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Income Inequality and Unsustainable Agriculture in Egypt: How Hydroponics Could Address Malnutrition and Wheat Reliance.

Whether it is criticized as food waste, or an affordable luxury, cutting the crusts off sandwiches is a common practice in the United States. While many Americans are not worried about wasting a few scraps of bread, sometimes that can be all Egyptians have to eat. Instead of worrying about their children brushing their teeth, Egyptian parents are trying to make sure their children do not starve. A large number of Egyptians, often children, face food insecurity. Malnutrition, a consequence of food insecurity, can lead to wasting and stunted growth.

In 2023, 14.4 percent of Egyptians were food insecure, meaning that they did not have access to enough healthy food or could not afford it (World Food Programme, 2023). Over 5.2 percent of children younger than five were wasted, ranking Serious on the Global Hunger Index (GHI; Global Hunger Index, 2024). Wasted is defined as a low weight for a given height, making it a reliable indicator of malnutrition. Additionally, over 21 percent of Egyptian children under five are stunted, which was ranked as Alarming on the GHI (Global Hunger Index, 2024). Stunting is defined as a low weight for a given age, reflecting malnutrition on a broader scale. Food insecurity is even more threatening for larger households with insufficient income.

While the Egyptian diet was generally considered healthy for most of its history, in recent years, it has become significantly less so due to rising costs. These price spikes have affected both ingredients and meals available. In 2017, the reliance on agricultural imports led to a 46% price increase in food, including the cost of tomatoes, the most nutrient-dense fruit, which tripled in price (Di Noia, 2014; Center for Strategic & International Studies, 2017). Even Egypt's national dish has become more unattainable. Koshari, a dish that consists of mixing pasta, rice, lentils, chickpeas, and tomato sauce, has increased in price from 36% to 60% at the most popular chain known for low prices in Egypt (Center for Strategic & International Studies, 2017). These markups are actively contributing to the rise of food insecurity, pushing people towards cheap, unhealthy food, or forcing people to limit their food intake due to a lack of funds.

To make matters worse, it is very difficult to address these health issues due to a lack of quality healthcare. According to the World Health Organization, in Egypt in 2014, there were 15 total hospital beds available for 10,000 people. In addition, there was only one health facility for 43,478 people, a decrease in facilities by nearly 40% from 2001 (Radwan & Adawy, 2018). This lack of quality healthcare, combined with rising costs of healthy food, perpetuates a cycle of unhealthiness, causing a desperation for food, with little regard to the sustainability of its production.

The average household size in Egypt was 3.9 members in 2023 (ArcGIS & Michael Bauer Research, 2023). Most of these household members are dependents, who are often in need of someone else to provide for them, and unable to contribute impactful financial support. In 2022, the age dependency ratio

in Egypt was 61.6 percent, which means that dependents, defined as someone from the ages 0–14 or 65+ represent 61.6 percent of the population (Statista, 2024).

In 2023, the average monthly salary in Egypt was 163 USD (CEIC Data, 2023). However, this is insufficient for the monthly cost of an individual's healthy diet in 2022, which was estimated at 136.5 USD. As a consequence, 44.4 percent of the population throughout Egypt could not afford a healthy diet (World Bank Group, 2024). When calculating the true costs of food for the average Egyptian family, it is impossible to afford a healthy diet. The average monthly cost of a healthy diet for an average family is 532.35 USD. This cost is exacerbated by the Age Dependency Ratio throughout Egypt. If only 38.4 percent of the population is not dependent and is earning the average salary, the cost of healthy food massively exceeds the total monthly earnings for a family by more than double the original budget. High food prices, low pay, and high dependency ratios are a vicious cycle. In Egypt's case, these factors can encourage unsustainable agriculture.

The constant need to focus on food within Egypt has led it to devalue other areas, specifically education. According to UNICEF, in 2024, Egypt made significant progress with school enrollment, hitting almost perfect enrollment for primary school. However, these enrollment statistics mask the fact that education is poor when compared to UNICEF standards. For example, in 2025, the pupil-teacher ratio (PTR) was estimated to be 41:1, a 57% increase from the goal of 26:1 (UNICEF, 2024). However, by alleviating some of the daily pressures in Egypt, there would be both more people and time that could be allocated to greater systemic problems, including education. By improving Egypt's agriculture, improvement of other sectors could soon follow.

Due to the presence of the Nile, it seems almost unlikely that Egypt could be so arid and struggle with agriculture. However, the main problem with Egypt's agriculture lies not within the lack of water and crops, but relies more on other factors, including long reliance on classical types of agriculture as well as an overreliance on certain types of food, such as wheat.

