2 Cotton in Egypt

Assisting Decision-Makers to Understand Costs and Benefits

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Introduction

Agriculture and forestry have been the largest contributors to climate damage over the past 200 years. Yet evidence is pointing to the reality that sustainable forms of agriculture can offer solutions. Research on SEKEM fields in Egypt has conclusively shown that biological, organically cultivated crops can be competitive to the conventionally cultivated ones in expenses and benefits since organic produce provides less negative externalities. Here we report on an update of “The Future of Agriculture in Egypt” study, conducted on five strategic crops, one of which is cotton.

Challenges Facing Egypt

Egypt is facing many challenges related to demographics, economy, and public health, which have the potential to become exacerbated unintentionally by new problems related to the environment. Three that will particularly impact the agriculture sector are water scarcity, rural development, and soil health.

Water Scarcity

Water scarcity continues to be a major issue for Egypt, which depends almost entirely on the Nile for the country’s water resources. Egypt is facing a current annual water deficit of about 7 billion cubic meters. According to some analysts, the country is on track to reach a threshold of “absolute water scarcity” by 2030. Uneven water distribution, misuse of water resources, and inefficient irrigation techniques are some of the major factors playing havoc with water security in the country. Large amounts of water are also lost through evaporation every year—something that climate change will worsen. Egypt has only about 20 cubic meters per person of internal renewable freshwater resources, and as a result, the country relies heavily on the Nile for its main source of water. The river Nile is the backbone of Egypt’s industrial and agricultural sectors and is the primary source of drinking water for the population. Rising populations and rapid economic development in the countries of the Nile Basin, pollution, and environmental degradation are reducing water availability in the country.

Rural Development

Changes to the climate, particularly higher temperatures, are expected to shorten growing seasons and reduce agricultural yields in Egypt. This creates a further challenge for agriculture and rural development in Egypt. As noted by Shalaby *et al.* (2011), Egypt's economy depends primarily on agriculture and rural resources. Agriculture contributes approximately 14% of gross domestic product and absorbs about 31% of the workforce. More than half of the population lives in rural areas where, directly or indirectly, their livelihood depends upon the agricultural sector. The agriculture sector contributes significantly to Egypt's economy and food security, yet faces many challenges which, in turn, impact rural development initiatives. Key among these are land and water issues, a lack of information on alternatives, including sustainable approaches to the use of natural resources and marketing that can support this. In addressing overall challenges of poverty, degradation of natural resources, other environmental issues, and population growth, Egypt faces inadequate support services, framework and institutional constraints, and a lack of agricultural and rural development policies.

Soil Health

Egypt is located in the severely dry region extended from North Africa to West Asia. In this region, soil erosion is regarded as one of the most serious environmental problems associated with land use. In many cases, erosion causes an almost irreversible decline in soil productivity and other soil functions and leads to environmental damage. Wind erosion is considered to be one of the main desertification processes affecting areas exceeding 90% of the state in the western desert, eastern desert and particularly Sinai area. These areas are characterized by a fragile ecosystem, scarcity of vegetation cover, and severe drought.

True Cost Accounting

True Cost Accounting (TCA) is a method to calculate the external effects of agriculture on the environment and society. "External effects" are described as all unintended effects on the life of one person occurring during an action done by another person, which can be any action in daily life, as well as any economic activity. Examples for human actions could include even one person spewing smoke into the air or dumping litter on the highway, although usually they are actions by groups of people.

The methodology of TCA as used here seeks to highlight further hidden costs besides the direct costs of raw material, labor, etc., and to place a value or cost on these. True Costs are described as the sum of internal and external costs, which can be understood for this study as "Direct Costs" and "Damage Costs."

Throughout this study, the most important examples for external costs are soil erosion, atmosphere damage through greenhouse gas (GHG) emissions, and water damage. In this study, the term "Damage Costs" (or "Environmental Damage

Costs”) is used as an equivalent for the more commonly used term of “externalities.” Right now these damage costs are being paid by the society and future generations. Internalization by, for example, an environmental tax would represent a cost shift from the common responsibility to the responsibility of the polluter.

“The Future of Agriculture in Egypt” Study

“The Future of Agriculture in Egypt” study was first released in April 2016, calculating the “true cost” of cotton, rice, wheat, potatoes, and maize, in the year 2015. The study concluded that at least for the five examined strategic crops it would be economically more expensive to produce crops based on a conventional farming system than to apply organic practices. For Egypt’s economy, the concept of true costs is highly relevant in the context of the shortage of natural resources such as land, water and fertile soil. Meanwhile, in conventional farming systems the inputs need to be increased over time to maintain the same output, which consequently increases the cost of production and use of natural resources.

