



MIDDLE EAST AND
NORTH AFRICA

REGIONAL PROGRAM | WORKING PAPER 18 | March 2019

Beyond the Business Case for Agricultural Value Chain Development

An economywide approach applied to
Egypt

Clemens Breisinger, Mariam Raouf, James Thurlow, and Manfred Wiebelt

TABLE OF CONTENTS

Abstract.....	iii
1 Introduction.....	1
2 The agri-food system in Egypt.....	2
3 Methodology.....	7
3.1 Model and data.....	7
3.2 Simulations.....	10
4 Results.....	11
4.1 Growth and employment effects.....	13
4.2 Poverty and nutrition effects.....	15
4.3 Priority value chains by region.....	18
5 Conclusions and policy recommendations.....	20
References.....	22

LIST OF TABLES

Table 1: National economic structure of Egypt, 2015.....	3
Table 2: Egypt's agri-food system – GDP and employment, 2015.....	4
Table 3: Egypt – Sectoral and sub-sectoral GDP and employment at national and regional level, percentage share of national total, 2015.....	5
Table 4: Expansion of production for value chain scenarios at national and regional level.....	10
Table 5: Agricultural supply and demand characteristics.....	11
Table 6: Impact of promoting value chains on GDP and employment, by region, percent.....	13

LIST OF FIGURES

Figure 1: Vegetable value chain, percentage share of total GDP generated by the component parts of the vegetable supply chain, 2015.....	4
Figure 2: Urban and rural food consumption shares, percent, 2015.....	7
Figure 3: Stylized Agriculture Investment for Development Analyzer (AIDA) model.....	8
Figure 4: Impact of promoting value chains on poverty, by region, percent.....	16
Figure 5: Impact of promoting value chains on nutrition (dietary diversity-growth elasticity), by region, percent.....	17
Figure 6: Value chains with strong poverty, nutrition, economic growth, and employment effects, by region.....	18

ABSTRACT

This paper goes beyond the “business” case for agricultural value chain development and presents an economy-wide framework to make the “development” case. We show that there are several key transmission channels that determine the economy-wide impacts of promoting various value chains, including forward and backward economic linkages, price responses, and net employment effects. These impacts all matter for household incomes, poverty, and dietary diversity. Results for Egypt show that agricultural value chain development generates economy-wide growth as well as growth in the agri-food system, but the impacts on employment suggest that agricultural growth can create new (and better) jobs in and beyond the agri-food system, but not necessarily more jobs. The results also show that productivity-driven agricultural growth in all crops is pro-poor and improves nutrition. However, potential adverse effects of livestock-led growth show that growth acceleration in single sectors can be negative, highlighting the importance of a systems analysis or, in our case, an economy-wide analysis. It is clear that no single sub-sector is best at achieving all the development outcomes examined. Moreover, the ranking of value chains by their development outcomes differs across sub-national regions. As such, results from this paper may provide useful decision support for the government and its development partners to select value chains depending on their priority development outcomes.

Several recommendations for policy emerge from this paper.

- Agriculture-led growth in the food system is important, but not necessarily sufficient for accelerating economic transformation in middle-income countries. Additional growth in other sectors is also needed to absorb labor from agriculture and increase demand for higher value agri-food products and services.
- When designing agricultural strategies and projects, it is critical to take a multi-sector development perspective. Focusing only on one value chain can have unintended negative effects on key development outcomes, such as nutrition.
- The findings support the current focus of many development partners on high value crops. However, there is mounting evidence that the focus on high value *exports* may not be sustainable. Especially smallholders often stop producing after export-support projects end due to high recurrent costs that often come with the high quality requirements of export markets. More attention to production for domestic markets and improving quality standards more gradually may be advisable, especially in a middle-income country like Egypt with rapidly growing food demand.
- Development and agricultural strategies should be regionalized. In addition to obvious sub-national differences that are driven by variation in natural conditions and other circumstances, e.g., rice is mainly grown in Lower Egypt and sugarcane in Upper Egypt, our results suggest setting region-specific priorities depending on key development goals.
- The government and its partners should support the transformation of the agriculture, food policy, and business environment. As the macroeconomic environment has substantially improved in Egypt, now sector policies and performance need to follow to support agri-food system development, such as through a thorough review of agricultural investments, subsidies, and other policies.
- There is an urgent need for systemic change to improve agricultural extension services, irrigation, and markets, potentially by leveraging digital innovations that can help to overcome some of the obstacles that have hindered change in the past.

1 INTRODUCTION

There is broad evidence that agricultural growth is important for development and poverty reduction (World Bank 2008; Diao et al. 2007). There is also mounting evidence that agriculture can help improve nutrition (Ecker and Breisinger 2012; Kanter et al. 2015). However, the role of agriculture changes in the course of economic transformation, and as countries move from low to middle and high-income status (Nin Pratt et al. 2017; McMillan, Rodrick, and Sepúlveda 2017). While the relative share of agriculture in economic output and employment declines as countries get richer, linkages between agricultural and non-agricultural sectors become more important. Agricultural production often becomes more capital intensive and mechanized and farms shift from production of staple foods to horticulture and livestock (Diao et al. 2014; Ruttan 2002). As such, the role of value chains in the economy increases and the relative economic weight shifts from primary production to processing and services (El-Enbaby et al. 2016; Breisinger and Diao 2008). Because of this, the agri-food system and related value chains are increasingly seen as important for creating jobs, reducing poverty, and enabling access to nutritious, safe, and healthy diets in low and middle-income countries (Chen, Reardon, and Hu 2015).

Food systems are defined as "the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products" (FAO 2013). The food system can also be viewed as the sum of all food value chains which make up an important part of the economy in all countries. For example, in the U.S. the share of the food system in employment stood at 11 percent in 2017, while the share of agriculture was merely 1 percent (USDA 2018).

Traditional agri-food system analysis focuses on value-chains and often provides the "business case" for investment in them. However, such analyses often do not take spill-over effects to other value chains and the broader economy into consideration (ul Haq 2012). But when scaled up, value-chains are likely to have significant economy-wide implications. For example, resource competition may mean that expanding a new value chain can come at the expense of an existing one, whether through land displacement, competition for labor, changes in producer and consumer prices, or limits to consumer purchasing power, among others. To capture such effects, it is important to establish the "development case" for a value chain development strategy by considering the economy-wide benefits and costs of investing in that value chain.

There are few papers that analyze the agri-food system in such a comprehensive way. For instance, Thurlow, Randriamamonjy, and Benson (2018) find that Tanzania can meet the long-term development objectives of poverty reduction, rural transformation, and economic growth by prioritizing a balanced portfolio of value chains which are most effective at achieving multiple policy objectives. Benfica et al. (2019) conduct an economy-wide public investment priority study for Mozambique and find that, rather than subsidizing irrigation and fertilizer, resources should be allocated towards agricultural research and extension. Using a similar approach, Pauw and Thurlow (2015) find that agricultural research and extension services are much more effective at promoting economic growth and poverty reduction than either rural feeder roads or irrigation infrastructure.

Our paper adds to this emerging literature and presents an economy-wide analysis on how the key value chains of the agri-food system in Egypt – such as cereals, fruits, vegetables, different livestock, and fishery, among others – may contribute to key development goals. To the best of our knowledge, it is the first paper to also capture the often significant socio-economic differences within countries and, thus, allows for regionally-specific prioritization of value chain development. In

order to do so, we build a regionalized, economywide model for Egypt that builds on previous national-level models developed by IFPRI (Diao and Thurlow 2012).

Egypt is an emerging economy with a population that is projected to reach 100 million by 2020 (CAPMAS 2019). The food system makes up about a quarter of the economy (CAPMAS and IFPRI, forthcoming). As an emerging country in transition, the food system is rapidly transforming, driven by urbanization and changes in technology and policy. There is also a renewed focus on agricultural development in Egypt. As in other countries, one of the key development questions for Egypt is which value chains should be targeted for increased public investment to harness the potential of Egypt's agri-food system to accelerate socioeconomic development and to reach national and international development goals. Specific attention is given to the role of the agri-food system in creating jobs and reducing poverty, and there is emerging attention towards the role of agricultural value chains in improving nutrition. Poverty and unemployment in Egypt remain key concerns and there is also growing attention, in the form of a new presidential initiative, to the problem of the double burden of malnutrition – undernutrition and obesity together – which in Egypt is amongst the highest in the world (Ecker et al. 2016).