In Egypt, unsustainable agriculture is encouraged by the lack of rainwater, the reliance on the Nile River, the growing population, and the lack of arable land (Mounir, 2021). In turn, all four of these factors increase food insecurity throughout the country. Egypt is an arid country, with the majority of its landscape a desert (Prokosch, 2015). This creates a dry environment with a lack of rainwater. In 2020, the most rainfall received in a city was 200 mm in a year, less than 8 inches of rain (Climate Change Knowledge Portal, 2020). This lack of water has led to an extreme reliance on the Nile River for all water sources. In 2022, the Nile River provided Egypt with 97 percent of its fresh water (Khayry, 2022). In the past, Egypt has relied almost solely on the Nile River, with little change over time. While the reliance may have been sustainable for a smaller population, the rapid exponential growth of the population made such reliance unhealthy. The growing population directly impacts the sustainability of agriculture, especially when compared to countries denoted as periphery and semi-periphery states in the World Systems Theory. What may be sustainable for a stable or decreasing population is not always sustainable for a growing population. Unsustainable agriculture vividly demonstrates this, through practices like monoculture and overgrazing of the land. For example, in 2011, desertification caused by overgrazing and overcultivation affected 3.6 acres of arable land an hour (Mounir, 2021). Often, however, the starving population of Egypt sees overcultivation as a solution, even though the long-term consequences can be highly detrimental. Overcultivation can lead to desertification and is made worse by the lack of arable land within Egypt (Mounir, 2021). In 2025, only 3 percent of Egypt's land was arable, concentrated near the Nile River delta (Smith & Goldschmidt, 2025).

The Egyptian government has tried to use subsidies to address the lack of arable land and rainwater, reliance on the Nile River, and the growing population. In 2024, 60 million residents relied on a subsidy

program that provided food, specifically grains, to Egyptian families (Ghoneim, 2025). However, in recent years, the subsidies have struggled to provide many foods, such as pasta and bread, which are crucial sources of carbohydrates. Throughout the history of Egypt, bread has been almost sacred, with a lack of bread causing riots and protests. In 1977, hundreds of Egyptians took to the streets to protest the cutting of funds for flour and other goods (Overtime Staff, 2011). However, the main problem with these subsidies is that the Egyptian government actively supports an unhealthy reliance on certain grains. In 2022, Egyptian wheat imports decreased by 28 percent from the previous year (El Safty, 2023). To make matters worse, the majority of these imports come from Russia and Ukraine, which have put their wheat production on hold due to the escalation of the Ukrainian-Russian war from 2022 onwards.

In the past, the Egyptian government has only focused on wheat and bread imports to address the food needs of the growing population. However, this approach is not sustainable, as prices rise while demand increases. A better option would be to diversify Egyptians' grain intake. This temporary solution of wheat and bread imports creates an unhealthy reliance on one single, expensive food source. Many grains offer the same benefits as wheat, without requiring reliance on imports. For example, sorghum, a grain native to northeastern Africa, almost exactly matches the protein-to-carbohydrate ratio of 1:7. This means that Egyptians could obtain similar nutrient value from native grains, without forcing the government to continue to push for more and more subsidies. However, Egypt is not yet ready to start planting new grains en masse, due to the limited water source, and space taken up by other, more intensively grown plants. For these plants, an alternative to traditional agriculture is the implementation of a hydroponic system. Hydroponic systems have multiple advantages. They need less water as the roots directly touch the water, the plants grow faster as they have direct access to nutrients, and they do not require soil, a non-renewable resource. This solution is well-known, cheap, and simple to use. Because many grains cannot be grown in hydroponic systems, these systems can instead help cultivate water-intensive leafy green plants, freeing up water and soil for both non-native grains like wheat and native grains such as sorghum.

In 2024, a hydroponics system was introduced to Egypt. Created by Partners for Water, the system both desalinated water and used a hydroponic system (Partners for Water, 2024). However, this system was implemented uniquely on farms, requiring training and relying heavily on manual labor. While the temptation of immediately changing agriculture within Egypt is great, namely, by immediately switching all forms of agriculture to hydroponic systems, a transitional approach would be better. This is largely because transitioning too quickly could lead to massive economic disruption caused by lost jobs, increased supply, and a steady or decreased demand.One way this approach could be implemented is by increasing the share of the existing food supply with hydroponic-grown plants rather than an immediate transition.

This process would require four phases: Create, Supplement, Supplant, Benefit. These phases would all build on each other and allow future and past phases to grow. The phases themselves come in two parts: part one, where phases one and two work together to promote immediate benefits such as a facility, subsidized greens, and increased UN funding, and part two, where phases three and four push for long-term national support as well as continuing previous benefits of part one.

