



**Standing Committee
for Economic and Commercial Cooperation
of the Organization of Islamic Cooperation (COMCEC)**

Resilience in The Seed Sector With The Rising of Risks After COVID-19



**COMCEC COORDINATION OFFICE
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**COMCEC COORDINATION OFFICE
November 2022**

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TABLE OF CONTENTS

LIST OF TABLES.....	II
LIST OF FIGURES.....	III
LIST OF ABBREVIATIONS.....	IV
EXECUTIVE SUMMARY.....	1
CHAPTER 1: INTRODUCTION.....	3
1.1 Agricultural Effects.....	5
1.1.1 <i>Agricultural Effects on Türkiye.....</i>	<i>7</i>
1.1.2 <i>Agricultural Effects on Azerbaijan.....</i>	<i>9</i>
1.1.3 <i>Agricultural Effects on Malaysia.....</i>	<i>11</i>
1.1.4 <i>Agricultural Effects on Morocco.....</i>	<i>13</i>
1.1.5 <i>Agricultural Effects on Pakistan.....</i>	<i>15</i>
1.1.6 <i>Agricultural Effects on SESRIC Countries.....</i>	<i>16</i>
CHAPTER 2: COVID-19 OUTBREAK ON THE SEED RESILIENCE IN THE SEED SECTOR	17
CHAPTER 3: SEED RESILIENCE IN THE COMCEC COUNTRIES' SEED INDUSTRY DURING COVID-19.....	23
3.1 Azerbaijan Seed Sector.....	23
3.1.1 <i>Seed Resilience in The Azerbaijani Seed Industry During COVID-19.....</i>	<i>25</i>
3.2 Türkiye Seed Sector.....	28
3.2.1 <i>Seed Resilience in The Turkish Seed Industry During COVID-19.....</i>	<i>31</i>
3.3 Malaysia Seed Sector.....	33
3.3.1 <i>Seed Resilience in The Malaysian Seed Industry During COVID-19.....</i>	<i>35</i>
3.4 Morocco Seed Sector.....	37
3.4.1 <i>Seed Resilience in The Moroccan Seed Industry During COVID-19.....</i>	<i>41</i>
3.5 Pakistan Seed Sector.....	42
3.5.1 <i>Seed Resilience in The Pakistani Seed Industry During COVID-19.....</i>	<i>45</i>
CHAPTER 4: POLICY RECOMMENDATION.....	48
CHAPTER 5: CONCLUSION.....	53
REFERENCES.....	56

LIST OF TABLES

Table 1: Top Five Seed Exporting Countries in the World and Reporting COMCEC Countries in 2020	18
Table 2: Top Five Seed Importing Countries in the World and Reporting COMCEC Countries in 2020	19
Table 3: The Seed Production Chain Involves Many Steps	21
Table 4: Number of TSUAB Member Companies Profile by Species	30
Table 5: Registered Varieties in Morocco	40
Table 6: Area, Seed Requirement and Seed Availability 2019-20 in Pakistan	45

LIST OF FIGURES

Figure 1: The Number of Varieties Registered on the Basis of Years	25
Figure 2: Activities Implemented to Ensure Seed Supply During the Pandemic	26
Figure 3: Seed Demand for Main Vegetables for 2019-2021 Years	27
Figure 4: Total Certified Certificated Seed Production	28
Figure 5: Certificated Seed Production in Türkiye Year by Year	32
Figure 6: COVID-19 Period in Türkiye Seed Import and Export	32
Figure 7: Total Imported Seed Industry in Malaysia	35
Figure 8: Total Exported Seed Industry in Malaysia	36
Figure 9: Certificated Seed Production in Morocco from 2009 to 2020	39
Figure 10: Basic Class Seed Demand and Achieved Statistics	42
Figure 11: Farm Input Price Increases Attributed to COVID-19.....	47
Figure 12: Seed Import and Export Values in Pakistan	48

LIST OF ABBREVIATIONS

ADF	:	Agricultural Development Fund
ADP	:	Asian Development Bank reports
AMSP	:	Moroccan Seed Association
AFSTA	:	African Seed Trade Association
APSA	:	The Asia and Pacific Seed Association
ASTAT	:	The State Statistical Committee of the Republic of Azerbaijan
BUGEM	:	Bitkisel Üretim Genel Müdürlüğü (General Directorate of Plant Production)
COMCEC	:	Standing Committee for Economic and Commercial Cooperation of the Organization of the Islamic Cooperation
DOA	:	Department of Agriculture
DOSM	:	Department of Statistics of Malaysia
EAIS	:	Electronic Agricultural Information System
EU	:	European Union
FAO	:	Food and Agriculture Organization
FNIS	:	National Inter Professional Seed Federation
FSCD	:	Federal Seed Certification Department
FSCRD	:	Federal Seed Certification and Registration Department
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GMP	:	Green Morocco Plan
GPS	:	Global Positioning System
ICFM	:	Islamic Conference of Foreign Ministers
INRA	:	National Institute of Agricultural Research
ISF	:	International Seed Federation
ISTA	:	International Seed Testing Association
MAD	:	Moroccan Dirhams
MAFI	:	Ministry of Agriculture and Food Industries
MARDI	:	Malaysian Agricultural Research and Development Institute
MT	:	Metric Ton
NAP	:	National Agriculture Policy
NSP	:	National Seed Project
NSC	:	National Seed Council
NSRD	:	National Seed Registration Department
OECD	:	Organization for Economic Cooperation and Development
OIC	:	Organization of Islamic Cooperation
ONSSA	:	The National Office of Food Safety
PARC	:	Pakistan Agriculture Research Council
PBR	:	Plant Breeders' Rights
PVP	:	Plant Variety Protection
RM	:	Ringgit Malaysia
SESRIC	:	Statistical Economic and Social Research and Training Centre for Islamic Countries
SIRIM	:	Department of Standard Malaysia
SONACOS	:	National Company for Seed Trade
SSCRA	:	State Statistics Committee of the Republic of Azerbaijan
TIKA	:	Türk İşbirliği ve Koordinasyon Ajansı Başkanlığı (Türkiye Cooperation and Coordination Agency)
TSUAB	:	Tohum Sanayicileri ve Üreticileri Alt Birliği (Seed Industrialists and Producers Sub-Association)
TTSM	:	Tohumluk Tescil ve Sertifikasyon Merkez Müdürlüğü (Variety Registration and Seed Certification Center)
TURKTOB	:	Türkiye Tohumcular Birliği (Türkiye Seed Union)
UPOV	:	International Union for the Protection of New Varieties of Plants
US\$	:	United States Dollar
VAT	:	Value added tax
WHO	:	World Health Organization
WAPDC	:	West Pakistan Agricultural Development Corporation

EXECUTIVE SUMMARY

The COVID-19 pandemic has been the world's most serious pandemic in recent years, bringing services to a halt. Breeding, seed production, registration, and certification, as well as international trade, have been severely curtailed as a result of the COVID-19 epidemic and government measures to protect their citizens. This has had a negative impact on farmers and the global food supply chain.

Food security is impacted by COVID-19 in both direct and indirect ways, and the results depend on the starting conditions in communities, nations, and regions as well as on their shock resistance. The impact of COVID-19 on short-, medium-, and long-term food safety issues varies between COMCEC member countries. The foundation of food security is a seed. The widespread awareness of the food price problem rapidly and directly led to the perception of a seed security crisis.

A workshop to better understand the impact of COVID-19 on the seed supply chain was organized in cooperation with representatives of the Ministry of Agriculture from COMCEC countries (Azerbaijan, Malaysia, Morocco, and Pakistan) and with the help of the Statistical Economic and Social Research and Training Centre for Islamic Countries (SESRIC), and a detailed analysis was carried out in terms of seed production.

The workshop results for Türkiye, Azerbaijan, and Morocco indicate a less severe impact of COVID-19. The Turkish seed companies reported that by 2020 they would not be experiencing any major obstacles to importing seed. While businesses in Pakistan and Malaysia were more adversely affected by COVID-19 in terms of demand, transportation, and human resources, the seed industry has been quite resilient. The seed supply chain, however, would have been far more impacted if the stringent measures implemented to manage the COVID-19 epidemic had persisted for a longer period of time. First, in the future, it might be increasingly challenging to find high-quality seeds. Travel restrictions prevented seed company experts from performing adaptation trials or quality checks at seed production sites. The long-term impacts of COVID-19 on the seed supply chain have been brought on by restrictive measures as well as customs limitations, in addition to limits on seed production, transportation, and marketing, all of which have in particular raised the price of hybrid seeds.

It is important to assist COMCEC nations in developing their national seed industries in accordance with global regulatory standards, for example, through capacity-building initiatives or twinning initiatives. This will strengthen their capacity to participate as seed-producing nations in the global seed supply chain and guarantee that local farmers in COMCEC nations have access to high-quality seeds. The COMCEC countries with the highest diversity of field crops, vegetables, and fruits are the five countries that this paper focuses on in terms of agriculture, seeds, and COVID-19 effects.

The seed supply chain can be made more resilient by implementing the following policy ideas, which can also help to lessen or even prevent the harmful consequences of the current epidemic and future crises:

- ❖ For the COMCEC countries, in order to develop technological knowledge and skills such as risk management, cultivation methods, and marketing, and to create regionally appropriate variations, it is important to develop varieties suitable for the region by increasing the breeder's capacities in the COMCEC countries. With the development of varieties adapted to their regions, higher yields and quality nutrients, and more importantly, seeds, are obtained. In addition, both nutritional problems and national food safety problems are solved.
- ❖ Seed networking methodologies and strategies should be developed both within the national context and among COMCEC countries. For this, the exchange of knowledge and experience between member countries in the seed sector and the development and strengthening of unions to ensure the horizontal transformation of food systems will further reduce the impact of crisis situations such as COVID-19.
- ❖ The empowerment of farmers and community-based organizations working to support locally based and farmer-focused seed systems is one of the most crucial activities to finance against such risks. For this reason, it is crucial to boost vitality, particularly in rural areas (especially by empowering women and youth), make it easier for small businesses to access financing, improve public health, give everyone fair access to nutritious and safe food, reduce food loss and waste, maintain a balanced and healthy diet, and encourage sustainable consumption.

- ❖ Community seed banking systems, seed storage techniques, and keeping endemic species and variations collected from the country using appropriate technologies and sharing them within COMCEC countries require low-cost seed conservation technologies. In order to create innovative, less expensive techniques for maintaining the seeds of these gene sources, pure lines, and commercial varieties, it is necessary to safeguard regional cooperation. Thus, the possibility of employing new natural resources can be investigated, or it can be intended to decrease this cost by utilizing other types of energy in order to reduce the energy costs in seed gene banks.
- ❖ The characterization of genetic resources adapted to local conditions and the identification of pure lines for the development of new varieties can be achieved by sharing these resources within COMCEC countries. Especially with the development of local varieties, new varieties that are both resistant to diseases and pests and have higher yield quality can be developed from materials that are adapted to the region and already contain resistance to biotic and abiotic stress conditions. In this way, the protection of gene resources through international cooperation and the further development of COMCEC countries with varieties to be developed from them can be achieved.

1. INTRODUCTION

Every aspect of human activity, including farming, tourism, transportation, education, and health care, as well as livestock, agriculture, mining, industry, and commerce, has been adversely affected by the various pandemics that humanity has faced, including the Spanish Flu, Asian Flu, Hong Kong Flu, HIV/AIDS, SARS, Ebola, and Swine Flu.

In late 2019, Wuhan, the capital of Hubei province in Central China, reported the first instances of the coronavirus illness 2019 (COVID-19), which was brought on by the brand-new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Since that time, to November 2022, the COVID-19 global pandemic has caused more than 633 million confirmed illnesses and taken the lives of about 6.5 million people.

In Türkiye, there have been 16.9 million confirmed cases of COVID-19 with 101,203 fatalities reported to WHO between January 2020 and November 2022. Since 2020, when the case first appeared, Malaysia has 823,761 confirmed cases of COVID-19 with 9,965 deaths, Pakistan has 1,266,639 confirmed cases of COVID-19 with 16,283 deaths, 1,574,679 confirmed cases of COVID-19 with 30,629 deaths in Morocco. In Azerbaijan, 1,266,639 confirmed cases of COVID-19 and 16,283 deaths were reported (Anonymous 2022).

The predominant symptoms identified in COVID-19 individuals may include chills, recurrent shaking with chills, muscle pain, headache, sore throat, and new loss of taste or smell. The most notable symptoms of COVID-19 include fever, coughing, and dyspnea (Rodriguez-Morales, 2020). Additionally, COVID-19 emergency warning indications include shortness of breath, prolonged chest pain, unexpected forgetfulness, difficulty rousing, and bluish lips or face. Patients exhibiting any of these symptoms should seek immediate medical assistance (Montero-Odasso, 2020).

According to Clark (2016), a pandemic is a serial killer that can have catastrophic effects on both people and the world's economy. For instance, the Spanish flu, which spread all over the world in 1918, destroyed the lives of 50 million people. In this case, there has been a contraction in global economic revenues, expenditures and labor markets, and per capita income has decreased by about 10% (Barro and Ursua, 2008; Ceylan et al., 2021).

A pandemic can cause economic and health problems as well as deaths. Besides, a crisis like an outbreak can lead to socio-psychological upheavals in society, with the impoverished being more heavily affected than the wealthy (Padhan and Prabheesh 2021). The supply and demand implications of COVID-19 can be roughly characterized as economic fallout. The reduction in aggregate demand is caused by the decline in income caused by the concomitant unemployment caused by lockdowns, which in turn is caused by the decrease in working hours, which affects supply. Maliszewska et al. (2020) stated that the pandemic had an impact on the economy through the following channels: (1) a direct impact on a decline in employment; (2) an increase in the cost of conducting business internationally; (3) a sharp decline in travel; and (4) a decline in demand for services that depend on close proximity between people.

One of the most crucial areas for human progress is agriculture, which is connected to food security (Abdelhedi and Zouari, 2020; Kogo et al., 2020; Lopez-Ridaura et al., 2019). According to the Food

and Agriculture Organization (FAO, 2020a), COVID-2019 has a substantial impact on agriculture in two key areas: the supply and demand for food. Resilience of agriculture and food systems was tested by the COVID-19 disruption. According to on-the-ground research being conducted by FAO, small-scale producers in countries already having problems with other crises are finding it increasingly difficult to obtain inputs like seeds and fertilizer due to rising prices for these products, drastically decreased household incomes, and/or a lack of these products on the market. COVID-19 was also bringing new challenges, including to smallholder farmers, seed systems, and seed security response.

There is very few research that investigate the impact of COVID-19 on agricultural in COMCEC countries, despite the fact that many scientific studies have addressed the responses of the countries to the COVID-19 issue. Considering this fact that, this report contributes to the literature in many ways. First, this study is one of the first attempts to the agricultural effects of the COVID-19 pandemic. Secondly, this report focused on the effects of the COVID-19 outbreak on the seed resilience in the seed sector. Finally, the impact of the workshop on sharing expertise and identifying best practices for effective seed management and distribution in the selected COMCEC countries (Azerbaijan, Morocco, Malesia and Pakistan) will be discussed.

1.1 Agricultural effects

Agriculture has always played a significant role in reducing poverty, raising earnings, and ensuring the food security of the poor and disadvantaged. According to a World Bank prediction under the pre-COVID-19 scenario, agricultural advancements were predicted to feed 9.7 billion people by 2050 and offer opportunities for employment to working-class adults, thus alleviating severe poverty. But during and after COVID-19 all aspects of the economy were affected, double-digit declines occurred. Travel and tourism have both sufficiently suffered and oil prices have fallen to levels not seen in the last 20 years. Due to the fact that agriculture relies heavily on labor-intensive in the production method compared to other sectors, it has faced a significantly greater risk of being affected by the COVID-19 epidemic.