The objective of this paper is to quantitatively assess the specific characteristics of agricultural value chains in Egypt and how scaling these up can contribute to improving key development indicators, including those around economic growth, employment, poverty, and nutrition. Section 2 provides an overview of the agri-food system in the context of the Egyptian economy. Section 3 introduces the underlying data, the model, and describes the model simulations that were done. Section 4 present the results at regional level. Section 5 concludes with policy recommendations.

2 THE AGRI-FOOD SYSTEM IN EGYPT

The agricultural sector in Egypt makes up 11.7 percent of GDP, 4.6 percent of exports, 6.5 percent of imports, and 14.5 percent of employment. Within the agricultural sector, the crop subsector is the largest component (6.3 percent) followed by livestock (4.3 percent) and fishing (1.1 percent). Crops also dominate agricultural trade and make up the largest share in employment. 2.7 percent of all agricultural produce is exported, whereas 8.5 percent of all agricultural produce consumed in Egypt is imported (Table 1). However, when looking beyond the agricultural sector and accounting for the whole food system, its importance in the economy increases.

Table 1: National economic structure of Egypt, 2015

	Share of total, %					
	GDP	Employment	Export revenues	Import expenditures	Export-output share, %	Import-demand share, %
All sectors	100.0	100.0	10.00	100.0	7.5	12.8
Agriculture	11.7	14.5	4.6	6.5	2.7	8.5
Crops	6.3	8.9	4.5	6.2	4.9	13.9
Livestock	4.3	5.1	0.1	0.2	0.1	0.7
Forestry	0.1	0.0	0.0	0.1	0.0	19.4
Fishing	1.1	0.5	0.1	0.0	0.7	0.0
Industry	31.3	18.7	48.5	68.0	7.2	17.3
Mining	9.1	0.9	14.4	5.9	16.2	11.8
Manufacturing	16.1	11.2	32.6	59.8	7.9	23.3
Agro-processing	3.7	3.5	4.4	7.4	4.2	12.0
Other manufacturing	12.4	7.7	28.2	52.4	9.2	27.1
Other industry	6.1	6.6	1.5	2.3	0.9	2.3
Services	57.0	66.8	46.9	25.5	8.9	7.8
Trade and hotels	17.8	6.5	16.3	5.3	10.0	5.5
Transport & communication	7.8	6.4	25.2	11.3	35.6	28.4
Finance & business	16.0	11.2	4.3	7.7	2.9	8.0
Government services	13.1	38.4	1.2	1.2	1.0	1.6
Other services	2.4	4.4	0.0	0.0	0.0	0.0

Source: CAPMAS and IFPRI (forthcoming).

Notes: Export-output share is the share of exported goods and services to total sector output.

Import-demand share is the share of imported goods and services relative to total domestic demand for these goods and services.

In the following section we disentangle the food system components from the broad sectors traditionally examined in national accounts, i.e. agriculture, industry, and services. Specifically, Table 2 splits the agri-food system into direct production, input production, and trade and services. Direct production includes primary production of agricultural products as well as agro-processed goods, e.g., wheat and grain milling. The input production category includes all goods and services that are used as intermediate inputs for the production of primary agricultural products and for agro-processing. These include, for example, fertilizer and seed for agriculture and energy and packaging materials for agro-processing. Trade and transport includes all services that are related to trading, transporting, and marketing of agricultural productions and agro-processed goods. Results show that the agri-food system makes up 24.2 percent of GDP and 22.9 percent of employment.

The majority of production and employment is related to direct production, which makes up 15.4 percent of GDP and 17.9 percent of employment, followed by trade and transport (7.0 and 3.2 percent of GDP and employment, respectively), and by input production (1.9 percent, 1.8 percent). Unlike in higher income countries, primary agricultural production still dominates food system GDP and employment.

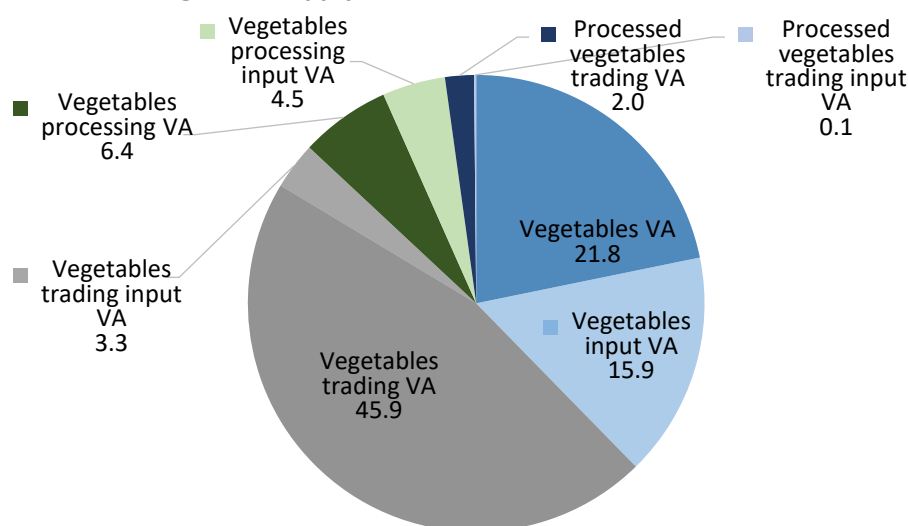
Table 2: Egypt’s agri-food system – GDP and employment, 2015

	Share of total, %	
	GDP	Employment
National economy	100.0	100.0
Agriculture-food system	24.2	22.9
Direct production	15.4	17.9
Agriculture	11.7	14.5
Agro-processing	3.7	3.5
Input production	1.9	1.8
Agriculture	1.0	0.9
Agro-processing	0.9	0.9
Trade and transport services	7.0	3.2
Agriculture	4.3	2.0
Agro-processing	2.7	1.2

Source: AIDA model.

To further illustrate the importance of taking an agri-food system perspective, Figure 1 presents the case of the vegetable supply chain. Out of the total GDP generated by the supply chain, trade and retail together make up more than half. Primary production of vegetables constitutes only 21.8 percent of vegetable supply chain GDP. Adding to this is the output generated by the intermediate inputs related to vegetable production, such as fertilizers and pesticides, which contribute 15.9 percent to vegetable supply chain GDP. The processing of vegetables together with the intermediate inputs required for processing together account for 11.1 percent of vegetable supply chain GDP. Compared to higher income countries, the production share is still relatively high, while the processing and retail shares are low.

Figure 1: Vegetable value chain, percentage share of total GDP generated by the component parts of the vegetable supply chain, 2015



Source: AIDA model; VA = value-added.

Sub-national, regional differences also matter as different value chains play different roles in different parts of the country. As Table 3 shows, the majority of economic activity in Egypt is in Lower Egypt (71.6 percent of GDP), followed by Upper Egypt and the Suez Canal regions. 7.0 percent of national value added is produced by agriculture in Lower Egypt, followed by Upper Egypt and Suez

with 3.5 and 1.2 percent, respectively. The large majority of agro-processing activity is also concentrated in Lower Egypt. 2.9 percent of national GDP is produced by agro-processing in Lower Egypt, while agro-processing in Upper Egypt and in the Suez region each contribute 0.4 percent to national GDP. However, given the small size of the Suez regional economy, this means that agro-processing makes up a larger share in its regional economy compared to Upper Egypt. This is despite the fact that primary agricultural production is significantly more important in Upper Egypt compared to Suez. Within the agro-processing sector, beverages and tobacco is the most important activity in Lower Egypt, followed by other food processing, grain milling, and dairy. In Upper Egypt, other food processing is followed by sugar refining and grain milling. Other agro-processing activities are negligible.

