FARRELLY & MITCHELL
Food & Agri-Business Specialists

KSA water report

Building a better food and water balance

Farrelly & Mitchell analyse the relationship between agriculture and scarce water resources in Saudi Arabia, and potential for a more sustainable future

www.FarrellyMitchell.ie

FARRELLY & MITCHELL

Food & Agri-Business Specialists

Preface and acknowledgements

Farrelly & Mitchell presents our perspective on the difficulty of balancing limited water resources with food security requirements through our report, Sustainable agribusiness in water-scarce Saudi Arabia.

In producing this report, we looked at what is a highly complex set of circumstances, encompassing the Kingdom of Saudi Arabia's culture, agriculture, climate, logistics, policies and technologies to enable a better understanding of the country's challenges when it comes to both food and water security.

We drew on our regional expertise and presence in Riyadh, as well as government and business archives, to research the issues and solutions on this topic, which grows in importance as the country's water resources diminish and the impacts of global warming loom larger.

The coronavirus that has blighted 2020, and threatened international food supply chains, has reinforced the need for Saudi Arabia to continue to develop a self-sufficient aspect to its food strategy. However sound policy and technology choices are needed to ensure the country's water supplies are conserved, complementing agricultural needs.

The great strides made in Big Data and its contribution to measurement and science augurs well for Saudi's future resource security, but the devising and implementation of suitable policy around that goal is crucial.

The pandemic has served as a reminder that the vital activity required to safeguard the country's food and water resources can never be taken for granted.

We would like to thank the contributors for their expert input and hope you find it provides useful insights. As always, we welcome your feedback. If you find this report valuable, please consider sharing it with your colleagues and peers.

Najeeb Alhumaid
Regional Manager, Farrelly & Mitchell
Alhumaid@farrellymitchell.com

FARRELLY & MITCHELL

Food & Agri-Business Specialists

The report at a glance

Saudi Arabia faces a perennial challenge in balancing water and food security

The Kingdom of Saudi Arabia, one of the most water-scarce nations on Earth, relies to a huge extent on non-renewable fossil aquifers and desalination to provide its water.

The country's relationship with agriculture is significant in terms of managing water supply. 82 per cent of water usage in the country is dedicated to agriculture.

Population expansion and food security strategy has substantially increased agricultural water usage, an issue that government have recently legislated to change through a 2018 decree on green fodder production. Complexity of the issue is also bound up with sensitivity among the farming population to change in traditional methods.

Wheat production is a significant player in the country's relationship with water resources, and as the implications of wheat growing on water supply became more apparent, the government opted to phase out that crop, replacing it with competitive imports.

Government policy has made inroads but not enough to substantially address KSA's existential agricultural water crisis, given that it is likely to reduce agricultural water consumption in 2019 by less than 10%.

A combination of monitoring technology and tariffs are seen as the way to make a greater impact in redressing the balance in overall water and food security.

FARRELLY & MITCHELL

Food & Agri-Business Specialists

Content

Executive Summary

The Kingdom of Saudi Arabia (KSA) relies almost exclusively on aquifers and desalination to provide its water. It is a severely water-scarce country.

KSA withdraws at least ten times its total renewable water resources, meaning the country is not only relying on renewable water resources, but also drawing heavily from its non-renewable fossil aquifers.

Roughly 82% of these water extractions are used for agriculture, and so any policy to improve the sustainability of water resources cannot ignore this agriculture dimension.

While Saudi Arabia has always faced a certain level of water scarcity, consumption levels were not always this high. Water consumption ballooned from the 1970s onwards as both agriculture and the population expanded.

Consumption reached 23.67 bn m^3 in 2006, before declining to 17.5 bn m^3. Since then, consumption has followed an upward trajectory reaching a record of almost 26 bn m^3.

Water consumption by agriculture accounted for 80% of this growth, largely driven by the increased production of the water-intensive alfalfa crop.

Justification for the continued support for local production in KSA is twofold:

- Food security (when defined as self-sufficiency)
- The agriculture industry is politically and socially sensitive

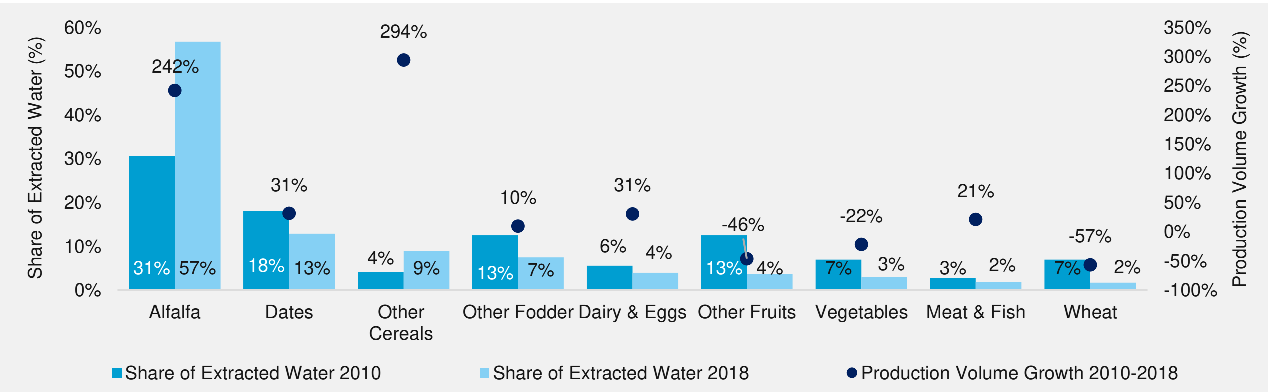
The quest for food self-sufficiency has had negative effects on the sustainability of groundwater resources. The government recognised the unsustainability of current trends and has responded with several measures. These included:

- The phasing out of domestic wheat production by 2016;
- Abolishing import tariffs on cereals, animal feed and wheat flour, and reducing the general tariff on foodstuffs from 75 percent to 5 percent;
- Providing support for agriculture production in overseas countries;
- Ministry of Agriculture set a target of a 30 percent reduction in water usage in the agriculture sector by 2030 through improving irrigation techniques and eliminating water-intensive crops, and this target may be increased to 50 percent.

As a water-saving measure, the phasing out of wheat production was largely unsuccessful, as production switch occurred with farmers shifting production from wheat cultivation to producing more water-intensive forage crops, such as alfalfa and Sudan grass.

This exacerbated the water problem with green fodder production volumes growing by almost 50%. In response, the Saudi government issued a new decree to dramatically reduce green fodder production by the end of 2018.

Figure 1: Estimated Change in Share of Water Used by Agricultural Production Type - 2010 vs. 2018

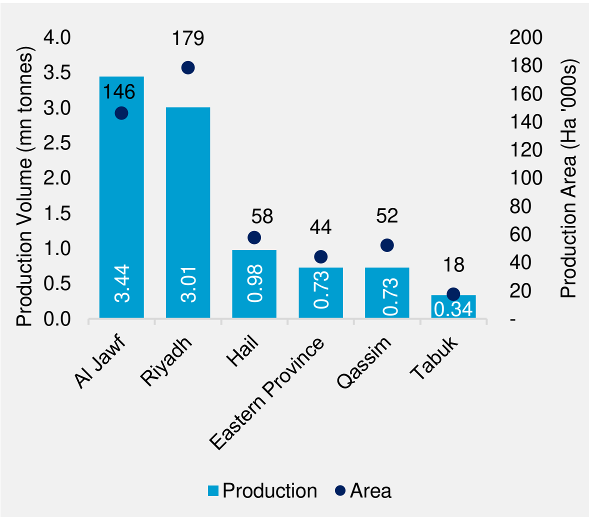


Source: MEWA, FAO, King Abdullah Petroleum Studies and Research Center, Farrelly & Mitchell

The decree restricts green fodder production across six regions (Riyadh, Tabouk, Eastern Province, Qassim, Hail, Jouf and Tabouk). These regions account for 99% of KSA green fodder production.

The decree restricts green fodder production to small and medium farms, with a maximum of 50 hectares of green fodder production allowable (across all the registered producer's local operations).

Figure 2: Production Volumes & Area of Key Green Fodder Production Regions in KSA



Source: MEWA

Under the decree, large farmers only have a right to invest in the following activities:

- Feed factories provided that raw materials are imported;
- Poultry projects and products;
- Raising and finishing livestock that depend on compound feed for nutrition;
- Advanced greenhouses which will contribute to the achievement of food security;
- Cultivation of pastoral open field crops using modern irrigation techniques;
- Fish farming in salt-water;
- Farming of green fodder outside the kingdom in order to import to Saudi Arabia; and
- Tourism projects that are not wasteful of water.

Data from 2019 registrations for agricultural licenses show 14,693 farms still growing fodder crops on 341,550 ha. The online registrations show 2,657 farms converting to wheat with a total of 107,215 ha averaging 40 ha per farm. Only 273 farms had taken the government pay out offer to stop both wheat and fodder crop production completely.

The combined total of 17,625 fodder crop and wheat farms make up two thirds of the total number of 26,976 approved, registered "pivot farms" in the country.

Based on these figures, measures to restrict green fodder production seem to have reduced the area under cultivation by almost 30% on 2018 levels. While a good start, it could be argued that this is not enough to deal with KSA's existential agricultural water crisis, given that it is likely to reduce agricultural water consumption in 2019 by less than 10%.

The introduction of water monitoring and tariffs have potential to stimulate more sustainable water usage. However, if water charges are introduced, costs should not undermine the economic feasibility of producing prioritised crops.

Introduction

When it comes to water, KSA has overcome many challenges during the past half-century of rapid population growth and unprecedented agricultural transformation through irrigation.

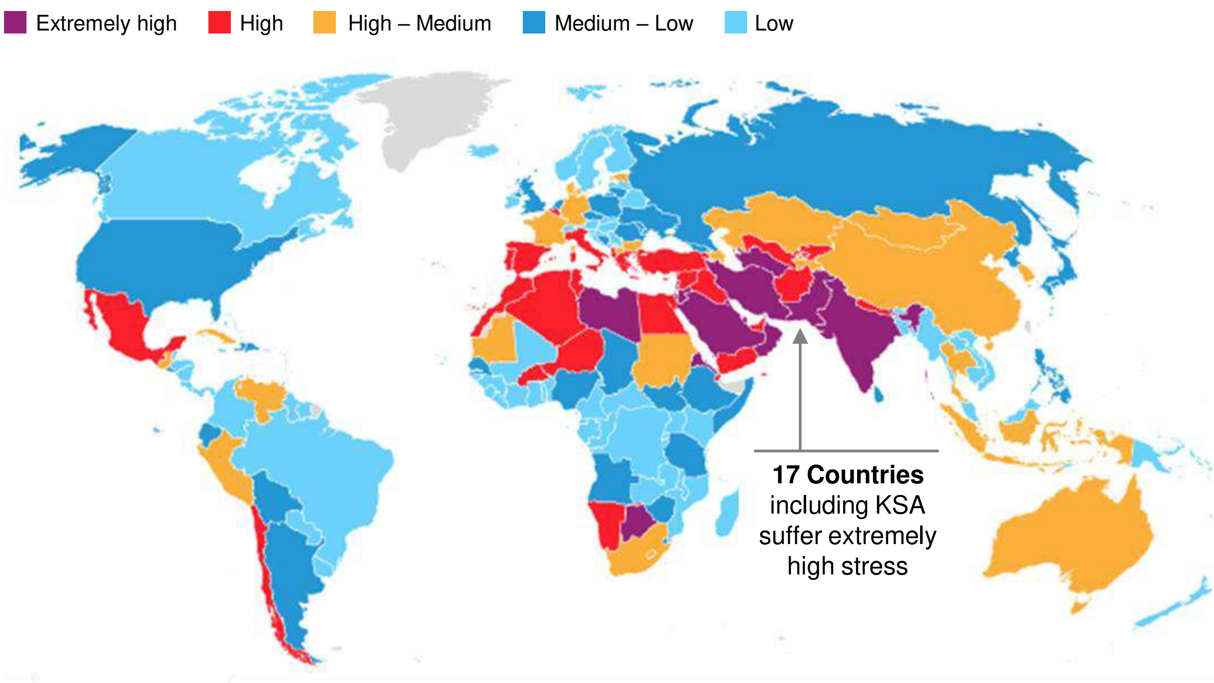
Since the 1970s, KSA has managed to increase household access to tap water from less than half of the country's population (c6 million at the time) to almost 100% of its current population of more than 30 million people. This is largely due to the investment in and construction of the largest water desalination capacity in the world.

