A Template Of Scientific Application In The Islamic World: Advent Of Agriculture In Saudi Arabia

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Abstract

The paper explores a survey of texts as well as physical surveys in Saudi Arabia to establish the importance that the Islamic culture places on scientific and technological development, along with preserving traditions and culture. This has led them to become reasonably large producers of food grains, fruits, vegetables as well as horticultural plants. Also, industries around this produce have also been encouraged. The political turmoils of the region notwithstanding, the Islamic people are part of the great human endeavour of life.

Key words: Islamic agronomy, nomadic pastoralists, rose oils.

Introduction

Agriculture in Saudi Arabia is an aspect that has not garnered much attention as it is generally presumed that the Middle East imports its food requirements in it's entirety. Agriculture is an important area of Islamic civilisation. Saudi Arabia is an exporter of crude oil and dates, but it is also focused on the domestic consumption and export of dates, dairy products, eggs, fish, poultry, fruits, vegetables, and flowers to markets around the world.

Although Saudi Arabia is widely thought of as a desert, it has regions where the climate has favoured agriculture. Rain falls in winter every year in Saudi Arabia but with an average of maximum 100mm except in the Southern area of the country.

The government has aided with this process by converting large areas of desert into agricultural fields. By implementing major irrigation projects and adopting large-scale mechanization, agriculture has developed in the country, adding previously barren areas to the stock of cultivatable land.[3] The Food and Agriculture Organization (FAO) recommends in a report that paying extra consideration on creating and nurturing the agrosystem in the desert may lead to an interference in the ecosystem of the desert which would lead to unpleasant results, but that is not a concern right now for the Arabic world, as it tries to create some food security for itself.

Traditional agriculture and pastoral nomadism

In the distant past of this Islamic region, the bulk of agricultural production was concentrated in a few limited areas. The produce was largely retained by these communities although some surplus was sold to the cities. Nomads or tribes that wandered in the desert, going from settlement to settlement, played a crucial role in this regard, shipping foods and other goods between the widely dispersed agricultural areas. Livestock rearing was shared between the sedentary communities and nomads, who also used it to supplement their precarious livelihoods.

The water supply in Saudi Arabia, and specifically the lack of water has always been the major constraint on agriculture and the determining factor on where cultivation occurred. The area had no lakes or rivers. Rainfall was slight and irregular over most of the country. Only in the southwest, in the mountains of Asir, close to the Yemen border and accounting for three percent of the land area, was rainfall sufficient to support regular crops. This region plus the southern Tihamah coastal plains supported subsistence farming for large communities. Cropping in the rest of the country was scattered and dependent on the little ground water that the region had. Along the western coast and in the western

highlands, groundwater from wells and springs provided adequate water for self-supporting farms and, to some extent, for commercial production. Moving east, in the central and northern parts of the interior, Najd and An Nafud, some groundwater allowed limited farming. The Eastern Province supported the most extensive plantation economy. The major oasis centered around Al Hasa, which enjoyed high water tables, natural springs, and relatively good soils, was the right place for the various crops unique to this geography, and Islamic scholars have talked about it in various texts.

Historically, the limited arable land and the near absence of grassland forced those raising livestock into a nomadic pattern to take advantage of what forage was available. Only in summer, the year's driest time, did the nomad keep his animals around an oasis or well for water and forage. The Bedouin developed special skills knowing where rain had fallen and forage was available to feed their animals and where they could find water en route to various forage areas.

Traditionally, the Bedouin were not self-sufficient but needed some food and materials from agricultural settlements. The near constant movement required to feed their animals limited other activities, such as weaving. The settled farmers and traders needed the nomads to tend camels. Nomads would graze and breed animals belonging to sedentary farmers in return for portions of the farmers' produce. It created oppressive social system Bedouin groups were contracted to provide protection to the agricultural and market areas they frequented, in return for such provisions as dates, cloth, and equipment. Bedouin further supplemented their income by taxing caravans for passage and protection through their territory.

