



Sustainable Eating Futures: A Case Study in Saudi Arabia

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Food systems are central to human societies. Developing sustainable, nutritious, and healthy food systems will be crucial to accomplishing sustainable development goals. The multifarious politics underlying food production, distributions as well as consumption are often ignored. The present paper analyses different factors affecting food consumption in the local population of Saudi Arabia and relates them to the supply chain. Different futuristic scenarios are discussed to develop sustainable food consumption practices in Saudi Arabia. This paper also addresses opportunities at the intersection of food and smart technologies. Moreover, the scenarios discuss the roles played by society and technological advancements in food conservation and consumption in Saudi society.

1. Introduction

Food is an integral part of all human life and the sustainability of the planet. It is vital to several social, political, cultural, and economic practices throughout history. Food security determines foods that are sufficient, nutritious, and safe to meet the needs of all people at all times. The concept covers availability, accessibility, and adequacy of food (Tyczewska, A., et al., 2018). Sustainable food has a lot of definitions and it has two main resources. Sustainable food can be roughly defined as “the system that works to provide food for all people and to secure food for the next generation” (Hamilton, H. et al., 2020). This sustainable system should also be economically profitable, socially beneficial, and have a positive impact on the environment (Belasco, W., 2012; Hurley, K., 2008).

World Economic Forum (WEF) 2010, proposed its new vision for agriculture and the production of food. The roadmap produced by this conference eventu-

ally concludes by outlining the necessity to ‘produce more with less, thus suggesting an ecologically modern clarification of sustainability through its idea of a technologically driven agri-business future (Davies, A. R., 2014; Hirsh, 2010; Borch. K., 2007). The United Nations describes a sustainable food system that, “delivers food and nutrition security for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for future generations are not compromised” (United Nations, 2018).

The Kingdom of Saudi Arabia covers an area of 2,149,690 square kilometers and is home to 35,993,994 people (Fiaz, S., et al., 2018; Worldometers, 2022). It is expected that the volume of food consumption in the Kingdom of Saudi Arabia will reach about 221 billion riyals (\$ 59 billion), with expectations that the volume of these investments will grow by 6% annually, according to the Saudi General Investment Authority

(SAGIA, 2021). There are some basic food items that are found in every household such as rice, flour, sugar, meat, tea, and coffee. The annual per capita food consumption figures in Saudi Arabia are shown in Figure 1. Wheat is an important component of the Saudi diet and is used in bread making, forms 64% of the country's total available cereals and its per capita consumption is around 298 g day⁻¹(Ahmed, H. F., & Mousa. H, 2016). The quantities are so high that it may lead to a shortage of food in the coming years (World Bank, 2020).

There are many behaviours that make Saudis waste a lot of food (Saudi Gazette, 2018). Firstly, they are known to buy more food than they really need. The excess food expires over time and gets wasted. Secondly, some Saudi people do not follow the appropriate food preservation practices which cause the food to rot and consequently get wasted. Thirdly, there are many people who normally fill their dishes and they do not consume all the food. This is a common practice at restaurants and even at home. Fourth, another common wrong behaviour is to preparing large quantities of food with large dishes for visitors during weddings or family gatherings as a sign of respect and generosity. Lastly, one of the fundamental reasons that make people waste a lot of food in Saudi Arabia is that people do not take their excess food from restaurants and consequently restaurants throw away any excess

food. In addition, the relatively low living expenses in Saudi Arabia compared to other countries also negatively impact food consumption and waste. Therefore, with such behaviours, achieving sustainable food supplies in Saudi Arabia is a challenging task (Abdullah, N., et al., 2022).

Food security in Saudi Arabia is very critical considering that it is a large country with a very young population (Faridi M. R., & Sulphay M. M., 2019). The research shows that the government of Saudi Arabia evaluates food consumption to be about 70 billion dollars annually (UNFO, 2011). Rice is one of the most popular food sources in Saudi Arabia. People use it to make the famous dishes of Kabsa and Mandi. and it is estimated that Saudi people consume 1 million tons of rice every year. Also Saudi Arabia is ranked as the sixth consumer of rice in the world. Saudi Arabia's consumption of flour is also massive and it is estimated to be more than 3.7 million tons per year. Moreover, Saudi Arabia consumes 8 billion cups of tea and coffee every year. This escalates the use of sugar which is used for these beverages and sweets to 1.3 million tons annually. Meat is also consumed massively in Saudi Arabia since it provides the main source of protein. These massive consumption numbers put a lot of challenges on the food chains and consumption in Saudi Arabia (Tugendhat, E. 2019).

