

Article

Effects of the COVID-19 Pandemic on Food Security and Agriculture in Iran: A Survey

Abdullah Kaviani Rad ¹, Redmond R. Shamshiri ^{2,*} , Hassan Azarm ³ , Siva K. Balasundram ⁴ 
and Muhammad Sultan ⁵ 

¹ Department of Soil Science, School of Agriculture, Shiraz University, Shiraz 71946-85111, Iran; arad@adaptiveagrotech.com

² Leibniz Institute for Agricultural Engineering and Bioeconomy, 14469 Potsdam-Bornim, Germany

³ Department of Agricultural Economics, School of Agriculture, Shiraz University, Shiraz 71946-85111, Iran; hazarm@shirazu.ac.ir

⁴ Department of Agriculture Technology, Faculty of Agriculture, University Putra Malaysia, Serdang 43400, Selangor, Malaysia; siva@upm.edu.my

⁵ Department of Agricultural Engineering, Bahauddin Zakariya University, Bosan Road, Multan 60800, Pakistan; muhammadsultan@bzu.edu.pk

* Correspondence: rshamshiri@atb-potsdam.de; Tel.: +49-(0)331-569-9410

Abstract: The consequences of COVID-19 on the economy and agriculture have raised many concerns about global food security, especially in developing countries. Given that food security is a critical component that is affected by global crises, beside the limited studies carried out on the macro-impacts of COVID-19 on food security in Iran, this paper is an attempt to address the dynamic impacts of COVID-19 on food security along with economic and environmental challenges in Iran. For this purpose, a survey was conducted with the hypothesis that COVID-19 has not affected food security in Iran. To address this fundamental hypothesis, we applied the systematic review method to obtain the evidence. Various evidences, including indices and statistics, were collected from national databases, scientific reports, field observations, and interviews. Preliminary results revealed that COVID-19 exerts its effects on the economy, agriculture, and food security of Iran through six major mechanisms, corresponding to a 30% decrease in the purchasing power parity in 2020 beside a significant increase in food prices compared to 2019. On the other hand, the expanding environmental constraints in Iran reduce the capacity of the agricultural sector to play a crucial role in the economy and ensure food security, and in this regard, COVID-19 forces the national programs and budget to combat rising ecological limitations. Accordingly, our study rejects the hypothesis that COVID-19 has not affected food security in Iran.

Keywords: COVID-19; Iran; food security; economic crisis; agriculture; food supply chain



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1. Introduction

Global economic growth was projected to reach 3.2% in 2019 and 3.5% in 2020, and emerging economies were expected to grow by 4.1% and 4.7%, as well as 6.5% growth for developing Asia in 2019–2020 [1]. However, the outbreak of a novel SARS-CoV-2 from Wuhan province (China) known as “COVID-19” [2] quickly changed all the predictions about the future of the global and regional economy. Although the global lockdowns assisted to control the disease outbreak, this pandemic damaged many economic sectors such as industries [3], tourism [4], trade and business activities [5], and agriculture [6]. Thus, investors have removed \$83 billion from emerging markets since the beginning of the crisis, and the most significant capital outflow ever recorded [7]. While there is no system to determine the actual economic damage from the pandemic [8], it is expected to impose the most influential threat to the future of trade [9], and global economic growth was forecasted to reach −3.2%, and the most extensive global recession was created during the COVID-19

pandemic, as well as declining the GDP by 5.2% in 2020 [10–12] that pushed 34 million people into severe poverty [13]. Due to the sharp economic losses, the concerns about the food security situation during the COVID-19 outbreak period aroused researchers' attention.

Food security, characterized as access to safe and sufficient food, is affected by economic crises. Pandemics can cause damage to the global economy [14], and the COVID-19 pandemic has short and long-term effects on food security and human health worldwide [15]. At this time, COVID-19 has infected more than 218 million and led to the death of 4.5 million people [16]. It appears that the economic consequences of the COVID-19 on food security are more significant in developing countries [17]. The \$64 million loss caused by lockdown each day in Bangladesh, the inability of 16% of Indian urban households to access government food aid, and the 14% reduction in food security for Mexican families are examples of food insecurity caused by the pandemic [18–20].

Iran, as a developing country with a population of 82 million people, has also been affected by the various consequences of COVID-19. In February 2020, some countries were battling the pandemic, and after China, Iran appeared as one of the earliest COVID-19 epidemic countries [21]. Now, COVID-19 has infected more than 4.9 million people with more than 107,000 victims in Iran [22], leading to a unique economic crisis. Enhancement of health sector costs (+28%) [23] and financial losses, caused by lockdown restrictions, led to a remarkable decline in revenue, growth of unemployment, and interruptions in transportation, industry, services, oil [24], tourism [25], and agriculture [26,27]. Restrictions on imports-exports generated hurdles for food transportation; meanwhile, consumers and producers faced difficulties that ultimately led to declining farmers' income and striking damage to agriculture [28]. However, the agriculture sector is challenged by environmental limitations such as climate change and water crisis.

After considering the mentioned concerns, these questions were created; (i) are the merged economic consequences of the COVID-19 and ecological constraints synergistic? (ii) What is the connection between agricultural constraints and the consequences of the COVID-19 on food security? In other words, (iii) what are the dynamic impacts of the pandemic on food security along with economic and environmental challenges in Iran? We began with the hypothesis that COVID-19 has not been linked to agricultural constraints and has no synergistic impressions. Since the shocks of COVID-19 on food security in Iran and the environmental approach in agricultural economics, examinations of the pandemic have not been considered; hence, the present study aims to investigate the various effects of COVID-19 on food security status in Iran with a new specific approach.

2. Materials and Methods

Since previous statistical studies on food security in Iran were primarily on a local scale, the present study proposed to draw a comprehensive schematic of the impacts of the COVID-19 crisis on food security in Iran. Hence, a systematic reviewing was applied as an appropriate method to collect evidence for hypothesis investigation to address the research questions. For this purpose, keywords food security, COVID-19, global lockdowns, trade disruption, agriculture, food supply chain, food insecurity, economic crisis, climate change, water crisis, natural disasters, environmental sustainability, and ecological constraints were searched in Google Scholar, Scopus, and other international and national databases. Global and Iranian databases, including statistics of governmental organizations, were adopted to explore the consequences of the pandemic on food security in Iran. The literature review of this study was conducted in three scopes: COVID-19 and food security, economic results of the COVID-19, and agricultural sustainability of Iran. Obtained evidence were associated to World Bank, International Monetary Fund (IMF), FAO, United Nations, WHO, OECD, World Trade Organization (WTO), and Iranian national organizations such as Central Bank (CBI) and Statistical Center of Iran (SCI), Department of Environment (DOE), and Iran Parliament Research Center (IPRC). After assembling the relevant information, the results of the study were presented in a classified style.

