

Food Self-Sufficiency: Opportunities and Challenges for the Current Food System

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ARTICLE INFO

Received: 📅 October 02, 2020

Published: 📅 October 14, 2020

Citation: Jean Pierre Enriquez. Food Self-Sufficiency: Opportunities and Challenges for the Current Food System. Biomed J Sci & Tech Res 31(2)-2020. BJSTR. MS.ID.005061.

Keywords: Food Production; Self-Sufficiency Index; Food Security; Food Energy Produced

Abbreviations: FSS: Food Self-Sufficiency; SSR: Self-Sufficiency Ratio; DEP: Dietary Energy Production

ABSTRACT

Food Self-Sufficiency (FSS) is defined as the ability of a household or region to maintain its own food requirements, which can be measured at different levels, and it began to take relevance around 2007-2008 food price crisis. The FSS all-together with food price volatility has become a high priority political agenda for governments all around the world, helping them determine the number of households that can supply their food by own production. Generally, a population depends on natural resources and available foods to meet their daily food demand, so a region can increase the stability of its food system by building its own FSS. Moreover, the pre-technological urbanism, consider the FSS as a strategic factor in the advancement and independence in localities. Since food systems operate at different scales, one way to reduce risks is to get smaller space units to maintain a degree of FSS. Therefore, it can ensure a level of FSS by supporting the agricultural sector focusing on improving production efficiency in countries with food insecurity. It is also necessary to work on research that allows the development of production models with the presence of FSS to avoiding isolating them from the reality in which it is developed

Introduction

FSS and price volatility have become a high priority political agenda for governments [1]. Developing governments face the conflict of agricultural policy between fully open trade and closed borders for food security and cheaper food [2]. Food procurement in a country could be stabilized creating a network of commercial partners working in a free-trade regime. However, regional economic integration increased recently, driving individual importers away from FSS [3]. Increasing crop diversity is an agroecological approach to improve FSS, so small producers can maintain the stability of their food systems, reducing the risks of stress, pest outbreaks or droughts [4]. A region can increase the stability of its food system by building its own FSS [5]. Food production is a starting point in the analysis of sovereignty and food security. Revenue generation through efficient field production provides a real productivity base [6]. The traditional agricultural production of production systems determines access to food and obtaining complementary income through the sale of products and by-products; this being considered as the result of the integration of life strategies [7].

FSS is defined as the ability of a household or region to maintain its own food requirements which can be measured at different levels [8]. In a narrow context, it determines the number of households that can supply their food from their own production, reporting the number of months of the year where households are self-sufficient in food. To measure the FSS, information on crop yields is needed as well as food production in the region under study [9].

For a population to meet their daily needs, it usually depends on natural resources and wild foods [10]. Globally, 52% of the countries produced insufficient calories per capita in 2005; however, 80% of all countries quantified as importers of at least 500 kcal / capita / day [11]. For the pre-technological urbanism, food self-sufficiency is considered a strategic factor in the advancement and independence of the localities [12]. Global food production continues to increase, making FSS at a country level, steadily declining. Also, urbanization trends and increased population density have been correlated with these decreases [13]. There is a concern because of the increasing

demand, climate, and environmental changes threaten turning the food more expensive and difficult to produce [14]. Therefore, vulnerability is observed in food systems due to population growth, water scarcity, and soil degradation [4]. Since food systems operate at different scales, one way to reduce risks on a large scale is to ensure that smaller space units maintain a degree of FSS [15]. It is essential to propose the application of technological innovations, urban agriculture, production in greenhouses, and zero tillage [16,17]. These technologies have the capacity to increase food production, releasing pressure on land, thus controlling resource depletion and environmental degradation [18]. In the future, it is necessary to dispel the conflicts generated between farmers and urban dwellers. People should also create a more holistic social awareness of the importance of restoring agriculture in places around cities [19]. One way to ensure, at least partially, FSS is to support the agricultural sector, focused on improving production efficiency, especially in countries with food insecurity [20].

