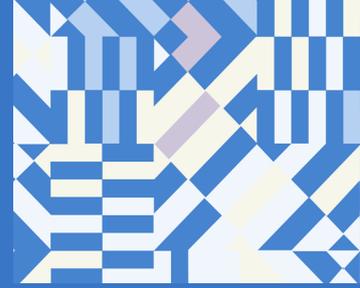




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Wheat Production Outlook in Egypt amid the Ukraine Crisis

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1. Introduction

The Ukraine crisis is having significant impacts on many countries worldwide, including those in Africa. It has disrupted agricultural production and trade with Russia and Ukraine, which together form one of the world's main grain-exporting regions (IFRC 2021). Egypt, a major wheat importer, is struggling to cope with the impacts of the ongoing crisis.

The Africa Agricultural Watch (AAGWa) platform, developed by AKADEMIYA2063, uses bio-geophysical remote sensing data, historical production maps, and machine learning techniques to predict the future production of various crops, including wheat. This information can help Egypt increase local wheat production, move toward self-sufficiency, and overcome the potential impacts of the crisis on wheat consumption in the country.

Remote sensing and machine learning are used together to produce more extensive, better-quality data and information than either technique could produce on its own (Ly et al. 2021). In this brief, we use the two techniques to forecast the quantity and spatial distribution of wheat production in Egypt amid the ongoing Ukraine-Russia crisis.

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THE UKRAINE CRISIS
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Remote sensing data enables the unique characterization of features on the earth's surface on several wavelengths without requiring an individual's physical presence on the ground, facilitating the production of extensive and high-quality data within a short time period. On the other hand, machine learning enables the extraction of information hidden in vast amounts of data, revealing the mechanisms at work within complex systems.

2. The Significance of Wheat in Egypt

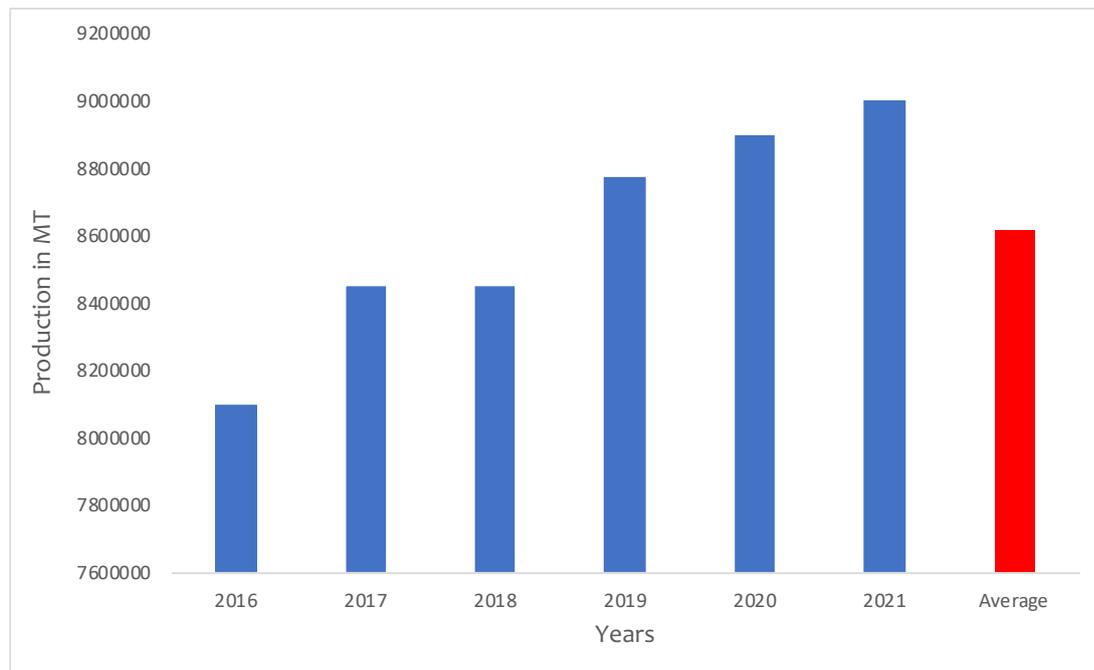
Wheat and maize are Egypt's staple food crops, and their per capita consumption is high. The country imports a lot of grain, and its domestic production has to substantially increase to meet the needs of its growing population. Wheat consumption in Egypt has generally been on the rise over the past five years. In 2021 and 2022, Egypt consumed a total of 20.5 million metric tons (MT) of wheat. This was a slight decrease from the 20.6 million MT consumed in 2020. Wheat represents a significant portion of the total value of agricultural production and imports, with the country's General Authority for Supply Commodities (GASC) of the Ministry of Supply and Internal Trade accounting for a significant portion of world wheat trade. The domestic wheat industry provides jobs and adds value to the agricultural sector.