3. Results and Discussion

3.1. COVID-19 and New Economic Challenges

Iran was challenged by significant economic problems such as high inflation, rising exchange rate, and declining industrial activities prior to the COVID-19 outbreak, and the economic growth and unemployment rates were -7.6% and 10.6% , as well as economic growth without oil 0% , agriculture 3.2% , oil -37% , and industry -2.3% in 2019 [29]. Hence, high inflation has been one of the significant economic concerns in Iran due to the destructive consequences on the Iranian monetary value [30]. In this regard, Sultan-Tavieh et al. [31] reported that rising inflation has significant adverse impacts on Iran's economic growth, and its long-term effects are more severe than short-term. The high inflation rate has led to a notable rise in the final price of products for consumers in recent years [32]. Accordingly, Iran has the sixth-highest inflation rate globally [33], and its per capita income was reduced by 34% between 2011 and 2019, while the number of countries that provided 80% of Iran's export revenue has decreased from 23 to 9 in 2001–2018. More so, statistics revealed that Iran's oil exports increased by two million barrels per day after the Joint Comprehensive Plan of Action (JCPOA) agreement [34]; nevertheless, with the return of sanctions in May 2018, oil exports were estimated to be less than 500,000 barrels per day [35], which reduced foreign exchange earnings and a worsening government budget deficit.

Therefore, Iran's economy has faced COVID-19 after two difficult years between 2018 and 2020 because the high inflation rate of 2018–2019 damaged many industries and business activities, and Iran's exports decreased by 30% in March 2020 compared to 2019. Additionally, Iran's per capita income has been split during the pandemic outbreak in comparison to 2019, due to a significant decline in the oil price (falling oil price to $\$40$ per barrel). The point inflation rate also reached 41.4% in September 2020 due to the COVID-19 economic consequences; thus, Iranian households have spent 41.4% more than September 2019 for buying the same products. Meanwhile, the point inflation rate for foods and beverages, as well as services, grew $9\text{--}40.5\%$ and $7\text{--}41.9\%$, respectively [36]. The COVID-19 pandemic has rigorously changed employment and salary in numerous labor-intensive activities, specifically in the informal sector. Thus, the employment opportunities have declined by more than one million jobs. Although poverty had reached 14% before COVID-19, it was estimated that a decline in incomes and increasing household costs, due to inflation, will drive poverty by 20% in 2020 [37]. During the lockdowns period, growth in the value of financial transactions was 41% lower than a month before the pandemic [38].

Consequently, COVID-19 had the most significant impact on livelihood and employment in Iran because 25% of Iran's employees are in the service sector [39]. The governmental revenue level was decreased due to severe financial consequences of COVID-19, such as the growing exchange rate. Rising exchange rates have affected inflation and led to higher prices for vital goods [40]. It seems that COVID-19 accelerated the growth of the currency exchange rate due to the reduction in exports by disruption of international trade in 2020 [41]. The average exchange rate has risen seven times from 2017 to September 2020. In other words, the value of Iran's national currency has decreased by more than 590% in the mentioned period. The dollar currency value was about 130 thousand Rial in 2019, but it reached 280 thousand Rial in September 2020 ($+111\%$) (1 US dollar = 27,000 Rial) [42]. Figure 1 shows that the exchange rate has been significantly increased since 2011.

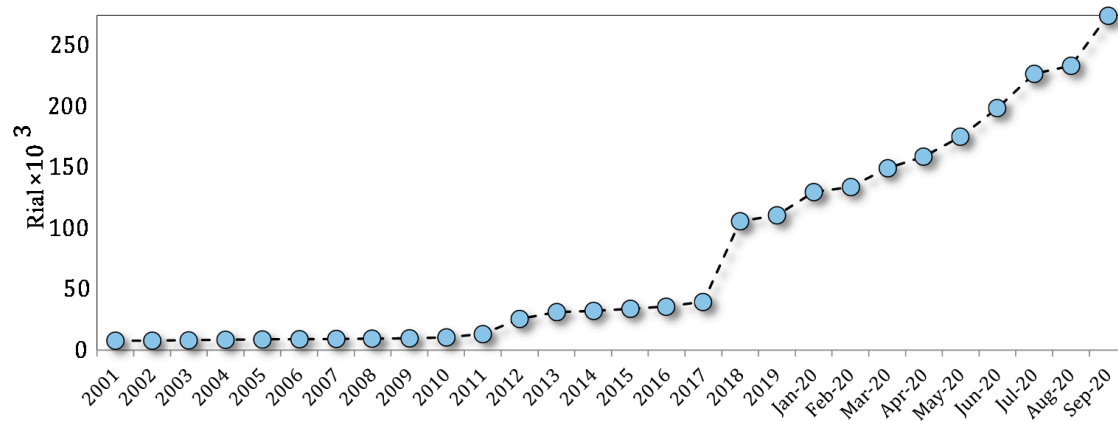


Figure 1. Rising exchange rate in Iran from 2001 to 2020; data source: [43].

Pakravan-Charvadeh et al. [44] demonstrated that Iranian families decreased consumption of some groups of foods during the pandemic outbreak due to new financial problems; therefore, COVID-19 can negatively impact food security by decreasing people's income [45]. Consequently, inflation led to food insecurity through poverty spread and reduction of income [46]. Additionally, controlling the goods price and monopoly pricing are severe problems of Iran's economy [47]. Figure 2 shows the impact of inflation on the increasing price index from 2001 to 2020. In addition, the growth trend of the exchange rate has led to an increase in production cost; hence, a significant rise in the final product price has been observed.

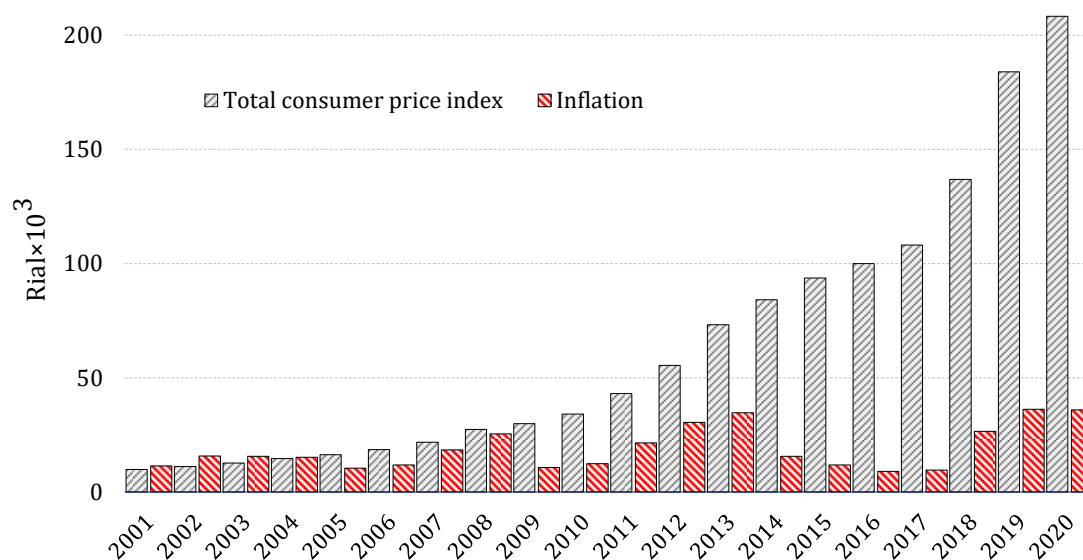


Figure 2. Demonstration of the increasing average inflation rate and total consumer price index from 2001 to 2020; data source: [48,49].