Table 3: Egypt – Sectoral and sub-sectoral GDP and employment at national and regional level, percentage share of national total, 2015

	National		Lower Egypt		Upper Egypt		Suez Canal	
	GDP	Employment	GDP	Employment	GDP	Employment	GDP	Employment
ALL SECTORS	100.0	100.0	71.6	74.4	15.2	14.9	13.2	10.7
AGRICULTURE	11.7	14.5	7.0	8.4	3.5	4.5	1.2	1.6
Crops	6.3	8.9	3.7	5.3	1.8	2.6	0.7	1.0
Food crops	5.6	8.0	3.6	5.2	1.4	1.8	0.7	1.0
Maize	0.9	1.3	0.4	0.6	0.4	0.6	0.1	0.2
Sorghum and millet	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0
Rice	0.6	0.6	0.6	0.5	0.0	0.0	0.1	0.1
Wheat and barley	0.9	0.7	0.5	0.4	0.4	0.3	0.1	0.1
Other cereals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundnuts	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0
Other oilseeds	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Root crops	0.6	1.0	0.5	0.9	0.0	0.1	0.0	0.1
Vegetables	0.7	1.2	0.4	0.7	0.2	0.3	0.1	0.1
Non-food crops	0.6	0.9	0.1	0.2	0.5	0.7	0.0	0.0
Sugar cane	0.4	0.7	0.0	0.0	0.4	0.7	0.0	0.0
Tobacco	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cotton and fibers	0.2	0.2	0.1	0.2	0.0	0.0	0.0	0.0
Fruits	1.7	2.7	1.2	2.0	0.2	0.4	0.2	0.4
Leaf tea	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other crops	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Livestock	4.3	5.1	2.2	2.6	1.6	1.9	0.5	0.6
Cattle	2.0	2.2	1.0	1.1	0.8	0.9	0.2	0.2
Raw milk	1.1	1.5	0.5	0.7	0.4	0.6	0.1	0.1
Poultry	0.6	0.7	0.4	0.5	0.1	0.1	0.1	0.2
Small ruminants	0.4	0.5	0.2	0.2	0.2	0.2	0.0	0.1
Other livestock	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0
Other agriculture	1.2	0.5	1.0	0.4	0.1	0.1	0.0	0.0
Forestry	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Fishery	1.1	0.5	1.0	0.4	0.1	0.1	0.0	0.0
Capture fisheries	1.1	0.5	1.0	0.4	0.1	0.1	0.0	0.0
NONAGRICULTURE	88.3	85.5	64.6	66.0	11.7	10.4	12.0	9.2
INDUSTRY	31.3	18.7	19.7	13.5	5.3	2.3	6.3	2.9
Mining	9.1	0.9	3.4	0.4	2.5	0.2	3.1	0.3
Coal and lignite	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

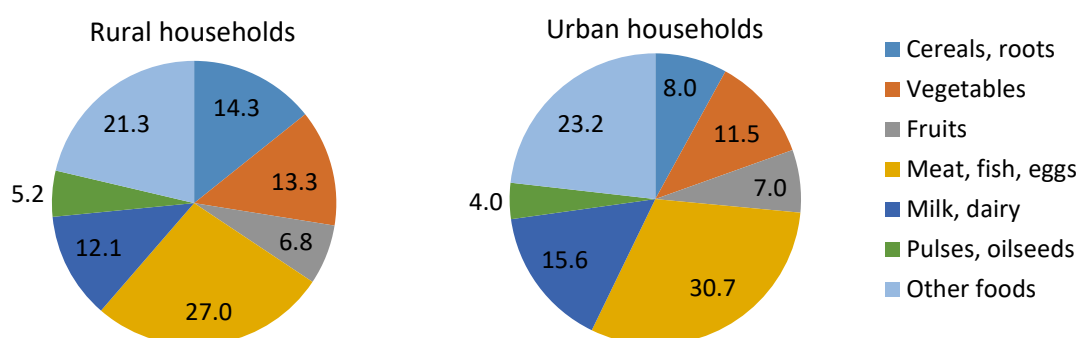
	National		Lower Egypt		Upper Egypt		Suez Canal	
	GDP	Employment	GDP	Employment	GDP	Employment	GDP	Employment
Crude oil	5.6	0.4	1.0	0.1	2.5	0.2	2.1	0.1
Natural gas	2.7	0.4	1.7	0.2	0.0	0.0	1.0	0.1
Other mining	0.8	0.2	0.7	0.2	0.1	0.0	0.0	0.0
Manufacturing	16.1	11.2	12.4	8.6	1.1	0.8	2.6	1.8
Agro-processing	3.7	3.5	2.9	2.7	0.4	0.4	0.4	0.3
Food processing	2.9	2.6	2.1	1.8	0.4	0.4	0.4	0.3
Meat processing	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Fish and seafood processing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dairy	0.3	0.3	0.3	0.2	0.0	0.0	0.1	0.0
Fruit & vegetable processing	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Fats and oils	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Grain milling	0.8	0.6	0.6	0.4	0.1	0.1	0.1	0.1
Sugar refining	0.2	0.4	0.1	0.2	0.1	0.2	0.0	0.0
Other foods	1.0	0.8	0.7	0.6	0.2	0.1	0.2	0.1
Animal feed	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Beverages and tobacco	0.8	0.9	0.8	0.9	0.0	0.0	0.0	0.0
Beverages	0.5	0.3	0.5	0.3	0.0	0.0	0.0	0.0
Tobacco processing	0.3	0.6	0.3	0.6	0.0	0.0	0.0	0.0
Other manufacturing	12.4	7.7	9.5	5.9	0.7	0.4	2.2	1.4
Textiles, clothing and footwear	1.1	1.2	0.8	0.8	0.0	0.0	0.3	0.4
Textiles	0.4	0.6	0.2	0.3	0.0	0.0	0.2	0.3
Clothing	0.4	0.4	0.3	0.3	0.0	0.0	0.1	0.1
Leather and footwear	0.3	0.2	0.3	0.2	0.0	0.0	0.0	0.0
Wood and paper	0.7	0.7	0.3	0.3	0.1	0.1	0.3	0.3
Wood products	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Paper and publishing	0.6	0.5	0.2	0.2	0.0	0.0	0.3	0.3
Chemicals	6.0	1.9	4.5	1.4	0.3	0.1	1.2	0.4
Petroleum	4.3	1.1	3.4	0.9	0.2	0.1	0.6	0.2
Fertilizers	0.5	0.2	0.1	0.1	0.0	0.0	0.4	0.1
Chemicals	1.2	0.6	1.0	0.5	0.0	0.0	0.3	0.1
Machinery	3.8	3.6	3.1	3.0	0.3	0.2	0.3	0.3
Non-metal minerals	1.2	0.8	0.8	0.5	0.3	0.2	0.1	0.0
Metals and metal products	1.5	1.7	1.5	1.7	0.0	0.0	0.0	0.0
Machinery	0.2	0.3	0.1	0.3	0.0	0.0	0.0	0.1
Electrical equipment	0.7	0.5	0.5	0.4	0.0	0.0	0.2	0.1
Vehicles	0.2	0.3	0.1	0.2	0.0	0.0	0.0	0.1
Other manufacturing	0.8	0.3	0.7	0.3	0.0	0.0	0.0	0.0
Other industry	6.1	6.6	3.9	4.4	1.6	1.3	0.6	0.9
Electricity and water	2.1	4.2	1.5	3.0	0.3	0.5	0.4	0.7
Electricity, gas & steam	1.5	3.2	1.1	2.4	0.1	0.2	0.3	0.6
Water supply and sewage	0.6	1.0	0.4	0.6	0.2	0.3	0.1	0.1
Construction	4.0	2.4	2.4	1.4	1.4	0.8	0.2	0.1
SERVICES	57.0	66.8	44.9	52.5	6.4	8.1	5.7	6.2
Trade and hotels	17.8	6.5	14.5	5.2	2.0	0.7	1.3	0.6
Wholesale & retail trade	15.3	5.0	12.8	4.2	1.7	0.5	0.9	0.3
Accommodation	2.5	1.4	1.7	1.0	0.3	0.2	0.5	0.3
Transport & communication	7.8	6.4	5.0	4.3	0.5	0.3	2.3	1.8
Transportation & storage	6.4	4.9	3.6	2.8	0.5	0.3	2.3	1.8
Information and communication	1.3	1.5	1.3	1.5	0.0	0.0	0.0	0.0