The effects of epidemics in the agricultural sector are not limited to COVID-19 only. First, the direct result of epidemics on agricultural production is a lack of labor. Such crises have occurred in

agriculture before. According to FAO, a specialized agency of the United Nations that coordinates global efforts to end hunger, among the 25 worst afflicted African nations, about 23 million agricultural workers will have perished from HIV/AIDS between 1985 and 2020. Within a few decades, these nations may lose up to 26% of their agricultural work force (Michiels, 2001). On the other hand, challenges associated with logistics and supply chain disruptions could agriculture production. It is difficult for farmers to obtain fertilizer, seeds, agricultural machinery and other inputs. For example, the 2014 EBOLA outbreak disrupted supply chains in agricultural markets. Strict prevention and control measures are frequently implemented to stop the spread of epidemics like HIV, SARS, EBOLA and COVID-19, but these measures are likely to have a detrimental effect on agricultural production due to resource misallocation and efficiency loss. When a negative effect appears inevitable, the main concern for policymakers is how to make up for the loss. We must determine the extent to which epidemics impact agriculture through various channels in order to respond to this question. Finding the most efficient method to reduce and compensate for the loss is made possible by understanding the mechanism of this impact.

Strengthening economic cooperation amongst Islamic nations is one of the key goals of the OIC (Sharqieh, 2012). For instance, trade cooperation attempts to create economic integration that results in the establishment of an Islamic public market. As a result, the OIC's Standing Committee for Economic and Trade Cooperation (COMCEC), which was formally established during the Third Islamic Summit in Mecca in January 1981, serves as a vehicle for the economic cooperation among its member countries that representing the OIC's Islamic countries.

The goals of COMCEC are to monitor the implementation of trade and economic resolutions, explore all avenues for enhancing cooperation in this area, and develop a recommended program to boost member nations' capacity in these areas (Orhan, 2019). The COMCEC Strategy, which consists of two primary instruments, was approved by the President of Türkiye, who serves as the organization's permanent chair, at the OIC Extraordinary Summit in Mecca on August 14–15, 2012. The creation of working groups to encourage cooperation on six priority issues, such as trade, transportation and communication, tourism, agriculture, poverty alleviation, and finance; and the promotion of project-based activities (Project Cycle Management/PCM) that are anticipated to support the success of COMCEC cooperation in the six working groups (Cheterian, 2015).

SESRIC was established to support the efforts of 57 state member countries in the field of

agriculture and food security, targeting socio-economic research, statistics, education and capacity building mandates. As a result of Resolution No. 2/8-E, which was adopted by the 8th Islamic Conference of Foreign Ministers (ICFM), which was held in Tripoli/Libya in 1977, the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC) was established as a subsidiary organ of the Organization of Islamic Cooperation (OIC). In Ankara/Türkiye, the Center first began operations in 1978.

1.1.1. Agricultural effects on Türkiye

Türkiye features a range of climatic types due to its location in the temperate zone and to considerable physical and ecological changes across short distances. The average yearly temperature varies between 18 and 20 degrees Celsius on the south coast, 14 to 15 degrees Celsius on the west beaches, and 4 to 18 degrees Celsius depending on height in the interior. The months of July and August record the highest temperatures. On the Mediterranean and Aegean coasts, the average temperature over these two months is 27° C; on the Marmara and Black Sea coasts, it is 22–24° C. The country's interior also experiences scorching summers. The summers are cooler in the northeast and on the east Anatolian plateau. In the winter, there are noticeable temperature differences between the shore and the interior. Despite being close to the sea, the Black Sea shores get more rain than the west and south coasts. In contrast to the interior and eastern parts of the country, these areas have higher summertime humidity levels (FAO, 2021; SESRIC, 2022a).

Türkiye's overall land area is used for agriculture to the degree of one third (Giray, 2012). As of 2020, of 23.1 million hectares of agricultural land, 15.6 million hectares are planted, 3.2 million hectares are fallow, 779 thousand hectares are cultivated vegetables and 3.6 million hectares are reserved for fruit, olive trees and viticulture (FAOSTAT, 2021a). With roughly a quarter of the population working in agriculture, Türkiye has one of the top ten agricultural economies in the world. Half of the country is made up of agricultural land. Türkiye is a significant producer of wheat, sugar beets, cotton, and fruits (cherry, apple) and vegetables (tomato, pepper) (FAOSTAT, 2021a). In Türkiye the Turkish agriculture industry was dominated by the state until the 1980s. Privatization and liberalization led to important results for Türkiye's agriculture, especially after 1990, after several legislative proposals, including the agriculture and seed law, aimed at accelerating the privatization process of Türkiye. In particular, the significant reduction in

government support has caused millions of farmers to leave agriculture and migrate to urban areas (Aydın, 2010). Agriculture, which accounted for 54.9% of the gross national product in 1960, accounts for 5.6% by 2021. However, the increase in both yield and quality, especially with the development of hybrid seeds, has affected the price of agricultural products taken from the unit area.

Data from the World Bank for the year 2021 show that its value-added agricultural output rose from \$27.5 billion in 2000 to \$46.04 billion in 2021 (in current prices). The indicator underwent a considerable decline from 2011 to 2018 before hitting a peak of \$69.7 billion in 2015. Agriculture's value contributed in the nation has increased over time, from \$40.9 billion in 2000 to \$66.3 billion in 2021, at constant 2010 prices. Agriculture continues to be an important export income source for Türkiye today.

Türkiye is an important agricultural country. Global restrictions and difficulties discussed all over the world also concern Türkiye. Its experienced price-related issues for all crops and livestock during COVID-19, despite its plentiful resources and favorable climate. The key issues have been accessing to both internal and external input and output markets, a scarcity of temporary workers, shifting marketing channels, and customer attitudes. The majority of agricultural producing activities in Türkiye are carried out in rural areas. Although precautions were taken, people living in rural areas were more at risk than those living in urban areas. In addition to the health risks, the difference in socioeconomic conditions in rural and urban environments and the problem of finding workers have become more evident.

The period of the emergence of COVID-19 especially in Türkiye was the sowing time for products such as vegetable seeds and seedlings, corn, cotton, sunflower, for seedlings planting time, fertilization, spraying and maintenance time period. In this period, the need for seasonal workers was higher than in all months. Despite the fact that Türkiye has the same framework as the whole world, a different reality has been experienced during the COVID-19 period due to seasonal labor characteristics. With the outbreak of the Syrian war and the migrations, there has been an increase in foreign labor force, especially in seasonal workers in Türkiye. According to estimates in Türkiye the number of seasonal agricultural workers is around 1 million. Approximately 60% of seasonal labor in Türkiye consists of migrant and refugee workers (Akçıl and Bayramoğlu 2022). The entire family, including women and teenagers, would frequently work in Türkiye, where many migrants

were housed in tents on agricultural land. In addition to migrant and refugee workers, seasonal workers from the Southeast Anatolian region worked seasonally in 50 provinces, especially during a 5-month period from April to September (Support to life 2020).

In this period, serious measures were taken with the thought that the transportation of the workers would increase the risks of accommodation. Even with the particular authorization granted to farmers and farm laborers, numerous urgent tasks like harvesting, sowing, or planting seedlings were hampered in different areas. Fresh weekly markets for fruit and vegetables had slowed down as a result of the lockdowns; small farmers in peri-urban areas were severely impacted in terms of market access. In Türkiye, all horticultural products aside from those sold directly by small farms must be distributed through municipal wholesale markets. In the wholesale markets, demand for fruits and vegetables is currently relatively low. Chain supermarkets as well as smaller grocery stores and greengrocers had seen a growth in online sales. Agriculture-related exports did not exhibit a negative growth rate. Agriculture products did not exhibit negative growth rate swings in exports, particularly in 2020 (Ay 2021). In the January-April 2020 period in Türkiye, overall compared to the same period of the previous year in export hazelnuts with the highest increase of 32.6 percent has been in its products (Timreport, 2020).

1.1.2. Agricultural effects on Azerbaijan

The climate in different regions of Azerbaijan ranges from dry to humid "subtropical." The lower mountains and foothills receive enough precipitation, between 500 and 800 mm, to maintain enough moisture. In the southwest, where the Talish Mountains and the Caspian Sea have an impact on the weather, there are frequent heavy downpours. In this area, annual precipitation amounts can reach 1,500 mm. In Azerbaijan, nine of the world's eleven climatic types exist. Summers are scorchingly hot, dry, and sunny. The temperature ranges at Absheron are 23.4–25°C. While it's scorching on the plains, summer in the Lankaran zone's mountains is chilly. The Kur-Araz lowland, where temperatures vary from 24.8 to 26.5°C, is the hottest region (FAOSTAT, 2021b; Country reports, 2022).

In Azerbaijan, ninety percent of the 1.585.400 acres of landscaped land can be irrigated. (Aksoy et al 2018). The socioeconomic significance of agriculture makes it one of the most significant industries in Azerbaijan. Due to the variety of the country's conditions, crops can be grown anywhere from subtropical to cool or temperate climates (Niftiyev, 2020). Azerbaijan's extraordinary soil variety and climatic circumstances support a very wide range of plant genetic resources. There have been more than 4500 higher plants recorded here, 237 of which are indigenous. The majority of the crops grown in this country are cereals (wheat, cotton barley, rye, oat, etc.), grain-legumes (chickpea, lentil, vetch, bean, etc.), vegetables (tomato, eggplant, watermelon, melon, pumpkin, etc.), leguminous and forage crops (alfalfa, sainfoin, etc.) and fruits (apple, pear, apricot, bush) (Anonymous 2006). Azerbaijan currently exports 30 different kinds of plant foods and foodstuffs to 85 different nations (Aliyeva, 2020). While agriculture constituted 26.5% of the gross national product in 1990, this rate is seen as 5.9% in 2021. The value-added agricultural output increased approximately from \$845.000 in 2000 to \$2.88 billion in 2021, according to data from the World Bank (at today's prices). The growth of the agriculture sector depends heavily on financial support. Additionally, farmers in Azerbaijan are now eligible for low-interest loans alongside business owners in other industries (Humbatova and Hajiyev, 2020).

Azerbaijan, similar to other countries, the COVID-19 outbreak has seriously affected agricultural trade and has had negative effects on the economy. Lockdowns and restrictions on people's freedom of movement slowed down the flow of products both locally and internationally. These effects have been felt extensively, especially by Azerbaijani agricultural and horticultural industries. Agriculture employs over 36% of Azerbaijan's workforce, primarily on small farms (SSCRA, 2020a). As in other countries, the curfew in Azerbaijan, especially at the beginning of the pandemic, prevented small farmers from going to the field. According to latest data from Azerbaijan, the agricultural sector had growth in 2020 at a rate of 2%, which is 3.5 times less than the analytical indicator from the prior year (7,2%). The agricultural sector's output in actual dollars was \$4,9 billion, which is 2% more than the analogical indicator for 2019 (4,6 billion USD). However, this difference resulted from the increase in the international dollar exchange rate and the international crisis. The agricultural sector's development rate did not enter the negative territory but has slowed compared to the prior year, according to data from the State Statistics Committee of the Republic of Azerbaijan on the results of 2020 (SSCRA, 2020 b). Despite this, the production of all agricultural products except corn, sunflower and cottons increased in 2020. The continuation of agricultural production's low growth rate demonstrates that the pandemic's effects did not have the predicted

impact on it. According to survey study in Azerbaijan, more than 70% of exporters stated that other than the tomato import embargo imposed by Russia on Azerbaijan, the epidemic had no negative consequences. The Turkish-Russian tomato problem, which is putting pressure on the Russian government, may be connected to these upward tendencies. Contrary to tomatoes, cotton export varies somewhat between the pre-pandemic and post-pandemic eras. In particular, cotton exports fell sharply to 15,8 million USD in the second quarter of 2020 (Sabina İzzat, 2022).

1.1.3. Agricultural effects on Malaysia

Malaysia essentially experiences tropical weather without the excessive heat. The nights in Malaysia are generally chilly, however humidity is a regular element. The typical temperature throughout the year is between 20°C and 30°C. On the east coast, November through February is the primary rainy season, whereas August is the wettest month on the west coast. From November through February, East Malaysia experiences significant rains (SESRIC, 2022b).

Agriculture has always been highly valued in Malaysia because, like all over the world, feeding people is paramount. Rice, palm oil, rubber and cacao are the major products for Malaysia. However, in recent years the proportion of rubber has decreased significantly, reaching only 2.08% in 2021. In addition to paddy cultivation, the cultivation of cereals, fruits and vegetables is one of the important agricultural activities of Malaysia. According to data from the World Bank, agriculture would account for 9.6% of the GNP by 2021, down from its 1960 level of 43.7%. As of 2020, there are 8.58 million hectares of agricultural land in Malaysia (FAOSTAT, 2021c). In the last five years, the contribution of vegetable production to Malaysia's agricultural sector has come to the fore even more. Vegetable production in Malaysia accounted for 12.4% of all agricultural output in 2020 (FAOSTAT, 2021c). 50 kinds of vegetables are grown on 56 thousand hectares of land and the most grown vegetable in Malaysia is a large leafy vegetable called *Brassica* spp (Sawi). The second largest species is Kangkung, followed by cucumber, watermelon, tomato and pepper. Other vegetables grown; long bean, eggplant, loofa, and pumpkin. The largest production in 2021 belongs to tomatoes (206,000 tons), followed by leaf mustard (154,000 tons), cucumbers (109,000 tons), cabbage (86,000 tons) and okra (62,000 tons) (MAFI, 2021). Among the ASEAN nations, Malaysia is one of the leading producers of grain (Xiang and Solaymani, 2022). Malaysia produced 2.39 million metric tons of cereal in 2020. According to FAO statistics, fruit production is carried out on

an area of 85,218 hectares. Due to its tropical climate, Malaysia is an ideal country for growing tropical fruits. The main fruit species grown are durian, banana and rambutan. Malaysia also produces papaya, jack fruit, star fruit, mangosteen and guava. Despite the increasing in total production, the supply by local producers cannot meet the demand. As a result, Malaysia imports nearly all varieties of agricultural goods. In 2020, Malaysia imported more than 13.77 billion agro-food items (Dardak, 2022).

Malaysia's agricultural and food security have been seriously affected by COVID-19. In 2018, 2.062,7 thousand people were working in agriculture sector in Malaysia and male workers made up 77.7% (1.220,6 thousand) of the total. According to Department of Statistics in Malaysia (FAO, 2020b), the biggest percentage of workers who lost their jobs due to the COVID-19 pandemic (21.9%) were employed in the agricultural industry. This comprises rubber, forestry, fisheries, oil palm, and livestock. As a result, it will have a significant impact on employment in the agricultural sector while also lowering productivity due to a lack of labor (DOSM, 2020). Also, Malaysia's agricultural sector is heavily dependent on foreign workers. Limitations mobility of people has especially affected foreign workers and caused labor shortages (Vaghefi, 2020). Closed roads and transportation limitations have hindered agricultural service, made it difficult for farmers, particularly smallholders, to sell their goods or purchase inputs, which has resulted in lost production and lost income. Especially perishable and fresh foods such as vegetables were more affected, causing levels to rise. For this purpose, a survey was conducted among farmers from various states of Malaysia. In that study was conducted with 217 small farmers. As a result of the study, the majority of the respondents (80%) stated that COVID-19 has affected agriculture. The majority of responders (67.7%) indicated that COVID 19 had the greatest impact on agriculture, followed by aquaculture (20.7%) and livestock (11.5%) (Rashidi, et al., 2021). In another study conducted in Penang, daily fruit and vegetable production values were examined between 19-31 March 2020. As a result of the study, vegetables and fruits production in Penang dropped at an average daily rate of 3% and 1.3%, respectively (Vaghefi, 2020).