3.2. COVID-19, Food System and Supply Chain

By cutting the connections between farmers and food markets, COVID-19 shocked the food supply chain and reduced food accessibility. Shocks to the food supply chain by the pandemic can be double in developing and low-income countries [50–52] and endanger the lives of millions of people and smallholders [53]. COVID-19 affects the total food demand and supply system in Iran by creating imbalance due to the following factors: (i) reduction of household demand due to an unwillingness to use the services sector for preventing the COVID-19 outbreak, (ii) reduction of consumer demand due to declining incomes for households who lost their jobs in lockdown restriction, (iii) reduction of household

demand for durable goods and increase of money-savings, and (iv) reduction of exports due to border closure. Motevali et al. [54] reported that rice acts as an imperative product in Iran and Iranian families need 3,200,000 tons of rice per year, and 50 million people will be without food if the government does not import this product; the ban on rice exports in India, Pakistan, and Thailand in 2020 increased price of rice in Iran and reduced its imports by 50%. Between January and August 2020, approximately 450,000 tons of rice were imported by the government, while in the same period of the previous year, 950,000 tons were imported [55]; thus, rice price in Iran has been increased by 13% [56]. Therefore, the food supply chain imbalance by COVID-19 in Iran has imposed a significant threat to food security in poor households. Arouna et al. [57] confirmed the same result for West Africa, and similar evidence demonstrated that fifteen countries observed more than a 10% increase in food prices, and fourteen countries have announced export bans for twenty various products in the first quarter of 2020, according to World Food Program Market Monitoring [58]. Rice prices in exporter countries, such as Russia and Vietnam, grew up, and they limited wheat and rice exports due to domestic demand enhancement. Philippines and Saudi Arabia have bought surplus rice and wheat, and the price of rice in Myanmar increased due to simultaneously rising demand and declining seasonal harvests [59,60]. In addition, Iran's government reduced subsidies for chemical fertilizers, which led to a significant fertilizer price enhancement in 2020 [61]. This excessive increase in prices has reduced farmers' demand for chemical fertilizers, and low crop yield and reduction of farmers' income were expected in 2020–2021. Moreover, the highest wages in the agricultural sector were observed in fruit picking (58.1%), disking by tractor (44.6%), and weeding (43.1%) [62]; hence, growing the price of agricultural inputs and workers' wages will reduce farmers' willingness to produce in the next cultivation seasons. From the global perspective, the low availability of pesticides and their high price has threatened crop protection in 2020 [63]. A similar global economic crisis in 2008–2009 raised prices of agricultural inputs and products, such as fertilizers and cereal grains, simultaneously and threatened food security in many countries (Figure 3) [64]. It can be concluded that COVID-19, similar to the economic crisis of 2008–2009, has increased the production costs and price of crop products, and a similar disturbance was recognized in Iran.

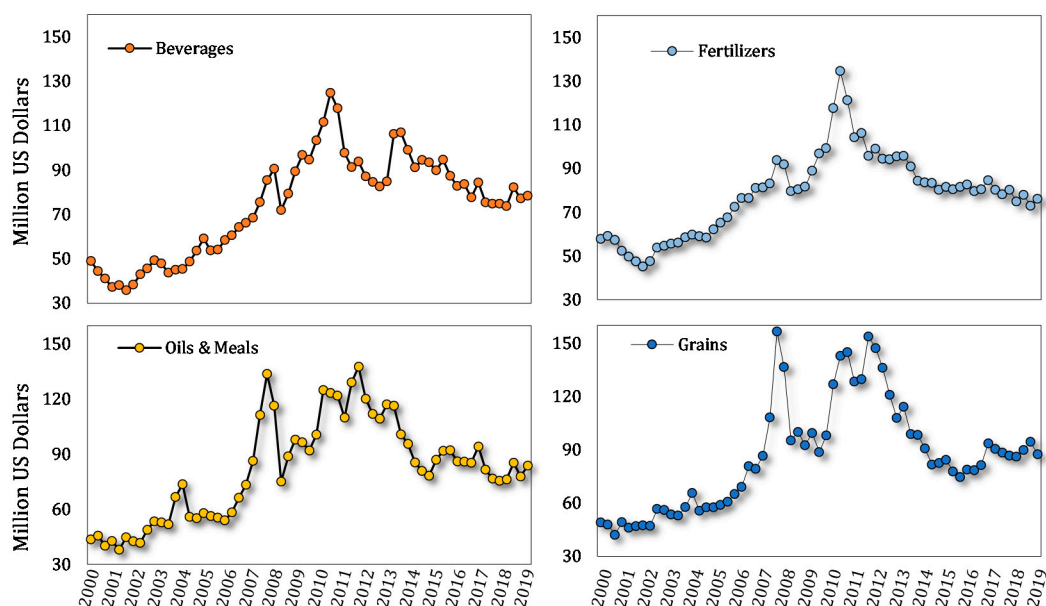


Figure 3. The global growth in monthly prices of agricultural products and inputs from 2000 to 2019, data source: [63].

Since the COVID-19 applied a general mechanism to affect the food supply chain and interrupt food trade between countries, the consequences for the food supply chain in Iran were similar to other countries. Furthermore, the results of other studies in many countries

can be correlated to Iran. COVID-19 has effectively changed food consumption patterns and disturbed the food supply chain in rural sub-Saharan Africa [53,65]. Restrictions on access to agricultural inputs and labor in Senegal changed the production of four critical grains such as rice, maize, sorghum, and millet [66]. By evaluating the shocks of the pandemic toward food security and livelihoods of Senegalese families, Middendorf et al. [67] found that 82.5% of households had difficulty accessing sufficient food. These studies demonstrated the vulnerabilities of the food supply chain, in developing countries, to COVID-19 [68]. Figure 4 shows the dynamic mechanisms of COVID-19 to affect the food supply chain and has symbolized that rising food prices ultimately increase poverty and food insecurity.

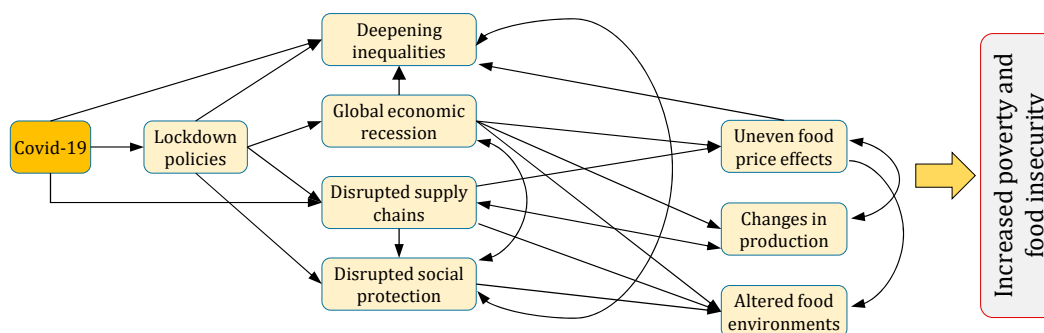


Figure 4. The dynamic mechanisms of COVID-19 that endanger food security; adapted from FAO [69].

After the extensive pandemic outbreak in Iran, the government has decided to pay a subsidy to low-income households in order to prevent food insecurity; however, it was not an efficient strategy to improve food security [70]. By considering the relative increase in subsidy and workers' wages in 2020–2021, it is observed that the purchasing power of every Iranian reduced by 30% in comparison to previous years [71]; furthermore, the government's ineffective policies to combat the consequences of the COVID-19 economic crisis have led to significant growth in the price of foods and a decline in people's revenue simultaneously, which leads to malnutrition in low-income households. Figure 5 shows the significant increase in different foods price from 2017 to 2020.