	National		Lower Egypt		Upper Egypt		Suez Canal	
	GDP	Employment	GDP	Employment	GDP	Employment	GDP	Employment
Finance, business and real estate	16.0	11.2	12.9	8.7	2.1	1.7	0.9	0.7
Finance and insurance	4.8	8.8	3.6	6.6	0.9	1.6	0.4	0.7
Real estate activities	8.0	0.6	6.3	0.5	1.1	0.1	0.5	0.0
Business services	3.1	1.8	3.0	1.7	0.1	0.1	0.1	0.0
Government services	13.1	38.4	10.5	30.6	1.7	5.0	1.0	2.8
Public administration	5.2	18.3	4.0	14.1	0.8	2.8	0.4	1.3
Education	5.0	14.4	4.1	11.7	0.5	1.5	0.4	1.2
Health and social work	2.9	5.7	2.4	4.7	0.3	0.7	0.1	0.3
Other services	2.4	4.4	2.0	3.8	0.2	0.4	0.2	0.3

Source: AIDA model; Note: n/a = not applicable

In addition to regional differences in production, differences in consumption patterns also matter for value chain prioritization. Total annual average estimated household expenditure is \$1,975 per capita. Rural households' per capita expenditure is lower at \$1,423 compared to \$2,714 for urban households. Rural households spend 32.6 percent of total expenditures on food compared to 26.7 percent for urban households. Within food categories, spending on meat, fish, eggs, milk, and dairy make up relatively large shares of urban households' spending, whereas rural households spend relatively more of their consumption basket on cereals, roots and vegetables (Figure 2). The differences in consumption patterns between rural and urban households are more pronounced than the differences for households between regions (Lower Egypt, Upper Egypt, and Suez Canal).

Figure 2: Urban and rural food consumption shares, percent, 2015



Source: AIDA model

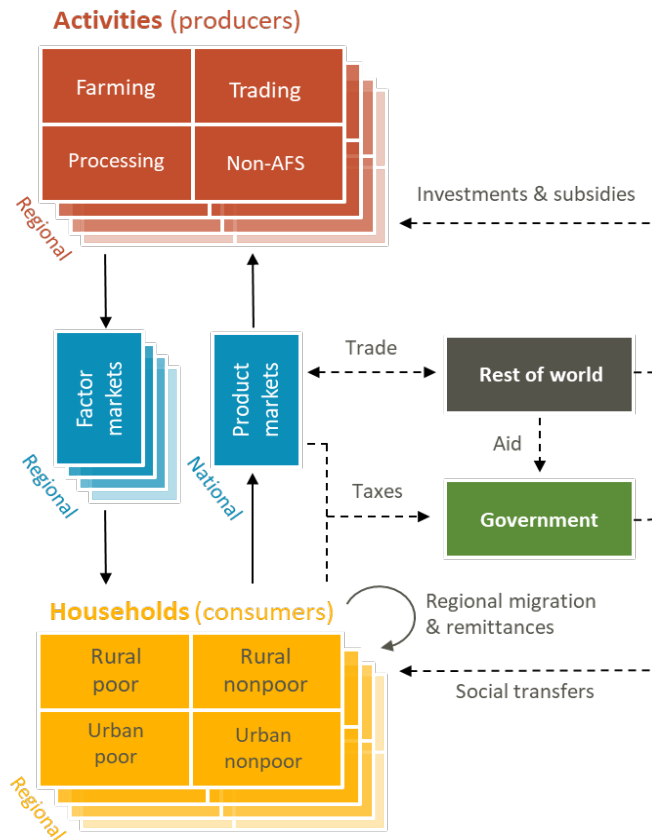
3 METHODOLOGY

3.1 Model and data

The effectiveness of agricultural value chains in generating additional growth and employment opportunities and in reducing poverty and improving nutrition is analyzed using an economy-wide regionalized dynamic computable general equilibrium model, the Agriculture Investment for Development Analyzer (AIDA) that has been developed by IFPRI in collaboration and with support from IFAD and CGIAR-PIM. This class of economy-wide models simulates the workings of a market-based open economy in which supply and demand of commodities and factors are determined by market-clearing flexible prices, subject to resource constraints and macroeconomic consistency (see Diao and Thurlow 2012 for a description and mathematical specification of the model together with

data requirements and calibration procedure). The flow diagram in Figure 3 provides a stylized picture of the circular flow of goods and factors as well as financial transactions between economic agents – producers and consumers in different regions, government, and rest of the world – acting in national and international product markets and regional factor markets.

Figure 3. Stylized Agriculture Investment for Development Analyzer (AIDA) model



Source: Authors' compilation

The AIDA model separates Egypt's economy into 62 sectors in each of three sub-national regions, Lower Egypt, Upper Egypt, and Suez Canal. The 62 sectors are made up of 20 agriculture (labeled farming in Figure 3), 11 agro-processing, 2 trading and transport (trading in Figure 3), and 29 industrial and services sectors, all of which, at least in part, are related to the agriculture and agro-processing system. These include fertilizer, water, or machinery and vehicles, all of which are used as intermediate inputs in agriculture or agro-processing. Sectors that are only partly used in agriculture or agro-processing include textiles and paper and publishing (labeled non-AFS in Figure 3).¹ Representative producers in each sector and region combine factors of production, i.e. land, labor, and capital, using a constant elasticity of substitution production function under constant returns to scale. Cropland and labor are defined regionally. Labor within each region is divided into four categories based on education level, i.e., uneducated, primary, secondary, and tertiary. Capital is

¹ The main database for the model is a spatially disaggregated social accounting matrix (SAM) for Egypt in year 2015 (IFPRI and CAPMAS 2019). This SAM has seven subnational regions: Greater Cairo, Delta, Alexandria, Northern Upper Egypt, Middle Upper Egypt, Southern Upper Egypt, and Suez Canal. For the analysis here, the first three regions are aggregated to Lower Egypt, the next three make up Upper Egypt, and Suez Canal is kept separate.

divided into four capital types depending on the sectors using the capital, i.e., crop, livestock, mining, and other capital.

The model is run over the period 2015 to 2022. Land and labor are fully employed and mobile across sectors, but not regions, and their total supply generally grows over time based on historical trends.² The exception is uneducated and primary educated labor, which are treated as underemployed and for which we assume wage elastic labor supply curves in all three regions. Past investment determines new capital stocks, which are allocated to sectors according to their relative profitability. Once invested, capital becomes immobile and earns sector-specific returns, i.e., the putty-clay assumption.

There is imperfect substitution between domestic and foreign goods, i.e., the Armington assumption. Producers' decision to supply to export markets or domestic markets and consumers' decision to buy imported or domestically produced goods are based on changes in domestic prices relative to fixed world market prices. All domestic, import, and export prices include relevant indirect taxes. The current account balance is maintained though changes in the real exchange rate.

The model separates Egypt's households into 15 groups within each region. These groups include farm and non-farm households within rural areas and households within urban areas, separated into per-capita-consumption quintiles. In each group, the lowest two quintiles (the lowest 40 percent) of households are regarded as poor. Representative households receive incomes based on their factor endowments and then use that income to pay taxes, to save, and to consume goods. The latter is determined by a linear expenditure system with income elasticities taken from Dawoud (2014).

The government receives direct and indirect taxes and foreign aid, and uses these revenues to pay for recurrent spending and investment. Private, public, and foreign savings, i.e., capital inflows, are pooled and used to finance domestic investment. We assume that public spending grows in line with recent trends and that the fiscal deficit adjusts in order to equate revenues and expenditures. Household savings rates are fixed, and investment demand adjusts so that it equals total savings in equilibrium.