Bedouin themselves needed protection. Operating in small independent groups of a few households, they were vulnerable to raids by other nomads and therefore formed larger groups, such as tribes. The tribe was responsible for avenging attacks

on any of its members. Tribes established territories that they defended vigorously. Within the tribal area, wells and springs were found and developed. Generally, the developers of a water source, such as a well, retained rights to it unless they abandoned it. This system created problems for nomads because many years might elapse between visits to a well, they had dug. If people from another tribe just used the well, the first tribe could frequently establish that the well was in territory where they had primary rights; but if another tribe improved the well, primary rights became difficult to establish. By the early twentieth century, control over land, water rights, and intertribal and intratribal relationships were highly developed and complex. Islamic historians do point out that this strife was the source of many Islamic wars as well, wherein the creativity and positive innovations of the culture took a back seat.

- **Irrigation**

The Arabs have shown special enthusiasm for the development of agriculture, as that was the main source of survival for any civilisation. Prior to the Arab Revolt, the ancient Babylonian and Roman canals of Syria and Mesopotamia had lain unused for centuries due to lack of proper preservation. With the help of these canals, the highly advanced irrigation system had once emerged in this area, but with time, that network dried out. The Arabs restored the ancient irrigation system by renovating these canals and cutting new canals where necessary.

History of Science, Contribution of Muslims to Technology, pg 169, Samarendra Nath Sen, Volume I & II, Shaivya Publications Division

In the areas where irrigation system was not possible due to lack of rivers or reservoirs, they have provided irrigation system by digging numerous tube wells.

In this context, the digging of subterranean wells by the Arabs is significant. This type of artesian well was first dug by the

French in the early 13th century in regions such as Artois. As soon as the Arabs came to know about this discovery, they realized its importance and took the lead in digging such wells. They eagerly imitated it and were the first to take full advantage of those discoveries and techniques of the West, which could be beneficial for their civilisation. That way, Islamic tradition has been open to knowledge acquisition and development.

- **Water Wheel**

The Arabs made great improvements to the water wheel. The Arabs made this ancient technique efficient and effective, and the water wheel became a major means of power supply, and with the rapid improvement of its construction techniques, the use of water power increased manifold. Arab engineers built a huge floating water wheel on the Tigris river in Mesopotamia to provide an uninterrupted power supply for wheat processing, paper making and other small and large factories.

- **Pawan Chakra**

Like the water wheel, the wind cycle became widespread in the Middle Ages and was made possible by the innovations of artisans and engineers. By controlling the air flow with the help of the device, humans engaged in various tasks such as mills. The Arabs thought of a type of pavan chakra to mechanically run the hapa, a type of rotating axis required for religious ceremonies. This combination of science within traditional rituals is an interesting feature of Islamic civilisation, though sadly, it gets obliterated in the shrill narrative of political Islam. According to an Arabian legend, Abulului, a slave of the second Caliph Hazrat Umar (RA), built the first wind wheel. R.J Forbes, Man the maker - A History of technology and engineering, Schuman, New York, 1950 P 93/4

- **Agronomy:**

There is evidence of Arab research in agricultural botany from about the eighth century. (740 - 828) They wrote several books

about various plants and the use of vines, palm trees etc. in preserving soil fertility and moisture.

Howard S. Reed, A short history of the plant science Chronica Botanica, P 53 (BE / 36,)

The efforts of the Arabs in the development of agriculture, botany and herbal science were successful. They were especially aware of the need for radical reform and improvement of the ancient irrigation system to make agricultural development possible. They introduced irrigation systems with the help of palm trees, water wheels run with the help of horses and camels, and various devices suitable for flood control.

- **Islamic agronomy**

The first Arabic book on agronomy to reach al-Andalus (or former Islamic states in Spain, Portugal and France) in the 10th century, was Ibn Wahshiyya's al-Filahat al-nabatiyya (Nabatean Agriculture), from Iraq; it was followed by texts written in the al-Andalus region, such as the Mukhtasar kitab al-filaha (Abridged Book of Agriculture) by Al-Zahrawi (Abulcasis) from Cordoba, around 1000 AD. The Al Andalus was a region of prosperity and natural produce even in those days.