1.1.4. Agricultural effects on Morocco

Morocco is the most northwest-facing country in the world, extending from the Mediterranean Sea and Atlantic Ocean in its north and west, respectively, through considerable hilly terrain in its interior, and ending with the Sahara Desert in its far south. The Mediterranean climate predominates in Morocco, where the cool season is dry and the rainy season occurs. The climatic conditions are highly varied, nonetheless, as a result of its latitudinal location. In fact, because of its richness, it was perfect for the Mediterranean's bioclimatic classification. In coastal regions near the Atlantic Ocean and the Mediterranean Sea, extreme temperatures are reduced, resulting in bioclimate sub-types of mild and moderate winters (SESRIC, 2022c).

Nearly 13% of Morocco's GDP comes from agriculture, which also employs 31% of the country's workforce when coupled with the fisheries and forestry industries. It has a disproportionately large impact on the economy because of the very variable grain production based on rain irrigation, its employment value, and its importance as a key export sector. Amounting to around \$3.24 billion USD as of 2021, the value contributed of agriculture in Morocco was 31.61 billion Moroccan dirhams (MAD) (Trade data, 2022). As of 2020, there are 9 million hectares of agricultural land in Morocco, 18% of which is irrigated. 5 million ha of cereals, 1 million ha of olive tree, nearly 400.000 ha for fresh legumes, nearly 260.000 ha of vegetables, 125.000 ha of citrus, 341.000 ha of fruit trees, and 69. 000 ha of sugar crops land area is devoted to agriculture.

Cereals are the most important crop occupies 60% of the agricultural area and, in Morocco, wheat is an important cereal crop that significantly contributes to the national economy. Morocco has also become one of the highest wheat-consuming countries in the world (about 255 kg/year per capita) three times more than the world average (FAOSTAT, 2021d). Morocco is now the world's fifteenth-largest fruit exporter in terms of value. Morocco's fruit exports more than doubled from \$729 million to more than \$1.5 billion between 2016 and 2021, making up more than a third of all agricultural exports in that year The most grown and exported fruits are Blueberries, raspberries, strawberries, orange, mandarin, avocados (USDA, 2022). Tomatoes, potatoes, eggplant, onions, zucchini, carrots, and pumpkin are common vegetables mostly grown in Morocco. The majority of agricultural inputs are imported into Morocco, including soilless farming medium, plant and animal health products, vegetable seeds, and many other vital components for domestic and international agricultural output (Lahlali et. al., 2022).

Similar circumstances saw in Morocco, where tiny farms account for 70% of all landholdings (Verner et al., 2018). At the end of March 2020, when the lockdown began, small-scale farmers began having trouble selling their produce. According to the Leonardelli et al (2021) farmers in that country are heavily dependent on local intermediaries and purchasers because watermelons are primarily produced for the domestic and foreign markets. The young local watermelon farmers had harvested their produce in April (2020), just weeks after the lockdown started. Several weeks after the lockdown began, in April (2020), the neighborhood's watermelon farmers had already gathered their crops. They stated that since there were no buyers in this period, most of the watermelons rotted without being sold, and the remaining ones were sold at very low prices. Another aspect from COVID-19, the majority of agricultural inputs are imported into Morocco, including soilless farming medium, plant and animal health products, vegetable seeds, and many other vital components for domestic and international agricultural output. In this period, with the decrease in imports, the exported products were either not found or their prices increased excessively (Brouziyne 2021).

In 2020 growing season also had a drought for all agricultural crops in Morocco. The agriculture industry began in 2020 under the danger of drought and with 85,000 fewer jobs than in 2019. The impact of the drought, along with COVID-19, has directly affected the production of grain and other agricultural products, threatening employment in rural areas, the vast majority of which are informal (Lahlali et al 2022). Bossenbroek and Ftouhi (2020) reported that the pandemic had a major impact on the marketing of dates, a crucial component of the economy of several oases like the Fezouata area, and that this impact was particularly severe. During the month of Ramadan, these were kept in order to be sold for a high price. The closure of the domestic markets has decreased demand, and the administrative restrictions placed on the movement of the items have unfortunately limited their ability to be transported.

1.1.5. Agricultural effects on Pakistan

Pakistan has 212 million people, making it the sixth most populous country in the world. 136 million people, or around 64% of the population, reside in rural areas. Pakistan has a well-integrated agriculture sector and a semi-industrialized economy. 22.1 million hectares of the 79.6 million hectares of land are cultivated; the remaining land is made up of culturable waste, densely inhabited forests, and rangelands. 23.3 million hectares of the total land area are used for agriculture, and 4.6 million hectares are covered by forests. Nearly 80% of the country's arable land is irrigated, making it the largest contiguous irrigation system in the world (SESRIC, 2022d). Among addition to producing rice in the top ten countries in the world, Pakistan is also a top ten producer of wheat, cotton, sugarcane, mango, dates, and kinnow oranges. Major crops like wheat, rice, cotton, and sugar cane make up about 4% of the total (PBS, 2022). In Pakistan, more than 35 different types of vegetables are cultivated in various ecosystems. In order to satisfy consumer demand throughout the country, vegetables produced in various zones utilizing various production technologies throughout various seasons are traded among regional marketplaces in Pakistan. Tomato, pepper, eggplant, potato, cucumber, gourds, beans, okra, cauliflower, cabbage, lettuce, spinach, onion, carrot, radish, turnip, coriander, fenugreek and peas are most grown in that country (Khokhar, 2014). In Pakistan, the value added by agriculture, forestry, and fishery as a percentage of GDP was reported to be 22.96% in 2021 by the World Bank's collection of development indicators (Anonymous 2021).

The Government of Pakistan implemented a countrywide lockdown as a result of COVID-19. According to the COVID-19 outbreak, Pakistan's GDP growth was predicted to be 3.2% for 2019–2020 and 2.9% for the agriculture sector (Economic Adviser's Wing 2020). However, the COVID-19 epidemic negatively impacted and slowed Pakistan's economy. Additionally, Pakistan faced one of the worst locust attacks in early 2020, the worst since 1993, which increased risks and losses in the agricultural sector (FAO 2020a, FAO 2020b). A countrywide lockdown to stop the coronavirus's spread has had an impact on rural areas' agricultural and supply chains. In 2020, 94% of Moroccan farmers who raised tomatoes had trouble selling their harvest or were unable to sell it at all. This ratio fell to 69% in 2021. Two-thirds of farmers in 2020 and roughly half in 2021 mowed their tomato crop as green manure without fully harvesting it due to marketing challenges and low pricing. Other high-value items, such as fruits, and vegetables, continued to have marketing challenges in 2021 (ADB 2021). Also, wheat crop in March 2020 was ready but because of corona

isolation in the country, no workers to work harvest while the government locks people in their homes. Also due to unexpected rains Punjab and Sindh, the farmer's entire year's labor is at stake (Khan, 2020). The other important crop mango harvested time. The main concern that year was the absence of workers to harvest the ripe fruit. Another issue was the limited means of transportation. For transferring harvested products to retail markets restrictions affected transportation, and many mangoes were left on the tree with labor and lack of transportation. The temporary suspension of international trade had an effect on the export market as well (Rasheed 2021).

1.1.6. Agriculture effect on SESRIC countries

Millions of people, particularly those living in rural regions, depend on the agriculture sector for their livelihood, which has continued to play a significant role in the social and economic growth of OIC member countries. OIC group member nations make up a sizeable portion of the world's agricultural output and are incredibly well-endowed with agricultural resources like water, arable land, and human resources. Half of the OIC members are among the top 20 producers of important agricultural commodities globally. Furthermore, in 36 OIC member nations, the agriculture industry employs more than 20% of the workforce. The total arable land of OIC countries constitutes 22.7% of the world's arable land. Agricultural production has increased in OIC member countries over the last decade. The gross agricultural production has increased by 16% since 2015, stronger than the global average of 7% (SESRIC 2021). However, despite this great development and enormous potential, the OIC member states' agricultural productivity is inadequate to support the increasing population. Additionally, several OIC member countries are currently facing multiple challenges to food security, including internal wars, pest/locust outbreaks, extreme weather, population displacement, and last but not least, the COVID-19 outbreak (SESRIC 2020). According to SESRIC statistics, that the undernourished population in the countries of the Organization of Islamic Cooperation fell from 14.2% in 2001 to a record low of 8.3% in 2018. But the COVID-19 pandemic has reversed this important progress. After 2018, the population struggling with hunger continues to increase, reaching 9.5% in 2020, resulting in 28.5 million more malnourished people. In 2020, 180 million people were struggling with hunger in OIC countries, representing 26% of the world's population hunger.

Depending on the degree of exposure to both production and consumption, the country's agricultural security threats may vary. Schmidhuber (2020) assert that demand-side exposure poses a greater danger for emerging nations as a whole. Demand-side effects occur when people cannot afford food due to reduced incomes or loss of income. People who lost income were forced to change their diets and/or sell their assets in order to survive. On the supply side, shocks to production factors caused prices to go up, which in turn led to less agriculture and food products being available. This indicates that, rather than the production side, the route of transmissions of the COVID-19 affects is more vulnerable when taking into account OIC countries' consumption sides. COVID-19 has also disturbed both demand and supply of food and agriculture products owing to shock on logistics and trade.

2. COVID-19 OUTBREAK ON THE SEED RESILIENCE IN THE SEED SECTOR

Until the seed studies and efforts of the United States and some European countries led to the production of higher quality seed and the introduction of seed quality standards, giving seed a commercial value from the 19th century onward, farm saved seeds were used as seed for the following cultivation for centuries. Most countries see the seed industry as a strategic and national issue. Farmers have a choice of three types of seed: farm-saved seed, seed purchased from public plant breeding, or seed purchased from the commercial sector (Heisey and Fuglie, 2011).

The market is expanding as a result of rising demand for seeds from the food, beverage, animal feed, and biofuel industries. FAO noted that out of the 7000 species that have historically been consumed as food, it concentrated on 30 goods to provide 90% of the calories needed by humans (FAO, 1997). 50% of the calories were given by just wheat, rice, and corn (FAO, 1997). In the global seed business, a few crop kinds are disproportionately significant. Almost half of the world's seed output is currently made up of grains like rice, wheat, and maize (IMARC, 2019). Currently, it is estimated that the worth of all seeds produced worldwide is at \$63 billion. Ranking first (\$12 billion), the United States is followed by China (\$10 billion), France (\$2.8 billion), Brazil (\$2.1 billion), and Canada (\$2 billion). With a \$0.75 billion manufacturing value, Türkiye comes in at number 11 (TURKTOB, 2022). However, other COMCEC countries are not included in this group.

When the data on the volume and value of seed exports and imports are examined, Global seed exports totaled 7.26 million metric tons (MT) in 2020, which is equivalent to USD 15.85 billion. With approximately 1.137.280 metric tons (MT) (about 8 % of the total seed export) in 2020, Netherlands shipped the most seeds globally, followed by the France, USA Poland, and Canada (Table 1). When researched to COMCEC members specified in the project, Türkiye exported the highest volume of seeds worldwide in 2020 at over 35.522 metric tons, followed by the Pakistan (5.148 MT) and then the Morocco, Malaysia. According to ISF statistics, there is no seed export data for the Azerbaijan government in 2020 (ISF 2020).

Global seed imports totaled 7.5 million metric tons in 2020, which is equivalent to USD 14.9 billion (ISF, 2020). Belgium is the top seed importer in terms of volume, accounting for more than 1.427.4360 MT or 19.02 % of all seed imports in 2020. Italy ranks second with 829,589 MT and the Netherlands ranks third in seed imports with 726.770 metric tons (Table 2). Due to the presence of numerous international seed trading companies in these three nations, the imported seeds are frequently sold to other nations. The amount of seeds for field crops is significantly more than that for other crops (vegetable, flower, potato and tree).

Table 1. Top five seed exporting countries in the world and in reporting COMCEC countries in 2020

VOLUME				VALUE			
World	Metric tons	COMCEC countries	Metric tons	World	Million USD	COMCEC countries	Million USD
Netherlands	1.137.280	Türkiye	35.522	Netherlands	3.193	Türkiye	90
France	820.819	Pakistan	5.148	France	2.293	Pakistan	1
USA	530.201	Morocco	2.911	USA	1.846	Morocco	6
Poland	520.349	Malaysia	136	Poland	341	Malaysia	1
Canada	349.452	Azerbaijan	n.a	Canada	309	Azerbaijan	n.a
Belgium	314.318			Belgium	287		

n.a: information non-available

Spain and Germany are in the 4th and 5th places, respectively, in seed imports. In COMCEC, Morocco imports the largest amount of seed, with over 52.000 MT, followed by Azerbaijan with 52.711 MT and Türkiye with 51.708 MT. In terms of imports, Pakistan and Malaysia rank 4th and 5th, respectively (Table 2). The fact that it is high in terms of tons and low in terms of price is mainly

due to the fact that Belgium prefers field crops seeds, while the other 5 countries are mostly importing hybrid vegetable seeds.

Table 2. Top five seed importing countries in the world and in reporting COMCEC countries in 2020

VOLUME				VALUE			
World	Metric	COMCEC	Metric	World	Million	COMCEC	Million
	tons	countries	tons		USD	countries	USD
Belgium	1.427.438	Morocco	64.749	Belgium	567	Morocco	117
Italy	829.589	Azerbaijan	52.711	Italy	785	Azerbaijan	33
Netherlands	726.770	Türkiye	51.708	Netherlands	1.332	Türkiye	195
Spain	5201.408	Pakistan	39.853	Spain	670	Pakistan	109
Germany	485.225	Malaysia	12.169	Germany	1.031	Malaysia	66
Poland	274.855			Poland	401		

With the increasing population, the global demand for food also increases. The development of demand and therefore trade, especially in developing countries, is of great importance for the seed industry. Because seeds are in high demand on the global market. The main reasons for this are the increasing farming areas of commercial production (compared to traditional production), the increase in the costs of agricultural inputs and the decrease in the rate of arable land. However, a number of factors, including globalization, the successful application of gene editing technology to different crops, the rise in demand for vegetable seeds for home gardening due to the coronavirus pandemic, the demand for organic vegetables, the increased awareness of consumer health, and the emergence of numerous new trends in this industry have all contributed to this situation (Market Research Report, 2021).

Before reaching the customers, the seeds' production route may pass through several nations. An overview of the numerous steps in the production process is provided in Table 3, which is quite similar for the majority of seed businesses, whether they are based in Malaysia, elsewhere in Asia, or somewhere else in the world. This procedure's several steps can all occur in various nations. The prime breeders for that crop are frequently located in one or more of the nations where genetic diversity is generated and parental material is crossed. Then, for a number of years, the offspring are chosen in numerous nations with various weather, climatic, and soil characteristics, taking into account the ideal circumstances for agriculture to find the candidate kinds that fit each location's

climate, soil, and weather the best. In order to expedite the selecting process, many seed firms produce. Many seed producers use counter-seasonal production, which enables at least two generations to be generated year, to accelerate the selection process by generating in the other hemisphere (Hein, 2020). The main nations for this counter-season production include Chile, Argentina, Australia, South Africa, New Zealand, and Peru, due to the fact that many seed companies are located in the Northern Hemisphere. The transnational character of the seed production chain is shaped in part by counter-seasonal production.

Globally, COVID-19 has brought forth new difficulties for everyone, especially smallholder farmers and their seed systems. Therefore, a top objective for crisis response is to strengthen the resilience of seed and smallholder farming systems (Francis 2016). Seed systems are complex and interventions requires a strategy rather than a temporary measure. Seed breeding and development takes seasons. This situation continues for many seasons and requires a lot of labor. Plant breeding and the seed industry create new and improved varieties as the foundation for the seed supply. The breeding industry has to deal with the COVID-19 catastrophe, just like every other industry on the globe and negative impact on agricultural breeding programs. The first one that will have an effect in 2020: Field sample collection and laboratory work have been put off for a few months because nearly everyone save for vital activities, such as hospitals, the food sector, and security, were on hold. As a result, many research projects that were scheduled for 2020 and for which sampling was a crucial activity will be postponed. For cereals and vegetable breeding are substantially more important in the second type of influence. There is undoubtedly a lack of funding for research into other species, like agriculture, as the need for monies for human health has risen in all countries (Davis, 2021).

