provides human nutritional and health needs; energy alike helps to achieve such needs as health, lighting, cooking and mobility. In our quest for a sustainable future, food security and energy sustainability remains two over-riding challenges in the agricultural and energy sectors (Edenhofer et al., 2011; Abbasi & Abbasi 2010; Kaygusuz 2012). There are about 800 million food-insecure people who live mostly in rural areas with agriculture as their source of livelihoods. Averagely, they live on less than $1 per day and food takes the greatest chunk of their incomes. Yet, the over 2 billion people living on more than $1 a day are also at risk of plunging into a food-insecure state due to high commodity prices (Naylor, Lisa, & Burke 2007). On the other hand, an estimated 1.4 billion have limited access to electricity with nearly 90% of them in rural areas and rely on the use of biomass- mainly wood logs. The use of biomass is thus projected to reach 2.8 billion in 2030 (Owusu & Asumadu-Sarkodie 2016; Kaygusuz 2012).The goal therefore is to achieve renewable energy production that improves food security and environmental sustainability (Osseweijer et al., 2015).

II. Fundamental Concepts

1. **Food Security** – "The term food security originally described a nation's access to enough food to meet its dietary energy requirements" (Pinstrup-Andersen 2009). The widely accepted definition of food security is: "the state or condition when all people at all times have physical, social, and economic access to sufficient , safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Brown et al., 2015; FAO 1996, 2012a; Aborisade & Bach 2014; IRENA 2015). An estimated 805 million people in the world are food insecure, 2 billion lack needed nutrients while 2.5 billion are obese or overweight. The core goal of (FAO 1996, 2012a) definition of food security are sufficient, safe and nutritious food as obesity has detrimental health outcome (FAO 2017; Brown et al., 2015; Ng et al., 2014). Food provisions with sufficient calories but lacking in nutrients mars nutritional status and can contribute to non-communicable diseases. Hunger and obesity remain two components of malnutrition (Gustafson et al., 2016; WHO 2014).

2. **Pillars of food security**
The mid-1990s arose a new approach to food security termed "community food security" incorporating all dimensions of food security (Power, 1996). The components of food security – access, availability, utilization and stability have been accepted in practice, research and policy (Brown et al., 2015; Aborisade & Bach 2014; Power 1996). Food production is a mandatory step to ensure food security. Even so, it combines with factors such as economic, demography and food safety. Food security is, therefore, not exclusively the summation of the balance between demand and supply but rather individual and community access to food as well as socioeconomic, political and environmental factors (Brown et al., 2015; Power 1996).

2.1 **Availability:** This dimension is the existence of food in a place at point in time. This focuses on the production and supply of food. Aggregate food availability may not guarantee proper utilization of nutrients to ensure food security, but it remains a necessity in food security. Food production, transportation, food stocks, storage and trade define food availability. Moreover, the availability of food considers food safety and consumer health. Food insecurity is thus inevitable in an economy whose food available does not meet its nutritional needs. Nonetheless, gender, poverty and education affect food production which may reduce food availability to cause food insecurity (Brown et al., 2015; Aborisade & Bach 2014; Power 1996).

2.2 **Access:** This measures individuals and households economic abilities to purchase food based on prices and disposable incomes. The argument is, as a measure of individual or group well-being, food security initiatives address the whether or not component. Affordability and distribution in communities determine populations' access to food to meet their dietary requirements. Whereas household long-term food deficits due to poverty and limited resources, lead to chronic food insecurity; transient food insecurity is the situation where there are unexpected food shortages owing to lack of imports, weather conditions, shortages in food productions, and high prices. Cost of farm inputs and transportation costs of moving goods to markets increase food prices thereby reducing people's access to available food. Here, emphasis rests on the resilience of the most vulnerable in extreme situations like price spikes and droughts to meet their nutritional needs (Brown et al., 2015; Power, 1996).