Because the focus is on agriculture and agricultural value chains, the CGE model gives emphasis to agricultural activities and their linkages to other production sectors, especially agricultural processing sectors and trade sectors, but also to manufacturing and services sectors producing intermediate inputs that are used by the agricultural food system. Moreover, the model takes into account regional differences in production and consumption. A SAM for 2014/15, the base period of the study, has been constructed by CAPMAS and IFPRI that integrates national income, input-output, flow-of-funds, balance-of-payments current accounts, and household income and expenditure data into a comprehensive and consistent data set. It is assumed to represent the initial equilibrium position of the Egyptian economy and provides numerical values to several parameters of the analytical model.

² Assuming interregional immobility for all labor categories implies that the short-run adjustment flexibility to regional shocks is limited since labor reallocation is restricted. Moreover, it implies that wages for the same labor categories may differ across regions.

3.2 Simulations

We design several scenarios in order to determine which agricultural value-chains, if scaled-up, are most effective at³:

- accelerating agricultural and national economic growth;
- raising farmers' incomes and reducing poverty;
- creating jobs on and off the farm; and
- improving nutrition by diversifying diets.

We use the AIDA model to simulate the effects of expanding farm production within existing agricultural value-chains. Total factor productivity (TFP) growth in each group of agricultural products and regions is accelerated beyond baseline growth rates, such that, in each value-chain scenario, total agricultural GDP or regional agricultural GDP is one percent higher in 2022 than it is in the baseline scenario.⁴ National and regional agricultural subsectors differ in size. So, to achieve the same absolute increase in total and regional agricultural value-added, it is generally necessary for smaller value-chains to expand more rapidly than larger ones. Table 4 lists the national and regional value-chains analyzed in this report, including their initial regional agricultural GDP shares and required TFP changes.

Table 4: Expansion of production for value chain scenarios at national and regional level

	National		Lower Egypt		Upper Egypt		Suez Canal	
	Agricultural GDP share, %	TFP change, %	Agricultural GDP share, %	TFP change, %	Agricultural GDP share, %	TFP change, %	Agricultural GDP share, %	TFP change, %
Agriculture	11.7		7.0		3.5		1.2	
Maize	7.3	4.3	5.5	2.2	10.6	1.1	8.4	1.0
Rice	5.5	7.3	7.9	3.6	0.0	1.0	7.7	1.9
Wheat and barley	7.8	2.9	6.5	2.6	10.0	1.6	9.0	1.9
Root crops	5.2	6.3	7.7	3.2	1.0	5.4	3.3	2.1
Vegetables	5.7	12.2	5.7	2.8	5.4	1.7	6.8	1.1
Sugar cane	3.8	9.3	0.0	1.0	12.7	2.4	0.0	1.0
Fruits & nuts	14.2	1.6	17.2	0.8	6.1	1.2	20.8	0.4
Cattle	17.0	1.6	14.6	1.3	22.1	0.8	16.1	0.9
Raw milk	9.1	2.5	7.8	2.0	11.8	1.3	8.6	1.4
Poultry	5.3	5.6	5.8	3.6	2.3	5.1	11.3	1.3
Small ruminants	3.3	6.8	2.2	6.6	5.4	3.0	3.8	3.3
Fishery	9.6	2.3	14.2	1.5	3.8	3.4	0.0	1.0

Source: Authors' compilation

Note: Total Factor Productivity (TFP) change is 1.0 for all agricultural sectors and all years in the baseline scenario.

Small ruminants in Lower Egypt (2.2 percent of regional agricultural GDP) and root crops in both Upper Egypt and the Suez Canal regions are the smallest agricultural subsectors on this list. So, these activities need large productivity gains to match the effects of even modest yield gains for cereals, e.g., maize (1.1 percent), or for fruits and nuts (1.2 percent) in Upper Egypt. While such rapid growth may be difficult to achieve, targeting the same absolute increase in agricultural GDP permits comparisons across scenarios. Fruits and nuts is the largest sector in both Lower Egypt and

³ The environmental sustainability dimension is not explicitly considered in this paper. Several aspects of environmental sustainability such as water, however, are included in the model as a production input, and the limited amount of water available is considered in the model as a constraint to land expansion.

⁴ The choice to target one percent increase in agricultural GDP is somewhat arbitrary, since results are largely unaffected by the magnitude of the target growth acceleration.

the Suez Canal, while cattle is the largest sector in Upper Egypt. These sectors require low TFP growth rates to reach the one-percent growth target for agriculture in these regions in 2022. Poultry, root crops, and small ruminants are intermediate value chains at the national level.

4 RESULTS

There are several key transmission channels that determine the impact of promoting agricultural value chains in an economy-wide context. Because we are primarily interested in the impact on the agro-food system, we focus on how and why prices, income generation, and employment differ across agricultural value chains and how these differences affect economy-wide income generation, employment, poverty, and nutrition.

Table 5: Agricultural supply and demand characteristics

	EXP- OUTshr (%)	IMP- DEMshr (%)	Import substi- tution elasticity	INT- OUTshr (%)	HHD- OUTshr (%)	Income elasticity of demand	QINTshr (%)	TRCshr (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maize		27.2	1.30	91.8	6.3	0.4	23.8	13.9
Rice	0.5		5.05	78.7	21.3	0.4	17.2	17.1
Wheat and barley		23.4	4.45	90.1	9.9	0.4	23.1	13.0
Root crops	5.8	6.2	1.85	9.1	90.9	0.3	19.0	21.5
Vegetables	3.7		1.85	14.4	84.4	0.6	51.9	54.2
Sugar cane	1.6	2.0	2.70	98.9	0.0	0.3	18.9	22.6
Fruits & nuts	12.6	7.8	1.85	36.3	63.5	0.9	13.7	27.6
Cattle		1.8	2.00	50.2	46.4	0.8	10.1	18.6
Raw milk				0.0	100.0	0.8	13.8	16.4
Poultry				13.7	86.3	0.8	64.0	22.7
Small ruminants				13.0	87.0	0.7	11.4	12.0
Fishery	0.7		1.25	13.5	86.5	0.9	7.2	21.0

Source: AIDA model.

Note: EXP-OUTshr = sectoral export-output share; IMP-DEMshr = sectoral import penetration rate; INT-OUTshr = share of sectoral output that is processed; HHD-OUTshr = share of sectoral output directly consumed by households; QINTshr = secondary inputs as a share of total sectoral input demand; TRCshr = share of total sectoral value of demand made up by trading services.

The first important transmission channel is the initial domestic output price response in agricultural sub-sectors. Rising TFP increases output and supply, resulting in lower domestic prices. The extent of the fall in domestic prices depends on the tradability of the agricultural goods, as reflected by export orientation, i.e., the share of export supply in total supply and the export transformation elasticity.⁵ The lower the export share and the lower the export transformation elasticity, the larger the domestic price reductions in reaction to TFP growth. From the sectoral export-output shares and the trade substitution elasticities shown in columns (1) and (3) in Table 5, one would expect large price reductions for all sectors except for fruits and nuts and for rice in response to higher sectoral TFP's. Half of the sectors are exclusively producing for the domestic market or exhibit low export shares and low export transformation elasticities. Other sectors, such as root crops, vegetables, sugarcane, and fish exhibit both low export shares and relatively low export transformation elasticities. Thus, their prices are largely determined by domestic supply and

⁵ The export transformation elasticity measures the percentage change in the export supply to domestic supply in response to a 1 percent change in the export price to the domestic price. The higher the export transformation elasticity the easier it is for the good to penetrate world markets.

demand. One exception is rice, where high export transformation possibilities lead to a sizeable restructuring of supply despite low export orientation. This lowers domestic supply of rice, thereby lowering downward pressure on prices. The other exception is fruits and nuts, for which a sizeable export orientation reduces downward pressure on domestic prices despite low trade elasticities.