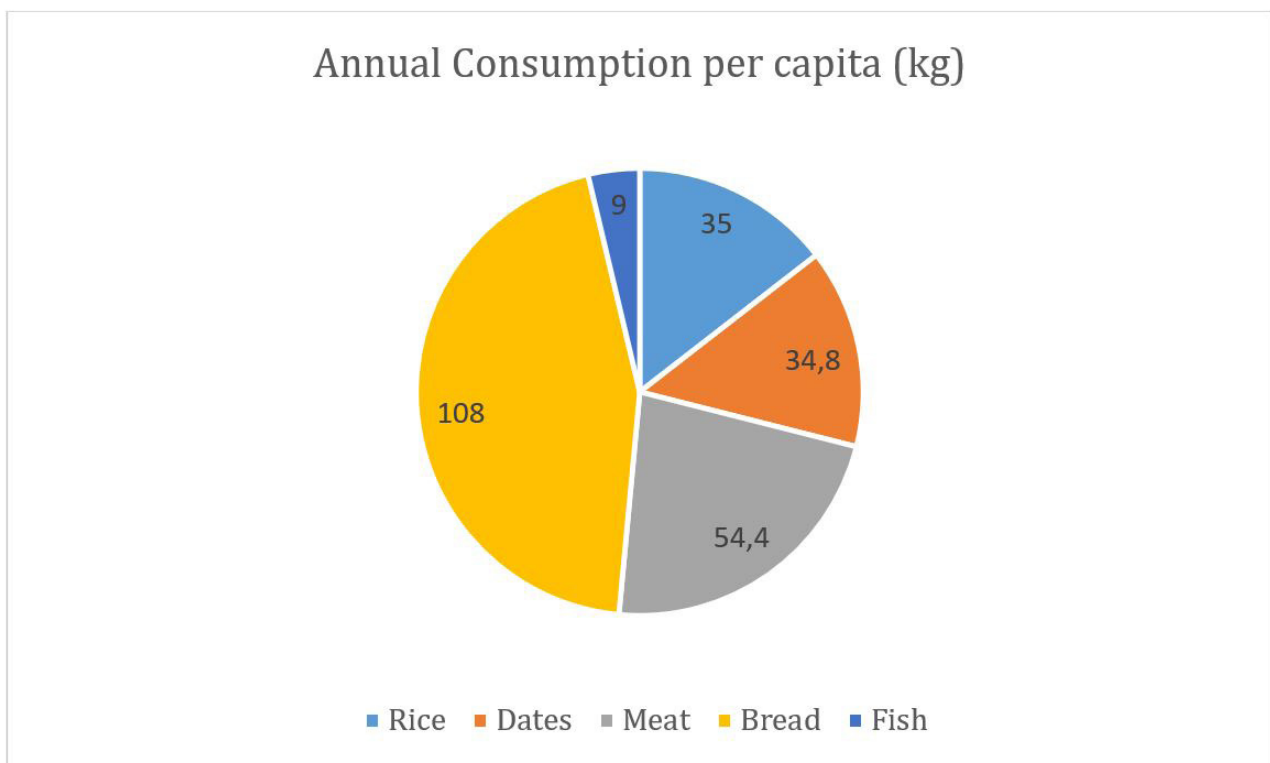


Figure 1. Annual consumption of various foods per capita in KSA

To meet these challenging food chains, Saudi Arabia spends more than 35 billion dollars to import a lot of food like meat, rice, tea, and flour. Saudi Arabia imports around 1.4 million tons of rice. Furthermore, 60% of this importation comes from India, 15% from America, 12% from Pakistan, 5% from Australia, and 3% from Thailand. Moreover, Saudi Arabia imports 3.8 million tons of flour from India, America, and France (Baig et al, 2022; Best Food Importers, 2020). These numbers are massive and put a lot of burden on the government budget and as such, it is critical that food is consumed and preserved through sustainable practices.

2. Methodology

The focal question in the current research was to explore the scenarios that will be able to feed the population of KSA in 2050. The focal question of a scenario analysis encompasses the central query to be explored through the scenarios. The methodology includes the identification of potential uncertainties and the development of scenarios.