One way to measure the levels of FSS of countries is through food energy production per capita [11]. More developing countries have supported the food sovereignty agenda in their national legislation including Bolivia, Ecuador, Malí, Nepal, Nicaragua, Senegal y Venezuela [21]. The drivers of food sovereignty have given significant support to greater food self-sufficiency based on agroecology methods to increase the resilience of local food systems [22]. For that reason, this article has as objective to review the challenges and opportunities of the FSS based on the last twenty years scenario.

Research strategy and selection

Publications included in this research were those written in English and Spanish focused on FSS. Hence the keywords for the search were self-sufficiency index, food production, food availability, and food energy produced. The review was carried out through extensive searches of literature in the databases Elsevier, Springer Link, and Academic Google. The content of the documents was revised and selected based on their direct or indirect relevance to this review. Additional references included were, which were found throughout the review process in some of the selected documents, relevant to the content of this article. According to the bibliographic evidence from the year 2000, where more than 83% of the selected publications are within the last ten years, four major topics were identified that encompass the challenges that FSS face: the FSS in the population, global experiences with FSS, interventions and small communities, and climate change. It was also identified three opportunities: Crops diversity and agroecology; self-supply, environmental sustainability and economy; and urban self-sufficiency.

Overview of food self-sufficiency

Food self-sufficiency is thermodynamically defined as the national production of enough calories per capita. This definition

assigns the per capita calorie needs of each local population [23]. In this way, countries are informed, if they are producers, which countries produce more than per capita needs, or if they are consumers, and which countries produce less than the per capita needs within the food supply system [19]. Self-sufficiency represents risks of food insecurity when more than 25% of the food components of the diet necessary to satisfy the needs of the population come from importation [24]. Conversely, food self-sufficiency is considered a waste since the farmers deprived of income as a result of potentially exportable foods not being sold abroad, affecting food economy and security [25]. Seventy-seven percent of the countries worldwide are not self-sufficient in terms of domestic calorie production [26]. The countries with high food self-sufficiency have large areas for agriculture, productive agriculture, and low-density rural populations, which produce food surpluses. On the other hand, there are small and highly urbanized countries, being extremely vulnerable to sociopolitical turmoil as well as the environmental catastrophe resulting from limiting arable land and net food deficits [13]. The strategy based on food self-sufficiency that limits the role of food imports took relevance in the 2007-08 food price crisis [2]. At the time, many countries considered it to be one of the key priorities for their agri-food policies [27].

The Self-Sufficiency Ratio (SSR) is defined as the percentage of food consumed that a country produces [28]. An equation concerning food production and trade is used to calculate the SSR: $\text{Production} \times 100 / (\text{Production} + \text{Imports} - \text{Exports})$. Net food-exporting countries are generally self-sufficient according to the SSR and the food energy produced or Dietary Energy Production (DEP). In contrast, net food-importing countries are not considered self-sufficient based on such measures [29]. Most SSR analyses focus on key staple crops, such as starch cereals and tubers, offering an approximation of a country's food self-sufficiency [2].

Challenges

Food Self-Sufficiency in the Population

In the face of an imminent decline in natural resources and population increase, it is necessary to create substantial socio-economic and biophysical actions to ensure food security [30,31]. Table food supply is a common indicator of food security, at least from an individual perspective [13]. At the beginning, food security focused on food reserves that allowed survive to famine. The increase in the level of human development helped discover that insufficient purchasing power of the poorest segments of the population is another factor for food insecurity [27]. Supporters of FSS defend the political right of states to insulate themselves from the vagaries of global food markets, increasing their dependence on domestic food production [2]. In 2010, the world's food production per capita was 5359 kcal per person per day, surpassing a 2500 kcal necessary for a healthy life [28]. Considering food waste, animal feed, and other uses of food crops, approximately 2870 kcal per

capita per day was available for food consumption worldwide by 2011, exceeding the threshold above which FSS is considered [32]. Between 1965 and 2005, around 25% of the world's population lived in countries that produced more than 2500 kcal per person per day, while 75% resided in countries that produced below that threshold [11]. Considering the percentage of countries that are self-sufficient, rather than the percentage of the population, it was estimated that around 77% of the world's countries have a caloric deficit [26]. The degree of food self-sufficiency will provide greater stability and resistance to global crises in regions with greater self-sufficiency. Similarly, a household with FSS will be more protected to regional and local changes [15]. Each country faces different scenarios regarding its ability to obtain food for its population, depending on its food productive capacity, import and distribution [29].