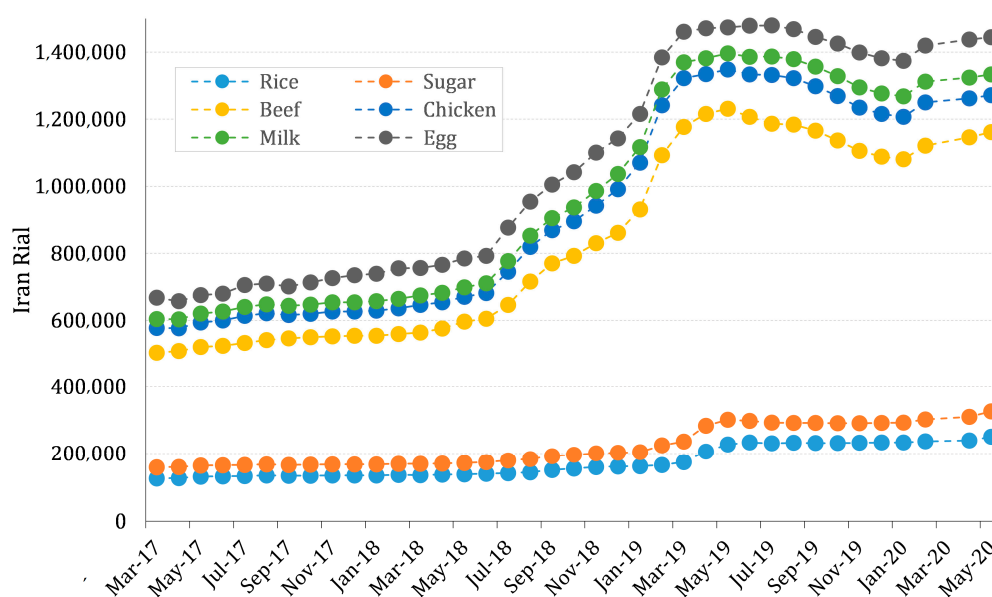


Figure 5. Rising prices of foods and beverages in Iran from 2017 to 2020 (Rial per kg^{-1} for rice, beef, sugar, and chicken; Rial per liter for milk; Rial per piece for egg), data source: [71].

The highest price enhancement in the food-beverages class is related to beef, milk, egg, and chicken [72]. Food prices have been significantly increased during the COVID-19 outbreak period compared to 2019, and the highest price in 2020 was related to wheat, lentils, watermelon, and apricots by 44.7%, 106.7%, 112.7%, and 46.4%, respectively. The red meat in Iran is higher-priced than in other markets worldwide; consequently, many low-income households have reduced their meat consumption due to its high price [73]. Therefore, the new economic crisis can shift the demand for nutritious foods such as vegetable oils and meat to cereal grains and poor-quality foods [74] through reducing purchasing power. Layani et al., [75] found that after the enhancement in the price of eight food groups, including meat, cooking oil, cereals, sugar, coffee, tea, dairy products, vegetables, and fruits, the abundance of vulnerable families raised by 10.63%. Despite the crucial role of a healthy diet in combating COVID-19, nutritional support is essential to prevent infection of individuals [76]. Hence, the people will be malnourished and more vulnerable to COVID-19 if they cannot consume nutritious foods such as vegetables, meat, dairy, grains, and fruits due to poverty and the high price of foods. COVID-19 has made people search for a nutritious diet, including foods that boost the immune system [77,78]; accordingly, food price monitoring by the government is necessary during the COVID-19 outbreak [79]. Consequently, COVID-19 also has indirect effects on infecting people in addition to direct impacts, and Figure 6 shows the indirect and direct consequences of the pandemic on human health.

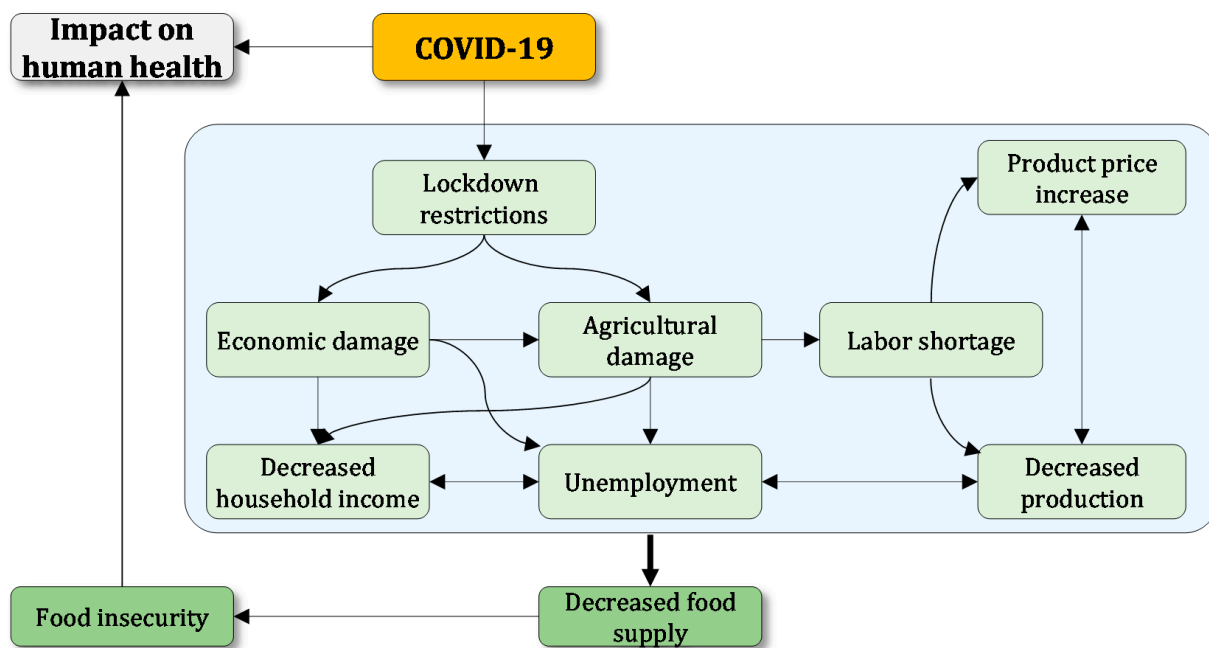


Figure 6. Various indirect and direct impacts of COVID-19 on human health.

According to obtained evidence of the COVID-19 results on food security, there are similar mechanisms that the pandemic influences food security through, which include a healthy diet [80], food supply chain [81], income, employment [82], national economic situation, and agriculture sustainability [26]. Therefore, the hypothesis that COVID-19 does not influence food safety was rejected, owing to its adverse consequences on food security through above six general mechanisms, which are obviously in Iran and other countries. Figure 7 shows that food security depends on the economy, household income, employment, food supply chain, and healthy diet, and the impact mechanism of the lockdown restrictions and economic crisis on food security in Iran has also been indicated.