The eleventh century agronomist Ibn Bassal of Toledo described 177 species in his Dīwān al-filāha (The Court of Agriculture). Ibn Bassal had travelled widely across the Islamic world, returning with a detailed knowledge of agronomy. His practical and systematic book both gives detailed descriptions of useful plants including leaf and root vegetables, herbs, spices and trees, and explains how to propagate and care for them.[10]

The twelfth century agronomist Abū l-Khayr al-Ishbīlī of Seville described in detail in his Kitāb al-Filāha (Treatise on Agriculture) how olive trees should be grown, grafted (with an account of his own experiments),

treated for disease, and harvested, and gave similar detail for crops such as cotton. Medieval Islamic agronomists including Ibn Bassal and Abū l-Khayr described agricultural and horticultural techniques including how to propagate the olive and the date palm, crop rotation of flax with wheat or barley, and companion planting of grape and olives. It is ironic that this world, this culture forgot its innovative designs for growing food and other cash crops and became a lot import dependent.

Arab Agricultural Revolution

The Arabs transformed agriculture during the Golden Age of Islam by spreading major crops and techniques such as irrigation across the Old World.

The **Arab Agricultural Revolution** was the transformation in agriculture from the 8th to the 13th century in the Islamic region of the Old World. The agronomic literature of the time, with major books by Ibn Bassal and Abū l-Khayr al-Ishbīlī, demonstrates the extensive diffusion of useful plants to Medieval Spain (al-Andalus), and the growth in Islamic scientific knowledge of agriculture and horticulture. Medieval Arab historians and geographers described al-Andalus as a fertile and prosperous region with abundant water, full of fruit from trees such as the olive and pomegranate. Archaeological evidence demonstrates improvements in animal husbandry and in irrigation such as with the sakia water wheel. These changes made agriculture far more productive, supporting population growth, urbanisation, and increased stratification of society.

The revolution was first described by the historian Antonio Garcia Maceira in 1876.[1] The name[a] was coined by the historian Andrew Watson in an influential[6][8] but at the time controversial 1974 paper. However, 40 years on, it has proven useful to historians and has been supported by findings in archaeology and archaeobotany.[8]

- **The improvement of agriculture**

The Arabs exerted their utmost energy towards the improvement of agriculture, and they surpassed their predecessors in this respect. The Muslims understood the soil and resources of their land better than any nation. Their method was one of the most complex, the most scientific, and the most perfect of all the techniques that the inventive power of man has so far adopted. These principles or methods of farming were gleaned from the plains of Mesopotamia and the Nile basin where soil cultivation had reached a remarkable excellence. The enlightened policies followed by the rulers in this regard became helpful in every field of agriculture. The government sent highly talented botanists to the fertile regions of Egypt, Mesopotamia and the Indo-Pak subcontinent to search for and collect seeds and fruits of valuable plants for experimental cultivation in the gardens of royal palaces.

Cultivation farmers (those who plow the land) were greatly encouraged and patronized to increase water flow dynamics production. This encouragement brought people's devotion to

the agricultural profession and brought a large area of dry (barren) land under agriculture. Barren valleys were transformed into rich orchards of olives, oranges, figs and pomegranates.' Where swamps existed and hid productive land, waste land was reclaimed by draining water and brought under cultivation. Arabian engineers developed excellent drainage and drainage systems from mountain springs, reservoirs, wells, cisterns, man-made underground tunnels, siphons, drains and canals. They improved and expanded Egypt's irrigation system. They employed the Persian cycle, which had a row of water vessels within its boundaries, driven by bullocks as a pump, or driven by the swift current of the Srotsvini, to distribute water from the latter source through the uplands.

1. Encyclopaedia, of Islam, Vol-1, p-492.

Lands were measured, and with the help of astrolabe land was classified and confirmed. There was a huge amount of construction work going on with government funding for irrigation purposes. The artificial basin near Alicante was elliptical, three miles in circumference, and 50 feet deep. The aqueduct at Manasses in Valencia was 720 feet long and supported by 28 arches. The principle of the siphon was used to a considerable extent in the Moors' public flow and drainage systems. The lightning channel of Al Manzora's huge siphon was 750 feet long, 6 feet in diameter, and it crossed 10 feet below a mountain riverbed. The subterranean aqueduct at Maravila, which waters the plains of Argile, is a mile in length and 30 feet in diameter. All these underground channels have been made by cutting the sheer rock.

The irrigation system of the Caliphs was regulated by special laws. The strictest moderation was enforced in this regard. All kinds of extravagance were forbidden. The cisterns were opened at specific times and the release of water was precisely sequenced according to the needs of the farmers. Under the special care of the government, the canals and reservoirs of

each district were kept under the watchful guard of the police. Every Thursday, water-judicial meetings were held for the purpose of solving water problems. Each side had its own story. The accused party could have taken measures for his own defence.