This solution will require a facility where plants can be grown. This facility would be created on a loan-like basis between the Egyptian government and the United Nations until it is paid off by the benefits it provides. Some of these benefits include reducing the costs the Egyptian government pays for the farm industry, such as irrigation and other forms of support. From 2022-2024, Egypt spent 2.8% of its GDP per year on Total Support Estimate (TSE), a measure designed by the Organisation for Economic Co-operation and Development (OECD) to track the monetary value of policies supporting agriculture (OECD Agriculture and Food Policy Reviews, 2026). This measure (tracked in percent of GDP) places

Egypt above all other member states of the OECD, including China, the European Union, and the United States. However, by creating a hydroponics facility, costs from the TSE would decrease due to reduced water consumption and other forms of support that are typically required for traditional farming. However, it would be impossible to build a facility simply with the promise that it will be paid back by a government, with no work from the Egyptian side. Nevertheless, this limitation can still be readily addressed. According to the 1981 Egyptian Law 143, all land two kilometers outside city borders is designated as desert land, which is owned by the Egyptian state by default. Typically, this desert land could never be used in an agricultural setting, but due to the nature of hydroponics, occasional shipments of water should suffice. In addition, by implementing water desalination such as in the Partners for Water system, ocean water could be used, further reducing cost. Without having to worry about the cost of land, the facility would rapidly become cheaper. The rest of the cost could now be covered by IGO programs such as the United Nations Environmental Programme (UNEP) and the UN Food and Agriculture Organization (FAO), which would be able to provide funding for the remaining costs. This loan request is made much simpler given the shared interest in stopping malnutrition and desertification, as well as having the immediate resources available due to the United Nations' budget. When the facility gives Egypt economic gains, Egypt can use the gains to repay the United Nations. This supports both parties, as the facility can continue to benefit the Egyptian government, who in turn can put more savings into the UN. Next, the solution must start to transition into the food markets. However, immediate disruption could cause a market collapse, so this must be done slowly so as not to push the supply of vegetables above the demand. By supplementing the leafy green supply, the facility is now helping support nutrition in addition to the other benefits already provided due to the efficiency of hydroponics. In Egypt, certain staples are subsidized, such as the bread previously mentioned along with grains. However, leafy greens and vegetables are rarely, if ever, subsidized, causing a nutritional gap between wealthier and poorer families and communities. Yet, since the facility is producing the greens at such a low cost, it could be beneficial to give a large portion of the yield to the Egyptian government to subsidize the greens for those in need. While selling the yield at a cheaper cost could be successful immediately, unchecked, it would likely force other suppliers to lower the price of their vegetables, which could impact the livelihoods of farmers and other producers in the region.

In short, the goal of part one is to create a facility and supplement the existing leafy green supply. These two targets would also lead to benefits such as an increase in UN funding from Egypt in accordance with the benefits received, decreased water consumption, and the new opportunity for subsidized vegetables or greens.

Continuing with part two of the solution, the facility needs to continue to increase output. By this point, part one should have been a success for at least a year, marked by supplementing over 100 tons of leafy greens into the national market. In addition, the capital given by the UN should have been paid back by the Egyptian government. If these criteria are met, in collaboration with the Egyptian government, the facility can attempt to increase their market share, with the goal of eventually becoming the primary producer of leafy greens and other water-intensive crops that are ideal for hydroponic systems. If the facility ever starts to reach a maximum capacity, Egypt can simply take some of the savings money for the UN to help expand the system. Given that the facility would be in the desert, there are no pressing limitations preventing expansion. Becoming the primary producer of these plants would allow for a slow transition into decreasing the cost of the plants, and thus remove the need for subsidies. While this could threaten the jobs of traditional farmers, this could be easily resolved by offering similar free training initiatives such as the one in the Partners for Water system. This would allow upward career growth while also benefiting the environment. Once hydroponic greens make up a majority of leafy greens' share, the profit from the facility can now go two places: continuously lowering prices to increase nutrition and the rest of the benefits from the saved water, and other growing costs can now go to solving the issue of wheat reliance. While one hydroponics system may not be able to replace all wheat in a year, this set of

steps can work to address issues such as overreliance, and benefit millions of residents who struggle with food insecurity.

All in all, Egypt's unsustainable agriculture is promoted by its lack of water, arable land, growing population, and its reliance on the Nile River. When addressing unsustainable agriculture, the implementation of hydroponic systems is beneficial for the development of agriculture because they do not require non-renewable resources, are cheaper, and support faster growth than other growing methods. These conditions render a transition to hydroponic growing systems ideal, addressing malnutrition, wheat reliance, and even jobs in one solution.

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