2.1 Potential Uncertainties

The critical uncertainties in a scenario analysis are the most important yet unpredictable driving forces that will have a significant impact on the central question. Through surveys, interviews, and meetings with food systems experts from business, academia, and relevant organizations, an initial list of critical uncertainties was compiled.

- i. Monetary Swings: Will the country pursue cooperative trade through open markets, or will it pursue more isolationist policies? How will commodity market confidence evolve? Will markets be more stable or volatile? Will food prices accurately and consistently reflect the externalities of health care costs and environmental impact? What effect will trade policies have on global and local markets?
- ii. Technology Developments: What will be the rate of wide-scale adoption and availability of new food-related technology? Will technological advancements be primarily targeted at wealthy or impoverished population segments? How will technological advances' benefits and risks be distributed?
- iii. Social Change: Will people choose to consume

healthier, more balanced diets or diets high in animal-based protein and sugar, salt, and fat? Will consumers demand food that is produced in an environmentally sustainable way?

- iv. Environmental Tendencies: How will policy and business decisions affect climate mitigation and adaptation in food systems? How will climate change and other threats affect ecological systems' long-term productive capacity, including soil health? How will increased water scarcity affect food production? What will be the rate of energy consumption, and where will it come from?

3. Results & Discussion

Combining the above uncertainties reveals three scenarios for the future of food systems in KSA. These scenarios with implications are discussed below.

3.1 Unrestricted Consumption

Food production and distribution have become more efficient as a result of technological advancements, with yield improvement being the top priority. Obesity and healthcare costs are skyrocketing as billions of people switch to a high-volume, high-calorie, low-nutrient-density diet. As natural resources – including water, biodiversity, and land – are depleted, components of key ecosystems such as fisheries and dry lands begin to collapse, raising the cost of water purification and exacerbating impacts in various provinces as consumers seek alternative food sources. Growing food demand is driving climate change well beyond 2°C of global warming. This future scenario has several short-term beneficiaries. Many international food producers and retailers benefit from increased sales as a result of increased food demand, particularly multinational corporations. A conviction that society can grow now and fix environmental issues contributed to this scenario.

3.1.1 Implications of Unchecked Consumption

In this scenario, the proportion of the population that is overweight or obese has surpassed the 2050 target of one-third of the global population. The majority of the country's population now has increased access to large quantities of mostly unhealthy foods. Confusion is created by conflicting evidence on social me-

dia about healthy diets and the spread of labels, which spreads unhealthy choices and increased calorie consumption. Natural resource depletion has accelerated in this scenario to make room for new agricultural production, and the effects of intensifying climate change are more acutely felt in the marketplace. Long and complex supply chains have unclear transparencies. Consumers are not interested in knowing where their food comes from and what its ingredients are.

3.2 Local Is the New Foreign

In this scenario, resource-efficient consumption and market connectivity have resulted in fragmented food systems in which the nation relies heavily on self-sufficiency. Local food movements are on the rise as consumers place a greater emphasis on sustainable local products. Consumers rediscover and value local diets, developing a new respect for food and taking additional steps to reduce food waste. Progressive policies by the government have successfully lowered the cost of healthier diets in comparison to unhealthy diets. These factors, when combined, allow for a shift toward more balanced diets and a reduction in obesity and related diseases.

This scenario brings about a change in Community Eating Culture (CEC) with high levels of lifestyle change. Figure 2 shows the details that how eating

practices are performed by modifying the lifestyles and social norms of the people. Production of meat in the laboratory will be common with the advancement of stem cell technology. It is reported that lab-cultured meat would consume around 45% less energy, 90% less CO₂ production, and 99% less land than what is used today. The cost of protein ingredients (e.g., fish and soybean-meal) is exacerbated by their competitive use in the Kingdom; therefore, alternative sources of food and protein are required. Among the alternatives, Locusts are sought-after insects for their medicinal properties and edibility. Agricultural regions in many parts of the Kingdom are in the grip of locust invasions. The skies are seen swathed in a moving carpet of these insects. Although eating these insects as such is not recommended due to the usage of pesticides and other chemicals. However, with a certain procedure, these creatures can become a rich source of vitamins, minerals, and micronutrients in future scenarios. Genetic modification of food is expected to increase manifold by 2050. By using the gene-editing tool CRISPR/Cas-9, food technologists will be able to create perfect food (Guraua, 2016). Non-browning apples, virus-resistant goats/camels, and the non-bruising potato will be available in this scenario. Local growth of vegetables will be supported by municipalities under “grow-it-yourself” and “community space” initiatives. Fast food will become less popular as against “slow food” events and sources in edible parks.