Together these characteristics imply large price reductions with increases in output and supply for most of the domestically produced agricultural goods. This will induce domestic users, both consumers and agricultural processing sectors, to change their composition of demand — less imports and more domestically produced substitutes —, thereby causing upward pressure on domestic prices. The resulting change in domestic prices depends on the cross-price elasticity of demand for the composite good, which itself depends on the price elasticity of demand for the composite good and the elasticity of substitution in use between the domestically produced and foreign goods. Lower domestic prices for agricultural goods will, *ceteris paribus*, lead to a large increase in demand for the domestically produced goods if the following conditions are met:

- If it is easy to substitute them for imports, as indicated by high trade substitution elasticities;
- If the sectoral import share is large, implying relatively large demand increases for the domestically produced product in order to compensate for relatively small reductions in imports; and
- If the demand for the composite good is relatively inelastic with respect to the composite price, reflecting the importance of these goods as intermediates in domestic production.

Returning to Table 5, from the demand characteristics of agricultural markets one would expect no secondary repercussions on domestic prices for all goods, except for maize and for wheat and barley. Half of the sectors face no import competition at all, while import competition is low for another four sectors (root crops, sugarcane, fruits and nuts, and cattle), as reflected by their low import penetration rates (column (2) and low import substitution elasticities (column (3)). The wheat and barley sector exhibits the highest import shares and import substitution elasticity, implying strong repercussions on domestic prices, while the price response is only moderate despite a higher import share as a result of lower import substitution possibilities.

Beside these transmission channels, which determine the initial domestic output price response in agricultural markets, there are other transmission channels that determine the final growth and employment effects of sectoral agricultural TFP growth: First, other things being equal, the stronger are the forward and backward economic linkages of a value chain, the stronger are the economy-wide growth effects. An extreme example is the vegetables value chain (Figure 1), where only 22 percent of total value-added stems from the agricultural sector and only another 6 percent is generated in downstream vegetables processing, while more than 70 percent of value added is indirect, generated either in backward linked non-agricultural intermediate input production or forward linked transport sectors. More than 50 percent of the value added generated in the vegetables value chain stems from trading services. Thus, TFP growth in vegetables will probably be dominated by indirect growth impacts outside vegetables production and processing.

Second, the economy-wide, net employment effects matter for household incomes, poverty, and dietary diversity. Promoting agricultural production through increasing productivity means that more output is produced with the same or fewer inputs by increasing the efficiency of factors, such as labor. As observed in all successfully transforming countries, the share and number of people employed in agriculture is expected to decline over time. However, given the forward and backward

linkages of agriculture, people that move out of agriculture may move to higher-valued jobs in the agro-food system, for example in processing or services.

Third, as already discussed for agricultural goods, the impact of promoting selected agricultural value chains on (relative) prices can be significant. The price effects crucially depend on the income elasticity of demand of households and the trade elasticities. The price effect (decline in price) of increasing supply is usually stronger the more inferior the good. For example, staple goods, such as bread, have a lower price elasticity and, even if the price falls, people are less likely to buy more bread. Fruits, on the other hand, often have a high elasticity of demand and so a reduction in price would lead to an increase in purchases of fruits. Regarding trade, usually the less internationally traded a good is, the more an increase in domestic production will lead to a decline in domestic prices. Obviously, lower prices lead to higher real incomes and greater dietary diversity for net consuming households, whereas net producing households of the commodity may experience negative real income and nutrition effects.

Against this theoretical discussion of key transmission channels, we now move to the discussion of the empirical results for Egypt. We first discuss the expected impacts on economic growth and employment and then on poverty and nutrition.

4.1 Growth and employment effects

Table 6 reports the regional growth and employment effects of expanding agricultural production in different value chains together with rankings of value chains on the basis of these effects. In each region, value chains are expanded over the period 2018 to 2022 such that total regional agricultural GDP is one percent higher in year 2022 than without the value chain expansion. The table reports growth and employment elasticities for the total economy and for the agricultural food system (AFS) only. The higher the total GDP growth that results from a one percent expansion of agriculture, the higher is non-agricultural growth. The higher the AFS GDP growth, the higher is growth in agri-processing. Thus, the former is an indicator of agriculture-led development, whereas the latter is an indicator of agricultural transformation.

The results in Table 6 show that all agricultural value chains contribute to AFS and economy-wide growth. However, there are substantial differences across sub-sectors and regions depending on forward and backward linkages, tradability, and income elasticities of demand.

Table 6: Impact of promoting value chains on GDP and employment, by region, percent

	Lower Egypt			
	GDP		Employment	
	Total	AFS	Total	AFS
Maize	0.19 (4)	0.69 (5)	0.00 (5)	-0.23 (7)
Rice	0.27 (2)	0.78 (2)	-0.01 (8)	-0.73 (9)
Wheat	0.16 (6)	0.61 (9)	0.01 (1)	0.03 (1)
Root crops	0.20 (3)	0.63 (7)	-0.02 (10)	-0.73 (10)
Vegetables	0.35 (1)	1.09 (1)	-0.07 (11)	-1.74 (11)
Fruits and nuts	0.15 (8)	0.65 (6)	0.00 (3)	-0.06 (3)
Cattle	0.16 (5)	0.72 (4)	-0.01 (7)	-0.20 (6)
Milk	0.14 (10)	0.58 (11)	-0.01 (6)	-0.16 (5)
Poultry	0.15 (7)	0.77 (3)	-0.02 (9)	-0.37 (8)
Small ruminants	0.14 (11)	0.59 (10)	0.00 (4)	-0.09 (4)
Fish	0.14 (9)	0.62 (8)	0.00 (2)	-0.03 (2)

Upper Egypt				
	GDP		Employment	
	Total	AFS	Total	AFS
Maize	0.21 (4)	0.70 (5)	-0.01 (6)	-0.57 (9)
Wheat	0.16 (6)	0.59 (9)	0.01 (1)	-0.03 (1)
Root crops	0.22 (2)	0.62 (8)	-0.02 (10)	-1.17 (10)
Vegetables	0.45 (1)	1.24 (1)	-0.09 (11)	-2.96 (11)
Sugar cane	0.22 (3)	0.88 (2)	0.00 (4)	-0.38 (7)
Fruits and nuts	0.16 (8)	0.65 (6)	0.00 (3)	-0.22 (4)
Cattle	0.17 (5)	0.73 (4)	-0.01 (8)	-0.30 (6)
Milk	0.15 (9)	0.58 (11)	-0.01 (7)	-0.29 (5)
Poultry	0.16 (7)	0.78 (3)	-0.02 (9)	-0.45 (8)
Small ruminants	0.14 (10)	0.59 (10)	0.00 (5)	-0.19 (3)
Fish	0.14 (11)	0.62 (7)	0.00 (2)	-0.05 (2)

Suez Canal				
	GDP		Employment	
	Total	AFS	Total	AFS
Maize	0.19 (4)	0.70 (5)	-0.01 (4)	-0.26 (6)
Rice	0.28 (2)	0.80 (2)	-0.02 (7)	-0.84 (9)
Wheat	0.16 (6)	0.61 (8)	0.01 (1)	0.04 (1)
Root crops	0.21 (3)	0.65 (7)	-0.02 (9)	-0.83 (8)
Vegetables	0.35 (1)	1.11 (1)	-0.07 (10)	-1.76 (10)
Fruits and nuts	0.15 (8)	0.66 (6)	0.00 (2)	-0.10 (3)
Cattle	0.16 (5)	0.72 (4)	-0.01 (6)	-0.20 (5)
Milk	0.14 (9)	0.59 (10)	-0.01 (5)	-0.16 (4)
Poultry	0.16 (7)	0.77 (3)	-0.02 (8)	-0.38 (7)
Small ruminants	0.14 (10)	0.59 (9)	0.00 (3)	-0.10 (2)

Source: AIDA model; AFS = agricultural food system.

Vegetables come out on top in all three regions (Lower and Upper Egypt and Suez). This is because of their strong backward linkages – 52 percent of total input demand is for secondary inputs (Table 5, column [7]) – and high trade margins – costs for primary-input intensive trading services make up 54 percent of total value of demand (Table 5, column [8]). However, vegetables have low forward linkages – only 14.4 percent of vegetables output is processed (Table 5, column [4]), while 84.4 percent is directly consumed by households (Table 5, column [5]). An AFS sectoral GDP growth elasticity of 1.09 to 1.24 for vegetables implies that a one percent increase in agricultural GDP driven by vegetables' productivity increases AFS GDP by between 1.09 and 1.24 percent.