- **Fertilizing the Land**

Similar care and frugality were observed in fertilizing the land. The land was divided into small parcels and hence it was cultivated more materially. Manure and dust were collected from high places and applied there. Street drains and underground litter were stored, dried and mixed with low-strength materials. Ashes, burnt and crushed fruit seeds, blood and bones of dead animals — these things played an important role in increasing the fertility of the soil. In addition to improved methods of applying manure, the Arabs invented a machine called the Marhifal' for compacting the soil. The Arabs carefully stored manure in a storehouse or cesspool to prevent evaporation and seepage through holes, and conserved all available substances to increase fertility for the purpose of more crops.

2. Iban Awams al-Filaha, High Translation by Syed Hashim Nadvi (Marif Hen, Aghmagarh, India).

The Muslims of Andalusia were fully aware of the flow of sap of trees, the sex discrimination of plants and the techniques of artificial reproduction of plants. They used eight well-defined methods of grafting trees. The use of perforated containers prevented the damaging effects of sunlight and allowed water to drip onto the pen. They were fully informed about the treatment of diseases in all known branches of the plant kingdom. They used to preserve the fruit for an indefinite period and those techniques are still used by the modern world. They drove away harmful insects and poisonous gases from wells and reservoirs with the use of herbs and simple machines.

S. P. Scott rightly comments, 'The valuable work of Abu Zakaria ibn Muhammad bin al-Awam of Seville, which is a great historical work of labor and erudition, and in which every tractable branch of the agricultural subject is dealt with, shows the remarkable perfection of agricultural science by the Arabic Muslims in the twelfth century. There is also a description of the birth, care, characteristics, relative excellence, defects, habits and diseases of all types of domesticated animals. Various types of sweets, jellies, syrups and all types of confectionery products are taught in this book.

- **Recent History**

During the 1970s and 1980s, the government undertook a massive restructuring of agriculture in Saudi Arabia. The stated objectives were food security through self-sufficiency and improvement of rural incomes. Although successful in raising the domestic output of several important crops and foodstuffs through the introduction of modern agricultural techniques, the agricultural development program has not entirely achieved these objectives. In regards to self-sufficiency, the kingdom produced a limited surplus, sufficient to export some quantities of food. However, if the entire production process were considered, the import of fertilizers, equipment, and labor have made the Kingdom even more dependent on foreign inputs to bring food to the average Saudi household.

Traditional agricultural regions do not always benefit from these development programs, and the government's financial support has led to the establishment of large-scale agricultural production units. Some of these are managed and operated by foreign entities and owned by wealthy individuals and large businesses. From an environmental viewpoint, the programs have a less than satisfactory impact. They have caused a drain on the kingdom's water resources, drawing mainly from non-renewable aquifers, and requires the use of massive amounts of chemical fertilizers too. These problems are being addressed now by scientists. In 1992 Saudi agricultural strategy was only

sustainable as long as the government maintained a high level of direct and indirect subsidies, a drain on its budget and external accounts. But at present, a lot of positive developments in sustainable agriculture are happening. We will discuss them later in this chapter.

Modern agriculture

Nomadic pastoralism declined as a result of several political and economic forces. Sedentarization was a means of imposing political control over various tribal groupings in the Arabian Peninsula. New legal structures such as the 1968 Public Lands Distribution Ordinance created novel land relations and spurred the dissolution of the Bedouin way of life. The establishment of a modern state provided incentives for large numbers of Saudi citizens to enter the regular, wage-based, or urban commercial employment. Moreover, modern technology and new transport networks undermined the primitive services that the Bedouin offered the rest of the economy.

- **The political role**

Until the 1970s, sedentary agriculture saw few changes and declined in the face of foreign imports, urban drift, and lack of investment. The use of modern inputs remained relatively limited. Introduction of mechanical pumping in certain areas led to a modest level of commercial production, usually in locations close to urban centers. Nevertheless, regional distribution of agricultural activity remained relatively unchanged, as did the average holding size and patterns of cultivation. During the late 1970s and early 1980s, the government undertook a multifaceted program to modernize and commercialize agriculture, in order to improve the nation's agricultural industry. Indirect support involved substantial expenditures on infrastructure, which included electricity supply, irrigation, drainage, secondary road systems and other transportation facilities for distributing and marketing produce. Land distribution was also an integral part of the

program. The 1968 Public Lands Distribution Ordinance allocated 5 to 100 hectares of fallow land to individuals at no cost, up to 400 hectares to companies and organizations, and a limit of 4,000 hectares for special projects. The beneficiaries were required to develop a minimum of 25 percent of the land within a set period of time (usually two to five years); thereafter, full ownership was transferred. In FY 1989, the total area distributed stood at more than 1.5 million hectares.