2.3 **Utilization:** This is individuals' ability to make healthy food selections available in their localities – homes, schools, and workplaces. In other words, are people able to make good use of food available and accessible to them? Essentially, this dimension examines critically the nutrients content of a population's accessible food, and their bodies' ability to absorb such nutrients. Food insecurity stimulates malnutrition – mainly insufficient calories/ and or nutrients, leading to stunting and wasting among people. Also, a disease like HIV/AIDS inhibits assimilation and utilization of nutrients due to reduced food intake and immune system response to infections. Meanwhile, households that have low dietary diversity have low calories. Again, societal norms and practices and the functional roles food play in these events may affect the utilization of food (Brown et al., 2015; Aborisade & Bach, 2014; Power, 1996).

2.4 **Stability:** There is stability when food availability, access, and utilization do not fluctuate to cause food insecurity. It assess households and communities resilience regarding food insecurity – either in the short or long term. This dimension questions whether or not people have the economic and environmental factors to ensure the physical availability of food to meet their dietary supplies. Again, it examines how households and nations deal with factors like weather, market prices, tariffs, diseases, and wars that inhibit the readily availability, access and utilization of food. For example, to ensure food security, it is essential to implement an agro ecosystem that enhances agricultural production as well as approaches to reduce food losses within the supply chain. (Brown et al., 2015; Aborisade & Bach, 2014).

3. **Renewable energy:** Bioenergy is derived from biomass, i.e. living organisms or their metabolic by-products. They may be purposefully cultivated energy crops, sewage, and food, animal or wood debris. The shift towards a safer energy alternative has increased the demand for bioenergy. It is easily available for cooking and heating space to meet local energy demand. More so, the Paris Climate Agreement, which

seeks global decarbonisation, has promoted renewable energy (Fritsche et al., 2017). Renewable energy is 19% of world energy use with 9% biomass. This is expected to rise to 36% by 2030 due to the mounting global appeal of renewable energy to address climate change, boost energy security, and improve energy access and socioeconomic development. The United Nations SDGs climate action for securing livelihoods imply that we have a moral duty to develop and supply large-scale bioenergy in ways that improve social development (Souza et al., 2017). Biofuels stimulate rural employment and energy security. Their environmental and social effects are more site and context specific. Likewise, the effects from biomass are short-lived, although impacts from non-renewable energy manufacturing may last for centuries (Fritsche et al., 2017; Parish et al., 2013). The share of biomass in global energy consumption has unchanged for over three decades. Biomass usage differs considerably by location. It is a dominant energy source in developing countries and moderately used in the industrialized countries (Karekesi et al., 2006). In 2013, biomass made up 10% of global energy mix. Traditional biomass such as fuel wood, cow dung and other agricultural waste constituted about 60% of the above energy supply (IRENA, 2015).

4. Food Security – Renewable Energy Controversy

Food and oil price spikes in 2008 further deepened the food against energy argument although it has existed since the 1970s. The competition for resources with food and food related use ranks relevant in this debate. Energy security accounts for increased for bioenergy expansion but, the competition in the nexus has two dimensions – 1) competition with food and food related use, and 2) competition with agricultural resources (Koizumi 2013). Agricultural produce are the main feedstock for bioethanol production. For example, maize used in bioethanol production was 45.9% of national corn consumption in United States in 2012. Between 2010 and 2011, bioethanol accounted for nearly 53% of use of sugarcane in Brazil (Koizumi 2013). Overall, about 17.4 % sugarcane and 14.2% maize are global share of crops used for bioethanol. About 15% more rapeseed oil (27.2%) against 11.9% soybean oil goes into biodiesel (Koizumi & Ohga 2006). An increased demand for these energy crops for non-food usages reduces their availability for food. Besides, the higher demand leads to higher prices. Maize prices rose from $2.60 per bushel to $4.25 United States in 2006/07 due to increased demand for ethanol (Naylor et al., 2007). This reinforces the assertion that biofuels have increased both the demand for staple crops used for food and feed, as well crop prices. On the other hand, there is a ripple effect on the demand for agricultural resources such as labour, land, water, and capital due to the rise in biofuel consumption. The high maize price witnessed in the United States between 2006/07 led to an expansion in the acreage of maize planted to about 38 million hectares representing 19% increment. The above resulted in about 6% reduction in soybean acreage to 24 million hectares (Naylor et al., 2007). Energy production thwarts food security by reducing available land for farming through mining for fossil fuels or deforestation for biofuels (Rosegrant, 2008). In Brazil, sugarcane farming due to bioethanol has displaced orange, rice and coffee cultivation (Koizumi, 2013). To alleviate the competition between biofuels and food production for land and water resources, biofuels could be produced on marginal and degraded lands (Hoff, 2011; Fritsche et al., 2017). Energy crops cultivated on abandoned lands help to reclaim such lands without food security perils (Fritsche et al., 2017), to enhance the resilience of food production systems (Hoff, 2011).