Table 3. The seed production chain involves many steps

Main step	Detailed step	Explanation
Plant breeding	Plant breeding methods	Creation of new variation
	Selection of offspring	Multi-locational trials to select for local adaptation
	Fixation of characteristics	Ensuring homogeneity
	Company and Official trials	Assessment for distinctness, uniformity, stability and performance
Seed production	Sowing of seed production	Once all official trials are passed, seed production can start
	Good Seed Production Practices	Good agriculture practice on the seed producing field Implementation of the seed production method required by the variety (e.g. crossing of parent lines in case of hybrid)
	Field inspection	Control of the field to ensure genetic integrity and health of the seed
	Fresh seed from field	Seed from the field may come with impurities, e.g. branches, stones, dust
Seed processing	Moisture testing	Too much moisture reduces viability of the seeds
	Drying	Most seeds come out of the field with too high moisture content
	Pre cleaning	Removes larger impurities
	Fine cleaning	Removes all remaining impurities
	Grading (gravity separation)	Ensures all seed are more or less of the same size and weight
	Seed treatment	Improves seed quality, protects the seed against pests and diseases and ensure good start during germination
Seed distribution	Sale to farmer/grower	Guarantees high quality production with high quality seed (good germination and varietal purity)

Note: Each of these steps can occur in a different country (OECD,2021a)

However, ensuring global food access depends on the seed trade. For every planting season, all farmers require high-quality seeds. Because seeds are essential to food security, they are a fundamental component of all crop production (Louwaars and Manicad, 2022). Modern agriculture is becoming strong largely through the combination of high-quality seeds. The majority of annual crops are started from seeds each season, and seed quality can have a significant impact on crop production potential. This production process of high-quality seed is a very delicate activity that

involves many steps to preserve it. These activities include sowing seeds on clean ground, making sure the seeds are planted correctly, identifying them, and keeping a safe sufficient isolation between them (UC Davis, 2020).

Examining COVID-19's effects on the world's seed supply chain, the majority of nations deemed the food and agricultural industries "vital", ensuring the free flow of agro-food products (including seeds) and enabling workers in these industries to maintain their jobs. However, several Asian countries did not guarantee free mobility in the agro-food sector during the pandemic's early months (APSA, 2020). Additionally, travel limitations in other industries had an indirect impact on the agro-food (seed) industry (OECD, 2020). There was little agreement in national rules, seed businesses had to modify their operations to comply with varied national laws. Such laws frequently changed day by day during the pandemic's early stages, making it challenging to plan seed shipments appropriately. There were restrictions on air and land travel, several airports were shut down, and seed shipments had to be transferred through one of the few airports that was still operational (Sun et al, 2020). Due to this, it was challenging to deliver seed to clients or farmers on time.

Companies and seed groups have reported that travel restrictions for seasonal employees and delays in the supply chains for agricultural inputs have impacted seed production and harvest in important areas (Erhie, Nevin and Osinubi, 2020). Due to fewer commercial flights, air travel became more expensive (APSA and WorldVeg, 2020), which had an impact on the seed supply chain's cost and timely delivery of seed. Due to tougher sanitary and public health regulations, a decrease in border employees, and other factors, shipping goods across borders also grew more expensive and time-consuming. Additionally, the restricted mobility of individuals hindered a number of processes, including production, trade, transit, documentation, and sales. Such restrictions on the production, transportation and marketing of seed have increased seed prices and their effects are being felt today. These rising prices mean the affordability of seed is reduced in the near future to many farmers throughout world especially developing country farmers.

Seed is a re-producible input that enables smallholder farmers to continuously produce food and earn money. 40 kilograms of product is obtained from one kilogram of wheat germ. At the same time one kilogram of sorghum seed can produce 100 kilograms of food, making seed an excellent investment. Governments, donors, and other investors should support policies that prioritize seed

since it is a crucial good. To ensure that the proper seeds are accessible when they are needed, continuing support for researchers, farmers, extension personnel, etc. must be provided by seed system investments that actually contribute to seed system health. This outcome does not come from a one-time crisis effort. While the initial COVID-19 period may place immediate emphasis on supporting human health systems, the early recovery and sustained development phases should provide top focus to seed systems.

3. SEED RESILIENCE IN COMCEC COUNTRIES' SEED INDUSTRY DURING COVID-19

Global food security depends on the seed commerce. COVID-19 has raised worries that seed supply chains will be interrupted and that nations that rely on imported seed won't have enough for the upcoming season. Despite the fact that seed companies in the Asia Pacific region were more negatively affected by the crisis, COVID-19 showed that the global seed industry was more resilient than other industries during the crisis. However, the seed supply chain would likely have been impacted if the restrictive measures had been applied to combat the COVID-19 epidemic for a longer length of time. First, it might be harder to guarantee a future supply of high-quality seed. In order to ensure the resilience of the restrictions on agro-food residues in the seed sector against crises and threats like COVID-19, a series of measures have been taken in the COMCEC Countries (Azerbaijan, Morocco, Pakistan, Türkiye and Malaysia) for the use of effective and continuous seed management. These measures will be explained in detail below.

3.1. Azerbaijan seed sector

Azerbaijan, which has one of the oldest agricultural traditions in the world, aims to develop seed production in the country. Currently, foreign seeds are the only source of agriculture in Azerbaijan. Numerous seeds are created by European businesses, and these seeds are not weather-adapted for the region. Although most of the seeds are imported from abroad, especially grain seed production in Azerbaijan is increasing day by day. For this purpose, it was published as Seed Act No. 257-IQ of the Republic of Azerbaijan in 2007. This law aims to increase seed production and improve seed quality. It establishes the basic rules and procedures regarding intensification of seed production, production of climate resistant seeds, plant health and pests. It also regulates provisions on plant

genetic resources, seed certification and registration of plant varieties. The law also regulates the provisions regarding seed boxes and other public services, their organizational structure, powers and functions. It also regulates the general principles regarding domestic and foreign trade, preservation and quarantine, and the responsibilities of real and legal persons engaged in seed production and trade.

Studies on the development of seed production, the varieties that are bred in Türkiye and which will adapt to the ecological conditions in Azerbaijan, have been continuing since 1992. The activities carried out since 1995 for the development of certified seed production in Azerbaijan are carried out through an institutional structure, and it is aimed to continue the activities of Turkish and Azerbaijani origin. In 2001, the Azerbaijan Seed and Research Institute was established in the Khachmaz region in order to try and improve the cultivars and to produce suitable cultivars. As a result of the seed work carried out in this center, a 25-30% increase in product productivity has been achieved. 500-600 tons of wheat seeds are sent by TIKa in Türkiye and these seeds are planted. Pre-basic and basic seeds are produced in Azerbaijan and distributed to farmers. This rate meets about 20% of the country's need.

Currently, initial grain seed production is carried out at the regional branches of the Research Institute of Crop Husbandry ("Tartar", "Gobustan", "Jalilabad", "Zagatala", "Sheki") and the Azerbaijan-Türkiye Seed Breeding and Research Farming Joint Enterprise on an average area of 1000 hectares. According to the State Statistical Committee of the Republic of Azerbaijan, basic seed production for 2022 is 17 tons, including wheat 15 tons, barley is 2 tons. In super pre-basic seed certification growing 173 tons, including 155 tons of wheat and 18 tons of barley. Pre-basic seed production in seed production was 1300 tons, including 1000 tons of wheat and 300 tons of barley (ASTAT, 2022).

In Azerbaijan, vegetable seed is available locally and is also imported from foreign seed businesses. There are several well-known seed businesses operating in Azerbaijan, including: Esi Group, Gilan Holding, Oguz, Organik LLC (Azerbaijan), Rijk Zwaan, Enza Zaden, Bejo, Monsanto, and Syngenta. Additionally, local seed is being improved because some domestic consumers prefer the standard flavor of regional variants. When growing vegetables for the high-end domestic and international markets, the greenhouse industry depends on high-quality seeds or planting materials (Ruijs, 2017). In 2021 statistics from Azerbaijan, the most grown vegetable type was tomato in open fields

and greenhouses. It was followed by cucumber, eggplant and cabbage. In the vegetable seed sector, open pollinated seed is grown too much, but especially tomato hybrid seeds have been used in recent years.

As of 2022, there were 246 registered varieties in Azerbaijan. Compared to 2015, the number of registered cultivars has increased approximately 12 times in the last seven years (Figure 1).

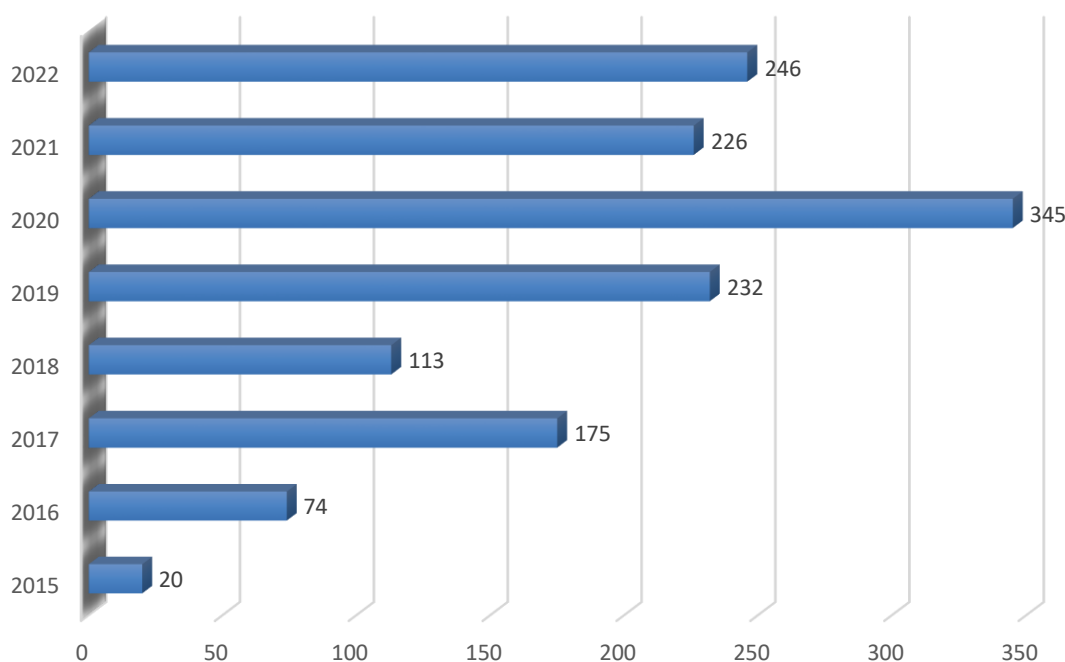


Figure 1. The number of varieties registered on the basis of years

Azerbaijan signed the Plant Variety Protection (PVP) Law (No. 98) in 2004 and it went into effect the following year. In the same year, Azerbaijan received approval from the Parliament to join UPOV as its 58th member.

3.1.1. Seed resilience in the Azerbaijani seed industry during COVID-19

Following the announcement of Azerbaijan's first COVID-19 quarantine regime on March 24, 2020, the following steps were taken to further simplify things. In the days of the pandemic, in connection with the planting season, mobile services were conducted in the regions in order to provide the

seed demand of farmers and farm owners at affordable prices. Mobile services were provided in the villages and towns of the country for different groups every day based on the requests received (Figure 2).

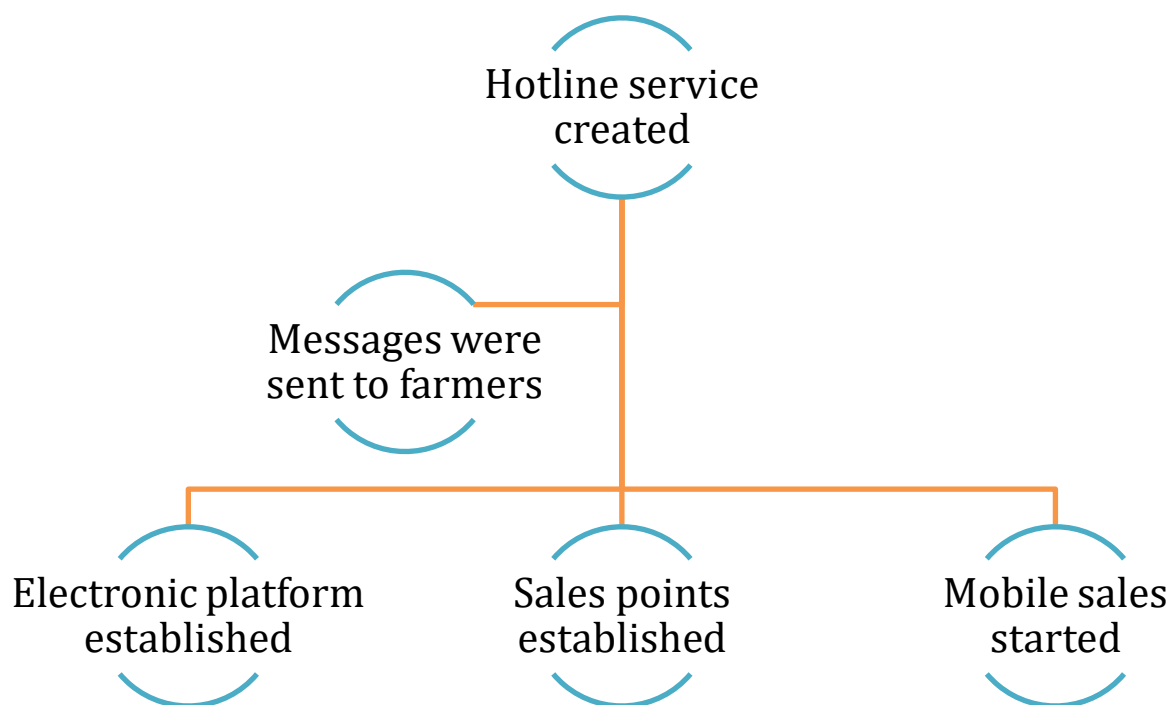


Figure 2. Activities implemented to ensure seed supply during the pandemic (Aliyeva M., 2022)

The early stages of the COVID-19 pandemic served as a stark reminder of the value of seed and other planting supplies. The current seed system, in which seeds are primarily imported from Azerbaijan, has weaknesses highlighted by media reports of panic purchasing, seed shortages, and supply chain disruptions. After that, measures were taken to address the existing problems. During the pandemic, data were collected about the problems faced by farmers, ideas were exchanged regarding the solution of those problems, and relevant tasks and recommendations were made for their solution (Aliyeva M., 2022).

In 2020, the demand for vegetable seeds decreased, especially with production. However, this demand rate provides a reduction of up to 1% compared to the previous year. It recovered in 2021 and exceeded the figures of 2019 (Figure 3). Farmers and seed producers were not overly affected by this small percentage. Because the government of Azerbaijan provided subsidies as an urgent

action plan. Before the COVID-19 "Rules for Subsidizing Agricultural Production" (Decree of the President of the Republic of Azerbaijan No. 759 dated June 27, 2019) was accepted. With COVID 19, transactions accelerated, and subsidies for crop, seed, and livestock production managed through the Electronic Agricultural Information System (EAIS) were established and began in 2020 (TVNR, 2021).