Figure 2. Public eating scenario 2050

In a world of fragmented local markets with resource-efficient consumption, resource-rich countries focus on local foods, whereas import dependent regions become hunger hotspots. Therefore, for KSA the best futuristic scenario is “Local Is the New Foreign”. Public eating scenarios include “slow food” events in edible parks developed in metropolitan areas. Grow-it-yourself campaign whereby grow groups share land and experience with each other. Similarly, “Farmers Market” whereby farmers sell their products directly to consumers. Composting of waste food and provision of community spaces for growing, cooking, and eating together are other possibilities. Similarly, Figure 3 shows scenarios using advanced technology contributing towards self-sufficiency. The idea of a living wall where vegetables and herbs can be germinated and grown using fertilizer from a food waste processor and filtered water from washings etc. Smart refrigerator can give information about leftovers, menu suggestions, and food safety information. Green fast food can be easily available in canteens, and small shops and to order online. Smartphones can be used as scanners in green supermarkets, as well as to provide information on the social, environmental, and health aspects of food products. Moreover, the use of Artificial Intelligence (AI) technologies in Saudi Arabia will also increase productivity and achieve food

security, because artificial intelligence can ease many things such as planting seeds and harvesting fruits (Choi, J. H.-J. 2014). Furthermore, the Global Positioning System (GPS) will be used to alert fishermen on the best places for fishing and also to avoid storms. GPS systems and drone technology will also be used to seed plantations and implement sanctuaries to protect animals from overhunting.

Another important aspect of the future of food consumption in Saudi society is 3D-printed food. By using 3D printing technology, suitable ingredients can be mixed and then processed into the most intricate shapes and structures that are impossible to be made or are uneconomical to produce under the traditional manufacturing process. These kinds of food can have entirely novel textures and flavours that are unimaginable to be produced through traditional cooking processes. Thus, in this scenario, 3D printing technology will take food preparation into the digital age. A wide variety of ingredients can be automatically mixed during printing on the basis of certain selected recipes and be made in the absence of an operator (cook) by introducing advanced settings. As Saudi society is going to be more and more health conscious, 3D printing of food will provide a calculated intake of proteins, carbohydrates, and fats (Zhang et al., 2021).