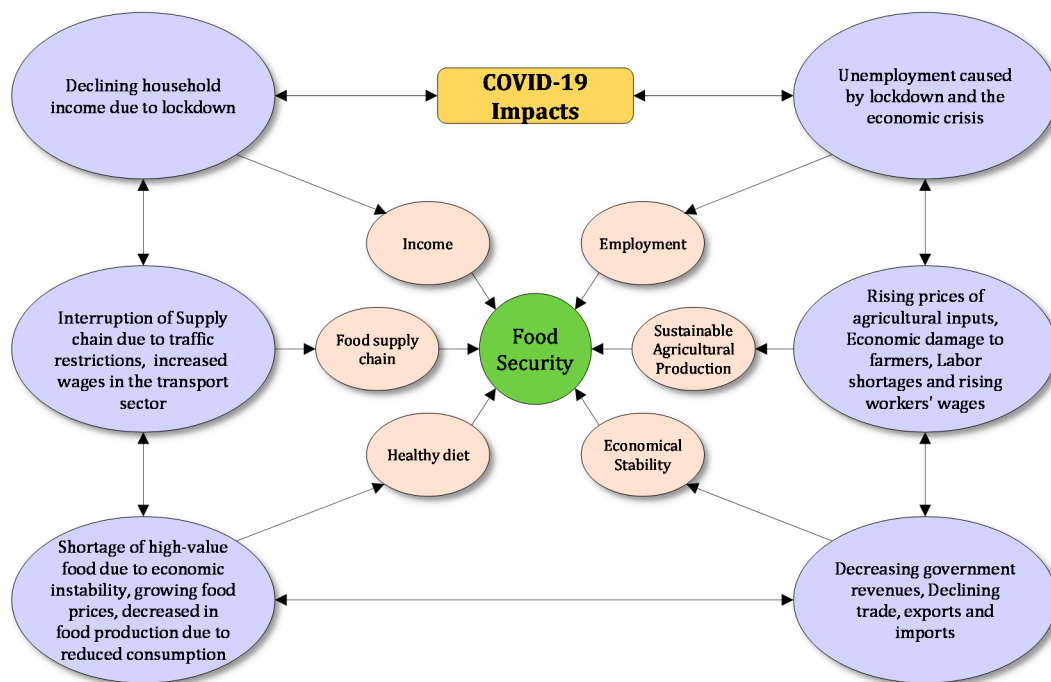


Figure 7. The profound effects of COVID-19 on food security by using six general mechanisms.

3.3. COVID-19, Challenges toward Sustainable Agriculture

As an important economic sector, agriculture has an intense connection with the economy (8% of Iran's GDP), supports food security [83–85], and activates the food system, which including connections between farmers, food factories, and the food supply chain [86]. COVID-19 cut these relationships and limited people's access to nutritious foods through lockdown restrictions [87]. Numerous evidence indicated that general consequences of the pandemic in the agricultural sector, including labor shortages, reduction of planting and harvesting, and reduction of agricultural trade, created an imbalance in the food system of many countries [88–90]. Although ecological constraints, such as climate change, water crisis, and land degradation, could significantly damage the prospects for economic growth and lead to food insecurity [91]. Growing agricultural limitations such as water shortage, desertification, and soil degradation are serious threats, and according to United Nations [92], 6.6% and 10.6% of the world's lands are arid and semi-arid, threatening the revenue of more than 1 billion people in 100 countries. Globally, 24% of the lands are being destroyed, and the portion of farmlands and rangelands is approximately 20–25%. Approximately 1.5 billion people are dependent on these degraded lands directly. The global degraded lands could produce 20 million tons of grain per year; thus, land degradation leads to a financial loss of \$42 billion in revenue annually [92]. However, previous studies have only investigated the final consequences of COVID-19 toward agriculture and food security from an economic approach. Climate change imperils human prosperity [93], and according to a study by Fuentes et al. [94], climate change and COVID-19 potentially create a global tremendous economic loss; furthermore, most of their outcomes are observed in vulnerable communities [95]. Hence, the damages caused by COVID-19 have a synergistic influence with the financial loss of ecological constraints.

Agriculture can support a dynamic and sustainable economy and maintains food security if ecological constraints are reduced. The consequences of the pandemic outbreak in Iran can be divided into stable and new challenges. Environmental constraints besides the disturbance of the food system can continuously threaten food security in Iran. Climate change, water crisis, soil erosion, and salinity are critical agents that reduce crop productivity [96–98]. Tehrani et al. [97] evaluated more than 20,000 soil samples and found that more than 50% of Iran's soils are deficient in nutrients. Thus, despite the simultaneous COVID-

19 crisis and ecological limitations [99], farmers are experiencing a massive challenge for producing crops in Iran. FAO has also reported that reducing available water resources, land degradation, and climate change will have long-term adverse effects on Iran's food security, although maintaining food security in global crises is a significant challenge [100] that requires attention to environmental health [101]. If the government fails to combat extensive environmental constraints due to the financial loss created by the pandemic, the synergistic effects of both crises will threaten food security in the future. A schematic of the stable and new challenges caused by the COVID-19 has been shown in Figure 8, and each ecological limitation is discussed in the next sections.

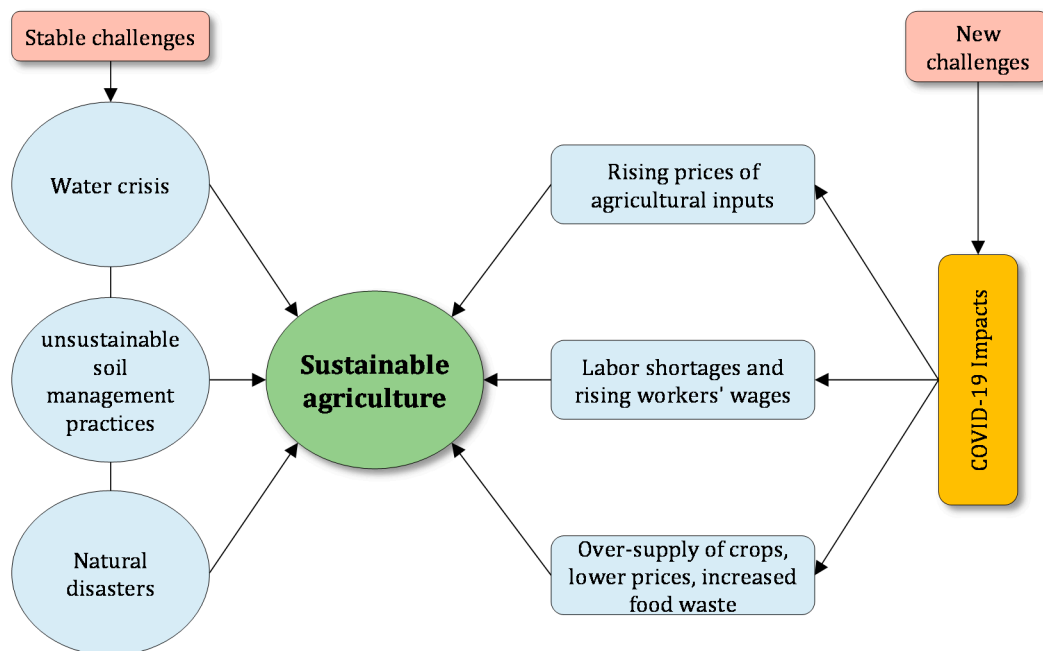


Figure 8. Impact of new challenges created by COVID-19 and continuous challenges on agricultural sustainability.