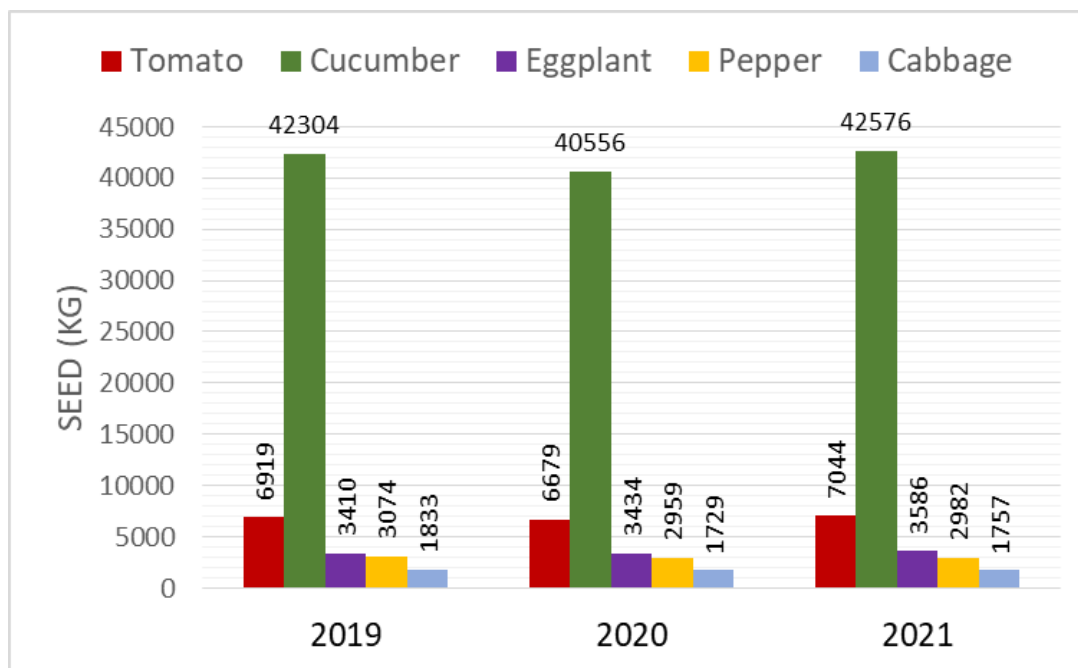


Figure 3. Seed demand for main vegetables for 2019-2021 years.

Total certified seed production on all crops also didn't affect COVID-19. The total certified seed production in all crops was also not affected by the COVID-19 pandemic process. Certified production, which was 97.184 tons in Azerbaijan in 2019, reached 135252.84 tons in the 2020–21 period, and this production increased by 1.07% and reached 145.000 tons in the 2021–2022 season (Figure 4). The production, which was made on approximately 40 000 hectares in 2020, grew by 1.35% in 2021–2022, and certificated seeds were produced on approximately 54 000 hectares.

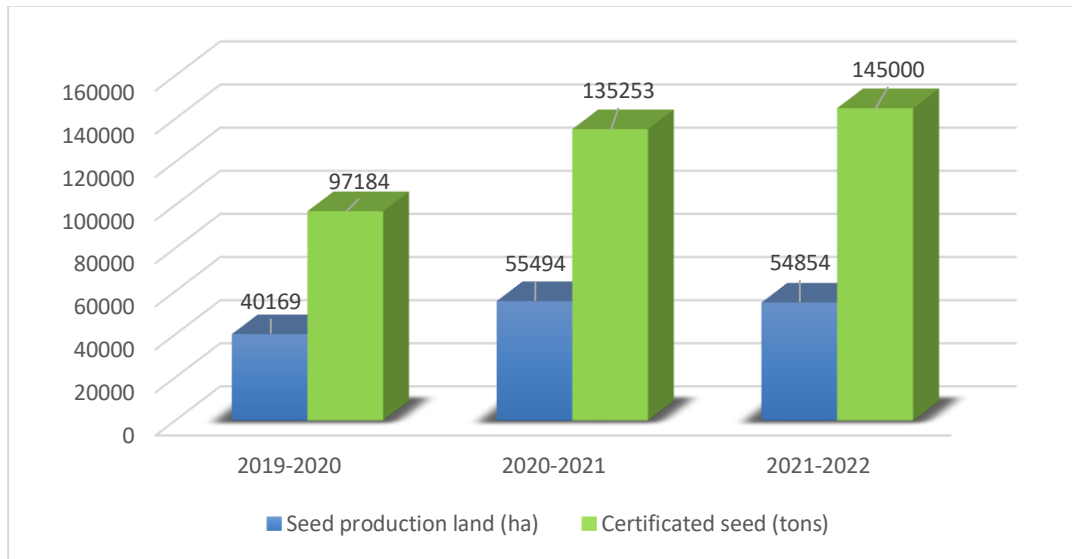


Figure 4. Total certified certificated seed production

In this context, under mechanism, product subsidies were grouped into three categories in Azerbaijan: cultivation, crop, and seed subsidies. The seed subsidy was determined by applying coefficients to the base amount per kilogram of certified 1st and 2nd reproduction seeds and each number of seedlings produced and sold in the country for plant types determined by the Council (Amirov, 2022). In this subsidy, the amount of seeds and seedlings sold to the farmer in the calculation of the seed subsidy is determined according to the need for sowing or planting, which is calculated according to the land area used.

3.2. Türkiye seed sector

Türkiye is perfectly adapted for agricultural and seed production due to its geographic location and climatic variability. As a result, there are many agro-ecological zones where various types of crops and plants are grown. Over time, efforts have been undertaken to capitalize on this in order to enhance seed and agricultural productivity. Turkey's seeds are due to the republic's years. However, official records started with the establishment of the Variety Registration and Seed Certification Center in 1959. Türkiye was included in the ISTA (International Seed Testing Association) in 1963 and in the OECD Seed Certification System in 1968 (Bağcı, 2013).

Türkiye began looking for improved seed varieties in the 1980s. The seed policies of the Ministry of Agriculture and Forestry underwent significant revisions. Private businesses were permitted to determine their own seed pricing. Strategies were put in place in 1984 to make it easier to import, and private enterprises began exporting seeds, which led to a growth in the private sector's dominance of the seed supply and production system. Türkiye joined the International Seed Federation (ISF) in 1998. The seed industry experienced significant growth after the passage of Law No. 5042 on the Protection of Breeder's Rights on New Plant Varieties in 2004 and Seed Law No. 5553 of 2006, which brought us into compliance with EU law and international standards. These laws were also aided by recent advancements in business, science, and technology. In 2007, the International Union for the Protection of New Varieties of Plants (UPOV) Convention on the protection of new plant varieties and plant breeders' rights was ratified, aiming at the protection of intellectual and industrial property rights (TTSM, 2022). The ten best agricultural economies in the world include Türkiye.

The Turkish seed industry has made great strides over the past 10 years, and since 2007, the number of seed companies and accredited seed producers has tripled. Along with recent advancements and developments in agriculture, the establishment of the Türkiye Seed Union (TURKTOB) based on Seed Law No. 5553 issued by the Ministry of Agriculture was crucial to this advancement. With the authority given by this law in Türkiye, Türkiye Seed Union is a professional, legal, and public institution that designs and regulates the seed sector. Following the creation of this organization, 1070 local seed producer firms were established in Türkiye as of November 2022 (TURKTOB, 2022), while many significant international seed conglomerates have been merging in recent years. 1.3 million tons of certified seeds were produced in Türkiye in 2021. (It was 100.000 tons in 2002.)

Additionally, local seed businesses engaged in breeding projects reached over 100 tons as well, focusing primarily on field crops, particularly cereals (Yalçın, 2018). Due to Türkiye's favorable temperature and ample fields, many foreign seed firms prefer to create their basic and certified seeds there before exporting them to other nations. This is especially true with hybrid seeds, which may be used for both field and vegetable crops. Professional organizations with the public legal personality of TSUAB, such as the ISF, Following the formation of this association, a slew of new local seed producer businesses sprouted up. TSUAB was established in 2008 in accordance with the requirements of the Seed Law, and its members have played a significant role in the development

of the Turkish seed industry to where it is today. The distribution of members varies according to the species (Table 4). There are 1070 companies, of which 93.4% are national, 41 are multinational (3.8%), and 25 have a foreign partner (2.8%) (TSUAB 2022).

Table 4. Number of TSUAB member companies' profile by species

Crop Group	Quantity of member
Cereals (Wheat, barley, oat etc.)	562
Industrial Crops (Sunflower, cotton, maize, soya, sugar beet)	211
Forage Crops (Alfalfa, sainfoin, <i>Vicia sativa</i> etc.)	166
Vegetables	315
Pulses/Legumes (Chickpea, lentil etc.)	195
Turfgrass and Ornamentals	50
Potato	192

* A member can be active in more than one crop.

Now, as of January 2022, there are a total of 13.680 registered plant varieties, including 4.984 field crops, 6.898 vegetables, 1.562 fruits and vines, and 236 fruit rootstocks. There are also seven registered ornamental plant varieties in Türkiye. Although 1.8 million tons of wheat seeds and 750 thousand tons of barley seeds are sown per year in Türkiye and 75% of these seeds are registered varieties. When the sectoral distribution of registered varieties as of 2021 is analyzed, it is seen that 77% of the total miscellaneous numbers are covered by the private sector, while 23% are provided by the public and universities (TTSM, 2021).

Plant Variety Protection (PVP) Law (No. 5042) was signed by Türkiye in 2004 and put into effect the following year. In 2007, Türkiye received approval from the Turkish Parliament to join UPOV as its 65th member (Ermiş et. al., 2010). Türkiye has established seed industries in the areas of registration and distribution, seed certification, and seed trading, and its administrative regulations are compatible with those of the EU and other nations. Based on the Law on the Protection of Breeder's Rights for New Plant Varieties in Türkiye, PVP protects plant breeder rights and registered cultivars. Since 2007, more than 2,000 plant varieties have been taken under protection. Of the 1,684 cultivars whose active protection continues within the scope of breeder's rights; 935 are field crops, 424 are fruit, 276 are vegetables, and 49 are ornamental plants (TTSM, 2022).

3.2.1. Seed resilience of the Turkish seed industry during COVID-19

Türkiye published the first information on whether the tourism, travel, and agriculture centers with a sizable refugee population could stop the new coronavirus epidemic on March 11, 2020, by announcing the first verified case of COVID-19. During this period, many economic measures were taken. Some of those, such as postponing tax payments within the framework of a certain program, postponement of official paperwork obligations, and VAT reduction, have been realized in many sectors. Short-time working also allowance was applied by the state for those who lost their jobs during that period (Çakmaklı et al., 2021). The role of the seed sector in strengthening the resilience of agricultural production has been broken in Türkiye by growing more products. Sustainability has been ensured in the production and distribution of certified seed, which is the basis of plant production in the 2020-2021 production seasons. The statement from the Ministry of Agriculture and Forestry that 75% of their cultivated seeds will be awarded in 21 cities if they utilize the government-certified seeds has been the most tangible demonstration of support for agricultural producers (Çiftçi-SEN 2020).

Due to the difficulty of crossing the border, there were also some delivery delays in Türkiye. Costs associated with imported items were also impacted by the Turkish lira's devaluation against the US dollar. However, it was observed that there was no problem, especially in seed production. Especially during the pandemic period, certified seed production increased by 100 thousand tons, making a great contribution to the country's economy (Figure 5). As of 2021, 1.324.222 tons of certified seeds have been produced (BUGEM, 2022). Farmers received 6.100 tons of free crop seeds to cover an additional 350,000 ha of planted land (MED-Amin 2020). At the same time, the process was followed instantly through coordination centers established in all 81 provinces of Türkiye, and necessary measures were taken without delay. Along with the coordination centers, the Turkish Ministry Agriculture and Forestry "Alo 174" hotline and WhatsApp Hotline provide 24/7 service regarding the notices, complaints, questions, and problems of Turkish citizens. Efforts to ensure supply security without causing any price increase. It was also carried out in many areas, such as economic and administrative (supervision and monitoring), in cooperation with the relevant ministries. Institutional infrastructure was developed in order to hold joint meetings with sector representatives during the epidemic process and to prepare for future crises.

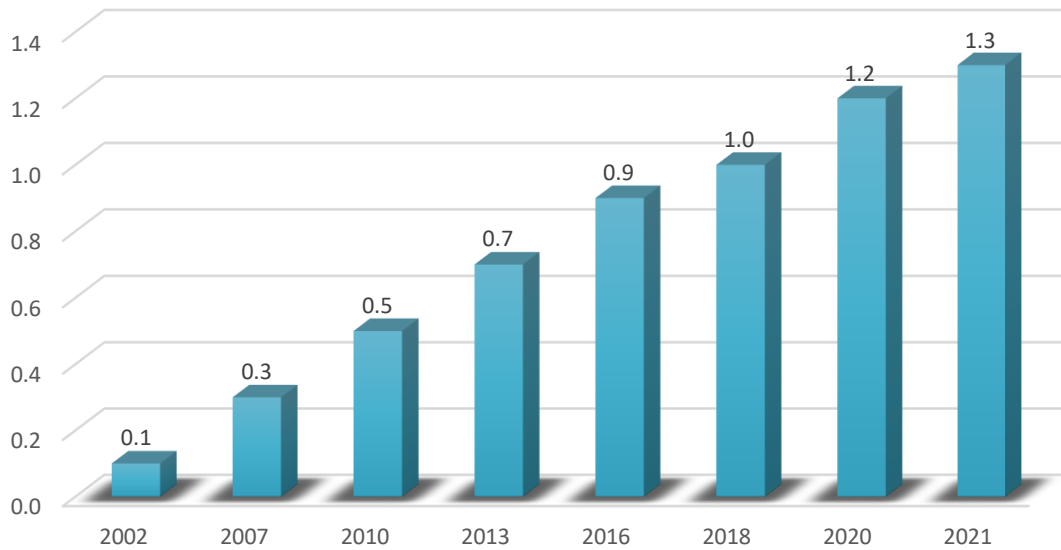


Figure 5. Certificated seed production in Türkiye year by year (million tons)

Seed imports in Türkiye did not decrease during the COVID-19 period; on the contrary, they increased by 1.2%, reaching 45.82 thousand tons in 2020 and 56.36 thousand tons in 2021. But seed exports have been affected by the COVID-19 pandemic. Seed exports fell from 74,70 thousand tons in 2019 to 72,31 thousand tons in 2020. It is thought that the reason for this is the trouble experienced at customs (Figure 6).

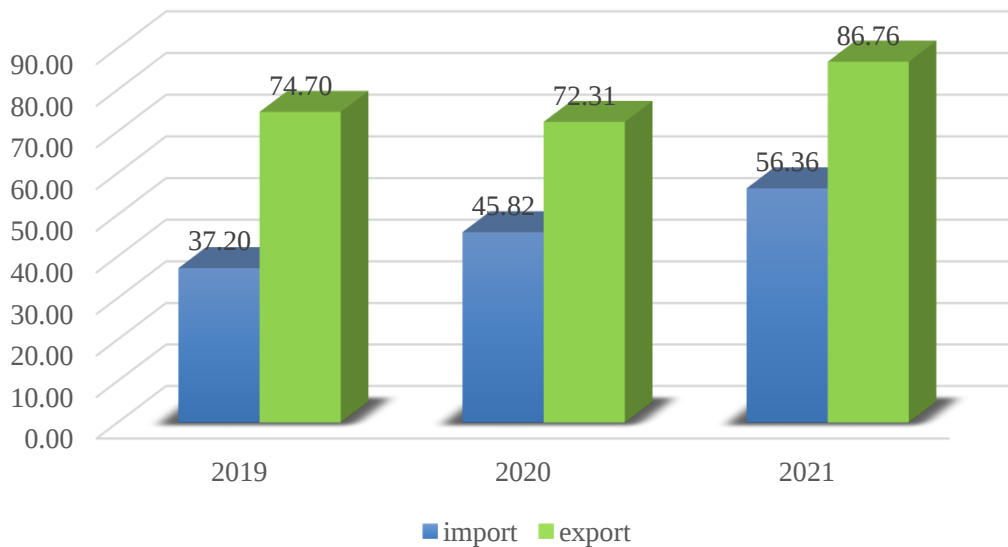


Figure 6. COVID-19 period in Türkiye Seed import and export (thousand tons)

3.3. Malaysia seed sector

Despite the lengthy history of the seed industry in Malaysia, there is still an uneven and insufficient supply of high-quality seed and planting supplies. As a result, the Malaysian government has revived the agricultural industry to a new level, and increased efforts have been made to modernize this industry into "New Agriculture".