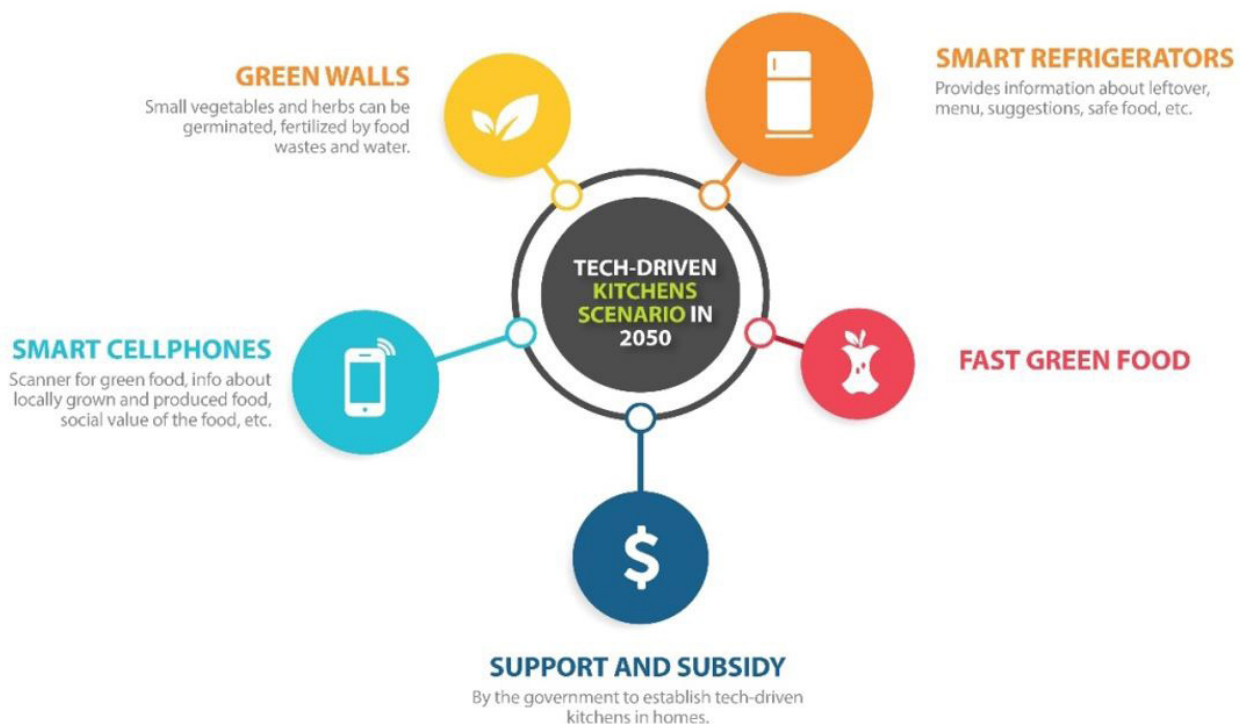


Figure 3. Technology-Driven Scenario 2050



3.2.1 Implications

In this scenario, the environmental impact of food production is reduced. Smaller food chains and more resource-efficient consumption reduce the agri-food sector's environmental impact. Digital transformation will play a pivotal role in the food consumption culture of the people. However, in the long run, a lack of access to foreign markets may result in unsustainable pressures on local land and ecosystems in certain regions of the Kingdom.

3.3 Survival of the Richest

In this scenario, only a few isolated, wealthy population segments can produce and innovate to meet their needs; isolated, poor, or import-dependent markets are experiencing increased hunger and poverty (Sundbo, 2016). Population growth, rising inequality, and rising food prices have increased resource needs. This has prompted a new wave of foreign investments in land and water resources. Climate change is accelerating. In this scenario, the majority of people are worse off than others. The upper classes are relatively better off than those in poorer contexts because they can still afford high food prices and comfortable lifestyles for the time being. In this scenario, there are many losers. For example, life has become risky and more uncertain for smallholder farmers than ever before: desperate economic conditions, limited access to natural resources (particularly water), and more adverse weather conditions have forced many to seek alternative sources of income to feed themselves and their families.

3.3.1 Implications

In this scenario, the majority of the people consume unhealthy diets, while a wealthy minority consumes nutritious foods and animal-based protein. In contrast, the vast majority of consumers are either eating high-calorie, low-nutrient diets, becoming increasingly overweight or obese, or are unable to access enough food, becoming increasingly undernourished.

4. Conclusions

Among the scenarios discussed, the "Local is the new Foreign" seems to be a more desirable future. In this

regards many important steps can be taken in the kingdom of Saudi Arabia to secure food for the future. These steps can range from penalties for those who do not contribute positively to incentives for those who enhance the future of food sustainability in Saudi Arabia.

- The government to establish a policy to mandate regulations to protect against food wastage. This should be followed by establishing violations for those who break the food security policy. For example, if a person does not complete his dish, he must pay for the amount of the remaining food.

- The government should create authorities to facilitate and encourage local food production, global supply chains, and building relations with other countries to enhance the economic importation of food.

- Enhanced use of social media and advertisements can also play a major role to enhance socialites' compliance with food preservation and sustainability. This should include conducting competitions for young men and women to make the best documentary film about food security and its importance for Saudi Arabia.

- One of the most important steps that must be taken by Saudi Arabia is to encourage the private sector to establish companies specialized in more active roles in food security. An example of these efforts is the focus of Saudi Aramco on helping farmers in the Jazan area to increase their coffee, mango, and honey production.

- The government can focus on increasing the agricultural lands in the Kingdom, and availing these to the farmer at reasonable rents will help to encourage farmers to start their businesses, increase crop production and achieving food security.

- The authorities should focus on establishing investment funds to encourage local businesses to implement their strategies that support food sustainability within the kingdom.

- The government also focus on linking health illnesses with overeating practices which will help in reducing food consumption and achieve better sustainability.



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- The government of Saudi Arabia focus on building healthy diplomatic relationships with various food-producing countries. This will help in the event of wars or diplomatic conflict to eliminate any disturbance to the food chains and production.

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