In 1975, the irrigated area of KSA was around 558,000 ha of which 70% was wheat and sorghum. By 1992 at the peak of wheat and fodder crop production, cultivated land had reached 1.6 million Ha thanks to tens of thousands of center pivot irrigation systems clustered strategically over underground water.

Despite these successes, the water security challenges facing KSA are significant. KSA is ranked 17th in the world among countries suffering from water stress. It is the top ranked country with a significantly large land area and population.

KSA is a severely water scarce country drawing heavily from its non-renewable fossil aquifers. The rapid depletion of non-renewable aquifers has necessitated a profound reconsideration of the role of agriculture in KSA's society and economy.

Figure 3: Global Water Stress Levels by Country



Source: World Resource Institute

A paper presented in 2002 concluded that 35% of KSA's non-renewable water sources had already been drained by 1994[1]. Since then the rate of groundwater withdrawal for agriculture has increased, reaching a record 21.2 billion m^3 in 2018.

Water is being added back at a rate of just 2.2 billion m^3 per year through precipitation. [2]

1. Al-Turbak A (2002) Water in KSA of KSA: policies and challenges. In: Proceedings of symposium on the future vision of the Saudi economy. 19–23 October 2002, Riyadh, KSA
2. FAO Aquastat

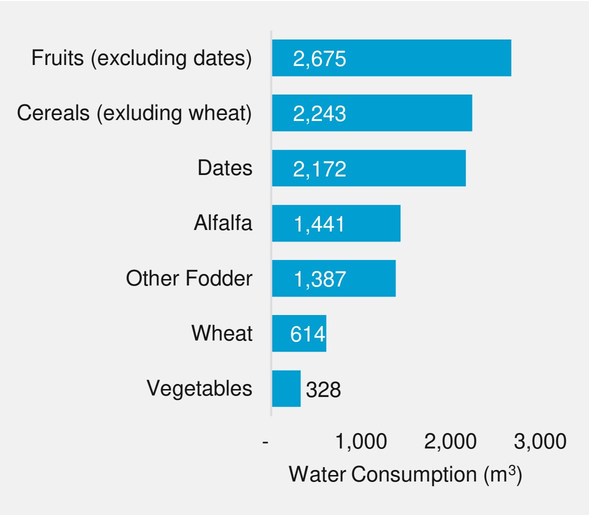
KSA has no permanent surface water in the form of lakes or rivers. Its aquifers are the remnant of a glacial age 15,000 to 20,000 thousand years ago. The water in deep aquifers is non-renewable, and renewal in shallow aquifers is limited (due to the high evaporation rates).

The area under irrigation in KSA has shrunk by over 40% since the peak in 1992, mostly due to the phase-out of wheat production. However, the rate of aquifer depletion has continued to climb as farmers shifted production to the more water-intensive alfalfa crop.

Measures to reduce green fodder production, including banning production by large corporate farms and restricting the production of smaller farms were implemented in late 2018. This should help to reduce the rate of aquifer depletion.

Potatoes, onions, tomatoes and melons as well as other fruits and vegetables are still produced in abundance in the desert. The area of date palms whose consumption of water per ha can exceed wheat, has been expanding slowly and is now close to 120,000 ha.

Figure 4: Estimated Water Consumption by Crop Type in KSA (m^3 consumed per tonne produced)



Source: Farrelly & Mitchell, King Abdullah Petroleum Studies and Research Center (KAPSRC)

Increasing non-agricultural water use is mostly dependent on increasing desalination capacity. High per capita consumption by the growing urban population points to the need for reforms to water policy to promote behavioural change for water conservation. Citizens of the Riyadh region are among the biggest users of water per person of any metropolitan area at 360 liters per day.

Enforcing a higher price, or for that matter, any price on industrial, agricultural and especially household water, however, is set to heighten sensitivities.

Adoption of the latest desalination and distribution technologies have great potential to make freshwater production more efficient with less leakage and wastage in getting it to households and businesses. Recovery and recycling can contribute hugely to water savings.

Conservation at the household and industrial level promoted through mass introduction of smart metering is needed on a national scale. Introducing technology and policy to promote more economical water consumption could cost much less than building even more desalination plants.

It is hoped that the upcoming privatisation of public water companies will accelerate the introduction of the new technologies needed to conserve water.

This report focuses on water use in agriculture given that it accounts for the lion's share of water usage in KSA.

The story is largely about what share of the country's finite subterranean water resources should be dedicated to agriculture, if at all, and how the allocation should take place i.e. the production of fodder crops, which supports domestic livestock husbandry, versus wheat; and date palms versus fruits and vegetables.

Irrigated agriculture

In KSA about 82% of annual water use goes to agriculture. This is significantly higher than the global average of roughly 70%. What distinguishes KSA most is the share of agriculture that depends on pumping water from non-renewable sources deep underground.

Only in the Al Ahsa Oasis zone does sufficient water still bubble to the surface in some places to allow for traditional canal-based surface irrigation of date palm plantations and even a small number of rice paddies.

In KSA's semi-mountainous southwest corner there is sufficient rainfall to support seasonal production of some crops, though mining of "fossil water", as non-replenishable aquifers are sometimes called, is also widely practiced there. Elsewhere, crop production is largely dependent on deep drilling and pumping fossil water from aquifers.

Unprecedented investment in irrigation has been the basis for creation of a modern agricultural sector that has brought a certain level of diversification to the KSA economy.

From a low base in the early 1970s (worth less than USD 0.3 billion), the total value of agricultural output reached USD7.6 billion in 1992, about 5.6% of nominal GDP. Since then the value of total agricultural output has more than doubled to USD17.5 billion. However, largely due to high oil prices, agriculture's share of GDP declined, by 2017 the share of agriculture in the economy had reduced to 2.6%[3]. In 2017 farming accounted for 6.7% of all labour in a workforce of 13.8 million, three quarters of whom were expatriates. [4]

From a socioeconomic perspective, the subsidisation of agriculture made a lot of policy sense to rulers and government planners in the 1970s. The benefits were felt by a large portion of the Saudi population which was much more rural at the time. In particular, drilling boreholes for farms helped improve the living standards of the Bedouins by allowing for permanent settlements facilitating access to education, health and social welfare services.

Since underground water extends in a wide swathe covering much of the northern and eastern parts of the country, the introduction of irrigated agriculture could have wide geographic distribution covering many diverse tribal groups.

The main goal of the initial push for large-scale irrigated agriculture was to achieve self-sufficiency in wheat production. Through government land grants and interest free loans for well drilling, irrigation and farm equipment a large number of Saudis could be engaged running farms that contributed to the KSA's food security.

Support for irrigation schemes benefited many small growers operating just one or a handful of center pivots.[5] At the same time the subsidies stimulated the rapid growth of a large number of integrated agribusiness firms that competed to adopt the most modern agricultural practices and adapt them to the unique conditions of the Arabian Peninsula.

Center pivot irrigation was relatively easy to introduce. Such was the demand that by the 1980s Saudi enterprises were manufacturing much of the equipment in KSA under license from companies in the USA and Europe that had pioneered the technology.

Generous government-backed schemes underwrote investment in irrigation systems beginning in the mid-1970s. By 1980, annual medium-term loans for capital investment in agriculture had reached SAR 6 billion (USD 1.6 billion) per annum.

During the period of rapid development in the late 1970s and 1980s, the rule of thumb was an investment cost of one million riyals (USD 330,000)[6] for each 50 Ha center pivot spread across a farm of 20 pivots of that size. This investment included:

- Drilling;
- Casings;
- Pumps and engines for the center pivots; and
- Tractors and combines.

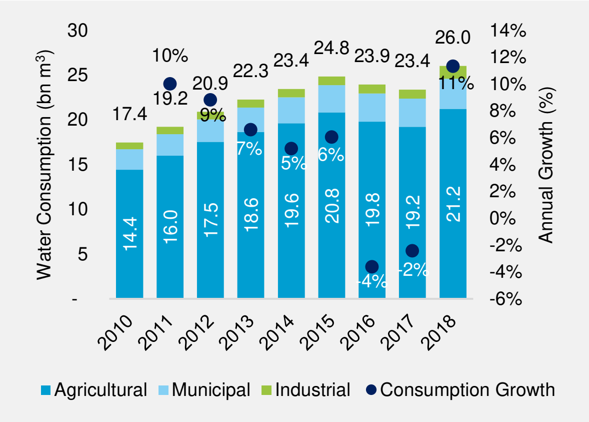
Agricultural firms were given large tracts of land at no cost. If they developed a certain part of it within five years, they were given title to the land. Development meant drilling wells and installing irrigation systems to farm crops, at first wheat and later fodder crops like alfalfa and Rhodes grass during the first couple decades of agricultural expansion.

3. CIA World Factbook.
4. https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html
5. Central pivots in KSA generally cover an area 50 ha.
6. At the USD to SAR exchange rate at the time.

Agricultural water

Already in 1982 total water withdrawal for agriculture was 15.3 billion m³. By 1997 it had increased to 20.8 billion m³, an annual record. Thanks in part to declining wheat production; water use in agriculture had declined to 14.4 billion m³ in 2010, but by 2018 it had climbed to 21.2 billion m³ (a new record). This increase was likely due to the large-scale switch to water-intensive fodder crops.

Figure **5:** Water Consumption by Sector in KSA 2010-2018



Source: GAStat

This rate of fossil water withdrawal remains highly unsustainable. It is estimated that 80% of KSA's groundwater resources has now been exhausted. Annual average precipitation of 59 mm is sufficient only to replenish 2.2 billion m³ of groundwater annually. This is, at most, 11% of fossil water extraction.

As KSA's population has expanded per capita internal renewable water resources have fallen from 138 m³ in 1992 to just 72 m³ in 2017.

In Qassim region, a prime agricultural zone, boreholes that reached water 70 meters below the surface when first drilled in the 1980s, have had to be extended every few years with additional sections of pipe to a depth of 200 meters. The level of the aquifer is said to be dropping two metres per year. Anecdotal evidence of shrinking aquifers is similar throughout the country.

The use of groundwater for agriculture is becoming increasingly problematic as the levels of water in aquifers continues to fall. The deeper the borehole the greater the cost to pump water to the surface. In addition, as fossil water deposits shrink, they tend to become more and more brackish. This limits their suitability for growing many crops.

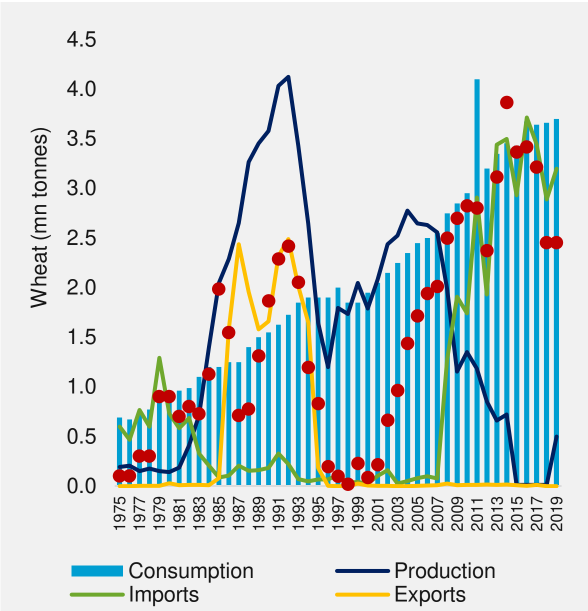
Wheat

The story of wheat production, more than any other crop, illustrates both the success and failure of water policy in KSA. By the late 1970s food security concerns had led the country to adopt a goal of self-sufficiency in wheat, highly-subsidised Arabian flat bread[7] being the principle source of carbohydrates for most households.[8]

In the 1960s and 1970s, when the population was a fraction of today's, wheat was grown on just 50,000 ha to 125,000 ha in areas where water was close to the surface. Domestic production supplied a large but declining share of national consumption.

By 1971, imported wheat covered 80% of total consumption of less than one million tonnes per year. The area planted in wheat then decreased significantly in the mid-1970s. As a result, wheat imports surged to meet the demands of a rapidly growing population. Wheat imports peaked at 1.3 million tonnes in 1979.