Malaysian Agricultural Research and Development Institute (MARDI) was established under the MARDI ACT (1969). Malaysia's national seed business began to modernize with the introduction of the National Seed Project (NSP), which was funded by a loan from the World Bank in 1979. MARDI is one of eight agencies and three departments under the Ministry of Agriculture and Food Industries (MAFI). The establishment of seven seed testing labs and seed processing facilities was a result of the implementation of NSP. Since then, the Department of Agriculture (DOA) and the Malaysian Agricultural Research and Development Institute (MARDI) have been providing the farmers with high-quality seeds and planting supplies.

There are already nine seed processing facilities and ten seed testing labs created specifically for paddy seeds. Through the National Agriculture Policy (NAP), the government created strategic objectives to achieve food self-sufficiency after the nation attained independence in 1957. (Sundaram & Tan, 2019). In Malaysia, there are five national agricultural policies (NAP). The NAP 1 project was carried out between 1984 and 1992 in order to develop the seed processing facility and laboratory. With further seed processing facilities and laboratory development in Malaysia during NAP 2, (1992-1998). Between 1998 and 2010, the development of a new plant variety protection act was provided as part of the NAP 3 project seed verification scheme. After that, NAP 3 focuses on the development of new plant varieties, voluntary schemes, and private sector involvement. In the part that was evaluated as the NAP 4 project between 2011 and 2020, the development of the seed quality bill was ensured. Malaysian National Seed Policies are now aligned with Industry 4.0, focusing on infrastructure development, modern technology, and ease of use. However, the national seed policy has not yet been implemented by the government. Malaysia continues to prepare the Seed Quality Bill and Regulation to control the seed industry in Malaysia. This policy is important for an effective seed production and distribution program that covers various components in the seed supply chain, such as plant breeders' rights, plant variety protection, the Seed Act, the Gene Bank, seed quality control, and legislation (Faslisyam, 2022).

The growth of the agricultural industry has had an impact on how the seed industry in Malaysia has developed. As these crops were and are still significant export commodities, industrial crops like cocoa, rubber, and oil palm were the emphasis of the sector's early development period (Suhana et. al., 2020). It was vital for the seed industry to develop further despite significant obstacles, such as the fact that good-quality hybrid seeds are currently primarily imported because of increased relevance owing to security concerns.

The export of these seeds has contributed significantly to the national income of Malaysia. Malaysia's seed distribution system is similar to that of many other developing Asian nations (FAO, 2000). Malaysia doesn't have many big players in the seed industry, but the seed industry has continuously been important in the national agenda. Most hybrid seeds are imported from other countries such as China, Thailand, Taiwan, Japan, and other producing countries. Vegetable, ornamental, cover crop, and fruit varieties account for the majority of imported seeds and planting materials. Nearly 90 percent of vegetables and fruit seeds in Malaysia, such as papaya and watermelon, are imported from foreign countries.

This is a result of the absence of breeding programs (for some crops), a lack of attention paid to seed production, and a lack of coordination among those involved in the seed business (Mahmood, 2006). From 2017 to 2020, a total of 5.570 mt of seeds valued at RM (Ringgit Malaysia) 130.5 million were imported. Malaysia imported 507 thousand seeds in 2017. This percentage has been increasing over the years. In 2020, it imported 2 million seeds, an increase of 4 times. (Figure 7). Malaysia also exported vegetable and fruit seeds, with a total of 49 metric tons worth 13.5 RM (Ringgit Malaysia) million from 2017 to 2020. Vietnam, Brunei, and the Philippines are Malaysia's top three exporting countries (Mazlam, 2022). The annual seed demand and the import-export scenario make it clear that improvement methods must be implemented to support the regional seed sector.

Although Malaysia currently uses its own standards (SIRIM, Department of Standard Malaysia) and ISTA standards for seed certification, it is not yet a member of ISTA. Therefore, a seed quality control laboratory (Seedlab) was established in 2009. Malaysia, which began implementing the New Plant Varieties Protection Act, is also not a member of the UPOV, an organization created to provide and support an efficient plant variety protection system to encourage the production of

new plant varieties for the benefit of the community. However, Malaysia is one of the 19 countries that has initiated the accession procedure for the UPOV (UPOV, 2022).

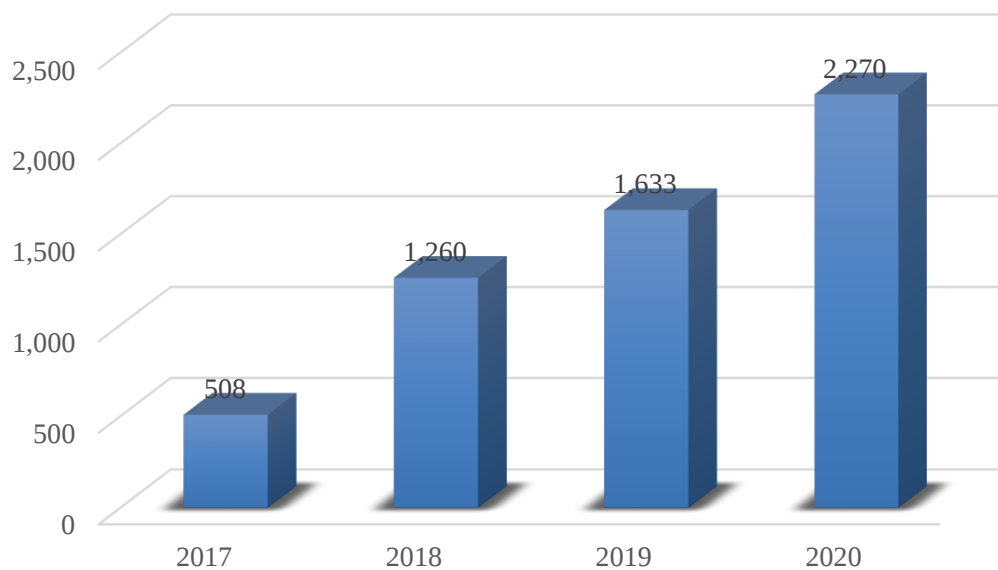


Figure 7. Total imported seed industry in Malaysia (thousand tons)

3.3.1. Seed resilience of the Malaysian seed industry during COVID-19

On January 25, 2020, COVID-19 was discovered by Malaysians, who were all quarantined in Wuhan, Hubei, China. Due to an outbreak of 22 cases that occurred during a sizable “tabligh” religious gathering of 16,000 people in Sri Petaling, a town adjacent to the capital city of Kuala Lumpur, the number of COVID-19 cases in Malaysia started to rise at the end of February (Hashim et. al., 2021). A measure of seed security is the population's consistent access to food, particularly food that is healthy and nutritious. Even during extreme weather events like earthquakes, floods, volcanic eruptions, tornadoes, and pandemics, there must be a steady supply of food. Malaysia is a country blessed with abundant natural resources and is free from natural disasters, with the exception of sporadic short-term floods that occasionally occur in some areas of the east coast (Chin, 2020). In Malaysia, there is a shortage of recommended seeds and planting supplies. Due to the commercialization of the agriculture industry, the seed multiplication program cannot keep up with the rising demand. In addition to the local production of vegetable seeds, it accounts for less than

5% of the total seed supply. Most of the seeds for some crops, including vegetables, watermelons, and sweet corn, are imported from abroad. This may lead to issues like poor seed quality and inconsistent supply. For this, MARDI produces some of the open-pollinated vegetable seeds in particular. (Mohlisun, 2022).

Another issue is the difficulty in anticipating seed demand due to a variety of factors, including planting season, location, crop type, and cropping patterns. After the pandemic, some important things came to the fore regarding the seed sector in Malaysia. Malaysians first understood that there must be a stock of basic seeds available at least one season in advance. However, since there was no stock before the pandemic, especially rice seed, and most of the production was made with imported seeds, the seed production and stock in the country can only meet less than 50% of the seed need (Azami, 2022).

During COVID-19, production was restricted in Malaysia, especially in open pollinated vegetables, due to the scarcity of workers and their inability to go out. While seed exports were approximately 275 thousand before the COVID-19 crisis, in 2020, with the onset of COVID-19, seed production was halved and 136 tons were exported (Figure 8). However, Malaysia's trade balance runs a deficit, especially since the seed import balance exceeds the export value (Faslisyam, 2022).

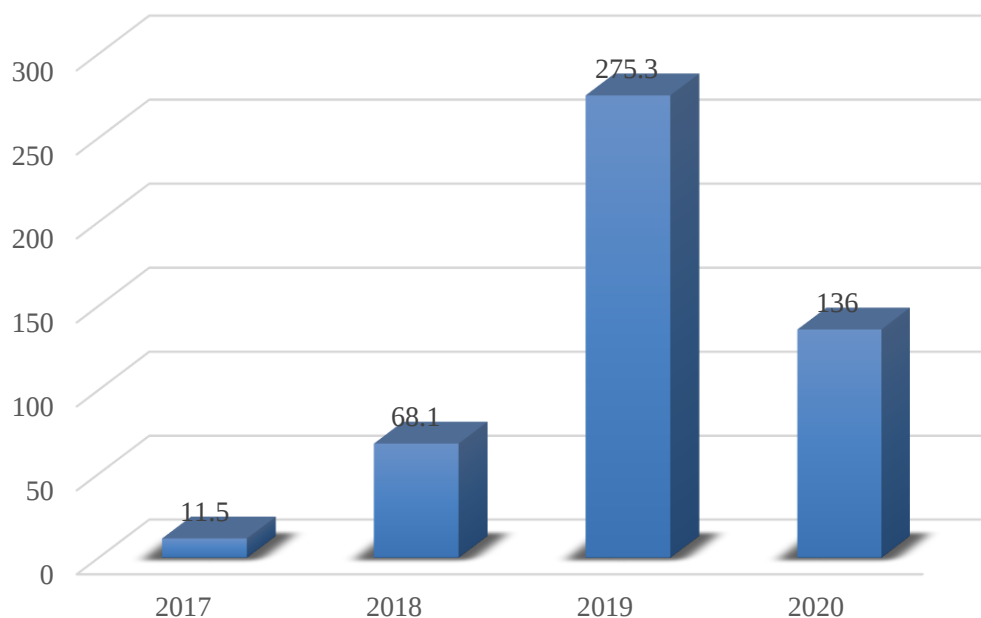


Figure 8. Total exported seed industry in Malaysia (thousand tons)

The seed and planting material market in Malaysia still has a substantial supply-demand imbalance. Currently, the Malaysian government is discussing what measures can be taken in future crises involving fugitives by drawing conclusions from COVID-19. However, especially seed production and marketing were interrupted during this period. Plant breeding and activities that increase capacity for seed multiplication must also be given special focus (Mahmood, 2006).

3.4. Morocco seed sector

In Morocco, seed production first began in the 1920s. It has been developed, and for a while, the nation served as one of the principal sources of improved seeds for vegetables, legumes, and other food crops for the surrounding Mediterranean nations. The first legislative texts were promulgated in the 1940s. The actual legislation related to the production and trade of seeds and propagated material is based on legislative texts promulgated in 1969 (AFSTA, 2006). The government's extensive participation during the 1970s and 1980s significantly increased the nation's seed output, particularly that of cereals, whose commercialization was liberalized by the end of the 1980s. In the 1970s, the seed sector in Morocco saw many important developments, such as the creation of the National Institute of Agricultural Research (INRA) for research and breeder seed production), the promulgation of texts adapted to international legislation and standards, and the creation, in 1975, of the National Company for Seed Trade (SONACOS) to promote the seed industry and commercialization. With the liberalization of the seed sector since the 1980s and the integration of newly established private companies, it has gained momentum with the introduction of foreign varieties and the increasing participation of privately contracted seed breeders. Commercialization of certified seed is done by accredited organizations through a substantial distribution network. The majority of these accredited organizations have joined the Moroccan Seed Association (AMSP), which was founded in 1991 to organize Morocco's seed industry in order to achieve quality and productivity targets from producers to end users. Morocco has well-adapted seed laws and regulations that adhere to international laws (ISTA, OECD, and EU). A plant variety protection law was also passed in Morocco in 2002 and is now in force. Morocco became the sixty-second member of the International Union for the Protection of New Varieties of Plants (UPOV, 2022). Later, with the formation of the National Inter Professional Seed Federation (FNIS) in 2009, the goal was to bring together seed grower and seed trade representatives (Elbakkali, 2022).

The market for seeds in Morocco is divided into three categories: hybrid, conventional, and varietal seeds; row crops (rice, wheat, maize, millet, cotton, and other row crops); and vegetables (onion, tomato, and other vegetables). To satisfy the rising production need, Morocco imports grains (corn, barley) and vegetable seeds (potato, sugar beet, beans, tomatoes) from the Netherlands, the United Kingdom, Denmark, France, and Peru. Due to improved quality and challenges with drought tolerance, Morocco depends on the import of numerous vegetables and cereal seeds. The largest component of imports and exports is vegetable seed. Morocco now imports and sells a variety of seeds to suit the country's growing domestic and international demand. The government of Morocco also helps by giving subsidies to market and store these resources locally (Mordor Intelligence, 2022).

For the marketing and storage of certified seeds, Morocco's Agricultural Development Fund (ADF) offers subsidies. The seed company in Morocco that was authorized to market the nation's production of certified wheat and barley seeds from 2016 to 2017. The ADF also contributes to the support of import corporations for rice seed and Monogram sugar beet seed for carryover stocks. But, Morocco is a net importer of sugar beet seeds. Morocco bought 234 tons of sugar beet seeds in 2019 (Selina Vamucci, 2019). This subsidy is given to the seed companies that discount the cost of the seed when they sell it to a farmer. Only seeds that have been certified by the National Health Security Office for Foodstuffs are eligible for these payments. The government provides direct price subsidies to farmers that represent about 35% of the cereal seed cost (ONSSA, 2022).

The use of certified cereal seed has increased by about 0.63 % in ten years (from 0.72 million quintals (500 kg) before 2008 to 1.15 million quintals in 2020) (Figure 9). Approximately 1.2 million quintals of certified seeds and roughly 220,000 quintals of carry-over certified seeds (for all seed producers) are annually subsidized by the Moroccan government.

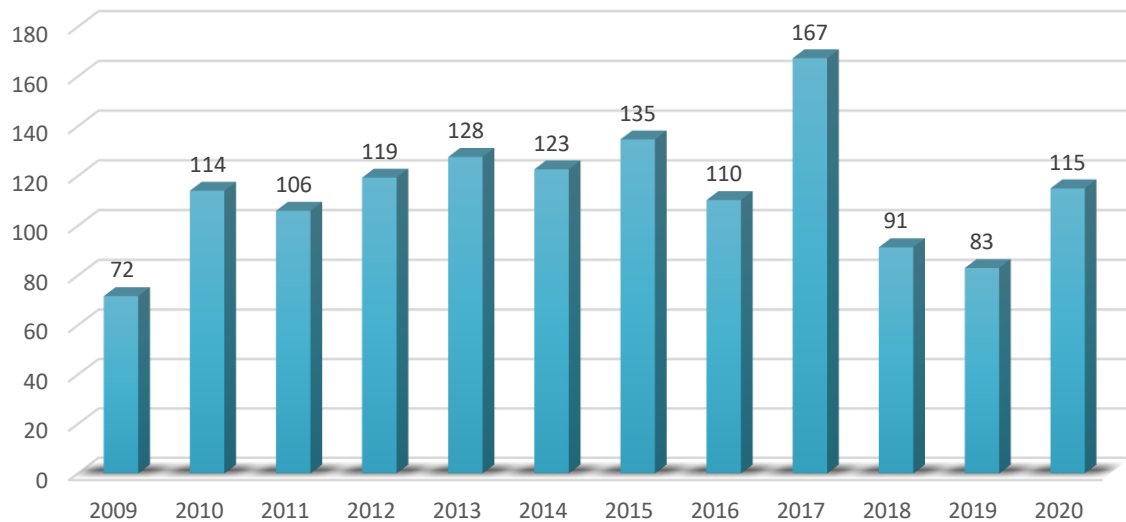


Figure 9. Certificated seed production in Morocco from 2009 to 2020.