3.3.1. Water Crisis

Every person needs at least 2000 m³ of water per year, but people that are living in arid lands have access to 1300 m³ only; hence water shortages affect between one and two billion people. Furthermore, 50% of the population of the world will live in countries under extreme water deficit by 2030, according to the climate change scenario. Water plays a crucial role in the agriculture, and the farming sector is responsible for 70% of total freshwater consumption [102]. According to a study by Zarei [103], most Middle Eastern countries face water-energy-food insecurity due to ineffective water management strategies. The general climate of Iran is arid and semi-arid, and drought is a prominent trait of Iran's climate [104]. Approximately 90% of water consumption is associated with the agricultural sector, which is consuming five billion cubic meters of groundwater resources per year in Iran [105]; consequently, many regions of Iran have experienced significant insufficient water resources for farming due to the over-exploitation [106], and the crop production has been threatened by drought. Figures 9 and 10 show that the water crisis scenario will threaten areas under cultivation in Iran by 2030. In this regard, Soltani et al. [107] showed that self-sufficiency in crop production would be reduced from 83 to 39% in Iran if water consumption for agriculture will be limited by 2030.

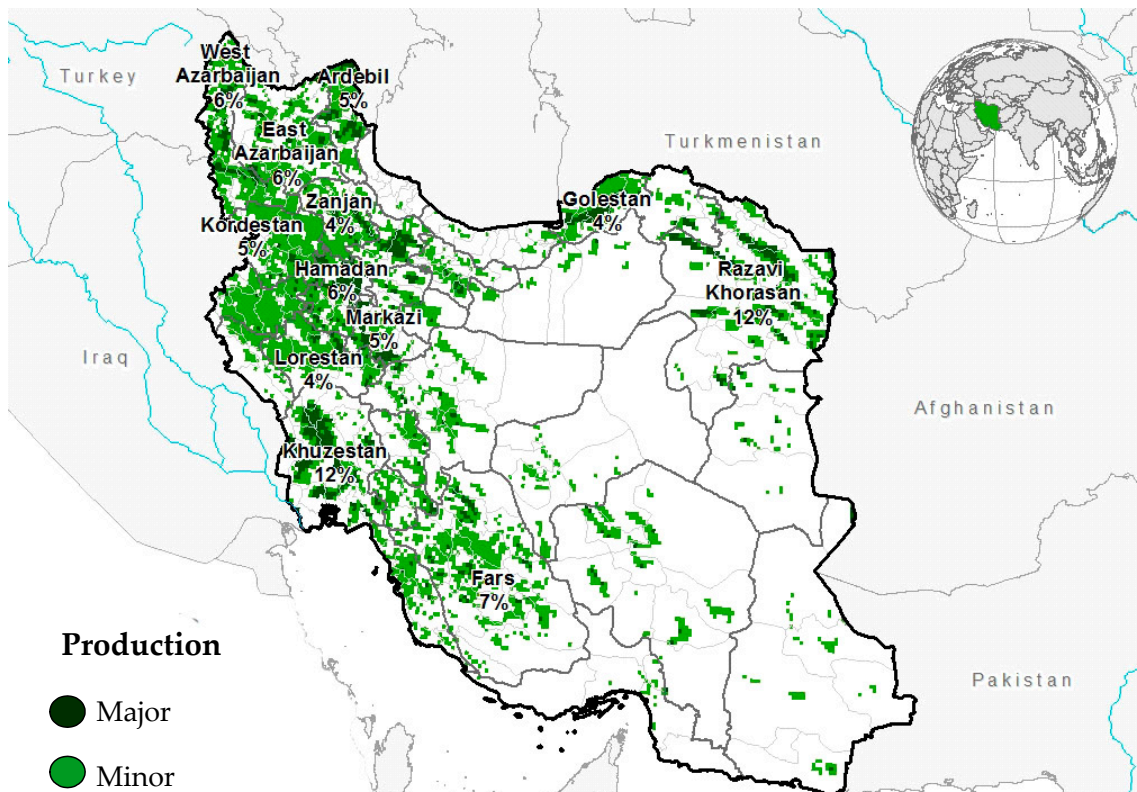


Figure 9. Map of farmlands under cultivation (wheat) in Iran in 2021; source: [108].

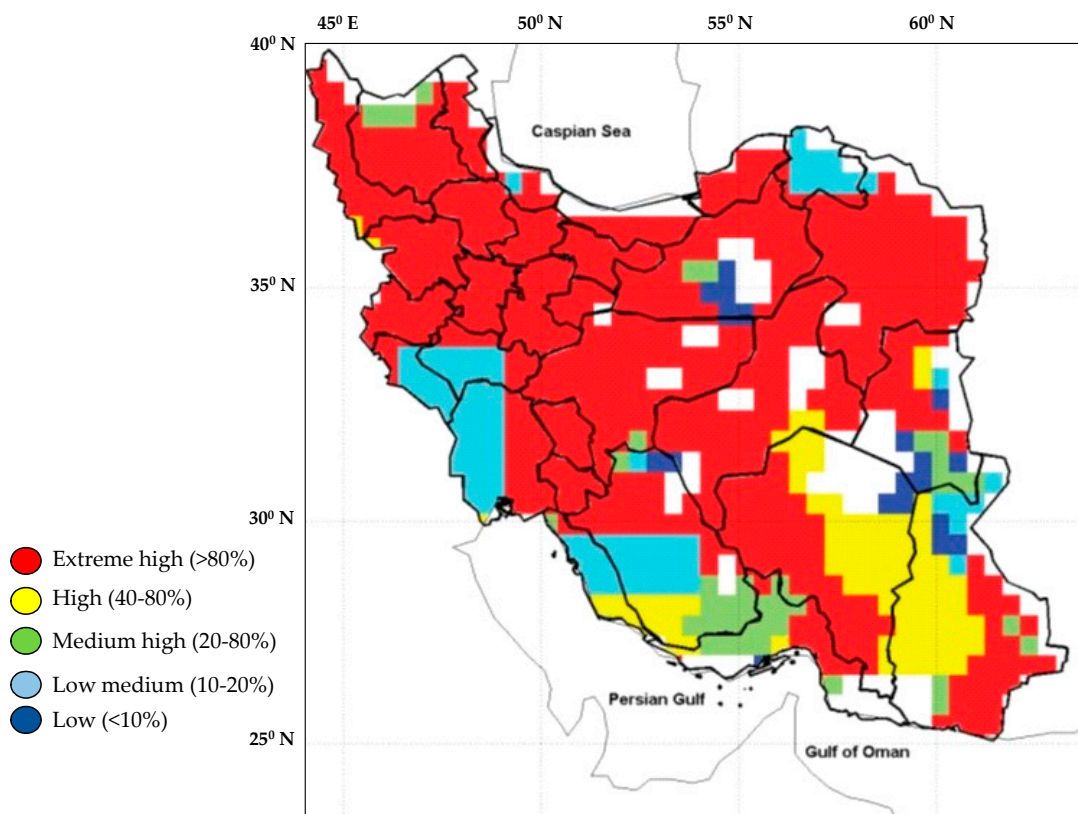


Figure 10. Map of areas under water stress in Iran according to the water crisis scenario in 2030; source: [109].