Global Experiences with Food Self-Sufficiency

FSS has become increasingly important to the political agenda in several countries, especially after the high volatility of food prices between 2007 and 2008 crisis [29-33]. Countries considered self-sufficient at the national level may have a percentage of their population with problems of hunger and malnutrition. However, those countries can produce enough crops such as grains, but they may also need to import significant amounts of fruits and vegetables to achieve a healthy diet [29]. Nowadays, around sixty-six countries cannot be self-sufficient due to natural resource constraints, limited availability of farmland, water, and soil fertility [34]. Approximately one billion people in Asia and Africa could become less vulnerable to global impacts if their local FSS increased [35]. The SSR of Africa had decreased from 100% in 1961 to 80% in 2007 [36,37], with food imbalances also found between rural and urban areas [3]. Therefore, African countries should seek to make food self-sufficiency less susceptible to changes in foreign food supplies [38]. In Asia, the surplus production allows rural people to generate income to battle poverty [38]. It is, therefore, suspected that FSS has changed in Asian countries as a result of wage increases and other factors returning to less affordable agriculture [39].

In Russia, food security is defined as a reduction in food imports and not simply an adequate intake of food in order to live healthy, since overall food security and FSS influence food trade policy [33]. For this reason, their level of food self-sufficiency increases as food products of foreign origin withdraw from the food market in the form of an economic recession, ruble depreciation and rising import price [40]. In Mexico, food security and nutrition intervention strategies in indigenous communities seek to ensure family FSS and promote the consumption of various diets based on locally produced foods [41]. Self-sufficiency, used as a strategy to achieve food security, is an alternative for regions with food shortages [42]. Egypt's government has increased its wheat self-sufficiency to insulate local markets from global supply and demand impacts [1]. On the other hand, in Spain, the potential for FSS of horticultural

products from Mataró (Barcelona) was evaluated, where there is a potential for self-sufficiency in fresh vegetables and potatoes of 88.7% [43]. For its part, in the Czech Republic, FSS is ensured by up 20% of the decrease in yield for most crops [44]. While in the United States, a "new food pantry" program aims to develop self-sufficiency in the poorest areas of the United States by providing emergency food assistance [45].

Interventions and Small Communities

Family nutrition, unable to achieve diversity and quality, becomes monotonous and unbalanced; thus, food security could be affected by poverty [46]. One of the most worrying factors is the social component that encompasses poverty, unemployment, and inequality [47]. Approximately, 39% of the world's population is overweight, while about 13% are obese [48,49]. Nearly 40 million Latin American people have insufficient food intake, while another 360 million are overweight or obese [50]. In Ecuador, indigenous families in rural areas have orchards as a job opportunity that at the same time provides them with food. Therefore, this generates savings in the home, as well as additional income from the sale of surpluses achieving stability in food availability and better food conditions [49]. In Seville, Spain, a community called "Los Portales" was developed to create innovations in areas such as organic agriculture, holistic education, natural medicine, art, clean energies, economy, personal development in search of greater sustainability and self-sufficiency [51]. In contrast, there are also the ecovillages to seek to recover the bonds of community between people heading towards sustainability. These projects find new ways to relate with the environment through logic of self-management and self-sufficiency in different fields: food, construction, mobility, energy, among others [52].

A condition where a cluster of factors (diversity of agricultural species, producer age, their schooling, number of members of the domestic unit, migration and geographical location) play an important role in the family FSS [7]. The livelihood of these small producers in southwestern Madagascar is highly susceptible to biotic and abiotic crises, due to their high dependence on natural resources, so they need to reinforce initiatives to improve the management of productive areas and FSS [9].