Furthermore, biofuels are the cause of higher cereal prices (Rosegrant, 2008), soil degradation, and colossal use of water resources (Escobar et al., 2009). But, high prices, in turn lead to the production of more food crops to boost income farmers income. Increased revenues may lead to adoption of irrigation, fertilizers, and better varieties to increase yields and food availability. This also means increased low-cost feed stocks in the form of residues to make biomass accessible (Osseweijer et al., 2015).

Other opinions focus mostly on energy in the food supply chain (i.e. fuel for land preparation and tillage, crop and pasture management, transportation, processing, distribution, storage and retailing). Likewise, there are concerns about the growth of modern bioenergy in this food versus energy controversy (IRENA 2015). The debate cannot depend on the impact of fuel prices on quantity of food produced and/or available as the other pillars of food security are relevant. Farmers do benefit from higher food prices (Osseweijer et al., 2015; Naylor et al., 2007). Also, farmland values have appreciated in recent years. (Naylor et al., 2007). Nonetheless, there is the need for a nexus approach that underscores the interdependence of water, energy and food security to yield a better framework for establishing trade-offs and synergies that fosters both demand and sustainability (Hoff, 2011). Also, energy production must be assessed within the framework of the overall energy system, from extraction to end use and externalities associated to reveal valuable insights. For example, biomass converted into electricity produces 80% extra transport kilometres in electric vehicles. Yet, the opposite holds for internal combustion vehicles that use biofuels (Campbell et al. 2009).

5. Role of bioenergy in food security

Bioenergy is a viable energy source for heating, cooking, lighting and transportation. The bulk of it comes from wood, charcoal, leaves, agricultural residues, animal or human waste, urban waste (Karekezi et al., 2006), and liquid biofuels. An estimated 2.7 billion people depend on traditional biomass while modern bioenergy production rose to about 100 million litres in 2011 (IRENA, 2015). Some significant contributions of bioenergy to food security are fuel wood and charcoal. They are used to cook food, heat water as well as preserve food by means of drying and smoking to extend food supply beyond productive seasons. About one-third of world's population depend on wood fuel for cooking in households and commercial purposes such as restaurants and schools. Fuelwood is dominant in deprived communities while charcoal is preferred in urban areas due to its greater energy content, ease of transportation and storage (Sooyeon et al., 2017). Comparatively, charcoal emits less smoke than fuelwood. Even so, biomass usage is a key cause of indoor pollution among women, children, and the elderly (Goldemberg & Teixeira Coelho, 2004), and kills nearly 4 million women and children each year (Osseweijer et al., 2015). There is a wide discrepancy regarding energy use within and among countries. Whereas developed countries use 5300 kg of oil equivalent per capita yearly, low income countries use only 420 kg. To add, cooking dominates energy use in developing countries. Conversely, in developed countries, heating, transportation and processing take a greater portion of energy consumption (Hoff, 2011).

On the other hand, thermal and hydropower production affects food security. For instance using water from a river to cool thermal power generation disturbs the water's ecosystem by increasing the temperature and modifies fish availability. At last, the local food supply is hampered (IRENA 2015). Large dams constructed for hydropower pose social and ecological threats –mainly relocation of communities and flooding (Hoff, 2011). Again, water stored in hydropower reservoirs could influence water accessibility for irrigation (IRENA 2015). Thus, there are major water and related costs linked to biofuels and hydropower in the energy mix (Hoff, 2011).