Wheat is important to the Egyptian government because it is critical to the country's social realities. More than a quarter of Egypt's population lives in poverty and ensuring the food security of all citizens is a challenge. The wheat sector is strategically important, hence the government's deep involvement in all levels of the wheat value chain.

3. Wheat Production and Demand Trends in Egypt

According to the Central Agency for Public Mobilization and Statistics (CAPMAS), Egypt is one of the largest wheat importers worldwide. Russia and Ukraine jointly account for 86 percent of the country's wheat supply, with 61 percent coming from Russia and 24 percent from Ukraine. Wheat is also one of Egypt's most important domestically grown crops. Its production increased slightly during the 2016-2021 period from 8,100,000 MT in 2016 to 9,000,000 MT in 2021, for an annual average production of 8,611,667 MT (Figure 1).

Figure 1: Wheat production in Egypt from 2016 to 2021.



Source: US Department of Agriculture

Egypt consumes up to 21 million tons of wheat, with approximately 13 million tons imported. In other words, the country produces less than half of what it consumes, making it extremely vulnerable to global grain market disruptions. With the production and shipping of wheat from Ukraine disrupted and the imposition of sanctions on Russian exports, wheat prices have soared globally. National officials have said that because of Egypt’s sensitivity to price increases, the country has been forced to rely heavily on current stocks of wheat, which last for two to four months. This means that longer-term production forecasts for wheat are not currently possible. To address this, Egypt’s wheat production in 2022 was predicted at the pixel level using the AAgWa platform. The platform incorporates an artificial neural network model that takes historical production maps and remotely sensed data. These were used to generate Egypt’s wheat production forecast. Figures 1 and 2 show the estimated wheat production in 2021 and the production predicted for the 2022 growing season. Wheat production in 2021 is estimated at 7,824,720 MT compared to a production of 8,072,157 MT in 2022, representing a ratio increase of 0.97 percent.

Between 2016 and 2020, Egypt imported a total of 83,902,000 MT of wheat, making it the largest wheat importer worldwide (Table 1). Wheat is also the single most imported product in Egypt (OEC 2020). The Egyptian government has announced plans to cut wheat imports by 8 percent by 2023 to reduce its dependence on external supplies. It will do so by increasing local production sources to satisfy the country’s needs. Wheat exportation during the same period is estimated at 4,719,000 MT, with exports going mainly to the United Arab Emirates, the United States, Saudi Arabia, and Italy.

Table 1: Egypt’s wheat imports and exports from 2016 to 2022

Market Year	Imports (MT)	Growth Rate	Exports (MT)	Growth Rate
2016	11,181,000	N/A	465,000	N/A
2017	12,407,000	10.97%	781,000	67.96%
2018	12,354,000	-0.43%	1,090,000	39.56%
2019	12,811,000	3.70%	978,000	-10.28%
2020	12,149,000	-5.17%	705,000	-27.91%
2021	12,000,000	-1.23%	300,000	-57.45%
2022	11,000,000	-8.33%	400,000	33.33%
Total	83,902,000		4,719,000	

Source: US Department of Agriculture

4. Projected Wheat Production for the Upcoming Harvest Season (2021-2022)

The Egypt wheat production forecasts are based on data from the Africa Crop Production (AfCP) model, which uses satellite-based information such as the normalized difference vegetation index (NDVI), land surface temperatures (LST), rainfall quantities, and evapotranspiration rates. An artificial neural network was created to learn correlations between various biogeophysical data and food crop production data at the individual pixel-level.