In regions where it is grown, rice comes out as the cereal sub-sector with the strongest growth effects, followed by maize and then wheat. In the case of rice, a high export transformation elasticity of 5.05 (Table 5, column [3]) implies that domestic prices do not differ very much from world market prices. As a result, TFP growth in the rice sector leads to a significant increase of GDP generation within the sector itself. Moreover, a supply share to processing sectors of 78.7 percent (Table 5, column [4]) implies strong forward linkages and additional income generation in agro and other processing sectors.

Root crops and livestock sectors also are growth enhancing with relatively little difference between sectors and regions.

Table 6 shows that growth effects may differ when considering the whole economy rather than just the AFS. According to the ranking of value chains, cereals are more effective in creating growth outside the AFS. In contrast, fruits and nuts and poultry are the value chains most effective in

creating growth in AFS while being significantly less effective at generating economywide growth. In the case of poultry, this result can be traced back to strong backward linkages within agriculture. Poultry production is very intensive in secondary inputs – 64 percent of total poultry sector output is made up of secondary inputs (Table 5, column [7]). Of these inputs, more than 60 percent is made up of forage produced in the maize sector.

The impacts on employment are more mixed and, in general, reflect expected movements of labor out of agriculture and into other sectors. While the productivity-driven agricultural growth leads to a reduction in employment in the agricultural sector, results show that agricultural growth can create new and better jobs in and beyond the agri-food system. The net, region-wide employment effects are almost neutral, with some slight declines induced by vegetables, root crops, and rice.

Wheat is the only value chain that is effective in creating additional jobs inside and outside the AFS, although it is not very effective at raising GDP growth. Egypt does not export wheat (Table 5, column [1]). As a result, TFP and output growth will lead to decreasing domestic prices for wheat, and, at given world market prices, will lead to import substitution and an increasing share of wheat imports (Table 5, column [2]). Import substitution elasticities of 4.45 (Table 5, column [3]) imply that a relative price reduction of 1 percent in the ratio of domestic to import prices leads to a relative quantity expansion of domestically produced to imported wheat of 4.45 percent. Thus, TFP growth in the wheat sector actually leads to higher employment in the wheat sector itself.

For all other value chains, the employment effects are negative. This finding clearly highlights that for a comprehensive and job-creating economic transformation, productivity-led growth in agriculture is not sufficient. Measures that support agricultural growth need to be accompanied by measures that also encourage non-agricultural sectors to grow and absorb the labor force released by the more productive agricultural sector.

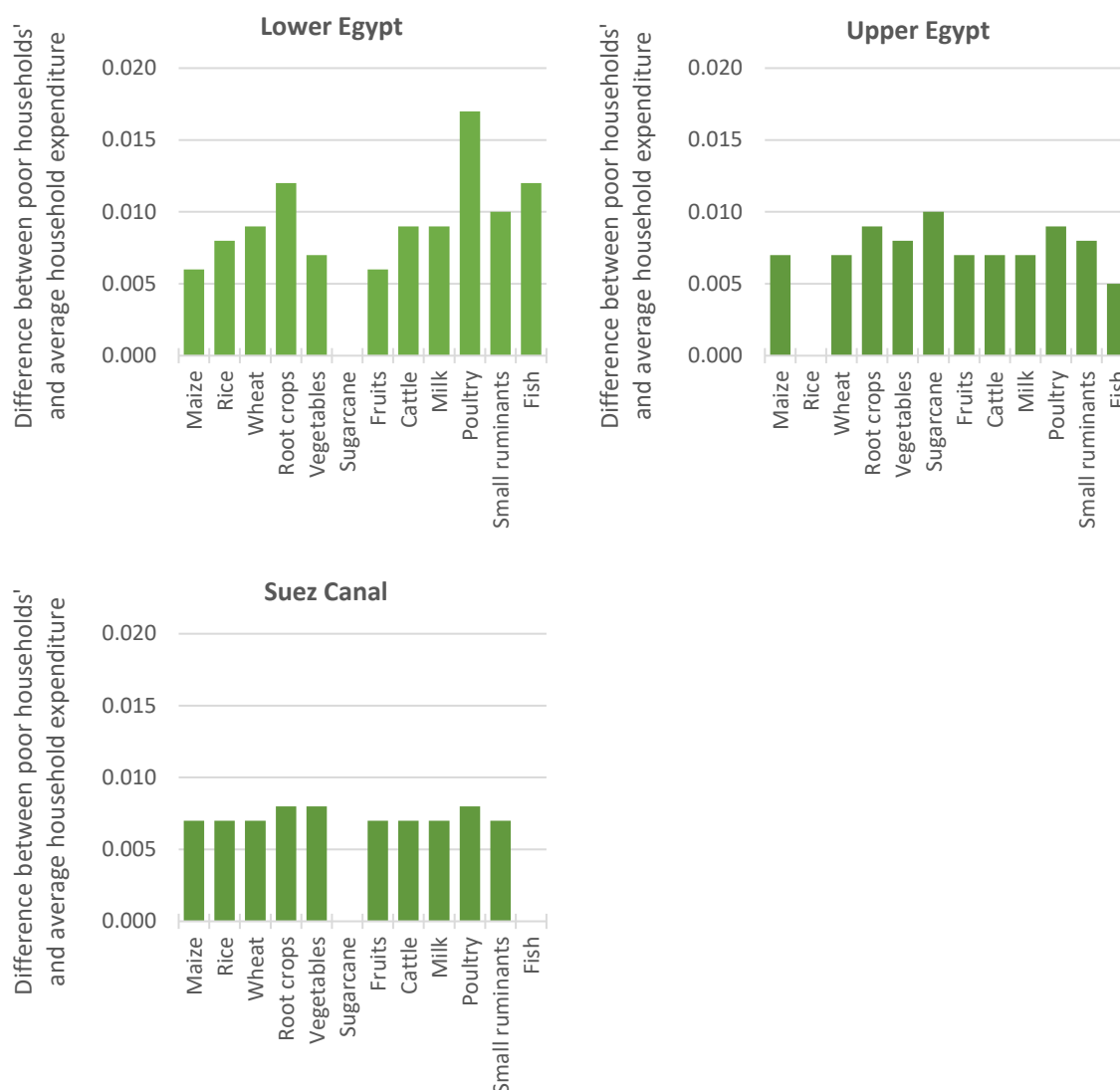
4.2 Poverty and nutrition effects

Consistent with the development economics literature, we consider the effect of agricultural value chain development to be pro-poor if the consumption level for households in the lowest two expenditure quintiles grows more than the average expenditure of all households. An agricultural value chain's impact on poverty depends on various factors, including whether poorer households engage in the value chain as a primary activity and earn higher farm revenues; whether poorer workers are employed in downstream processing and trading and earn higher wages; or whether poorer households consume the final product at lower prices.

The key mechanisms through which changes in agricultural productivity translate into changes in household welfare (or poverty) are net employment and income effects and relative price changes. As discussed above, net employment effects are almost neutral across all regions and by type of agricultural sub-sector-led growth. What dominates the positive impact on all households, and particularly on poor households, is the price effect in the domestic markets for agricultural and processed products. This impact is quite strong given the low trade orientation of most sectors. The more that an increase in production comes as a result of productivity-driven growth in a sub-sector, the greater the reduction in the price for the respective agricultural good, the more a certain household consumes that commodity or a related processed item that benefits from the lower input prices, and the higher the positive impact on the household's welfare. Figure 4 shows that, depending on the size of the employment and price effect, impacts vary across regions and agricultural subsector, with poultry and root crops being most effective at reducing poverty in Lower

Egypt. In Upper Egypt, sugarcane and poultry are most effective, while in Suez Canal root crops and vegetables are the leading value chains.