3.3.2. Soil Salinity and Erosion

Through using the UNESCO World Soil Map (1970–1980), FAO estimated that global total saline lands are 397 million hectares, and 38.7 (2%) and 195.1 (6.3%) million hectares have been located in Africa and Asia, respectively [110]. As a rising concern that limits sustainable agricultural production, soil salinity encompasses the large areas of the Central Plateau, southern coastal plains, and Khuzestan in Iran (Figure 11) [111]. From 6.8 million hectares of saline agricultural land, 4.3 million hectares are saline, and approximately 2.5 million hectares have other restrictions such as soil erosion and groundwater scarcity.

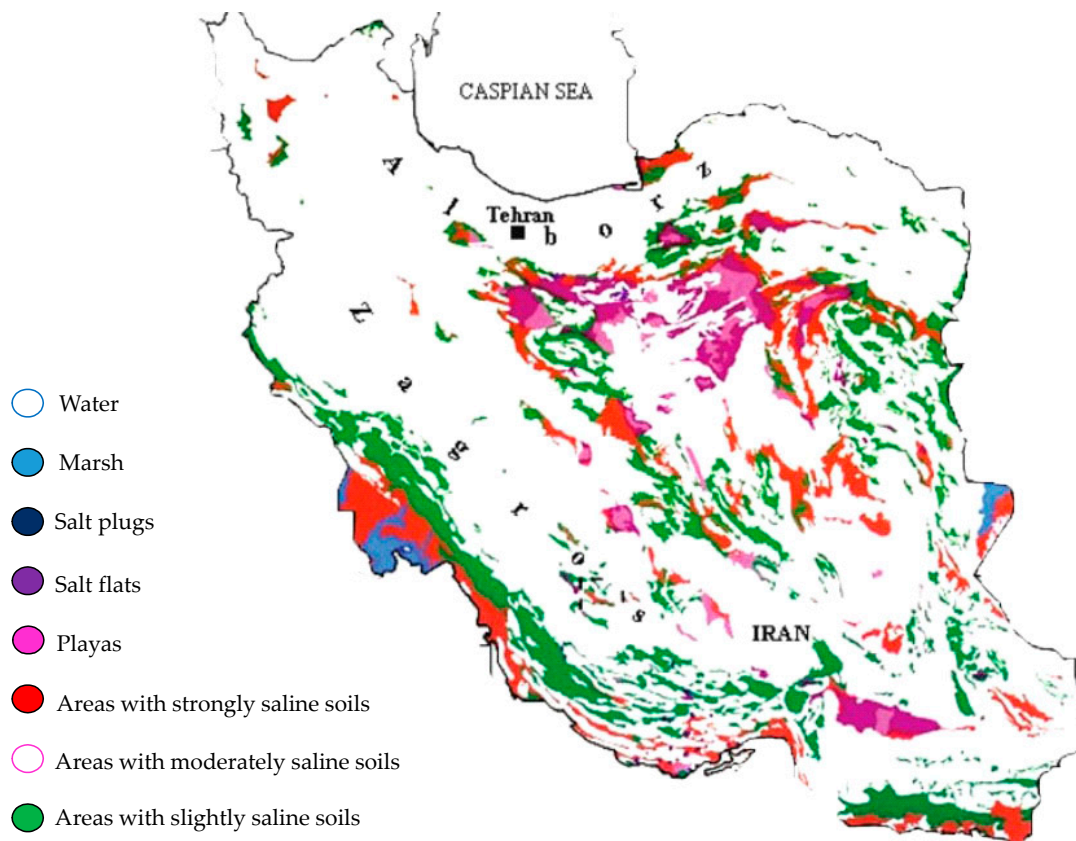


Figure 11. Map of saline soils in Iran; source [112].

Anthropogenic activities and land-use change also lead to soil erosion, which degrades 20–30 billion tons of soil per year and severely decreases soil productivity; hence, extreme soil erosion has been predicted for developing regions such as Southeast Asia, South America, and sub-Saharan Africa [113]. In a study by Mosaffaie and Talebi [114], water erosion using the EPM model was estimated at 975 million tons per year, and the total volume of erosion sediment was also estimated at 129 million tons in Iran. Hence, limited soil productivity of farmlands in Iran limits crops production, and Figure 12 shows that extensive areas of lands of this country cannot perform as arable lands, due to soil erosion or specific topography traits.

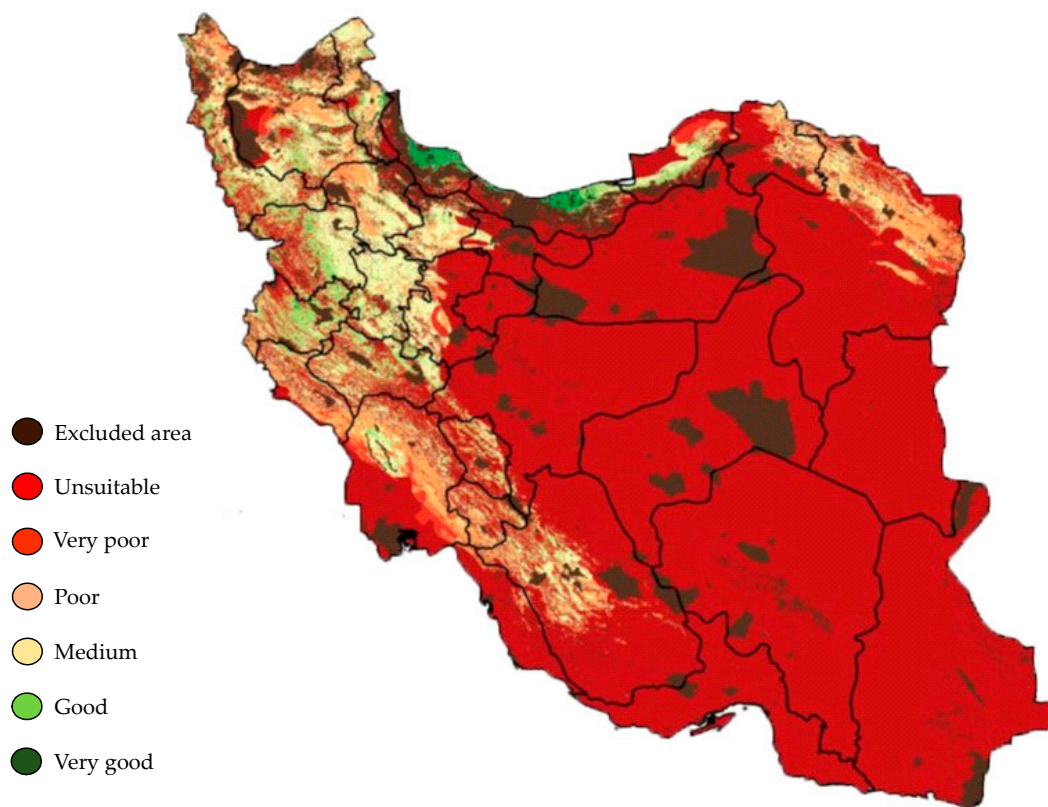


Figure 12. Soil suitability map of lands of Iran for cultivation; source: [115].