A comparison of Figure 2 and Figure 3 shows that wheat production increased between 2021 and 2022 in almost all cultivated areas. Figure 4 shows the projected production share for 2021-2022 across Egypt. The most significant increases were concentrated in the northwest, central-east, and southeast Nile basin. A significant increase in wheat production was observed in Egypt’s east and part of the northern region in 2022 compared to 2021.

Figure 2: Estimated wheat production in Egypt, 2021.

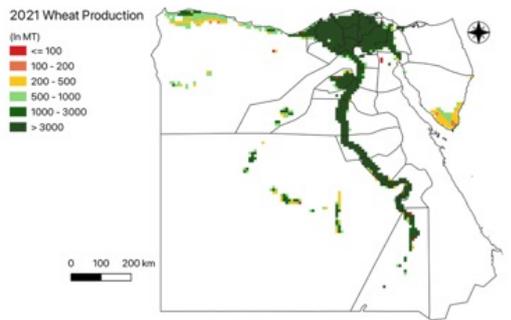


Figure 3: Predicted wheat production in Egypt, 2022.

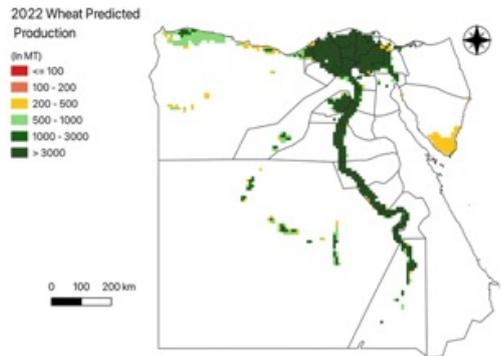
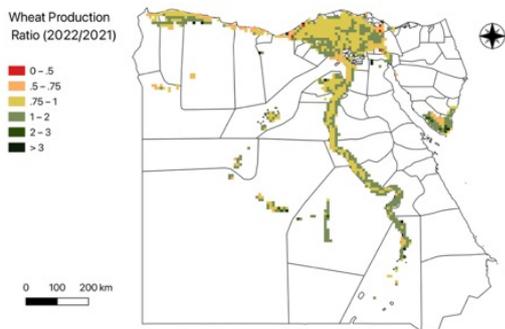


Figure 4: Ratio of predicted wheat production (2022) and estimated wheat production (2021) in Egypt.



For Figure 4, a ratio of more than one means greater wheat production in 2022 than in 2021, while a ratio of less than one means the opposite.¹

5. Comparison of Estimated Wheat Production Levels in 2021 and 2022

We compared wheat production levels for the 2021 and 2022 seasons by computing and mapping their ratios at the pixel-level. The analysis allows for a detailed assessment of where wheat production is expected to increase or decrease and provides critical information for planning interventions in response to possible supply disruptions. At the national level, Egypt was expected to experience an increase in wheat production of 3.07 percent between the 2021 and 2022 seasons. In 2021, the country produced 7,824,719.89 MT, while our forecast estimates an overall production of 8,072,157 MT for 2022. However, national-level data mask geographical variations across wheat-producing areas. Figure 3 above shows the pixel-level data, which reveals substantial differences across sub-counties. Some localities were expected to experience a decrease in wheat production in 2022 relative to 2021. For instance, in 2022, wheat production was expected to decrease in Dirkirnis (0.81 percent), Shirbin (1.2 percent), and Mahalat Dimnah (3.72 percent).