Figure **6:** KSA Wheat Production, Trade & Consumption Volumes 1975-2019



Source: USDA

Between 1981 and 1992 the area planted for wheat expanded by a factor of 15, increasing from 60,000 ha to an all-time high of 924,000 ha in 1992. Heavy investments in center pivot irrigation systems, supported by generous government subsidies, made this possible.

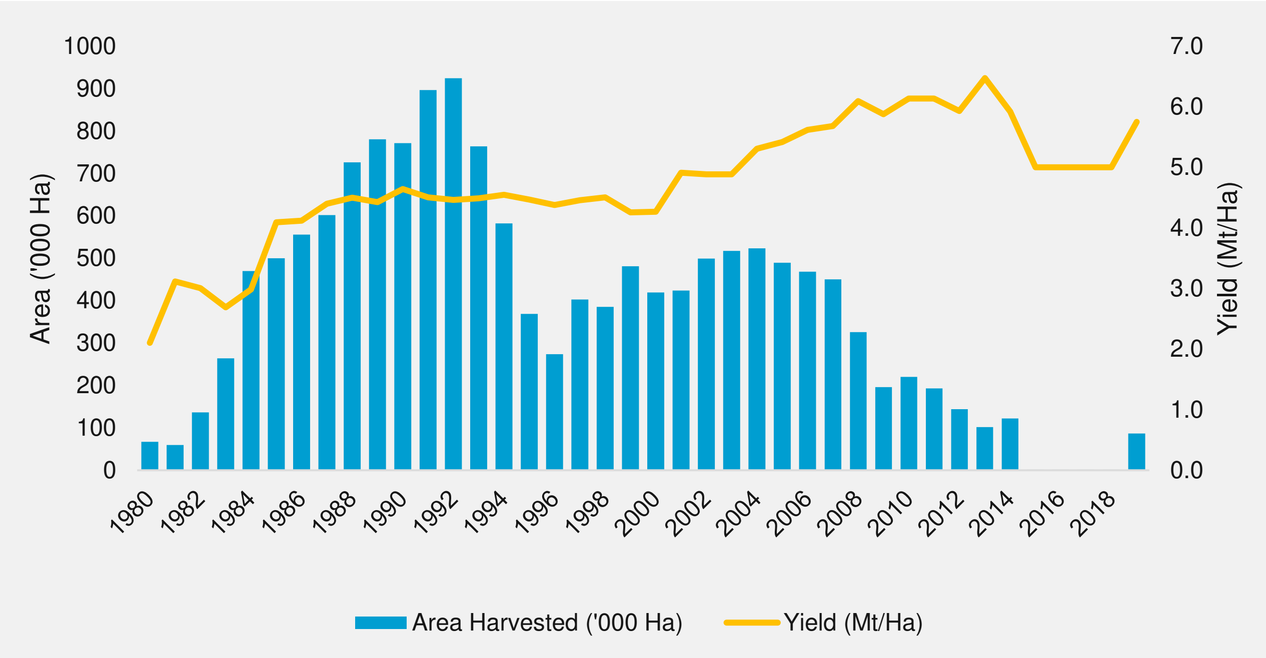
Domestic wheat production skyrocketed, reaching 4.1 million tonnes in 1992.

7. Arabic bread remains subsidised, costing SAR 1.15 for 500 gm
8. Arabic bread remains subsidised, costing SAR 1.15 for 500 gm

Thereafter, the area planted with wheat began to decline, dropping to 274,000 ha in 1996, before subsequently recovering to an average of 460,000 ha out to 2007.

Total wheat production in the ten years through to 2008 was another 23 million tonnes, due in part to better average yields, reaching 6.3 tonnes per hectare in 2008. The best managed farms achieved yields of 10 to 12 tonnes per ha.

Figure 7: KSA Planted Area & Yield (Wheat) 1980 to 2018

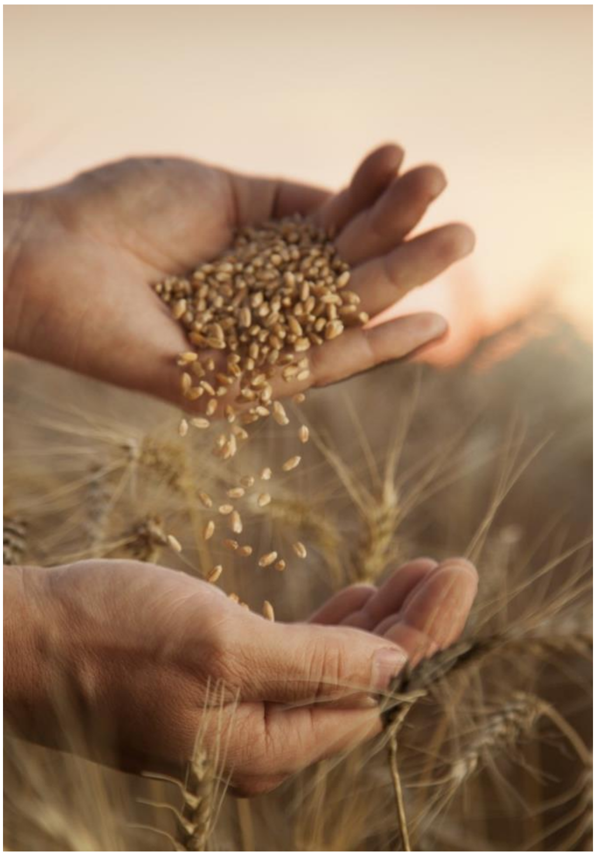


Source: USDA

Despite these successes, Saudi planners ultimately decided, that no more of the country's precious groundwater should go to wheat, given the abundant supply of the cereal in international markets.

Faced with the need to give small farmers an alternative to water-intensive fodder crops, in 2018 SAR policy shifted once again. After bringing Saudi wheat production to almost a complete halt by buying almost no domestic wheat for four years, the government reinitiated its wheat purchasing programme in 2019, committing to the purchase of up to 700,000 tonnes of wheat from domestic producers over the next five years. In 2020, it was announced that this figure would increase to 1.5 million tonnes over the five-year period.

In 2019, SAGO purchased more than 200,000 tonnes of domestic wheat. As more farmers switch back from alfalfa to wheat, industry expectations are that government wheat purchases will increase again in 2020.



Wheat prices

Purchasing wheat at an artificially high price was the principle means of subsidising wheat production in the country and rendering feasible private sector investment in center pivot schemes.

The government was the sole buyer of domestically produced wheat. It has also maintained a monopsony on wheat imports.

From 1979 to 1986 the government price of USD $933 per tonne enabled farming enterprises to rapidly pay back loans taken out to buy irrigation equipment and state-of-the-art farm machinery.

Wheat production volumes were inflated by the high government purchase price, and largely declined in line with reductions in this price over time. In 1986 the government wheat price was lowered to USD 800 and then halved to USD 400 from 1989 to 2005, when it was again cut to USD 250 per tonne, a level approaching the price of international wheat delivered to Saudi ports.

At this price much of the domestic production was no longer profitable. Wheat output started to fall gradually, then declined rapidly from 2008 onwards.

Wheat surpluses and exports

The government guarantee to buy all wheat produced in the country at a very high support price led to an extraordinary period of surplus production. The only outlet for disposal of this wheat was export markets.

Between 1986 and 1994, the state wheat monopoly organisation GSFMO9 (now known as SAGO) exported 17.7 million tonnes of wheat, an average of nearly 2 million tonnes per year. During the same period domestic consumption of wheat was 14 million tonnes, an average of less than 1.6 million tonnes per year. Roughly 60% of KSA's highly subsidised wheat production in those years was sold at international market prices that were much of the time between $100 and $150 per tonne.10

From 1989, the government paid farmers $400 per tonne (reduced from $800). This amounted to a gross subsidy of $250 per tonne. Additional costs included storage and transport to ports for export as well as other overhead costs.

KSA was the sixth largest exporter of wheat in the world at the time. However, the drain on the national budget was huge and, more importantly, the amount of fossil water used was highly unsustainable.

9. Grain Silos & Flour Mills Organisation
10. https://www.indexmundi.com/commodities/?commodity=wheat&months=360

Water for wheat

There are no official figures for the total amount of water drawn from aquifers to grow wheat or fodder crops. The amount of water pumped from individual wells has never been monitored consistently on a national or even on a regional or local level through metering. In many cases, farms have no clear idea of how much water they are consuming.

Despite the increasing sense of urgency about water shortages, fees for the extraction of water from non-replenishable aquifers have yet to be introduced. Water extraction costs are limited to well-drilling and pump installation, along with moderate charges for electricity or generator fuel to power the pumps.

Some agricultural experts maintain that under the hot and dry conditions of KSA, with its extremely high rates of evaporation, each tonne of wheat may have required an average of 6,000 m^3 of water during the early expansion of wheat production.

Relatively low yields of as little as three tonnes per ha in the first years of wheat farming contributed to the high-water use per tonne. However, the leading private sector farming enterprises recorded some notable achievements during the period of peak wheat production. Under competitive pressures to survive as the government wheat price was cut, they achieved remarkable increases in yields that enabled them to reduce water consumption per tonne produced.

According to industry sources, in 1978, wheat farming enterprises were using over 6,000 m^3 of water per tonne of wheat produced. By 2010, water productivity rates had improved by 90%. The top 20% of these enterprises had increased yields nearly threefold from 3.1 tonnes per ha to 9.1 tonnes.

Assuming an average water consumption of 2,000 m^3 per tonne of wheat produced during peak export years, total water use for exported wheat during those years can be estimated at more than 35 billion m^3. This is enough to meet KSA's current household water consumption requirements for approximately 11 years. [11]

In the 32 years from 1984 when wheat production was ramped up until the wheat purchasing programme was phased out in 2016, KSA produced almost 70 million tonnes. Based on the same average water productivity rate, this equates to around 140 billion m^3 of water, enough to meet current household needs for more than four decades.

There is potential to import this wheat at a highly competitive cost, with the added benefit of significant water saving.

11. It is the equivalent to over 1,000 m^3 per capita based estimates of KSA's current population. At around 250 liters per day KSA has one of the highest per capita household consumption rates in the world. The average person uses about one cubic meter (1,000 liters) every four days.

Fodder Crops

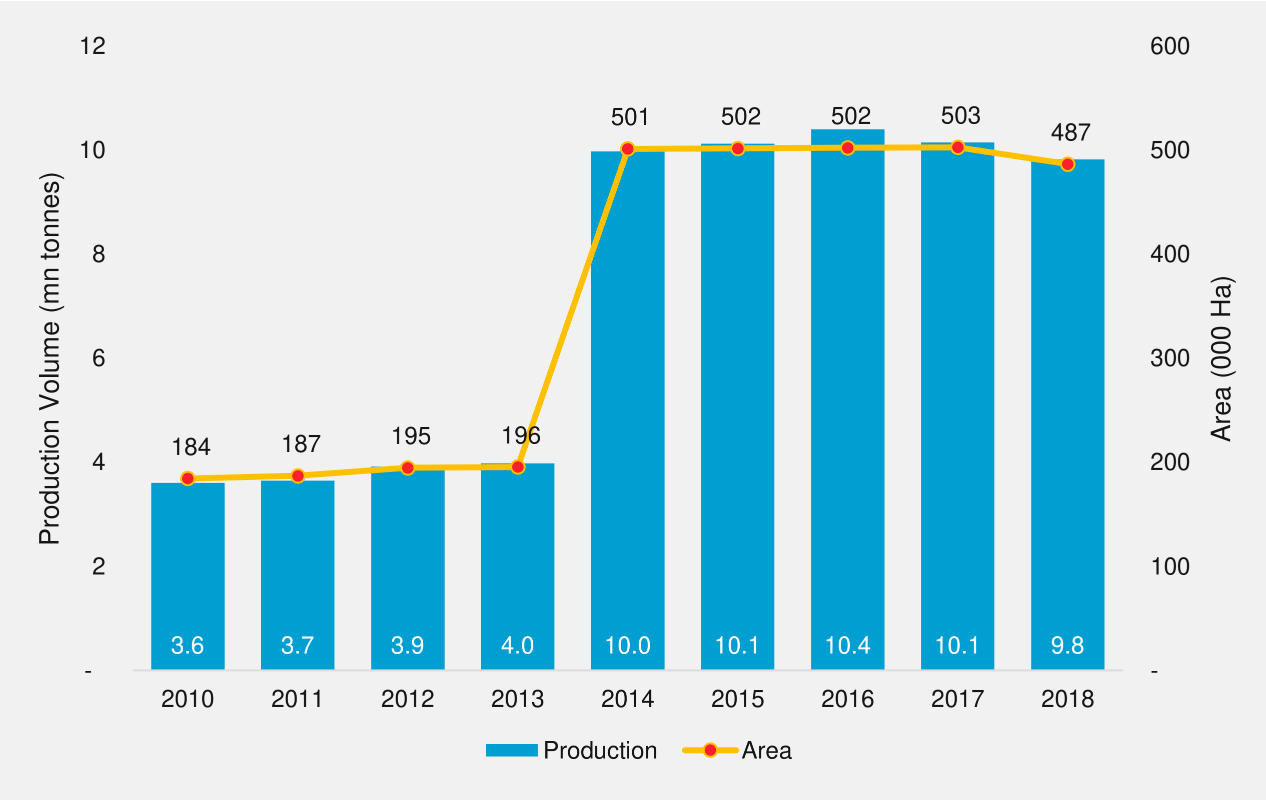
Introduction of modern dairy farms to KSA in the 1980s brought about the first surge in large-scale production of fodder crops under center pivot irrigation.