Climate Change

The design of new cities, as well as the transformation of existing cities considering sustainability criteria, is paramount to address climate problems [53]. In different parts of the world, climate change will negatively affect food production, especially in sub-Saharan Africa, where a high percentage of the population faces chronic hunger [54]. There are also environmental consequences in countries that dominate export markets in certain crops [55,56]. Crops, such as maize, are generally associated with a high use of agrochemicals and irrigation [57]. Other crops, such as palm oil and soy, are often associated with deforestation [58], contributing to the

negative effects of climate change. In the current climatic conditions, in southern Mali, it was achieved to meet the food needs of large and medium-sized farms, while small farms were the opposite. On the other hand, under current farming practices and the future of climate, food availability decreased for all types of farms, but large farms still achieve FSS. What this shows is that in order to achieve a family FSS, it is necessary to improve current crop management strategies [59].

Opportunities

Crop Diversity and Agroecology

If farmers diversify their crops, the probability of harvest success will increase, at least partially in the event of a mishap; however, stable and diverse agroecosystems may not be economically efficient. The production of highly specialized staple food monocultures is highly productive, but there is a risk that crops are fragile as they are produced on marginal lands by small subsistence farmers [60]. The probability of a household being self-sufficient increases with the number of crops grown, so crop diversification serves as a strategy for improving food self-sufficiency at the family level [4]. The cornfield known as "Milpa" in its original area in Latin America, is a family garden or backyard of small-scale production considered as a plant genetic reservoir close to the house that forms an economic unit of self-consumption at the door of the home [61]. The right to food is not the emphasis of food sovereignty, but also the right to produce food. This concept is based on the role of family farming, organic production methods, and a fair distribution of productive inputs [62].

Self-Supply, Environmental Sustainability and Economics

In the context of discussions on trade and food security, self-sufficiency generally refers to countries seeking to produce all or most of their own food for domestic consumption. In another perspective, from an autarkic position, FSS can be defined as a country that closes its borders to all food trade, concentrating its resources in the agricultural sector to produce national food requirements [29]. The origin of food is related, among other factors to family economic income, proximity to the supply place, the variety of products, price and freshness of foods [63]. Agriculture is essential for the supply of food, as well as for the basic needs of human beings [13]. This right is guaranteed by achieving the FSS to achieve new forms of sustainable management available among producers. The challenge is to identify and transfer them through the establishment of agroecological lighthouses to restore low yields [64]. Hence, in times of scarcity, countries that depend on food imports face a disadvantage in terms of food security, compared to states that meet food demands with local crop production [65].

Urban Self-sufficiency

Nowadays, urban demographic change correlates with declining FSS. In 1965, predominantly rural countries with low to

intermediate population densities produced enough food for their population; consequently, only two of the more urbanized countries Bermuda and Malta (> 75% urban) had food production deficits. In 2010, in less than half a century, countries with dense and highly urbanized populations had deficits in their food production [13]. European urban consumption centers have the advantage of being connected to their peri-urban and rural agricultural production areas [66]. The informal food system, under which active urban gardeners produce, consume, and share their products, is geographically highly localized, creating short food circuits and energy flows. The gardens and the food supply are essential parts of the urban food system [67]. The urban centers, which usually have local food deficits, are surrounded by large areas, where neighboring communities also cannot meet their demand for food through domestic production [68]. Peri-urban agriculture has the potential to create local circular food economies, reusing human-derived nutrients as fertilizers, also contributing access to fertilizers in developing countries [69]. Peri-urban agriculture is essential to avoid food lost and wastes as it reduces the distance from the field to the table [70]. However, research in peri-urban agriculture has developed in a few cities [68,71].

Conclusion

It is necessary to direct research developing production models that possess FSS, which should not be isolated from the reality of the country in which it is growing so that, when taking it to a real-world scenario, the results are just as efficient. FSS does not necessarily imply that the daily food needs of the population are filled equally, but it is a challenge that needs to be addressed and discussed in the government policies of those nations that emphasize food self-sufficiency. It is important to consider that the security of FSS cannot be isolated, both the academy and the government entities must take into account these principles to face and prevent public health problems of hunger, malnutrition, overweight, obesity and chronic diseases.

Acknowledgement

I would like to thank the Master's Program in Sustainable Tropical Agriculture for financial support. Also, I would like to thank Dr. Gloria Arevalo, and Dr. Adriana Hernandez at Zamorano University for assistance in this manuscript.

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2020.31.005061

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