According to the calculations of Kohneshahri and Sadeghi [116], economic losses of soil erosion were 31% of the agriculture sector value-added in 2000. Hence, annual loss by soil erosion has been estimated at \$56 billion in Iran [117]. Water erosion caused by flooding led to a 100-billion-dollar loss in 2019 because the floods in the three areas of Dez, Karun, and Karkheh were about 12 thousand billion cubic meters, which led to the erosion of 3.5 billion tons of soil [118]. Water erosion also removes 23–42 and 14.6–26.4 million tons of nitrogen and phosphorus from farmlands, and their costs are \$1.45 and \$5.26 per kilogram; accordingly, the financial losses are \$33–60 and \$77–140 billion for wasted nitrogen and phosphorus per year [119]. A lack of a strategic plan and insufficient knowledge about the consequences of soil salinity and erosion are the critical challenges in Iran [120]; consequently, soil erosion and salinity threaten sustainable agricultural production by reducing land fertility and crop productivity.

3.3.3. Deforestation and Land-Use Change

According to a study by Mirakhor-Lou and Akhavan [121], the deforestation rate is 0.74% per year in northern Iran, and the area of Hyrcanian forests in the three provinces of Gilan, Golestan, and Mazandaran was 1,811,788 hectares in 2004, and in 2016, it was estimated at 1,650,498 hectares. Forests in the northern regions of Iran (Gilan, Mazandaran, and Golestan provinces) have been decreased by 9% between 2004 and 2016 due to land-use change. Higher than 86 million hectares (52%) of Iran's lands are pastures, which contain more than 7000 plant species, and the livelihood of about 916,000 rural and nomadic households depends on the use of rangelands. The situation of Iran's rangelands is also unfavorable, and a decreasing trend has been observed in Figure 13; accordingly, SCI shows that the total area of Iran's rangelands has been reduced between 2002 to 2012 [122], and the reduction in rangelands vegetation will be extreme if the overuse of rangelands for livestock grazing increases due to the high price of livestock fodder.

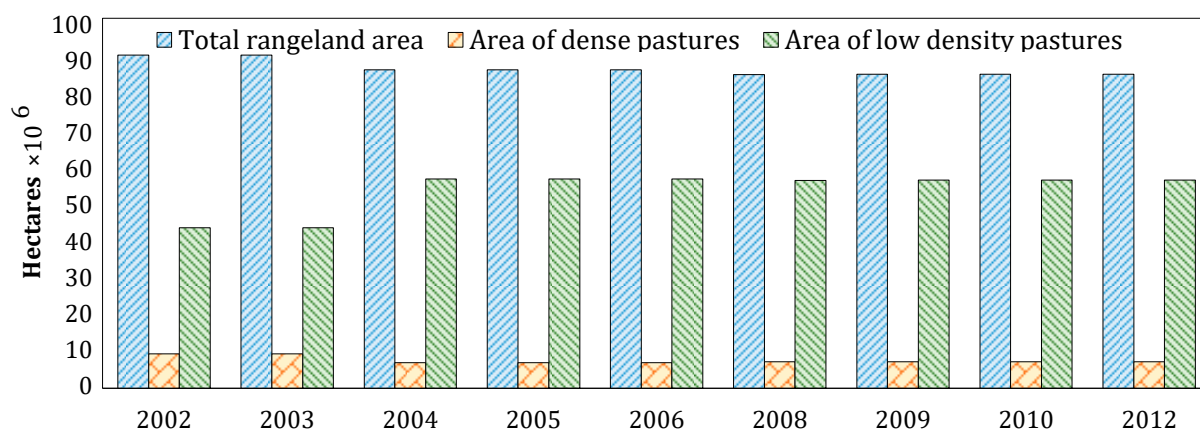


Figure 13. Reducing rangelands (dense, semi-dense, and low) in Iran from 2002 to 2012, data source: [121].

3.3.4. Natural Disasters

Sudden and irregular rainfall is a significant climatic train that creates big floods in Iran, and the difference between the average rainfall in the water year 2018–2019 and 2017–2018 was 46–181%, which led to severe floods in the provinces of Golestan, Lorestan, and Khuzestan in 2019 [123]. In addition to floods, locust attacks also cause significant damage to the agricultural sector. Desert locusts (*Schistocerca gregaria*) are found in the Middle East, Asia, and Africa and have destructive effects on crop yields. According to the Iran Agriculture Commission of the Parliament, this crisis caused a ten billion Rial (370 million US dollar) financial loss, in the southern provinces of Iran, in 2020 [124]. A similar locust attack in April 2012 affected the plantation in southern Indian Ocean Island, and FAO estimated that four million people were at risk of food insecurity in rural Madagascar in June–July 2013 [125]. The locusts have caused enormous damage in Ethiopia and Somalia because a small group of 80 million locusts can destroy the share food of 35,000 people per day and seriously threaten food security. This crisis has shocked the food supply chain of 23 countries in 2020 [126]. The cost of control for locusts increased from \$1 million to \$100 million in West Africa in 2003. A joint assessment by the Ethiopian government and FAO shows an outbreak of locusts destroyed 356,286 metric grains, destroying 197,163 hectares of crops and 1.3 million hectares of pastures. Then, COVID-19 exacerbated the locust crisis by disrupting the supply chain of pesticides [127], and Northern Somalia and asymptotic regions of eastern Ethiopia and borders of Djibouti, Pakistan, India, Sudan, and Oman were at a high risk of locust outbreaks [128].

4. Conclusions and Recommendations

Along with the appearance of the pandemic in 2020, the economic recession led to food insecurity in many countries due to financial loss and food prices enhancement. Among the developing countries, Iran has been affected by macroeconomic problems such as inflation and high currency exchange rate. Iran's per capita income significantly decreased, and rising inflation and the dollar exchange rate increased prices of various foods and beverages due to the rise in production costs in recent years and during the pandemic. Food shortages and their price enhancement endangered food security directly, and oversupply reduced some product prices, leading to financial losses for producers and farmers, ultimately threatening food security. Besides the complex economic effects of the pandemic, ecological constraints such as a water crisis, salinity, extreme soil erosion, deforestation, and natural disasters have severe adverse consequences on food security in Iran. Hence, COVID-19 causes direct and indirect damages and interruptions to the agriculture sector by limiting the production of some crops and disregarding environmental protection policies, due to economic losses, because stable ecological problems such as salinity and soil erosion can threaten sustainable agricultural production in the future. In response to the main hypotheses of this study, it can be demonstrated that consequences of the COVID-19 and

ecological constraints have synergistic impacts. The enormous financial loss can pause support for small-scale farming and agricultural research projects. Therefore, governments must improve food security and environmental health through promoting sustainable agriculture measures and eco-friendly policies. It is necessary to implement sustainable agriculture policies during the COVID-19 outbreak period in Iran, and other countries, by considering ecological constraints. It should be highlighted that, while sustainable agricultural development can provide sufficient nutritious food, protect environmental health, and presumably support mitigate the financial losses in the post-COVID-19 crisis, it is still difficult to improve the economic consequences of pandemics. Therefore, future studies may involve investigating strategies that support the agricultural sector to endure the long-term economic consequences in the post-pandemic and maintaining food security by means of developing agroecology training courses, accelerating agricultural projects via sustainable and eco-friendly approaches, and assisting small-scale farming projects by providing site-specific solutions, automated instruments, and new breeds of seeds and plants to compensate for the drought and salinity problems.

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