6. Achieving food and energy security

Although bioenergy is largely is perceived to be the cause of higher food prices, the work of Baffles and Dennis (2013), pointed fossil fuel prices instead as a determinant of food prices. But, oil prices affect the economic viability of biofuels (Escobar et al., 2015). Higher food prices are incentives for farmers to grow more crops to earn extra income albeit with land constraints as the same farmlands may be used to cultivate energy crops for bioenergy. First generation biofuels feedstock vies with agro commodities, while second generation biofuels strives with feed use of such crops (i.e. wheat and rice). Similarly, bioenergy inhibits the production of other crops and livestock (Koizumi 2013). Osseweijer et al (2015), suggested double cropping, land fallow reductions and crop-shifting as witnessed in major maize, sugarcane and soy production areas could mitigate the above effects. They reported second crops are equally important especially in Brazil where soybean and corn are cultivated in succession yearly to be used for food or biofuel on the same parcel of land.

According to Souza et al. (2015, 2017), to ensure a balance between food and bioenergy, there should be unified efforts to ensure food and water security along with energy access. Namely, technology, extension services and innovation that builds capacity and infrastructure together with stable prices to promote local production. Also, they reiterated Chum et al (2015), double cropping and flex crops systems to grow plants for food and non-food consumers, to safeguard food and energy availability as well as other services (Osseweijer et al., 2015).

Biofuels production improves macroeconomic performance and living standards through growth linkages (Urbanchuk, 2012), or multiplier effects to a local economy. Eventually this could bring extra incomes to households for food access and affordability (IRENA, 2015). Access links food prices and household disposable incomes, plus access to lands and other natural resources for subsistence producers to generate income, provide energy services or food (Osseweijer et al., 2015). Also, rural development is essential to reduce poverty and food insecurity. As such, countries with favourable climate and land to develop biofuels have greater opportunities to transform their agriculture to affect the people noticeably by means of higher incomes (Escobar et al., 2009).

In spite of the above, regulation and observance of sustainable standards are necessary to match biofuel growth environmental, economic and social goals (IRENA, 2015). In essence, governments must regulate land use and its distribution to avoid issues of land ownership concentration that may breed poverty, monoculture, and forest destruction to exacerbate environmental impacts of biofuel generation (Escobar et al., 2009). Policies for food supply disruptions or prices shocks should be flexible, and not limited to the only the production of bioenergy from land (Osseweijer et al., 2015).

Energy security is a precondition for sustainable food production and long-term food security, specifically rural areas where about 70%–80% people suffer food insecurity. Energy access in deprived communities would improve trade, storage and packaging (Souza et al., 2015), among others in the food supply chain to reduce food insecurity. Osseweijer et al (2015), recommends the adoption of modern bioenergy technologies such as biogas, biomass gasifiers and bagasse based co–generation systems for rural power generation, cooking and related services to promote rural development, improve food safety and reduce the high indoor pollution and mortality among women and children from low quality traditional energy.

III.CONCLUSION

The study analysed the relationship between food security and renewable energy. The study revealed bioenergy's potential in the world energy mix. Mainly, as renewable resource, it can reduce the global demand for fossil fuels if managed sustainably. Moreover, bioenergy can reduce unemployment as well as provide substitutes for coal, natural gas and petrol for domestic and industrial purposes. It ensures food security by providing heat and/or power to process, cook, heat store or preserve food.

Food security exists: when there is food availability, access, utilization and stability. That is, all times, people should have economic and physical access to sufficient nutritious food irrespective of market shocks, war, gender, climatic conditions among others.

The propensity to grow more bioenergy crops over other staple crops is high due to high prices. It is imperative to adopt an approach that improves agriculture such as the implementation of modern technology and land management systems – (i.e. using marginal lands for bioenergy and arable lands for food crops. Also, the application of flexible and double cropping schemes would be useful.

Furthermore, sustainability governance that addresses various actors in bioenergy production should be considered. In other words, the economic, environmental and social aspects of biomass must be balanced to make food security, energy security and environmental sustainability attainable.

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Cite this article as :

Eric Owusu Asamoah, "Food Security and Renewable Energy : Insights", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 6, pp. 187-193, November-December 2020. Available at doi : https://doi.org/10.32628/IJSRSET207625
Journal URL : http://ijsrset.com/IJSRSET207625