Alfalfa is by some distance the most important source of fodder in KSA. Along with wheat, alfalfa has ranked for decades as KSA's first or second most important irrigated crop.

Despite the official policy to phase out fodder crops announced in late 2015, producers have been slow to react. Green fodder accounted for 49.1% of open-field cultivated area in 2018, compared to 48.5% in 2015.

MEWA data shows only a slight decline in the area planted with green fodder from 501,200 ha in 2014 to 486,600 ha in 2018. Total production fell only 3% from 10.1 million to 9.8 million tonnes. Alfalfa accounts for 88% of green fodder production.

Figure 8: KSA Green Fodder Production Volume & Area Plant 2010-2018



Source: MEWA, GAStat

The sharp increase in agricultural water withdrawals from 14.4 billion m^3 in 2010 to 21.2 billion m^3 in 2018 reflects the production switch from wheat to alfalfa production.

Alfalfa and Rhodes grass are far thirstier than wheat and other grains since they are perennial plants that need water year-round. The water productivity of alfalfa is about half that of wheat.

The cutting regime for Alfalfa may include up to 8-9 cuttings per annum. Each hectare needs from 13,000 m^3 to 16,000 m^3 of water on a well-managed farm depending on the number of cuts. Conversely, wheat in KSA has a 130-day growing season spanning the cooler winter months. It needs around 8,000 m^3 of water per hectare during that period.

Dairy Fodder

In comparison to wheat, stopping or even just reducing green fodder production is highly problematic. Wheat has a single government buyer, in contrast, there are thousands of buyers of alfalfa in the country.

The ten or so leading private dairy enterprises that account for over 90% of milk production are highly dependent on alfalfa in their feed formulations. Annual green fodder consumption at leading dairy farms in KSA is estimated at 3.6 tonnes per milking cow.

In addition, there are thousands of livestock farmers that use alfalfa as a feed for their livestock.

As the government repeatedly cut wheat prices, in the 1990s it became attractive for farmers to switch to alfalfa for which there was a steady demand from the national dairy herd. As the wheat purchasing programme was phased out, the total area planted with green fodder shot up. Annual green fodder production more than doubled in 2014. However, alfalfa area and production tonnage may have peaked in 2016 when new restrictions were finally put in place.

In the past, the large dairy enterprises produced much of their own green fodder consumption needs. However, driven by the continued evolution of government policy on domestic green fodder production, these enterprises are and have been reconfiguring their supply chains.

Dairy companies have been shutting down their alfalfa production operations in KSA and sourcing supply from a combination of imports and other domestic producers.[12]

In late 2016, after the wheat phase-out was complete, Saudi authorities announced a plan to mostly halt the production of fodder crops for commercial sale. As a result, planners are facing a new dilemma, the need to protect and sustain a viable dairy industry while severely limiting domestic production of fodder crops.

According to the USDA, high protein alfalfa imports[13] accounted for only one third of dairy consumption in 2016. The remaining two thirds was sourced from domestic production.

High protein alfalfa is a critical component in the carefully calculated diet that makes it possible for KSA's "turbo-cows" to yield up to 40 litres of milk per day.

According to industry sources, on the most advanced dairy farms, the daily consumption per head of a milk cow averages 8 kg of alfalfa and 2 kg or Rhodes grass. On an annual basis that equates to 2.9 tonnes of alfalfa and 730 kg of Rhodes grass per cow. A herd of 400,000 cows would produce at least 1.2 million tonnes of high-quality alfalfa per year.

Based on current prices, the cost of alfalfa imports to replace the portion of alfalfa sourced domestically by the dairy industry will be approximately $300 million.

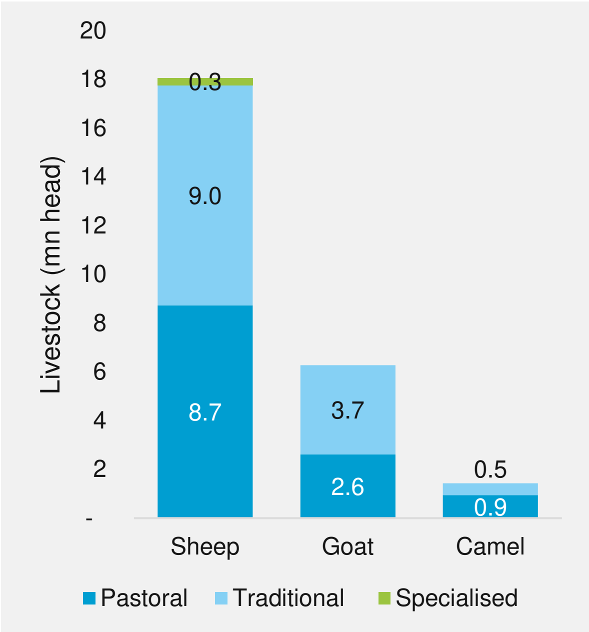
12. Almarai recently announced they would source 100% of their feed requirements from imports. Its strategy to secure its feed supply includes investments in overseas farmland, having made several such investments over the last ten years.
13. The USDA estimates consumption of high-quality alfalfa by the dairy herd at 1.21 mn tonnes

Livestock and Fodder Crops

The majority of green fodder produced in KSA is consumed by the livestock industry (mainly camels, sheep and goats). The national livestock herd is estimated at c26 million head.

KSA's ability to sustain a herd of this size is closely related to the sustainability of fodder crop production in KSA. It is important to nail down the amount of alfalfa and other fodder crops being grown to feed this industry.

Figure 9: Estimated KSA Livestock Herd by Species & Farming System



Source: MEWA, Farrelly & Mitchell

Despite the goal to reduce the amount of water going to these crops, government data shows a steady year to year increase in the numbers of traditional livestock and cows since 2014. The latest MEWA data shows that the enclosed national livestock herd is growing a rate 1% per annum.

Data on pastoral herd is harder to obtain. The 2014 agricultural census estimated that the pastoral herd accounted for almost 50% of the livestock herd.

Based on available data, the industry's total feed requirement is estimated at c13 mn tonnes per annum. However, actual feed consumption is likely considerably higher due to waste and poor feeding practices.

Alfalfa and imported whole barley are the two key feed commodities used by the industry, while compound feed consumption is limited. Historically SAGO have had a monopoly on the importation of barley and currently import 6 to 8 million tonnes of barley to distribute to livestock famers as ruminant feed. Market liberalization of barley is ongoing.

Both barley and alfalfa pose problems, with up to a third of whole barley fed to ruminants passes through their digestive system undigested.

In order to increase the efficiency of the livestock industry and reduce water consumption, government policy is to support the development of the feed milling industry through subsidised feed ingredients and low cost capital investment loans. MEWA has an ambitious objective of reducing barley imports to just 1.5 mn tonnes. [14]

However, the livestock sector is traditional and resistant to change. The efficient use of feed and good animal husbandry in general is not the rule, many livestock farmers prefer traditional feeds.

Even if livestock farmers are successfully converted to compound feed, ruminants will still require roughage in their diets. We estimated, based on current livestock numbers, an ongoing roughage requirement of approximately 4 million tonnes.

Up to the end of 2018, local alfalfa production was meeting the livestock industry's needs, albeit at a great cost in terms of water consumption. We estimate water extraction for this alfalfa production at between 8-11 billion m^3.

The new policy restricting alfalfa production to small and medium farmers on a max of 50 ha should reduce extraction, but not significantly, at least in short term.

Latest estimates have green fodder production taking place on 341,550 ha of registered farmland in 2019. Large corporate farms can achieve water efficiency rates of 15,000 m^3 per ha, but it is debatable if smaller farms can achieve those efficiency levels.

Assuming average water efficiency at half the rate of corporate farms and yield per hectare of 20 tonnes, water extraction for 6.8 million tonnes of green fodder be within the range of 8-10 billion m^3.

14. This is to be used exclusively as an ingredient in compound feed.

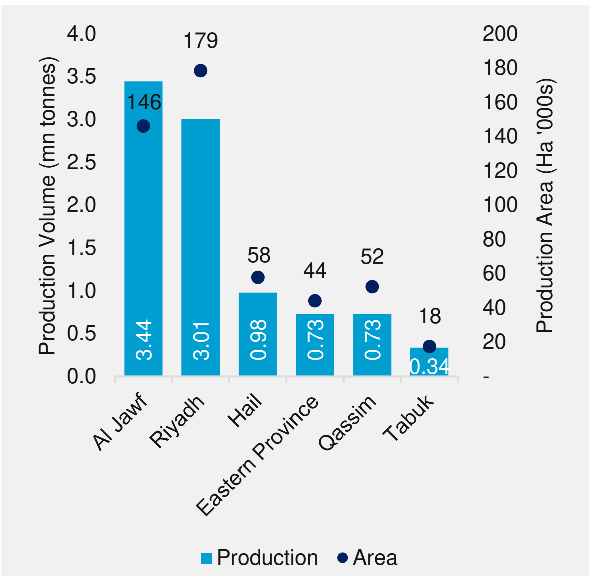
New policy

In order to further rationalise and reduce the use of water in agriculture, the State Council of Ministers issued a series of decrees over the last four years that especially target the phasing out of fodder crops. Recently we have seen subsidies for imported grains coming to an end while subsidies for imported fodder have increased, encouraging domestic production of grains while suppressing domestic fodder production.

The first two decrees (issued in December 2015 and October 2016) declared and reaffirmed that production of fodder crops would stop by 2019. A third decree issued in October 2017 detailed the measures that would be put in place to restrict production of fodder crops starting from November 5, 2018 in the six major green fodder producing regions KSA.

A MEWA booklet that came out in 2018 uses simple illustrations and language to summarise the regulations to be implemented.[15] The new set of rules divides all farms into three categories - small, medium and large - and proposes alternative production, compensation or investment options for farms based in this categorisation.

Figure 10: KSA Green Fodder Production Volume & Area by Region 2017



Source: GAstat

It restricts the production of various green fodder crops due to excessive water use in six regions in KSA. These include:

- Alfalfa;
- Rhodes grass;
- Sudan grass; and
- Rye grass.

No new licenses are being issued for these crops. Only small farmers with licenses first obtained no later than 2015 may grow them. Feed barley and maize production is also restricted.

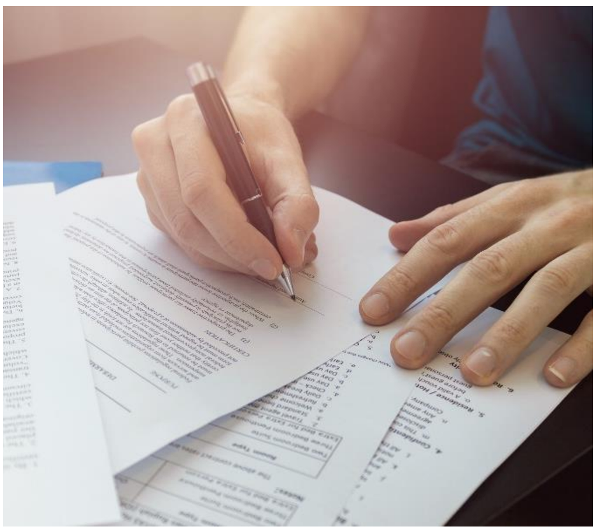
A second category of licensed crops may be grown by a farm of any size, but these crops may not be exported outside KSA. These crops include:

- Potatoes;
- Tomatoes;
- Onions;
- Melons and watermelons;
- Grapes;
- Pumpkins;
- Olives; and
- Sweet corn.