The government also mobilized substantial financial resources to support the raising of crops and livestock during the 1970s and 1980s. The main institutions involved were the Ministry of Agriculture and Water, the Saudi Arabian Agricultural Bank (SAAB) and the Grain Silos and Flour Mills Organization (GSFMO). SAAB provided interest-free loans to farmers; during FY 1989, for example, 26.6 percent of loans were for well drilling and casing, 23 percent for agricultural projects, and the balance for the purchase of farm machinery, pumps, and irrigation equipment. SAAB also provided subsidies for buying other capital inputs. GSFMO implemented the official procurement program, purchasing locally produced wheat and barley at guaranteed prices for domestic sales and exports. the government has granted import monopolies for some agricultural products to the GSFMO, while procurement and import subsidies on certain crops have been shifted to encourage a more diversified production program. Finally, agricultural and water authorities provided massive subsidies in the form of low-cost desalinated water, and electric companies were required to supply power at reduced charges.

- **Private sector investment in R&D**

The program prompted a huge response from the private sector, The private sector also plays a role in the nation's agriculture, as the government offered long-term interest-free loans and low-cost water, fuel, electricity, and duty-free imports of raw materials and machinery, though Private

investments went mainly into expanding the area planted for wheat. Between 1983 and 1990, the average annual increase of new land brought under wheat cultivation rose by 14 percent. A 35 percent increase in yields per ton during this period further boosted wheat output; total production rose from 1.4 million tons per year in FY 1983 to 3.5 million tons in FY 1989. To put the sheer volume in perspective, exports were lifted to the point where Saudi Arabia was the sixth largest wheat exporter in the early 1990s.

Other food grains also benefited from private investment. Output growth rates for sorghum and barley accelerated even faster than wheat during the 1980s, although the overall amount produced was much smaller. During the 1980s, farmers also experimented with new varieties of vegetables and fruits but with only modest success. More traditional crops, like onions and dates, did not fare as well and their output declined or remained flat. In 2018, the Saudi Ministry of Environment, Water and Agriculture adopted a new plan that aims at boosting organic farming in the country. The aim of the plan is to increase organic agriculture by 300 percent and the allocated budget is US$200 million, and research is being undertaken at the universities to achieve that.

There has been a reasonable growth of meat and poultry production in this region, but fishing, has been an underdeveloped aspect of the Saudi economy despite the abundance of fish and shellfish in coastal waters. The major reasons for the small size of this sector were the limited demand for fish and the comparative lack of fish marketing and processing facilities. Iraqi actions in releasing crude oil into the Persian Gulf during the Gulf War caused irreparable damage to fish and wildlife in the gulf, and the resulting ecological problems are visible there. Data concerning postwar catches were not available in late 1992, but in 1989 the Food and Agriculture Organization of the United Nations estimated Saudi Arabia's total catch at more than 53,000 tons.

An appreciable growth in the production of all basic foods and the kingdom's self-sufficiency in a number of food items to feed its population have been reported by many sources (Al-Hazmi, 1997; FAO, 2009; Royal Embassy of Saudi Arabia, London, UK, 2010; Royal Embassy of Saudi Arabia, Ottawa, Canada, 2010; Oxford Business Press, 2010). Al-Hazmi, (1997) reports the successful farming sector in the kingdom as cereals like: wheat, barley, sorghum and millets have been grown in some areas. Similarly, tomatoes, potato, watermelon, eggplant, cucumber and onions are some of the vegetables grown in the kingdom. The cultivation of fruits like date-palm, citrus and grapes remained successful in the kingdom. Alfalfa was grown as a forage crop, may be on small scale (Al-Hazmi, 1997). The most prominent agricultural accomplishment of the kingdom was its rapid transformation from importer to exporter of wheat (Royal Embassy of Saudi Arabia, Ottawa, Canada, 2010). Exports remained below 10 percent and imports reached as high as 40% for livestock products of the total agricultural imports. The Kingdom has also built its first silo to store extra grains in 1978 (Saudi Arabia Magazine, 2001).