In June 2020 the study was repeated for the same five crops to provide an update after five years and to re-evaluate the costs after the economic changes in Egypt owing to the currency devaluation. Once more, the organic agricultural methods were put to the economic test in comparison to conventional agriculture, using TCA.

Methodology: Calculation and Evaluation

The comparison structure and the calculation for the direct cost parameters is based on the methodology of the Food and Agriculture Organization of the United Nations (FAO) Study “Economic & Financial Comparison of Organic and Conventional Citrus-growing systems” prepared by the University of Valencia in 2000 (Food and Agriculture Organization of the United Nations, 2000), except for the financial investment calculation. This is because the presented study aims to focus on the explanation of the specific damage costs, which would be distorted by integrating financial multipliers. The calculation methodology for the damage cost parameter for water quality, atmosphere damage, GHG emissions, and soil erosion is based on the FAO report on Food Wastage Footprint: Impacts on Natural Resources (Food and Agriculture Organization of the United Nations, 2013). Other calculations are described in detail below.

Carbon Footprint Calculation: The Carbon Footprint assessment is conducted by the Cool Farm Tool (CFT) (<https://coolfarmtool.org/news-resources>), which is an online greenhouse gas, water, and biodiversity calculator for farmers. The CFT was originally developed by Unilever and researchers at the University of Aberdeen and the Sustainable Food Lab to help growers measure and understand on-farm GHG emissions. The Cool Farm Tool requires general information about farms, such as crop area, yield, soil type, fertilizer, and inputs, as well as some detailed information on electricity and fuel

use (for field operations and primary processing). Carbon sequestration is a key feature of agriculture that has both mitigation and adaptation benefits. The CFT includes calculations of soil carbon sequestration, defined as a long-term storage for carbon dioxide or other forms of carbon.

In organic farming, the calculation for the carbon footprint assessment includes the carbon sequestration through the use of compost. The sequestration amount from compost might offset carbon dioxide emitted by other farm operations, such as diesel consumption. Through calculations using the CFT, the results for total GHG emission in organic farming in Egypt are calculated to be negative or zero. Subsequently, in conventional farming, the calculation for the carbon footprint assessment was done by the previously described methodology of the Cool Farm Tool.

Water Footprint Calculation: The concept of water footprint emerged in 2002, and it has been created in an analogy to the ecological footprint. While an ecological footprint measures how much land a human population requires to produce the resources that it consumes, and to absorb its waste, a water footprint measures human demand on freshwater. An updated manual of the *Water Footprint Assessment Manual* was published by the Water Footprint Network (www.waterfootprint.org) (Hoekstra *et al.*, 2011).

The Water Footprint methodology distinguishes three types of water usage:

- Consumptive use of rainwater (green water).
- Consumptive use of water withdrawn from groundwater or surface water (blue water).
- Pollution of water (graywater; the gray water footprint is an indicator of the degree of freshwater pollution that can be associated with the consumptive use of water).

In organic farming, the water calculation was conducted with the previously described methodology “Water Footprint Assessment,” to determine the amount of water required per acre (of both green and blue water). The water quality costs (gray water) for organic farming equates to zero, as these costs are related to the usage of pesticides and to the number of nitrates in sources of drinking water.

In conventional farming, the calculation was conducted by using the Water Footprint Assessment to determine the amount of water required per acre (green and blue water). These costs are dependent on the usage of pesticides and the number of nitrates in sources of drinking water, therefore integrating gray water data as well.

Soil Erosion: In organic farming, the soil loss from erosion is 15% less for organic agriculture than for conventional agriculture according to Auerwald *et al.* (2003).

The wind erosion ratio in Egypt is about 5.5 ton/hectare (2.33 ton/acre) a year in the oasis areas in the western desert and 71–100 tons/hectare a year in areas of rain fed agriculture on the northwest coast, with wind erosion risks in these areas wavering between moderate and severe. This information was used to calculate the amount of soil erosion from wind for conventional farming and the cost is calculated according to the FAO (2014).

Parameters

Direct Costs

The direct costs are all variable factors of production, which have been broken down into different subcategories.

Raw Materials Inputs: This category represents the costs generated by inputs—that is the value of all inputs used during the production process.

Irrigation Water: The irrigation cost includes the energy cost such as diesel and electricity used for the irrigation and calculated per acre. As water is freely available to Egyptian farmers, the cost of irrigation is only related to the energy cost. The cost of irrigation water regarding electricity and diesel cost is calculated according to the Ministry of Electricity and Renewable Energy prices in 2019 as follows:

- Irrigation using electricity costs 0.75 Egyptian pound per kilowatt hour.
- Irrigation using Diesel costs 6.75 Egyptian pound per liter.