Exportation of processed foods using these domestic crops as raw materials is also prohibited. For example, this means that KSA's large potato chip producers may not ship to other GCC countries. Apparently, an exception has been made for KSA's highly regarded organic olive oil which still reaches markets in other GCC countries.

All other crops may be freely produced without a special license and may be exported. The reality is that aside from dates, few of the remaining crops grown in KSA are competitive in international markets.

KSA has large production of high-quality strawberries in temperature-controlled glass greenhouses. However, Egyptian strawberries grown in the open field easily undercut Saudi prices in third country markets of the GCC.



15. Available at: shorturl.at/pwy68

Farmer options

The goal is to phase out as much as possible the lowest value, most water-thirsty crops, but at the same time to soften the impact of this policy on the income of small farm households who may have grown these crops for many years. The new policy gives such small and medium farmers three options when it comes to wheat and fodder crops.

Figure 11: Alternative Options Green Fodder Producers Post-Implementation of Production Restrictions

Farmer options

Large Farmers (>100 Ha)

- Feed milling using imported raw material
- Poultry and poultry products production
- Livestock breeding and finishing using compound feed
- Advanced greenhouse production
- Salt water fish farming
- Overseas investment in green fodder production for export to KSA
- Cultivation of pastoral plants using modern irrigation systems
- Tourism

Medium Farmers (50-100 Ha)

- Stop growing fodder and receive compensation (SAR 4,000/Ha)
- Grow fodder (max 50 Ha) and thereafter receive compensation (SAR 4,000 Ha)
- Grow wheat (max 50 Ha) and thereafter receive compensation (SAR 4,000 Ha)

Small Farmers (<50 Ha)

- Stop growing fodder and receive compensation (SAR 4,000/Ha)
- Grow fodder on an area not exceeding 50 Ha
- Grow wheat on an area not exceeding 50 Ha

Source: MEWA

Under the first option the government will pay small farmers (those with less than 50ha) who agree to stop growing fodder crops or wheat compensation of SAR 4,000 SAR per ha for up to the maximum of 50 ha.

The total payout to stop wheat or alfalfa on one irrigation circle would be SAR 200,000 ($53,000). Official farm registration statistics show that only about 1% of farms have taken this option.

The second option is for small farmers to continue growing fodder crops but only for feeding their own livestock.

Planting wheat on an area not exceeding 50 ha is the third option for small farmers of fodder. However, the entire output must be sold to the Saudi Grains Organisation (SAGO) at the fixed government price. SAGO will then allocate this wheat to local milling companies. The 2019 farm registration figures show that around 10% of farms have converted from fodder to wheat.

Medium farmers are categorised as farmers with between 50 ha and 100 ha. These may accept the same payout per hectare that small farmers can get for up to 100 ha (maximum compensation SAR 400,000). Alternatively, they can grow either fodder crops or wheat on an area not exceeding 50 ha and receive compensation of SAR 4,000 per hectare for the rest of their agricultural land holding.

Farmers can continue to grow other crops (subject to restrictions) on the land previously used for fodder production. In short, KSA policy now encourages small farmers to grow wheat in place of perennially thirsty fodder crops.

Large farms (i.e. those with more than 100 ha) are no longer allowed to grow grain or fodder crops. Official policy encourages them to invest in foreign production of fodder crops for import to KSA and to divert assets domestically into areas such as:

- Higher value horticultural crops in greenhouses;
- Processing of imported raw materials for feed production;
- Livestock production;
- Marine fish farming; and
- Tourism enterprises.

Farmers now use an online system called "Sajjel" to register their farms and obtain their licenses. In doing so they must commit to compliance with the decree of December 2015 limiting fodder crops. Local MEWA inspectors inspect licensed farms to ensure compliance with regulations.

The MEWA regulations contain a set of ten guidelines to limit farmers ability to get around the regulations. These include:

- A farmer with a number of farms is only eligible to grow can only continue to grow fodder or wheat on one farm;
- Tenant farmers can grow wheat only if they possess a farm lease agreement;
- Farmers switching from fodder crops to wheat or alternatives must pay off old loans to get new loans from the Agricultural Development Fund;
- Farmers seeking compensation for the cessation of fodder production must pay off their ADF loans;
- In cases where farmers are stopping fodder production completely and opting for monetary compensation, the farmer does not have the right to revert back to farming any of the mentioned alternatives.
- Farmers must present their farm registrations and license to obtain power from Saudi Electricity Company and diesel fuel from ARAMCO.

Wheat resumption

The new policy has once again changed the course of Saudi agriculture by reinstating wheat as a key crop. In 2019 SAGO announced that it would procure up to 700,000 tonnes of domestic wheat from farmers over the next five years, at either the international cost of SAGO's imports or 1,250 SAR ($333) per tonne (whichever is highest). This figure has since been increased to 1.5 million tonnes.

In 2019 a number of the 13 government-owned but semi-autonomous milling sites that depend on SAGO for wheat resumed milling domestic wheat after a four-year hiatus. Official sources put SAGO's purchases of domestic wheat in 2019 at 202,150 tonnes, worth SAR 240 mn.

MEWA officially reports there are 2,675 farms with 107,215 ha with agricultural licenses to grow wheat in 2019. This would equate to production of almost 700,000 tonnes . However, some sources estimate that domestic production could increase to 1.5 million tonnes over the coming years, approximately half of KSA's annual wheat requirement. The last time Saudi wheat production exceeded 1.5 million tonnes was in 2008.

The 700,000 tonnes would be the largest Saudi wheat harvest since 2012. At around 40 ha per farm and 6 tonnes per ha, the national yield before wheat production stopped, it would require around the roughly 2,700 farmers should reach this level of production.

Since no new farm licenses are being issued it can be assumed that around 107,000 ha will be taken out of alfalfa production. If this is so then, assuming alfalfa production at 20 tonnes per ha, national production should decrease by around 2.1 million tonnes helping to curtail the current overproduction that has resulted in low domestic alfalfa prices and the use of high protein alfalfa to feed livestock.

Data from 2019 registrations for agricultural licenses show 14,693 farms still growing fodder crops on 341,550 ha. The online registrations show 2,657 farms converting to wheat with a total of 107,215 ha averaging 40 ha per farm. Only 273 farms had taken the government pay out offer to stop both wheat and fodder crop production completely.

The combined total of 17,625 fodder crop and wheat farms make up two thirds of the total number of 26,976 approved, registered "pivot farms" in the country.

The measures to restrict green fodder production seem to have reduced the area under cultivation by almost 30% on 2018 levels. While a good start, it could be argued that this is not enough to deal with KSA's existential agricultural water crisis, given that it is likely to reduce agricultural water consumption in 2019 by less than 10%.

16. Flour milling is currently undergoing privatisation
17. Based on an average yield per hectare of 6.5 tonnes.

Outlook for Saudi Agriculture

Water metering and tariffs

After at least a decade of deliberations, KSA's government laid out a policy that will require farmers to pay for water.

In October 19, 2019 the State Council of Ministers issued a decree stating that all underground and drainage water is the property of state. Furthermore, all water used by households, businesses, industry and farms should be metered.

For farmers this means that the water they pump from underground to the surface will be measured and recorded at the pump. The next step will be tariffs on agricultural water.

Social media prior to the decree had reflected public pushback against government efforts to broaden the number of entities whose water was metered.

Water consumption of households in large cities has been metered for some time. With the decree the government made clear its intention to go forward by setting a clear legal basis for eventually making all users pay for water.

In terms of national level water management this is a long-awaited and significant development, given that farming accounts for over 80% of total water consumption. Up until now, farmers only had to bear the cost of drilling a well and installing casings and pump engines and associated energy costs. Water itself has had no price.

The methods and timeline for implementation of this urgently needed policy had not been made public at the time of this paper. Nonetheless there is much speculation about how the directive could be implemented.

The water department within MEWA may simply install flow meters on all submersible pumps used to draw water from underground. A chip installed in the meters could allow the pump to function only if the farmer has purchased a prepaid monthly card for his planned water utilization.

What is certain is that farming enterprises, large and small, will almost certainly have to start paying for water. This could happen as early as 2021 according to certain MEWA sources.

The impact on food costs will depend on the size of the tariffs but also on farmers ability to adopt new water conservation technology.

Pricing water will not be a simple process. One approach could be to adopt a system such as used in Australia where the market sets the price of agricultural water. Farmers, or any investor for that matter, can purchase either "permanent water" or "temporary water" on a type of exchange.

Currently prices are AUD 5,000 (USD 3,400) and AUD 1,000 respectively, the latter being a record price reflecting the multi-year drought afflicting many agricultural regions. At such prices expanding crops like almonds is no longer feasible.

Water monitoring and tariffs have the potential to accelerate the adoption of efficient technology across the agricultural value chain.

For example, the largest date palm plantations, with 100,000 trees or more, already have sophisticated systems to measure soil moisture and automatically control the amount of water released to each tree through their drip systems. The rate of watering makes a difference in the size of the fruit at maturity.[18]

Date palm farmers with a few hundred to several thousand trees will be more likely to invest in similar technology once they have to pay for the water that they themselves may know they are wasting needlessly.

Monitoring water use for any crop especially means the measurement of moisture levels near the root of the plants at different soil depths. By constantly checking, both over- and under-watering can be prevented.

18. Depending on the season, a date palm tree may require 50 to 125 liters of water daily, released from a ring of drip tubing around the base of the trunk during the early morning or late in the day.

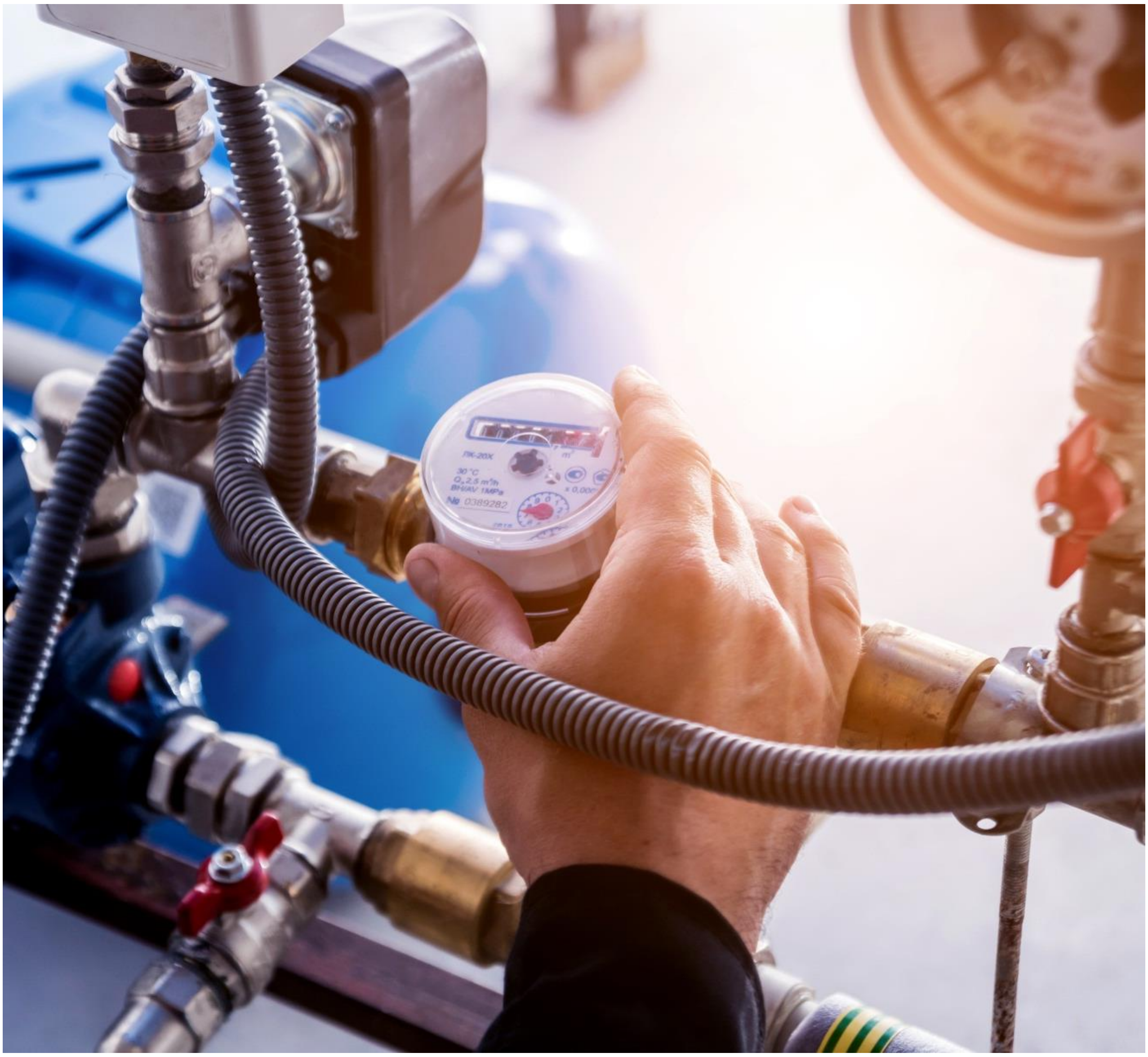
Saudi farming enterprises have only recently adopted modern 3G systems utilising solar-powered, wireless probes with lengths from 15 cm to 90 cm. These can be utilised to regulate the speed of water application from pivot systems in field-scale agriculture, and not just in greenhouses.