The variety registration system is well established, having registered many varieties from the national breeding program in Morocco. In order to safeguard Moroccan agriculture, the system is also allowed to eliminate numerous types. The official public institutions (research centers, extension, control, production, and commercialization units), the corporate sector, through its professional organizations, and farmers' unions are all permitted to participate in decision-making through the variety registration system (Bishaw, 2019). Vegetables account for the majority of the 3,514 registered varieties, with 1,400 different types (39.8%). 850 varieties of cereals and food legumes are registered. 92% of all registered plant varieties have been bred and registered by the private sector, and 8% belong to the public sector (Table 5) (Elbakkali, 2022).

Table 5. Registered varieties in Morocco

Registered varieties	Private (%92)	Public (%8)	Total
Autumn cereals	178	102	280
Spring cereals	579	32	611
Fodder crops	250	52	302
Food legumes	93	26	119
Industrial crops	452	0	452
Oilseeds	193	30	223
Potatoes	369	3	372
Vegetables	1400	0	1400
Total	3514	245	3579

The Law 9-94 on plant breeders' rights in Morocco and its implementing regulations (Decree No. 1-196-255 of 21 January 1997) were both published in the official bulletin after which the PVP (Plant Variety Protection) system was put into place. ONSSA is responsible for implementing the examinations of the PVP.

The official government policy to ensure food security, sustainable resource management, and agricultural competitiveness is known as the Green Morocco Plan (GMP). In April 2009, the Moroccan government has adopted the global strategy of the agricultural sector, entitled Green Morocco Plan. It aims to fully exploit the agricultural potential of the country and fight against poverty through a focus on modern agriculture with high added value, productivity and solidary agriculture, located in rather unfavorable areas (Elbakkali, 2022).

3.4.1. Seed resilience of the Moroccan seed industry during COVID-19

The spread of the COVID-19 pandemic to Morocco was confirmed on March 2, 2020. Morocco put measures in place from March 9 to March 15, 2020, to stop the virus from spreading. As a result, travel to a number of nations is prohibited, but return flights are still permitted. Additionally, sea connections to Spain and France are halted. On March 26, 2020, the head of government announced the cessation of hiring until the end of the coronavirus crisis (El Kahkahi et al., 2020).

The Moroccan government implemented a nationwide monitoring and response strategy that was based on solidarity, involved the public sector, and involved the entire population. A government action plan that addressed agricultural, social, economic, and health issues was put into effect. The country's king took the initiative to establish a specific fund for the control of the pandemic (Barkia et al., 2021). Postponement measures have been taken so that all companies, including those working in the seed sector, do not have to pay penalties in case of a delay in the payment of social contributions for March, April, May, and June 2020. During this period, seed companies with a turnover of less than 20 dirhams also benefited from the postponement and payment of their tax returns. The Ministry of Agriculture has issued a decree explaining that the agricultural sector continues its normal course and that agricultural workers are excluded from the scope of unemployment imposed by COVID-19. Although these decisions were taken, the Moroccan government stated that the seed sector was not affected much, but the interest in planting seeds in the pre-basic class of field crops decreased during the pandemic period (Benjelloun, 2022). Grain seed demand, which was 1100 tons in 2019, decreased to 750 tons in 2020, but the demand increased by 100% compared to the previous year (Figure 10).

Some measures implemented during COVID-19 have been taken to facilitate the provision of agricultural inputs to farmers and producers in Morocco. Inputs for farmers, for instance, have a mobile application where payments may be made. The application has been effectively used by many farmers in the different regions of the Kingdom, which has allowed seed companies. Also in this period, with the digitization of national seed marketing, an automated and digitized tracking system was implemented, aiming to provide better inventory management by providing barcodes for identification and traceability of seed lots. Thus, GPS identification of all seed outlets allowed campaigns to better control the distribution network (Elbakkali, 2022).

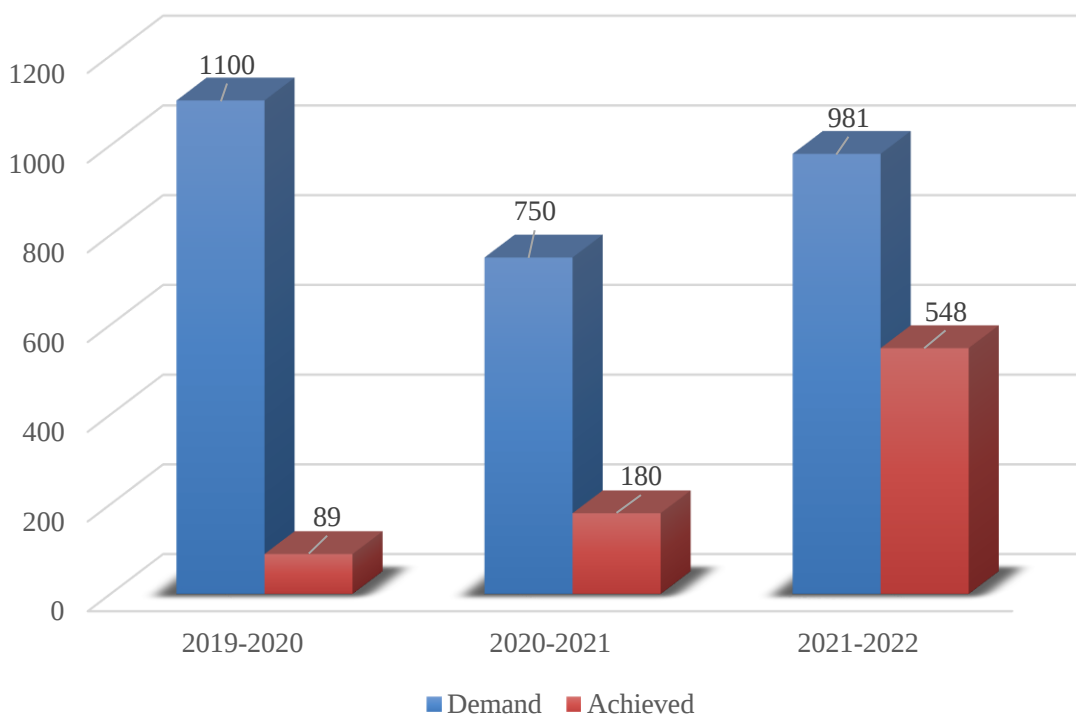


Figure 10. Basic class seed demand and achieved statistics

3.5. Pakistan seed sector

Since the establishment of Pakistan in 1947, the organized seed industry has gone through several evolutionary stages. In Pakistan, until 1961, the reproduction and distribution of new varieties through agricultural extension were carried out by farmers. Production and distribution, as well as other agricultural development-related activities, are organized. However, due to ineffective marketing, the organization failed and dissolved in 1972. In 1973, the Government of Pakistan, with the help of FAO and the World Bank, prepared a national seed development project with strong recommendations for private sector involvement, laying the foundations for today's seed growing (Hussain and Bhutta, 2002).

The seed sector in Pakistan can be sharply defined as a formal and informal sector. The formal seed industry in Pakistan is made up of both public and private institutions and organizations that are involved in a variety of seed-related activities, including the development of new seed varieties,

their multiplication, and their distribution, with the public sector also playing a role in the overall regulation of the seed market. Various research institutions in the public sector, federal and state levels are engaged in research activities to develop high yielding seed varieties. With increasing financial and managerial challenges in public sector institutions, as well as private sector expansion, the former's role in seed development was taken over by the latter (Wagas, 2022). In Pakistan, the seed sector, especially for cotton, maize, and rice crops, is covered by the private sector for most of its seed needs. In 1961, the West Pakistan Agricultural Development Corporation (WAPDC) was established.

In Pakistan, the informal sector also controls the seed market. The informal seed sector in Pakistan involves farmers saving their seeds for planting in the future, with medium- to large scale selling of seeds in brown bags and non-commercial seed exchange between farmers (Rana et al. 2015); (Huda et al. 2011). In addition to cash transactions, seed exchange for labor, seed swaps, and in-kind seed loans are a few of the mechanisms of seed trading (Ali and Ali, 2004).

Punjab and Sindh had the majority of the public and private sectors' capacity for processing seeds such as wheat, rice, maize, and cotton seed. The Seed Act (No. XXIX of 1976) of 1976 established the rules controlling Pakistan's seed system. As the executive branches of the National Seed Council (NSC), the National Seed Registration Department (NSRD), and the Federal Seed Certification Department (FSCD). These two departments merged in 1997 to become the Federal Seed Certification and Registration Department (FSCRD). Crop variety registration, crop inspection, and seed testing were all methods used by the FSCRD to offer quality control. Thus, FSCRD served as the organization in charge of overseeing the quality of all seed types. For the most part, crop inspection and laboratory testing were used for seed quality control to make sure the seed fulfilled the minimum requirements outlined in the rules (Ali and Ali, 2004).

To promote investments in varietal development in the seed market, proper enforcement of intellectual property rights must be made. In this regard, the government passed the Plant Breeders' Rights Act in 2016, although it took until 2018 for the act's regulations to be developed. However, there are still issues with the PBR registry's residence in the FSCRD (Jafri et al., 2022). Currently, the Pakistan Government is among the group of governmental and intergovernmental organizations in contact with the Union Office for assistance in the development of laws based on the UPOV Convention (UPOV, 2022).

Particularly in emerging nations like Pakistan, the demand for seeds is still unmet, offering international firms numerous prospects for growth and a sizable consumer base. Due to the export potential of vegetable seeds from the global population, the nation is moving toward the adoption of high-quality seeds. For instance, Pakistan is adopting high-yielding varieties more frequently due to the possibility of export. An important factor in the development of the seed industry is the increased spending on hybrid seed R&D (Wagas, 2022). A genetically modified kind of cotton known as Bt cotton was introduced to Pakistan about a decade ago in an effort to cut down on farmers' use of insecticides. However, since the early 2000s, this technology has been brought into the nation illegally (Malik and Ahsan 2016).

In Pakistan, about 95% of the area under cotton crop production has been modified to Bt varieties in just a few years due to cheaper crop management costs caused by the seed's insect resistance and farmers' ignorance of the problems associated with these types. However, a combination of issues, such as lax enforcement of laws and regulations governing the seed industry, the dissemination of fake seeds, the emergence of insect resistance, a lack of R&D for variety creation, shifting climatic conditions, etc., resulted in a considerable reduction in cotton production (Jafri et al., 2022). In order to increase crop output, the Rice of Pakistan Agriculture Research Council (PARC) proposed 12 novel hybrids of rice for commercial cultivation across the country's rice-growing regions in 2019. As a result, new technology is anticipated to help Pakistani farmers produce more crops and make their nation's agriculture self-sufficient. Seed companies are very interested in Pakistan because of the enormous development potential and supportive government regulations. This may accelerate the development of the nation's seed industry (Report Linker, 2022).

Many researchers in the country today have emphasized the need to simplify the process of providing certified seeds to farmers and approving varieties for the development of the agricultural sector in Pakistan. The most important factor is that the certified seed supply is primarily controlled by the private sector. In the most recent years, in 2022, farmers bought more than 41% of wheat, 72% of maize, and more than 12% of paddy-certified seeds from private companies. The demand for certified seeds in the public sector is very low for this species. However, according to 2022 figures, most of the vegetable and maize seeds are imported into the country (Table 6).

Table 6. Area, Seed Requirement and Seed Availability 2019-20 in Pakistan

Crop	Sowing Area* (000 Ha)	Total Seed Requirement	Seed Availability			
			Public (%)	Private (%)	Imported (%)	Total
Wheat	8.709	1.075.562	6	41	0	513.487
Cotton	2.310	39.940	2	72	0	33.801
Paddy	2.957	44.148	11	112	22	63.795
Maize	1.328	32.802	1	7	40	15.615
Pulses	1.185	42.674	1	5	0	2.833
Oilseeds	830	10.790	3	4	8	1.678
Vegetables	280	8.400	0	14	36	4.158
Fodders	2.038	61.140	0	7	36	26.465
Potato	166	415.000	0	0	1	6.006
Total	19.803	1.736.161	4	31	3	667.839

Source: Federal Seed Certification and Registration Department of Pakistan (FSCRD,2022)

3.5.1. Seed resilience of the Pakistani seed industry during COVID-19

On February 26, 2020, cases of COVID-19 were detected in Islamabad and Karachi. Pakistan is one of the Asian nations with the highest population density. The community's reaction was conflicted. Few individuals were interested in the news, and some even thought it was phony (Akhtar, 2021). The COVID-19 pandemic has affected every sector of the economy in Pakistan; the agricultural

sector is no exception. However, the agriculture and seed sectors, which proved resilient in one of the country's worst economic slowdowns, far outperformed other service and small-scale manufacturing sectors. According to the Pakistan Economic Survey 2019-2020, it has been noted that COVID-19 has not had a significant impact on the agricultural sector, where it grew by 2.67 percent (OXFAM, 2022).

Women have a significant role in agricultural growth in rural Pakistan. They carry out numerous important chores, such as tilling and weeding the ground, sowing seeds, gathering manure from the farmyard, and harvesting. Additionally, they are in charge of washing, drying, and storing grains. Studies show that the typical woman in rural Pakistan works an average of 15.5 hours a day, of which 5.5 hours are engaged in agriculture (sowing, harvesting, and livestock), and only has 50 minutes a day to take care of her own children. These women are now more vulnerable as a result of the COVID-19 epidemic. Given that many of the informal laborers and the rural poor do not receive regular salaries and that the majority do not have access to any economic activities, the lockdown is inflicting unimaginable suffering on them (IFAD, 2020).

The disruption in supply networks across the country caused by COVID-19 had a significant impact on seed transportation from distribution centers to farmers. But notwithstanding the pandemic crisis that has gripped Pakistan for the past few months, safety procedures and a number of steps implemented by the government have made seeds punctually available to farmers and producers. But, according to a survey study in Pakistan, 55.2% of respondents reported an increase in the cost of farm inputs due to COVID-19, 29.4% reported no increase, and the rest (15.4%) are unsure. The majority (90.7%) stated that the cost of seeds increased, while the prices of fertilizers and pesticides increased by 31.2% and 35.9%, respectively. This rate was found to be higher in paddy and wheat producers (92.7%), and it was determined to be 77.3% in the mixed crop zone, which is a system where two or three crops are planted together, one being the main product and the other being a by-product, on the same land (ADB BRIEFS, 2020).