Fertilizers: This includes the cost of compost for organic farming and the cost of fertilizer for conventional farming. The price is calculated using data from the Ministry of Agriculture and Land Reclamation (MALR) for conventional farming and data from the Egyptian Bio-Dynamic Association (EBDA) for organic farming. The amount of fertilizer usage varies according to the type of crop.

Insecticides, Fungicides, and Herbicides: Conventional systems rely on pesticides (herbicides, insecticides, and fungicides), many of which are toxic to humans and animals. The data for the cost of pesticides for organic farming is assumed to be zero, as no harmful synthetic pesticides are used. The emphasis in organic agriculture is on using the inputs (including knowledge) in a way that encourages the biological processes of available nutrients and defense against pests. Most pesticides are prohibited in organic farming as they can hinder these processes. In organic agriculture, management is directed towards preventing problems, while stimulating processes that assist in nutrition and pest management. Organic agriculture uses biocontrol methods instead of synthetic pesticides.

Seed Costs: The cost of seeds is similar in conventional and organic farming. Prices were taken from the MALR and EBDA.

Other Costs: Costs that are not directly related to the manufacturing of a product or delivery of a service such as maintenance or emergency.

Labor and Machinery: Includes the total cost of labor required during the production cycle to perform farming tasks. It also includes the cost of renting machinery, as this is common in Egypt.

Certification: Cost incurred by the farmer to have his or her land certified as organic by the Organic Farming Board, which is the agency responsible for inspecting land and verifying the nature of the used growing method.

Damage Costs

The damage cost determines the amount of damage to the environment and society caused by agriculture through the unsustainable use of water, atmosphere, and soil. The environmental impacts of food wastage have been monetized. These costs are estimated via the wastage quantities and unit costs of the related environmental and social impacts. This also applies to the categories that are assessed on the basis of per-area cost data, as the area numbers related to food wastage are at the end linked to the food wastage quantities.

Water Quality: Describes the effect on water resources, occurring through the use of pesticides and fertilizer in agriculture.

Pesticides in Drinking Water Sources: These estimates are based on the removal costs of pesticides from drinking water for the United Kingdom and Thailand, as more specific information for Egypt is not available (see FAO, 2014).

Table 2.1 Cotton Cost per Acre: Detailed Breakdown of Costs and Damages

<i>Impact category</i>	<i>Evaluation method</i>	<i>Unit value used (US\$, 2012)</i>
Water quality (Nitrate and pesticide contamination of drinking water, N/P eutrophication)	Remediation expenditures (costs of pesticide, nitrate, phosphate removal from drinking water), damage costs, WTP (willingness to pay) to avoid	N Eutrophication (based on \$0.286/kg N leached in UK, correction for N input and output levels and agricultural areas in each country, and benefit transfer). P eutrophication (based on \$12.32/kg P leached, correction for P input and output levels and agricultural areas in each country and benefits transfer). \$78/ha (Thailand) for pesticide contamination (total 264 million in the UK, 14.6 million Thailand, corrected for toxicity levels, area, and benefits transfer ¹).

Nitrate and Phosphate in Sources of Drinking Water: These estimates are based on the removal costs of nitrate from drinking water for the UK (and Thailand), as no other data were available (FAO, 2014).

GHG Emissions: Damage cost of GHG emissions (including deforestation and managed organic soils), based on a range of approaches, damage costs, and remediation expenditure.

Table 2.2 Cost Benefit Analysis – Cotton (Old Land)

<i>Impact category</i>	<i>Evaluation method</i>	<i>Unit value used (US\$, 2012)</i>
GHG emissions (including deforestation and managed organic soils)	The social cost of carbon (based on a range of approaches, damage costs, and remediation expenditure)	\$113/tCO ₂ e (globally, no benefit transfer needed)

Soil Erosion: The cost of soil loss through wind erosion caused by food production.

Table 2.3 Conventional Total Costs 2015

Impact category	Evaluation method	Unit value used (US & 2012)
Soil erosion (owing to wind)	Damage costs (on-site and off-site)	\$27.38/t for wind erosion (US values plus benefit transfer, plus per ha soil erosion levels from 48 countries and regional averages; corrected for soil erosion potential of different cultures)

Total

Total Income: The total income is calculated regarding the crop’s revenue per acre and it depends on the market price per each crop. The average premium price between organic and conventional crops was 14.49% in 2019.

Table 2.4 Organic Total Costs 2015

Crops/price ²	Rice	Maize	Potatoes	Wheat	Cotton
Conventional	6,000 LE	2,714 LE	6,000 LE	4,567 LE	16,680 LE
Organic	7,200 LE	3,250 LE	6,700 LE	5,200 LE	20,016 E

LE: Egyptian pound

Total Expenses: The total expenses are the sum of the total direct cost, which represents all variable factors of production and the total damage cost which determines the amount of damage on the environment and society caused by agriculture through the unsustainable use of water, atmosphere, and soil.