There is a strong argument for the registration and licensing of all wells used in agriculture. This should entail identifying the exact location of each one through GPS with depth and pump capacity.

The area irrigated by each well should be measured. Within the framework of the evolving regulatory structure described above, each borehole could be licensed for the production of certain crops, with consideration of the need for rotation of crops from year to year, or season to season.

In the case of center pivots each borehole must be fitted with an official water meter and a rotation sensor. The well could be linked to both the farm company's office and to the government agency responsible for water monitoring via an internet, cloud-based system. Data could be uploaded as frequently as every half hour.

In general technology upgrades are needed to better monitor all wells and piping to ensure flows are measured as accurately as possible and to control for leakage. Only through regulation of water usage and strict imposition of penalties for over usage can more efficient use of water be realised. Guiding the process should be a truth that all stakeholders must learn to accept "We cannot manage what we cannot measure."



Foreign farmlands

With an area four times the size of France but with only just over half the population KSA can be considered sparsely populated. But based on its population of around 850 per km2 of arable land, KSA ranks on the same level as the population of India when it comes to "real density".

Encouraging Saudi overseas investment in farmland in more water-rich countries makes sense from both water and food security perspectives. The government has identified a host of favored investment destination countries across the five continents.

A central question concerns the trade-offs involved in investing in primary agricultural production versus simply buying commodities on international markets. When it comes to cereals like wheat, maize and barley, trading volumes are large with numerous countries having large surpluses for export. KSA has been the number one importer of barley for around two decades and is now one of the top ten wheat importing countries.[19]

Saudi investors have already acquired major holdings of farmland in other countries. These enterprises now operate large farms in the USA, Sudan, Egypt, Argentina, Australia and the Ukraine. In practical terms, KSA is incurring much lower water costs for agricultural production by investing in these countries.

Figure 12: Target Countries for KSA Oversea Agricultural Investment

Source: MEWA, The Land Matrix

Around 40 deals have been signed across 13 countries (mostly in developing countries). However, only around half of these farmland investments were operational at the time of writing, with a number of investments having been discontinued. A high percentage of proposed deals also fail at negotiation stage.

Investors must always carry-out appropriate due diligence. While investment in developing countries is potentially highly rewarding, they carry a high degree of risk. Some of the main constraints on investments in farmland in developing countries include:

- Weak infrastructure and high transport costs.
- Ill-defined property rights which can lead to conflicts with local populations.
- Poorly designed and erratic agricultural policies in the host country.
- Lack of investment in processing and related activities in host country.

These issues increase costs associated with investments and have prevented many such investment projects from going ahead as planned.

19. On a per capita basis it has been the world's largest importer of wheat with over 100 kg per person per year.

In 2020, SAGO committed to a special wheat procurement arrangement with majority Saudi owned companies. The objective is to buy up to 10% of KSA wheat needs from these companies' overseas investments in wheat production as a food security measure.

Vegetables

The best use of limited groundwater is the production of high value, perishable crops to the extent it is feasible in the country's extreme heat. A key challenge has been to modify existing irrigation technology in order to use less water to grow horticultural crops in the open field.

KSA's agriculture has diversified greatly since the 1980s and 1990s when grains and fodder were the most planted crops. While the latter remain important, a much higher share of agricultural water withdrawal from aquifers goes to grow potatoes, tomatoes, watermelons, melons, onions and carrots.

Yields and value per hectare are potentially greater for these crops than for wheat or alfalfa. According to MEWA, potato, tomato and onion yields per ha have averaged over 25 tonnes, 23 tonnes and 26 tonnes since 2014.

Certain farms with superior agronomic practices in terms of varieties, planting, spacing, water application and use of fertilizer and agrichemicals have achieved yields significantly higher than average. For example, onion yields on some large, well-managed corporate farms reached over 100 tonnes per ha according to industry sources.

According to MEWA, over the period 2014-2018, the area planted with vegetable crops increased at a CAGR of 1.8% to production to almost 86,000 hectares, with production volumes increasing at a CAGR of 2.3% to nearly 2 million tonnes.

Four crops account for 76% of vegetable production, with three of these almost exclusively grown under central pivot (watermelon, potato, and onion).

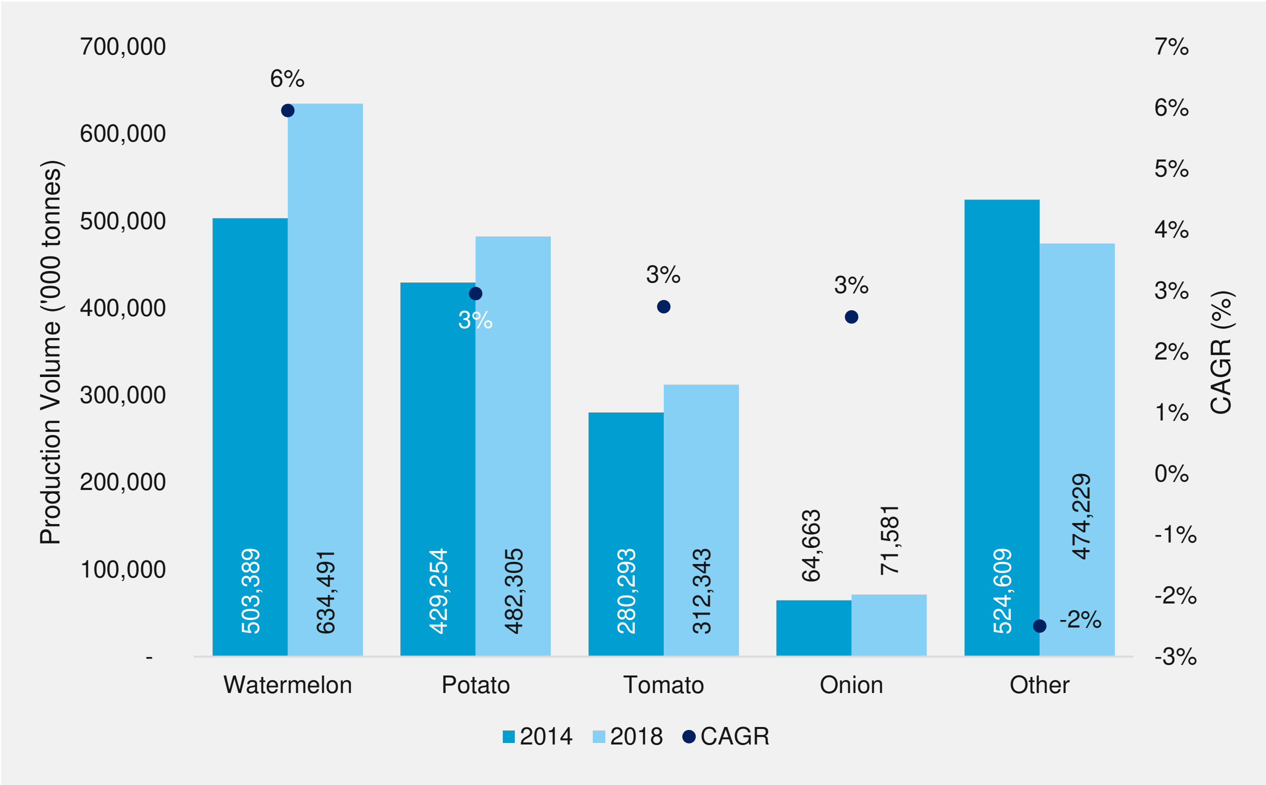
Watermelon is the key crop, accounting for 32% of production. Production recently reached a record 634,000 tonnes. Generally, watermelon production has increased every year since 2009 and grew at a 6% CAGR between 2014-2018.[20]

Potato is the second most important crop, accounting for 24% of vegetable production. The potato harvest has shown moderate increases over the last number of years.

Despite significant production volumes, KSA remains a large importer of certain processed potato products e.g. french fries. It has developed its own markets in the region for exportation of processed potato products. These may now be restricted based on the new rules.

20. On the other hand, melons ("shamam") have seen production steadily fall including in the five years up to 2018 from 76,000 ton to 39,000 tonnes with a switch to watermelon planting probably explaining the decline.

Figure 13: KSA Vegetable Production Volumes & Growth Rate



Source: MEWA, GAStat

Tomatoes accounted for 16% of production in 2018, with production growing at 3%CAGR over the period 2014-2018. Around one third of production takes place in greenhouses. Tomatoes are the key greenhouse crop, accounting for around 40% of greenhouse production.

Onion production has increased from 65,000 tonnes in 2014 to 72,000 tonnes 2018 (4% of total vegetable production).

Overall, there were 1.7 million tonnes of outdoor vegetable production in 2018. Agribusiness enterprises are continuing to experiment heavily to see what they can grow to meet market demand.

There has been a lot of diversification of field grown crops that is not revealed in detail in the data. Carrots, broccoli, cabbages, leeks and even garlic are now all grown at field-scale production levels. Broccoli, cabbage and lettuce, in particular, are reported to be increasing.

In some places sweet corn is sequentially planted on a 10ha circle. It matures and is harvested over a period of 6 weeks guaranteeing freshness that imported produce cannot match.

Open field production in KSA, excluding tree fruits, took place on less than 840,000 ha in 2018 (the 12 principal non-tree horticultural crops totaled 82,726 ha). By comparison the planted area for wheat was 924,000 ha in 1992.

This highlights the trend to reduce the total area of cultivation and switch to crops with much higher value per hectare of production and per unit of water used.

Date palms

Dates are KSA's number food crop by volume and value.

As the emblematic national tree featured on the country's flag, the date palm may seem to be well-suited to Saudi climate, soil and water conditions. Nevertheless, date palm trees are enormous consumers of finite groundwater in many areas where large orchards have been planted.

Water for date palm irrigation, like all agricultural water, is not metered and has no cost to the farmer, so there is no systematic collection of water use data by crop.

Official data shows 28 million date palm trees. These are significant consumers of extracted groundwater. Dates palms may account for as between 1.5 billion cubic meters of water use per year, equivalent to 8% of total agricultural water withdrawal from underground sources.

This calculation is based on each tree consuming 56 cubic meters of water per tree per year equivalent to 155 liters daily. This is an average of 25% above the standard application rate of 125 liters per day using controlled drip irrigation.

Since about half of date palm cultivation is still done with much less efficient surface irrigation, total water used may be significantly higher. If surface irrigation on half of the total date palm area uses twice the estimated water of drip, then total water used for date palms could be as much as 2.6 billion cubic meters.