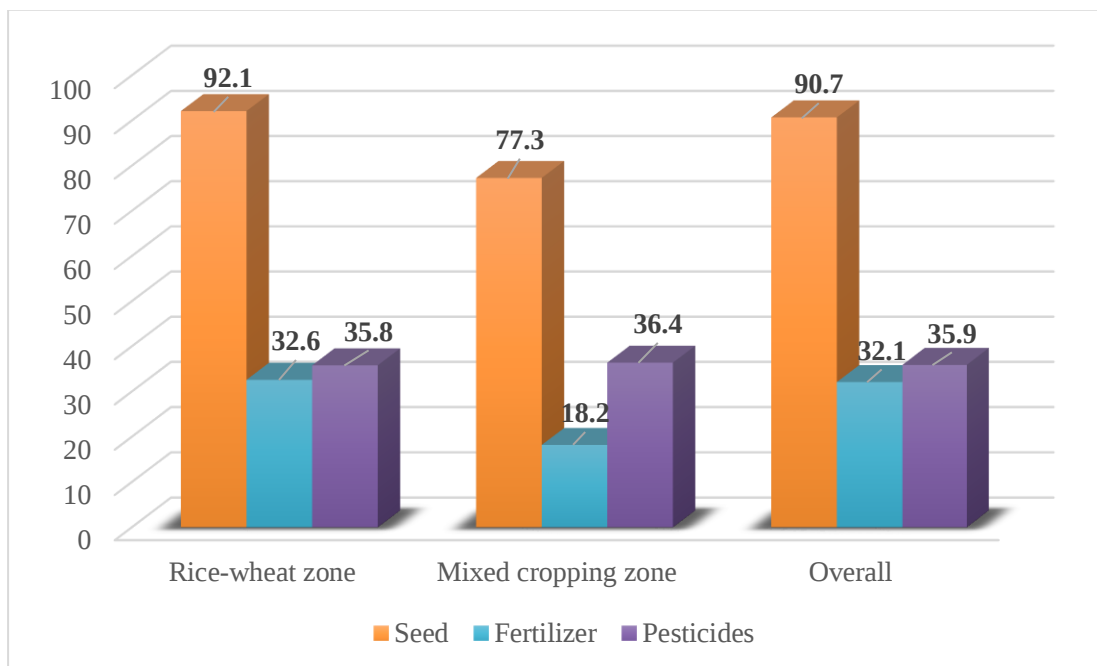


Figure 11. Farm Input Price Increases Attributed to COVID-19 (% of total respondents)

The value of exports of seeds, fruits, and spores of a kind used for sowing materials from Pakistan totaled \$ 2.15 million in 2021 (Figure 12). Although imports were not affected much during the COVID-19 pandemic in Pakistan, there were significant decreases, especially in seed exports, in 2020 (Trend economy, 2022). This gives us detailed information about seed production, especially in the COVID-19 period. Breeding, seed production, etc., which could not be done due to the shortage of workers, had a significant impact on exports.

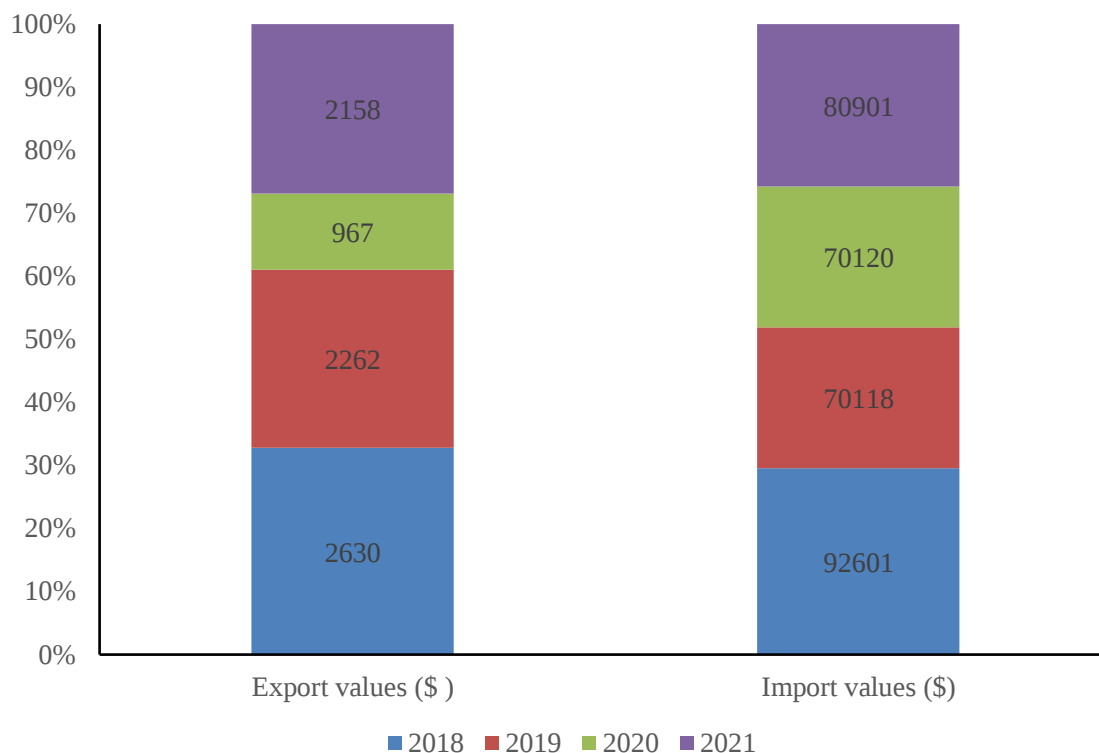


Figure 12. Seed import and export values in Pakistan

4. POLICY RECOMMENDATIONS

This chapter provides policy recommendations on resilience in the seed sector with the rising risks after COVID-19 in the four countries, namely the Türkiye, Azerbaijan, Malaysia, Pakistan, and Morocco, selected for this study. Within the scope of the project, a "Workshop on Resilience of the Seed Sector for the Crisis of COVID-19" workshop was organized in Antalya/Türkiye for this purpose. An expert from SESRIC, representing OIC countries, attended the meeting. 14 participants from COMCEC members and 20 participants from the Turkish delegation attended the workshop. In the workshop, it has been discussed that best practices and communication are the key elements to gathering information on situations experienced with selected partners of COMCEC countries. Country members shared their country's seed industry, breeding programs, and their experiences in the seed industry during the pandemic period and shared them at the meeting. During the

pandemic days, as in other countries, international institutions and organizations in COMCEC countries took measures in all affected areas. However, it has been argued that the food and agriculture sectors are vital, as the safe production and continuous circulation of food ensure food safety and security. It was also emphasized that building resilience to the vulnerabilities, shocks, and stresses of agricultural systems is an important priority in today's world. The growth of agricultural crops and the reinforcement of desired plant production outcomes, such as high yield, disease control, and environmental protection, depend on seed. The yield increase can be provided with the use of high qualification seed in agricultural production by 20% to more than 100%. For the sustainability of agri-food systems, and in particular for food security, seed, which represents the first stage of plant production and is the means of propagation for many plants, is strategically important. Crop diversity, seed systems, and stakeholder support mechanisms are significantly impacted during times of food crises, such as conflict, war, relocation, and climate change. Crop diversity and related seed systems are lost, ignored, or damaged in long-lasting crises. This significantly affects farmers' livelihoods and household and communal food security.

At the workshop, members identified the most critical resilience factors relevant for seed production and enterprises to sustain during and after the COVID-19 pandemic. At the same time, what happened in the seed sector before and after COVID-19 was openly discussed in the workshop. Those critical factors refer to labor resilience, production resilience, financial resilience, organizational resilience, and impact resilience. Based on these findings, a toolkit was created to enhance the seed industry's resilience both during and after the COVID-19 outbreak. In particular, in the workshop, findings were presented that illuminated how seed systems can maintain function in the face of external shocks such as the COVID-19 pandemic and how we can apply the lessons learned toward building resilience for an uncertain future due to factors such as climate change, war, and another global epidemic.

The coronavirus pandemic has exposed the fragility of the agricultural ecosystem. Like an epidemic, climate change has been highlighted as an inevitable threat that must be addressed before it is too late. While it was stated that the economy and agriculture started to recover with the gradual easing of the COVID-19 restrictions, it was stated in the workshop that it was necessary for farmers to support a recovery centered on combating climate change and biodiversity loss. In the workshop, instead of forward-looking statements that can be defined with terminology such as "expect," "will," "potential," "plans," "expectations," "estimate," "target," "on track," and similar expressions, more

precise It was also emphasized that future projects should consider the evidence and potential solutions.

For this purpose, group work was carried out on the last day of the workshop, and the COMCEC members were divided into various groups and the following questions were asked: Members of each group shared and discussed their input and developed answers and suggestions for the questions below:

1. Which of risks/crises in national and global level would you consider as the most important ones regarding the seed sector?

Seeds are the foundation of our food system. Resistant seed systems are at the heart of sustainable food systems that are renewable, resilient, equitable, diverse, healthy, and interconnected. The value of resistant seed systems goes far beyond any economic measure. Resilience in seed systems “Climate Change”- related natural disasters, “Wars/Conflicts”, “Labor Scarcity,” and “Aging and urbanization of the rural population” are stated to carry the main risks for the seed sector at the national and global level.

2. What type of information and measures could your Agency/Ministry should take into account for the elimination process of these risks/crises?

In general, ministries in the country establish gene banks in order to protect biodiversity and strive for the protection of endemic plants. In addition, it is necessary to establish early warning systems in order to minimize climate change. Varieties that are tolerant to abiotic and biotic stresses should be developed, and these varieties should be tested especially against drought and salinity. Precautions should be taken to prevent the spread of other pests and diseases, especially the locust epidemic in Pakistan. With new breeding methods, especially with the help of molecular markers, issues such as selection and resistance breeding should be given more importance in COMCEC countries. Today, especially with molecular studies, we can know what makes a plant good or which underlying feature is good, such as whole genome sequencing. We know that we can sequence that germplasm (seeds, plants, or plant parts used in crop breeding, research, and preservation) to

catalogue and make it available for improvement. However, there are countless seed banks all over the world that house a wide range of diverse plant species and variations. There are also smaller and larger ones. The genetic material must be preserved so that it can be used to generate new crops for use in agriculture or even medical.

In order not to be affected by wars and conflicts, an international discussion and cooperation platform should be established. Seed should not be restrictive, and border closures should not be imposed. Discussions are currently ongoing about the details of the attack and the extent of the loss at the National Center for Plant Genetic Resources of Ukraine. Concerns remain about how damage to a national seed bank could affect national and international food security.

Regarding foreign worker dependency and the labor shortage, there is a need to use technology to attract local and young workers. Lack of skilled labor will constrain future growth and job creation, especially in the seed sector. But when the right policies are implemented, including targeted investments in education and skills training in the digital economy, and efficient management of labor migration flows, the digital economy will significantly contribute to the advancement of decent work and inclusive economic growth at the global, regional and national levels.

3. What might be challenges at the operational and policy level when intervening into crises at national and international level in the seed sector? (Please consider the Covid-19 experience)

The three pillars of the Green Revolution have, however, lost strength in recent years. Use of fertilizers has significantly decreased in growth. One key barrier is the lack of quality seed in sufficient quantities, at the required time, and for a fair price. The growth of irrigation has also slowed, which frequently makes salt and water logging issues worse. As a result, the effectiveness of using all three criteria has significantly decreased. Therefore, in addition to this, price stability must be maintained, especially in seeds. The increase in seed prices during the pandemic period can be given as an example. High seed cost is one of the most important inputs in our day. Prices are increasing day by day due to the difficulty of obtaining hybrid seeds and the labor cost. There is a need for smart agriculture technologies in which technology is adopted. More seed production

and less labor should be adopted while benefiting from these technologies. However, the use of new breeding method techniques should be provided.

On the other hand, in such pandemic periods, a highly mobile legislative method is needed. An effective and authoritative crisis desk must be established, and decisions must be made and implemented quickly. It is important to coordinate the digitization network and make it easily accessible.

4. Do you consider seed sector sensitive and vulnerable to the crises and why? (Please consider with respect to seed using farmers, seed growers, associations, distributors, public authorities, international organizations and trade etc.)

Nutrition-specific and nutrition-sensitive treatments can improve nutrition and health in many areas, including seeds. Seed has been of great importance in human nutrition since the beginning of human history and is the most important way to reach the fork from the field today.

The seed industry is influenced by a number of instruments and procedures, and it's sensitive. Before reaching a farmer, a seed lot is likely to transit through multiple nations for production, processing, and packaging. With specific times for planting and harvesting various crops and kinds, it is likewise time-sensitive. Therefore, the necessary movement and shipping restrictions imposed by governments to protect people from COVID-19 and similar disasters have the potential to severely affect the production, certification, distribution, and cost of the seed. This is an issue for all nations, but it will likely have a higher effect on COMCEC nations because they may be more dependent on seed imports and may be more severely affected by the economic crisis.

5. Which organization/organizations should play the most active role in evaluating the seed sector risks?

Creating a policy and regulatory environment that facilitates both innovation and access to seed is critical to addressing risks. For this reason, it is especially important in terms of issuing new

regulations at the ministerial level of countries and creating an action plan against risks. It is necessary to play an active role in all stages, from seed planting, production, packaging, sale, and delivery to the farmer, by establishing a crisis desk within the Ministry.

Secondly, seed associations and related sub-unions must play an active role in all stages, from the producer to the distributor, and share information about the risks. Seed unions in countries can manage things more easily and interact with one another more easily because they are not bound by official procedures. Cross-country support can be obtained in assessing risks.

Along with the increasing risk of food adulteration and the limited food defense systems in the OIC geography, emergency action plans should be implemented, especially for sudden pandemics such as COVID-19, war, climate change, and pests and diseases invading plants. At this stage, it is of great importance that the COMCEC countries cooperate and manage the crises together.

5. CONCLUSION

Seed is a vital component of the agricultural supply chain. They are essential to the agricultural and food systems that supply enough nutritious food for the entire world's population. For farmers and other participants in the value chain to maintain their livelihoods and become more resilient, access to high-quality seeds is essential (OECD, 2021b).

Resistant seed systems, which permeate every aspect of the food chain from seed to fork, are at the core of renewable, long-lasting, equitable, diverse, healthy, and interconnected sustainable food systems. Resistant seed systems have benefits that go far beyond their economic value because they specifically relate to human nutrition. We are faced with a critical choice as the planet's life is threatened by accelerated climate change and biodiversity loss. In order to transition from industrial food systems—characterized by chemical-intensive agriculture, concentrated livestock agriculture, ultra-processed foods, and deregulated global supply chains—to varied and sustainable food systems, we need to make certain fundamental changes. Most of all the land wars

and crises in the world have been caused by the type of plant grown in that country and its geography. Seed collection and transport of genetic material, which started in the early 1900s, still continue today. It can be said that especially the collection of endemic species of third world countries and the development of new species for breeding by keeping these species in gene banks and selling them again to these countries is actually the "green war" of the last century.

The main goal of this research project, which COMCEC commissioned, is to exchange knowledge and identify best practices for efficient seed management and distribution during the pandemic in a few COMCEC countries. This will help stakeholders in the agro-food systems be more resilient to threats and COVID-19-like crises and enable food security.

With this project, a workshop was organized, and it was discussed among Turkish participants and selected COMCEC countries what precautions to take against risks such as COVID-19. The workshop also discussed the experience of the COMCEC countries, in particular, on how they enacted adequate policies and measures that could reduce the impact of this epidemic on seed supply and thus on farmer resilience. In addition, this event has been a useful tool for ensuring good governance at the national and international levels. This event also led to the sharing of best practices and benchmarks for food safety. In the workshop, we discussed not only the COVID-19 crisis but also the fight against biotic and abiotic stresses such as drought and salinity, which occur with climate change, and the risks that may arise from sudden diseases and pests in plants, in particular, on how they enacted adequate policies and measures that could reduce the impact of this epidemic on seed supply and thus on farmer resilience. In addition, this event has been a useful tool for ensuring good governance at the national and international levels.

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In view of the resilience in the seed sector and the recommendations on how to establish resilience in the sector, the report provides some policy recommendations to further develop the industry.

The recommendations identified are classified into five broad areas:

Firstly, by creating regionally appropriate variations through the development of technical know-how and abilities such as risk management, breeding methods, and marketing for COMCEC countries.

Secondly, seed networking methodologies and strategies should be developed both within the national context and among COMCEC countries.

Thirdly, the empowerment of farmers and community-based organizations working to support locally based and farmer-focused seed systems is one of the most crucial activities to finance against such risks.

Fourthly, community seed banking systems, seed storage techniques, and keeping endemic species and variations collected from the country using appropriate technologies and sharing them within COMCEC countries all require low-cost seed conservation technologies.

Finally, the characterization of genetic resources adapted to local conditions and the identification of pure lines for the development of new varieties by sharing these resources within COMCEC countries.

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