There are troubling aspects in this growth story too. Saudi Arabia is suffering from a major depletion of the water in its underground aquifers and a resultant break down and disintegration of its agriculture as a consequence. As a result of the catastrophe, Saudi Arabia has bought agricultural land in the United States, Argentina Indonesia, Thailand and Africa Saudi Arabia ranked as a major buyer of agricultural land in foreign countries.

A case study

A sterling example of the application of Science and Technology in the Islamic world and also the impact of tradition is the Taif Rose Factory in Saudi Arabia.

- **The History of the Taif Rose Factory**

The Gadhi family have been in the horticulture and perfumery industry in Taif for almost 100 years, refining a centuries-old precision process — particularly collecting the pure oil that is considered by many to be the best in not just the Middle East but also Asia. In the 1970s and ’80s, King Khalid bin Abdulaziz, ruler of Saudi Arabia, was known to buy the whole season’s oil. Today, visitors from the United Arab Emirates pay huge sums for liters of pure Al Gadhi rose oil, which is considered to be a gift of the highest respect in Arabic culture. A tolah of rose oil has also become a classic souvenir for pilgrims traveling to Makkah, where the Yemeni corner of the Grand Mosque’s Holy Kaaba is scented with its aroma.

Why the roses are so special here is, in some ways, a mystery of nature. Sometime after the mid-14th century, they are said to have been brought to Taif from the Balkans and Turkey by traders and entrepreneurs who wanted to grow roses close to Makkah. The seeds themselves were no different from those planted in Turkey, Bulgaria, Iran or India — but the microclimate created by Taif’s altitude resulted in especially fragrant petals, greatly improved in recent times due to research and development. The aroma scents the morning air in Al Hada and Al Shafa during the spring, when farmers wake before sunrise to pick roses by flashlight, since excessive sun exposure will diminish the fragrance of the rose petals. A very delicate balance of water and organic fertiliser ensures the quality of the flowers. Whether among the apricot trees of the Wadi Mahram valley or the high peaks of Al Shafa, it’s possible to take in the full breath of what goes into the aroma of the famed roses beloved by pilgrims, sheikhs and kings alike.

A magical type of alchemy is also responsible for determining whether the roses produce oil. Even when the petals are distilled in sealed alembic pots, such as those at the Al Gadhi factory, there’s no guarantee that they will produce rose oil. The factory is impeccably clean and has all modern amenities, but the traditional process of oil extraction is still continued, as

the quality and aroma of the oil produced has few parallels in the world today.

- **Taif Rose Oil and Water**

Visitors wanting to buy rose oil or rose water can do so at the Al Gadhi Rose Factory, or at Al Gadhi's little shop in Taif's central market, where a small bottle costs around SAR50 (about US$13). The little shop is often manned by Omar and Abdullah Al Gadhi, two of the five second-generation brothers who own Al Gadhi. Opposite the shop is a concession stand run by Al Kamal (another old family-owned rose producer, with a factory in Al Hada, that makes everything from lotions, soaps, air fresheners and scented tissues to its own brand of perfumes made with attar in it. A visitor will also find a cafe serving rose tea and a small garden of knee-high rose bushes right there, for the visitors to savor the delicacy and beauty of the invaluable flower and the traditions associated with it in the culture of the area.

It's also possible to visit the area's small farms accompanied by local guides like Khalid Sherbi, whose English is as impeccable as his knowledge of his hometown. In his own words, "Taif is simultaneously one of Saudi Arabia's largest, yet coziest cities. What I love most about Taif is the amount of diversity we have in one city — diversity in agriculture, folkloric dances, dress, and even accents! And, of course, the geographic diversity. We have mountains, valleys, hills, and deserts within 50 kilometers of each other."

Conclusion

The paper highlights the evolution of a civilisation in the Islamic world, where traditions have been complimented with investments in science and technology, the inspiration for which may be found in the historical texts of Islam. A desert civilisation has had, at the centre of its culture, self-sufficiency in food and water, and the Arab world is trying to balance this very difficult trapeze.

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