The top four wheat-producing counties in 2022 were projected to be Abu-al-Matamir, Al-Husayniyah, Qena, and Asyut, with total production levels of 217,348 MT, 213,837 MT, 198,906 MT and 194,673 MT, respectively. These localities are in the Nile delta and Upper Egypt, rich in farmland, with double cropping a common practice in irrigated areas (Global Yield Gap Atlas, 2019). The landscape of southern Egypt is made up of low mountains and deserts, while northern Egypt has wide valleys near the Nile River and deserts to the east and west (National Geographic, 2015).

¹ The boundaries and names shown, and the designations used in maps do not imply official endorsement or acceptance by AKADEMIYA2063.

6. Status of Crop Growing Conditions in Egypt

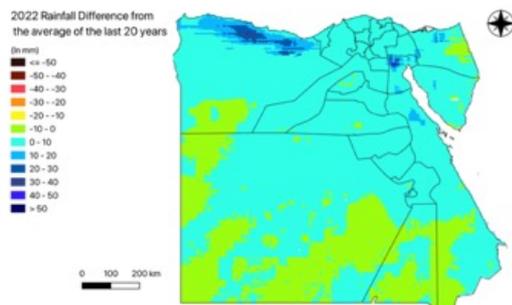
Wheat production and productivity are vulnerable to climate change, specifically severe hydro-climatic fluctuations, and variability. Most of Egypt's residents are dispersed across the densely populated urban centers of Cairo and other major cities in the Nile Delta. The fertile land area is an estimated 3.3 million hectares, about one-quarter of which is land reclaimed from the desert, while recycled land adds 7 percent of the total value of agricultural production. Just 3.8 percent of the land in Egypt is currently used for agriculture. Over the past few decades, more people from its expanding population have moved into previously farmed areas, hampering agricultural development. This explains the concentration of agricultural production mostly along the Nile area. Better rainfall conditions are observed in the northwestern regions of Egypt, as seen in Figure 6.

7. Anomalies in Land Surface Temperatures, Rainfall Levels, and Normalized Difference Vegetation Index (NDVI)

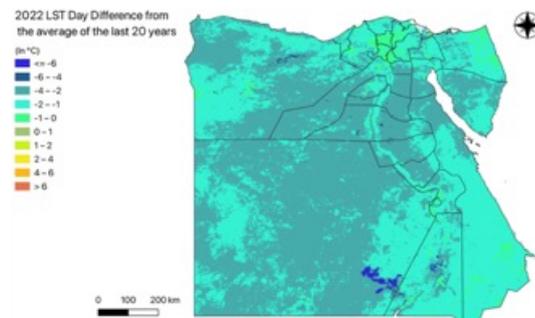
Figure 5 shows the spatial correlations between anomalies in land surface temperatures, rainfall, and vegetation index distribution across the country. Rainfall and temperature variability may affect wheat growers in Egypt. In 2022, positive rainfall anomalies are mostly observed in the country (0-10 mm), with the largest increases (40-50 mm) occurring in the northeast, indicating higher levels of precipitation. However, negative anomalies (-10-0 mm) are observed in the south, indicating decreasing rainfall levels. Simultaneously, the land surface temperature analysis indicates negative anomalies (-2, -1 °C) and (-1-0 °C) in most parts of the country, meaning cooler temperatures. Positive NDVI anomalies identify areas with a biomass or vegetation vigor higher than the average value of the respective land cover class that constitutes the majority observed in the country. These biophysical conditions can be beneficial to wheat production and favor the highest levels of growth.

Figure 5: Anomalies in a) Rainfall, b) Land Surface Temperatures, and c) NDVI observed in Egypt, 2022.