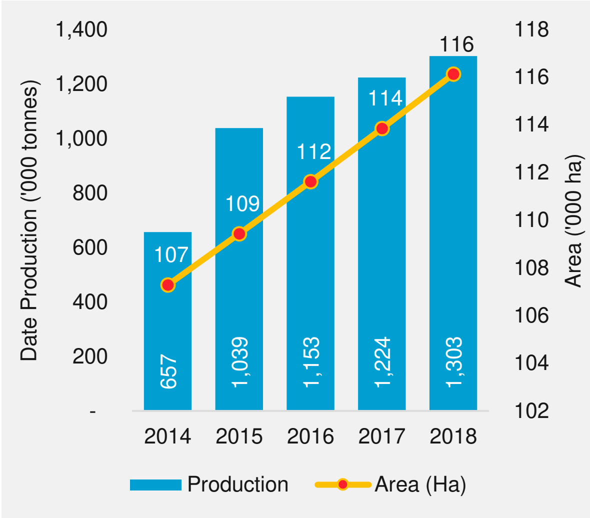
The average date palm plantation may require 8,000 m^3 of water per ha.[21]

Date palms have high salinity tolerance. They can survive saline levels that would kill anything else except barley and fodder crops. While most crops require a certain level of air in the water, date palms can live in total saturation.

Due to their water usage which about the same as wheat per hectare, date palm plantations face some restrictions. No special license is required but the planted area may be only increased by 5% per year on any existing orchard.

Officially the planted area of 116,125 ha in 2018 is an increase of 6% since 2014. Total date production volume was up by 25% since 2015 reaching 1.3 million tonnes, as many immature trees started bearing fruit. Production is equivalent to 38 kg annually per capita or over 100 grams per person per day.

Figure 14: Date Production & Planted Area 2014-2018



Source: MEWA, GAStat

Culturally date palms have more significance than any other agricultural product in KSA. In pre-modern times dates were a major source of carbohydrates. Even today they can still be considered a staple food accounting for over 10% of caloric intake.

Special processing and attractive packaging of premium varieties make dates one of the country's few value-added agricultural exports. At the other end of the quality spectrum, excess production bought up by the government is also donated from time to time as humanitarian food aid for countries facing emergency situations.

KSA produces much larger volumes than it consumes or exports. Some sources report that much of the crop, as much as one third, is not harvested and consequently wasted. One barrier to export is the fragmented nature of production and the absence of an organisation that can aggregate production and carry out marketing of the crop abroad. In addition, many date palm orchard owners do not prioritise date production as a source of income.

21. Based on an average of 224 trees per ha.

KSA's Al Ahsa Oasis with 1.5 million date palms was declared an UNESCO world heritage site in 2018. Up to 30 years or so ago water bubbled to the surface from 40 or 50 natural springs feeding a network of open canals to irrigate the trees. With the depletion of the aquifer, boreholes are now needed to pump much of the agricultural water to the surface, though some artesian wells still flow.

At one time Al Ahsa, as one of the world's largest oases, contained a few dozen villages. The urban spread of the regional capital, Hofuf in the middle of the oasis, has resulted in the cutting down of many trees for building construction. The UNESCO designation now prevents this to some extent.

Qassim region in the centre of the country boasts 7 to 8 million date palms. Many of these are located on corporate plantations. At least 50 companies each have over 20,000 trees.

Other tree crops

A diversification of permanent tree crops away from date palm monoculture has been another trend in water-constrained Saudi agriculture. Capital costs are higher with some species requiring years to bear fruit. Therefore, strategic investment decisions are weightier.

Olive production in the north near the border with Jordan is a success story in more efficient use of water for agriculture. Olive trees require only 10% of the water needed by alfalfa.

JADCO, an agricultural company in Jouf, is a leader having planted millions of olive trees that account for a significant share of national olive and olive oil consumption.

The trees can take 5-10 years to mature and bear fruit. All are organic and can produce large fruits, as is the case for Saudi stone fruit and grapes, thanks to consistent heat and, in general, better growing conditions than in nearby Jordan where olive production is also expanding.

In KSA, olive trees are planted with hedge cropping in a straight line touching each other. They are harvested with tree shakers.

In the north of the country, counter season cropping is possible for grapes. Saudi table grapes are fully mature six weeks before those in Europe. Since 2014 planted area have been steady at around 3,800 ha yielding 45,500 tonnes of fruit from 4.4 million vines.

Pomegranates and fig trees have made for further diversification with 1,225 ha and 1,135 ha planted respectively, both equally split between drip and surface irrigation. MEWA has actively promoted pomegranate orchards for smallholders, particularly in the mountainous Al Asir region in the southwest.

At 4,530 ha, citrus trees occupy about the same area as the combined total for grape vines, pomegranate and fig trees. Some orchards have been removed since 2014. Total citrus production, for which there is no statistical separation of type, is around 88,000 tonnes.

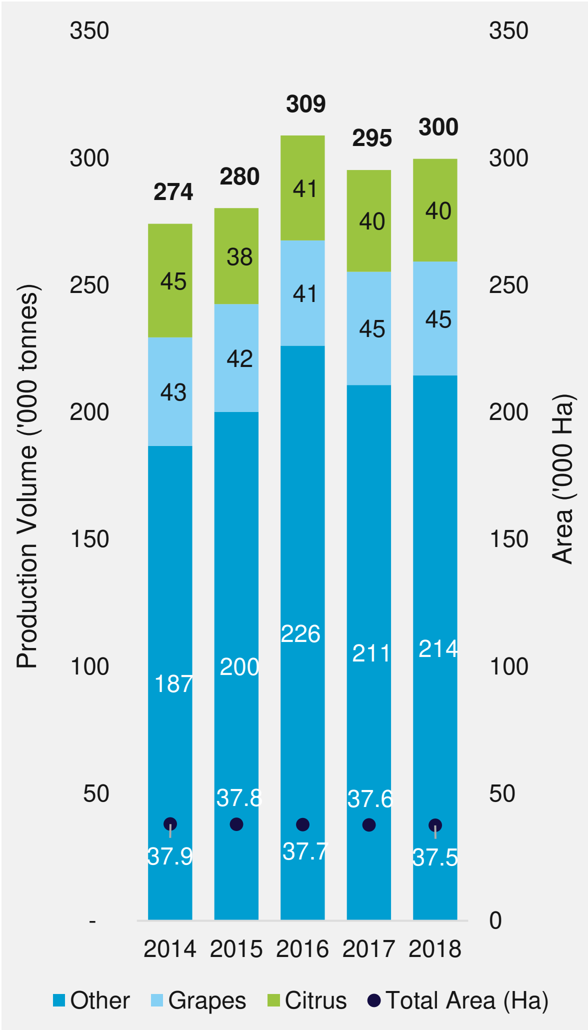
In MEWA data, other fruit is a non-delineated category that is likely made up primarily of stone fruits like olives, nectarines, plums and peaches as well as pomes. Total planted area was 29,000 ha yielding 210,000 tonnes of fruit.

The increasing importance of the above types of permanent tree crops in addition to date palm plantations in Saudi agriculture is reflected in the irrigation data.

In 1992 "harvested, permanent irrigated crops", meaning primarily orchards, accounted for just 6% of the total irrigated area at 94,700 ha. By 2014,[22] the orchard area had doubled to over 200,000 ha, accounting for 17% of the significantly reduced total irrigated area.

The shift from wheat and alfalfa to permanent orchard crops as well as greenhouse cultivation is reflected in the decline in sprinkler irrigation from 75% of the cultivated area in 1993 to just 50% in 2014. In its place, surface and drip irrigation have expanded.

Figure 15: Fruit Production (excluding dates) in KSA 2014 to 2018



Source: MEWA

22. The year of the last KSA agricultural census.

Irrigation technology

KSA, like the USA and Europe, imports fruits and vegetables from all over the world. Saudi producers need innovative irrigation technologies in order to compete with imports. For local production the key consideration is the quality of the produce and less the price. Any imported fresh produce is expensive because of transport costs.

One of the most innovative approaches has been the cultivation of tomatoes as a field crop under center pivots using hose drag irrigation. NADEC's farm in Wadi Ad Dawasir, several hundred kilometers southwest of Riyadh, has been a pioneer in this water-saving technology. Evaporation loss inherent in sprinklers is greatly reduced by replacing them with hoses that are dragged through circular furrows to feed water to neatly spaced plants.

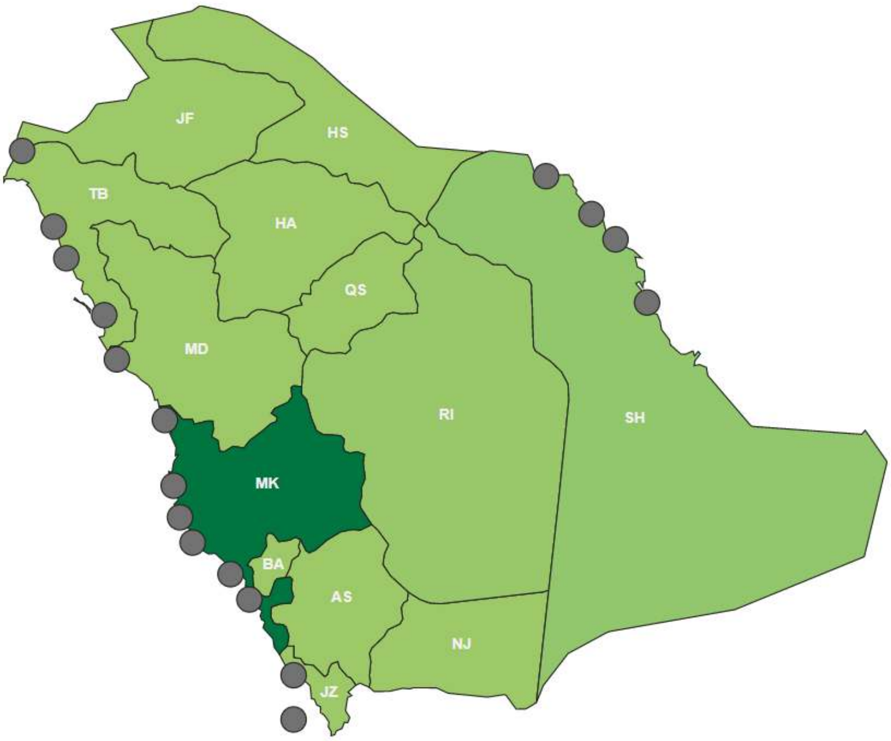
Field tomato production is good from March to May, then it drops off until September and is good until October. It is an open field crop in those periods. In winter, local tomatoes are sourced from greenhouse production.

Orchards under center pivots benefit from "low energy precision application" (LEPA) of water via sprinkler heads suspended a foot or two above between the concentric circles of trees.

Desalination

In the absence of rainwater and with groundwater levels diminishing, the primary other water source is the sea. KSA is the largest producer of desalinated water in the world with more than 30 plants around the coastline. This water is nearly all used in urban households.

Figure 16: Main SWCC Desalination Plants in KSA



Source: SWCC

Total annual desalination capacity has been expanded from 683 million m^3 in 1992 to 2.18 billion cubic meters in 2017. This amounts to 66 m^3 annually per capita or 181 liters per day, roughly two-thirds of household water consumption.

The country launched a globally unprecedented programme to build over two dozen desalination plants that now provide most of the freshwater to households in large urban areas. A double pipeline over 1500 km long from desalination plants on the Red Sea provides nearly all of the household water used by Riyadh's 7 million inhabitants.

The enormous capital investment costs and diesel fuel and natural gas required to operate these plants can be counted among the opportunity costs of using finite subterranean water for wheat and fodder crop production in KSA.

The potential of using desalinated water in agricultural production is limited by potentially high cost. A conservative estimate puts the annual direct cost of the SWCC water supply at USD 1.3 billion (excluding capex to cope with rising demand for desalinated water), which equates to approximately USD 0.71/m^3.

The feasibility of producing many crops would be significantly undermined if farmers had to pay water costs at this level.