Net Benefit: The net benefit is the result of deducting the total expenses which included the direct cost and the damage cost from the total income.

Data Analysis

Here we present the calculated production costs of the five strategic crops covered by this study. This compares the cost trends of producing these crops under conventional farming and organic farming systems in old land (the Delta region) as well as in new land (reclaimed land from the desert) in Egypt during the past four years. Some crops can only be cultivated in old land; such as cotton and rice, owing to their high water consumption.

The results are presented using the previously described parameters. They include two main components of the production cost: “Direct Costs”, which

are costs commonly paid by the farmer during production, and “Damage Costs”, which are not included in the individual cost calculation.

Cost Overview - Cotton (Old Land)

Figure 2.1 Cotton Cost per Acre: Detailed Breakdown of Costs and Damages

Results and Conclusion

Figure 2.2 Cost Benefit Analysis - Cotton (Old Land)

The four graphs below give an overview and show the main outcome of the previously described results in 2015, while updating calculation for the results of 2019. These figures provide a comparison of the total production costs of organic and conventional farming considering all five evaluated crops.

Figure 2.3 Conventional Total Costs 2015

Figure 2.4 Organic Total Costs 2015

The graph outlines the higher costs for the environment and society occurring through the use of conventional farming methods, as they include higher damage costs. Organic farming enables a cost reduction for society per acre for nearly every crop evaluated in this study, because of the lower damage costs.

Figure 2.5 Conventional Total Costs 2019

Figure 2.6 Organic Total Costs 2019

To summarize the results of the study, the figures presented give an overview of the five evaluated crops in terms of total income and total expenses, calculating the net benefit and comparing it with organic farming and conventional farming methodologies. The result of this comparison shows that the net benefit for society and the environment using conventional farming methodologies is negative, while organic farming produces a positive net benefit for the most part.

Conclusion

Organic farming has proven to be remarkably effective in reversing the negative impact of agriculture on the environment. The study concludes that although

organic agriculture has a slightly higher direct input cost of production, it enables a reduction of the environmental damage costs and therefore results in better cost-effectiveness and profitability in the long term for society as a whole.

The study shows that, with regard to prices, organic food is in fact already cheaper to produce than conventional products, if the externalized costs for pollution, CO₂ emissions, energy, and water consumption are considered. These are currently transferred to society or future generations, but if they would appear on supermarket bills, this would be evident to everyone. Organic agriculture has recently gained importance as an alternative farming system, soil organic matter plays a key role in sustainable agriculture in terms of ecology and farm economics. The agricultural inputs in organic farming systems are not subsidized, but they improve the soil structure, maintain water quality, increase soil organic matter, increase biodiversity and yields while decreasing the total cost to produce one ton of any crop.

As a matter of fact, organic farming enables a cost reduction for the society for every crop evaluated in this study, because of the low damage costs included in the calculation. Even if the selling price of organic products was equal to conventional products, the organic products would still be more profitable for the farmer and cheaper for society, when including the true cost.

The Future of Agriculture in Egypt study, prepared by the Carbon Footprint Center and the Faculty of Agriculture of Heliopolis University for Sustainable Development, is endorsed by the World Future Council, IFOAM–Organics International, and the Biodynamic Federation–Demeter International e.V., which call on policymakers to advance these recommendation based on the outcomes of the study:

- 100% organic agriculture in Egypt.
- Future studies to include a more comprehensive set of indicators to measure the true cost of products (for instance results of TEEB or DALY studies).
- The Egyptian government to implement a polluter tax to reveal the true price of pollution.
- The government, researchers, and farmers to conduct such a study of all crops in Egypt.
- Governments, researchers, and farmers in all countries of the world to conduct such a study to determine the future of agriculture in their countries.
- All members of the organic and biodynamic agroecology and sustainable agriculture movement worldwide to promote these kind of studies.
- Researchers worldwide to study the economic impact of organic agriculture regarding water consumption, health and social impacts, and climate mitigation and adaptation.
- Entrepreneurs and companies worldwide to include the True Cost Accounting approach in their business models.
- Governments and education institutions worldwide to increase the education and training opportunities in organic agriculture to enable more farmers

worldwide to benefit from the economic, ecological, cultural, and social benefits of organic agriculture.

- Governments and all media representatives to increase awareness of all the benefits of organic agriculture among their citizens; and
- All consumers of the world to contribute to a better future for forthcoming generations by their educated and responsible purchase decisions today.

Notes

- 1 Benefit transfers are carried out as region-wide as possible. Where values for the UK and Thailand are given, UK numbers are used for developed country benefit transfer and Thailand numbers are used for developing country benefit transfer (FAO, 2014).
- 2 This table of prices refers to the Egyptian market prices in 2019 for organic and conventional mentioned crops per ton.

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