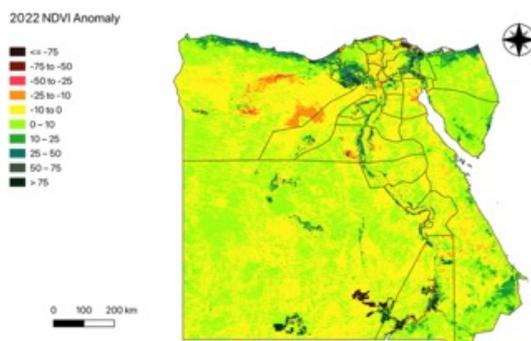
a) Rainfall



b) Land Surface Temperatures



c) NDVI



8. Conclusion

The AfCP model was used to forecast Egypt's wheat production in 2022 at the pixel-level. The model found that production in 2022 is predicted to be highest in the northwest, central-east, and southeast Nile basin. This increase is especially noticeable in the east and part of the northern region of Egypt.

The ability to forecast wheat production can help mitigate the impacts of the Ukraine crisis which Egypt is currently experiencing. Several alternatives could be explored to improve yields on land that is currently unused, such as growing crops using better-quality local seeds or reducing Egypt's dependency on imported seeds. Modern irrigation systems that save water should also be considered for effective production. Wheat production in Egypt's east should be intensified, especially because that region has already seen increased wheat production.

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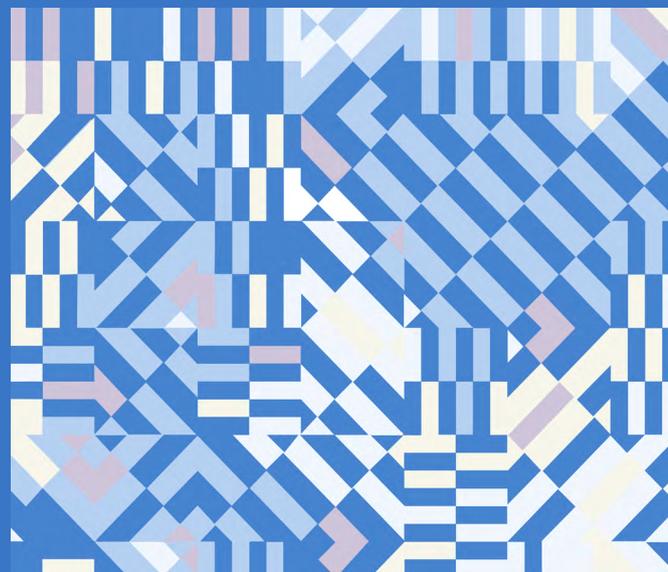
Annex

Table 2: Egypt Level 1 (County) Wheat Production in 2021, 2022, and 2022/2021 ratio

County	2021 wheat production (MT)	2022 wheat production (MT)	2022/2021 wheat production ratio
Ad Daqahliyah	718,226.30	706,483.55	0.98
Al Buhayrah	1,037,174.98	1,010,898.32	0.97
Al Fayyum	408,751.59	435,279.97	1.06
Al Gharbiyah	378,417.98	382,121.29	1.01
Al Iskandariyah	146,750.23	134,247.39	0.91
Al Isma`iliyah	154,292.29	156,801.97	1.02
Al Jizah	192,507.46	192,557.10	1.00
Al Minufiyah	384,875.74	392,010.81	1.02
Al Minya	581,335.53	601,178.06	1.03
Al Qahirah	87,876.99	97,767.25	1.11
Al Uqsur	30,026.16	39,961.59	1.33
Al Wadi al Jadid	111,748.12	130,388.39	1.17
As Suways	47,738.61	64,697.39	1.36
Ash Sharqiyah	1,005,625.54	1,043,659.43	1.04
Aswan	173,007.02	224,525.76	1.30
Asyut	446,182.52	482,709.33	1.08
Bani Suwayf	369,394.58	367,534.98	0.99
BSa'id'id	27,051.74	250,44.73	0.93
Dumyat	90,317.08	81,816.32	0.91
Janub Sina'	25,911.65	30,623.14	1.18
Kafr ash Shaykh	503,214.20	474,589.15	0.94
Matrouh	97,935.74	90,401.95	0.92
Qina	325,013.69	387,511.58	1.19
Shamal Sina'	47,757.66	52,670.36	1.10
Suhaj	468,541.92	504,702.63	1.08

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