Saudization of agriculture

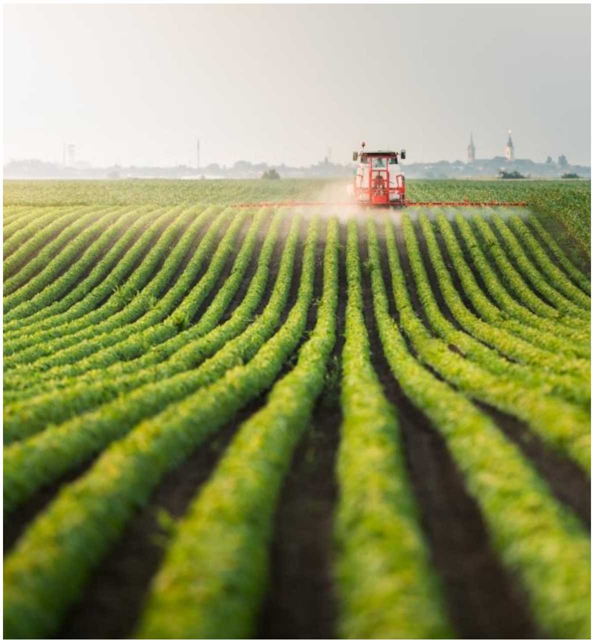
KSA has a young population, median age of 30 years, and very high youth unemployment rates.[23] One key goal of Saudi Vision 2030 is to increase the share of labour force participation of Saudi nationals.

In part this should take place through a continuing reduction of the total immigrant work force. However, there could be a number of challenges in reconciling this goal with future agricultural development (and indeed economic development in general).

Most agricultural enterprises of any size rely on expatriate workers from top level technical management right down to hard physical labour in the fields and in warehouse packing lines.

Official data shows that only 30% of the agricultural workforce are Saudi nationals. Much of this may be concentrated in areas like the southwest where there is a tradition of smallholder farming.

The current focus of agriculture on higher value perishable crops will lead to reduced application of water on crops. However, these crops are labour-intensive, increasing the need for field and warehouse labour per unit of water consumed. Given that Saudi workers prefer to avoid these types of jobs, immigrant workers will be required to fill these roles. These additional workers will put a greater burden on water resources in KSA.



Recommendations

The decades-long and ongoing depletion of its non-replenishable aquifers poses an existential challenge to agriculture in KSA. To the extent that farming has contributed to the diversification of the country's economy, a central focus of Saudi Vision 2030, putting primary agriculture on a sustainable basis is an issue of critical importance.

Simply stated, ways must be found to use less water in agriculture in order that production of a diverse assortment of crops can be continued into future generations.

An agricultural water balance sheet could be a useful tool. From the literature and data available, it is not clear that there is a systematic calculation of the total amount of water used for production of each crop and of the value of that production per unit of water used.

Lack of a price on water means a disproportionate use of water to grow low value crops like alfalfa instead of higher value ones like fresh vegetables.

Better data on water usages per crop is needed. Measuring progress is difficult when planners cannot point to the baseline from which they are starting.

This paper suggests that of total agricultural water withdrawals of about 21.2 billion m^3 per year, thirsty fodder crops like alfalfa are using from one third to one half based on 487,000 ha of fodder crops that were still under sprinkler irrigation.

The planned implementation of metering in order to levy fees on agricultural water will be a critical step. If farmers are required to, in effect, buy from the government the water they draw from underground, they will be more likely rationalise their use of that water.

Since so much agricultural water goes to produce fodder for camels, sheep and goats, the outcome of imposing water tariffs should be a general reconsideration of how livestock are fed and ultimately of the number of large animals in the country.

23. https://www.cia.gov/library/publications/resources/the-world-factbook/geos/sa.html

There are huge cultural considerations at play, since keeping camels, goats and sheep is a significant part of the traditional rural lifestyle.

Date palms accounts for 13% of total agricultural water. Smaller planters in particular may be very wasteful in their use of free irrigation water. Furthermore, it is thought that at around one third of the crop is not even harvested. This occurs mostly among smaller producers for whom their orchards may be less a business than a pastime.

The imposition of water tariffs will force date producers to take a more businesslike approach. Ultimately many smallholders may reduce the size of their orchards, saving the country more water. But dates are a much higher value crop than alfalfa. With water tariffs there may be much less fodder crops but only slightly fewer date palms.

The feasibility of using desalinated water for crop production remains uncertain. Ultimately a better use of desalinated water may be for urban landscaping. Trees line the roads in most of KSA's regional capitals. In addition, the Riyadh Green project just getting under way proposes to increase the number of trees in the capital to 7.5 million, one for every resident and to expand the green area per person by several times.

In theory comprehensive recycling of municipal water may be enough to irrigate this public landscaping.

Our senior research team

Michael Sweeney

Senior Analyst

msweeney@farrellymitchell.com

Shamali Narsinh Naik

Food & Agribusiness Analyst

snaik@farrellymitchell.com

Amy Ward Whelan

Food & Agribusiness Project Specialist

Awhelan@farrellymitchell.com

Seamus Roarty

Agri-Food Economist & Financial Analyst

sroarty@farrellymitchell.com

Experts in this Report

EUROPE

Paul Fagan,
PARTNER (ADVISORY SERVICES)
pfagan@farrellymitchell.com

Contact for more about food security

SAUDI ARABIA

Najeeb Alhumaid
REGIONAL MANAGER (MEA)
nalhumaid@farrellymitchell.com

Contact for more about food security

AFRCIA

Stephen Awuah,
SENIOR MANAGER, Africa (SSA)
sawuah@farrellymitchell.com

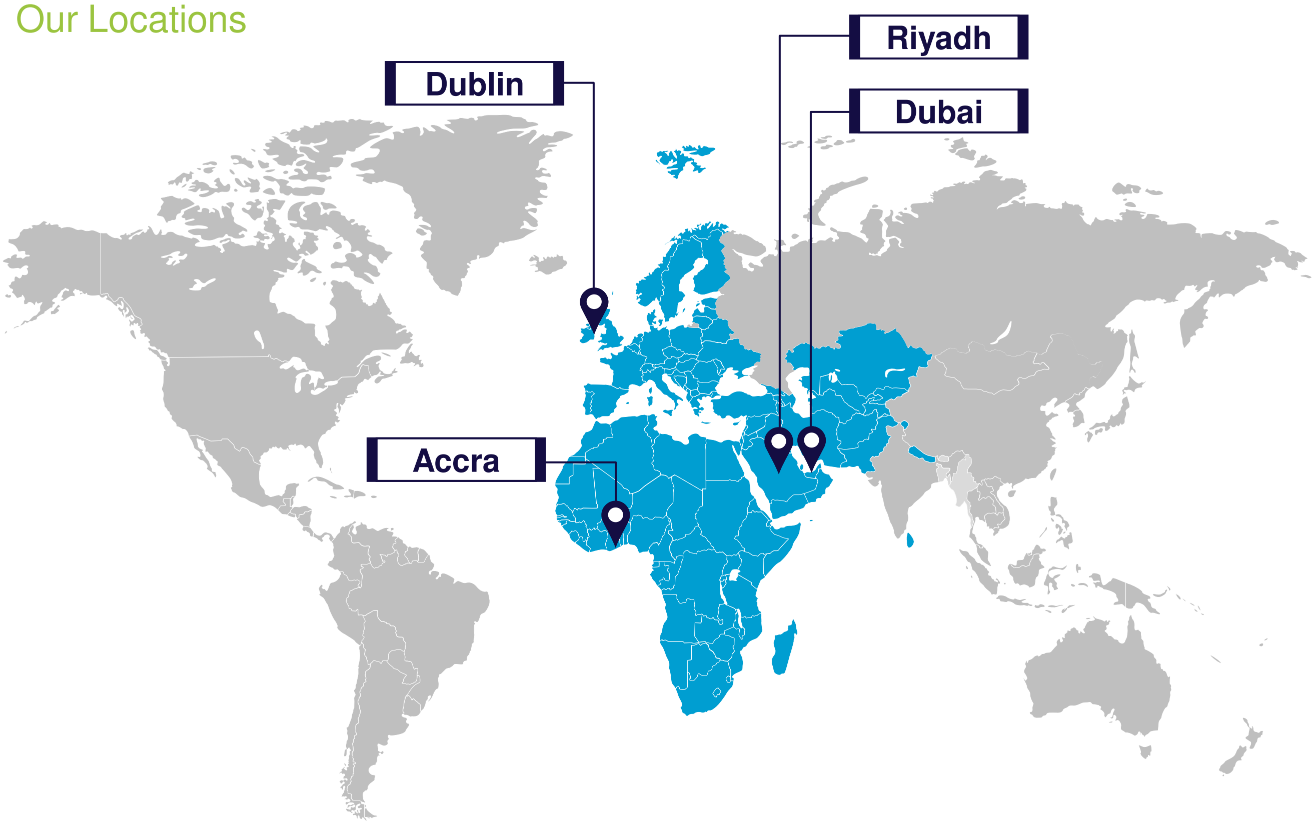
Contact for more about food security

MIDDLE EAST & NORTH AFRICA

Chiatanya Grk
SENIOR MANAGER, U.A.E.
cgrk@farrellymitchell.com

Contact for more about food security

Our Locations



About us

Farrelly & Mitchell empower some of the world's most ambitious companies and agencies to make the right decisions. With expert insight, local market intelligence and airtight recommendations, we build and implement sustainable strategies that allow our clients to restructure, transform and grow.

We have the hands-on industry experience and expertise, which we combine with local market insight and contacts to help our agribusiness, food and beverage clients to increase profits and improve efficiencies.

What makes us different?

We go above and beyond traditional consultants. As an international management consultancy, we specialise in the global food and agribusiness industry, with a particular focus on the implementation or execution of our recommendations. So we are committed to working with our clients, not just in the development or planning phase of a project, but importantly in its full implementation.

Food an agribusiness specialists

We understand food and agribusiness; we built our experience in this sector, and we employ the best global talent to provide in-depth solutions by addressing real problems sustainably and creating new opportunities for clients.

For the past decade, we have worked with clients across the globe and generated measurable results. We have worked on mandates across every link of the food and agribusiness value chain from large-scale farming operations to food or beverage manufacturing, distribution, retail and hospitality.

Each member of our team of over 200 experienced consultants has worked in industry at an operational and executive level.

We work globally with significant experience in Europe, Middle East and African markets.

Why partner with Farrelly & Mitchell?

Our team has worked at operational and strategic levels all over the European, Middle Eastern, and broader international food, beverage and agribusiness sectors. We have seen projects through from paddock to plate.

We understand the opportunities presented by the growth of the food, beverage and agribusiness sectors, in the Gulf region and across the globe. We work with primary producers, manufacturers, distributors and retailers.

If you are you looking to grow or expand your business, improve efficiency or quality control, or are buying or selling a business, get in touch, and let Farrelly & Mitchell become your project partners.

Farrelly & Mitchell

Global specialists in agribusiness & food

200+
Sector Specialists

Global
Reach & Experience

Established
Over 15 years

Clients
Corporate & Government

Strength
Operational & Strategic

Value chain
Farm to Fork

FARRELLY & MITCHELL
Food & Agri-Business Specialists

Contact Details

www.FarrellyMitchell.com

EUROPE

Dublin (Head Office)
Malachy Mitchell, Managing Director

Farrelly & Mitchell
Unit 5A, Fingal Bay Business Park, Balbriggan Co. Dublin Ireland. K32 EH70

Telephone : +353 1 690 6550
mmitchell@farrellymitchell.com

SAUDI ARABIA

Riyadh
Najeeb Alhumaid, Regional Director

Branch of Farrelly & Mitchell Business Consultants Ltd
Jarir Plaza Building, Suite 106, King Abdullah Road,
Al Hamra District, Riyadh 12211-3857,
Kingdom of Saudi Arabia

Telephone : +966 11 463 4406
Mobile : +966 54 338 7199
nalhumaid@farrellymitchell.com

MIDDLE EAST & NORTH AFRICA

United Arab Emirates
Chaitanya GRK, Senior Manager (MENA)

Farrelly & Mitchell (DMCC)
Unit 1001, 10th Floor, Swiss Tower, Cluster Y
Jumeirah Lakes Towers, Dubai, United Arab Emirates

Telephone : +971 4 279 8331
Mobile : +971 551991356
cgrk@farrellymitchell.com

AFRICA (SSA)

Ghana
Stephen Awuah, Senior Manager, Africa (SSA)

Farrelly & Mitchell Ghana Limited
Utopia Office, 14 Senchi Street, Airport
Residential Area,
Accra Ghana

Telephone: +233 302 906850
Mobile: +233 59212 1723
sawuah@farrellymitchell.com

Connect with