Figure 4: Impact of promoting value chains on poverty, by region, percent

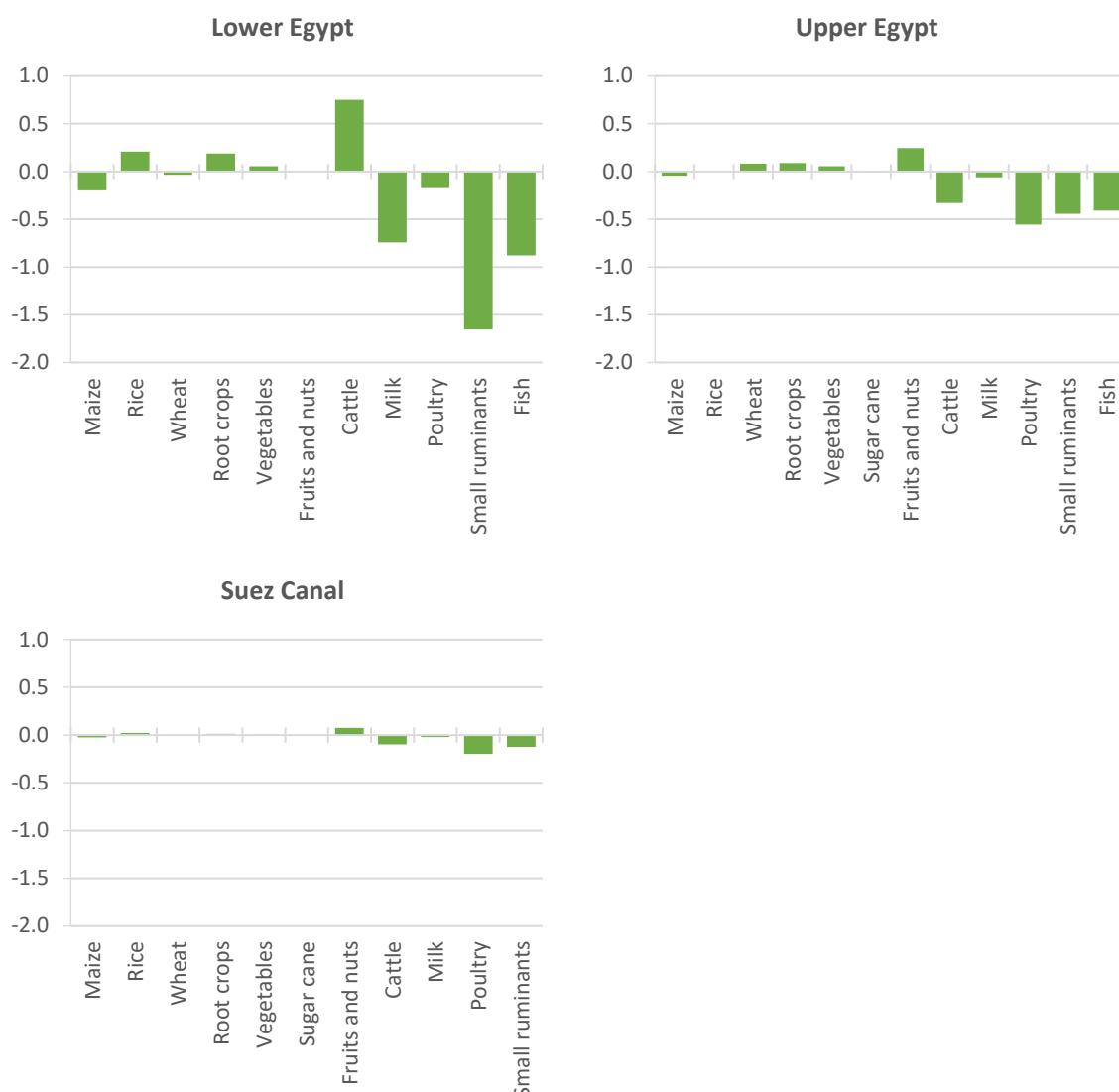


Source: AIDA model results

With regards to nutrition, the results show that productivity-driven agricultural growth in all crop subsectors, except maize, improves nutrition, while growth in the livestock sectors and maize can worsen nutrition (Figure 5). We define nutrition outcomes by dietary diversity, which is estimated using a generalized entropy measure across seven food categories – cereals and root crops; vegetables; fruits; meat, fish and eggs; milk and dairy; pulses and oilseeds; and meals prepared outside the household.

Prices are the main transmission channel through which dietary diversity changes. The more prices decrease for those products that increase dietary diversity, especially those that are currently under-consumed and have a high demand elasticity, the more positive the impact on the nutrition of households. As such, growth led by fruits and nuts shows the most positive impact on households' nutrition across all regions, whereas the impact of growth in other crops varies significantly and even may become negative in some regions, as in the case of the wheat value chain expansion in Lower Egypt and the Suez Canal.

Figure 5: Impact of promoting value chains on nutrition (dietary diversity-growth elasticity), by region, percent



Source: AIDA model results

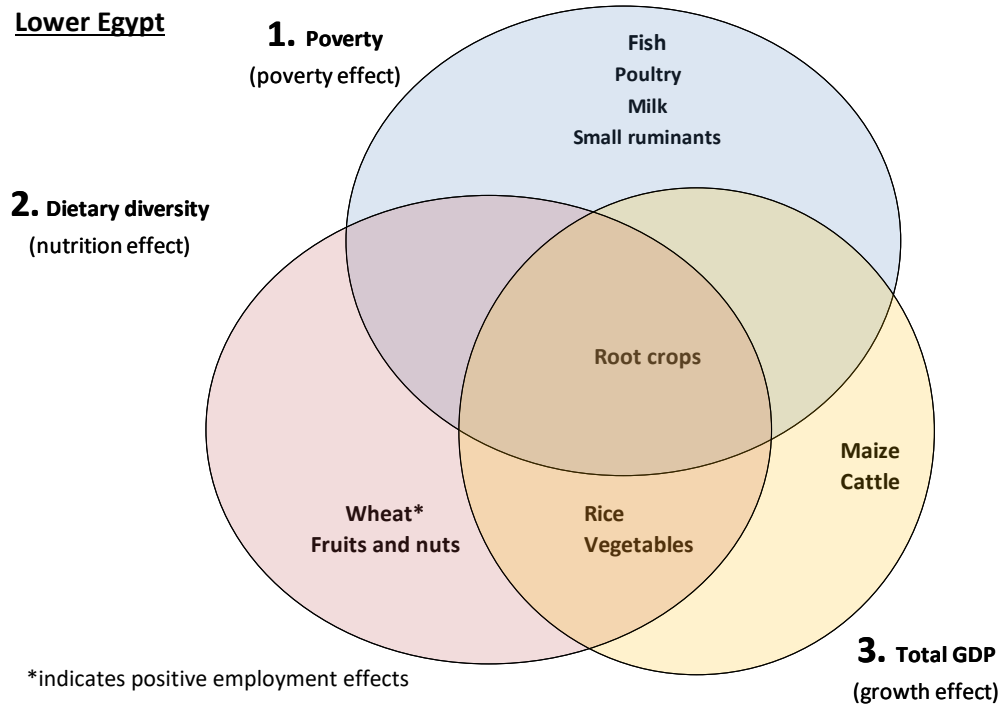
But the example of livestock-led growth shows that growth acceleration in single sectors can have negative effects, highlighting the importance of a system-wide or, in our case, an economy-wide analysis. The negative impact on dietary diversity caused by rapid growth in poultry, cattle, and other livestock can mainly be explained by increasing prices for other agricultural goods. Livestock production heavily relies on other agricultural produce as intermediate inputs, especially fodder crops, such as cereals. By increasing the demand for cereals, rapid growth in livestock sectors raises the price of cereals. This has a detrimental impact on households purchasing power and, thus, their dietary diversity. The lowering in the prices of livestock produce through higher production does not sufficiently compensate for the higher costs consumers have to pay for other food items, especially cereals. This finding points to the importance of a system approach, where changes in one sector can have unexpected consequences for other sectors and overall negative impacts on households.

4.3 Priority value chains by region

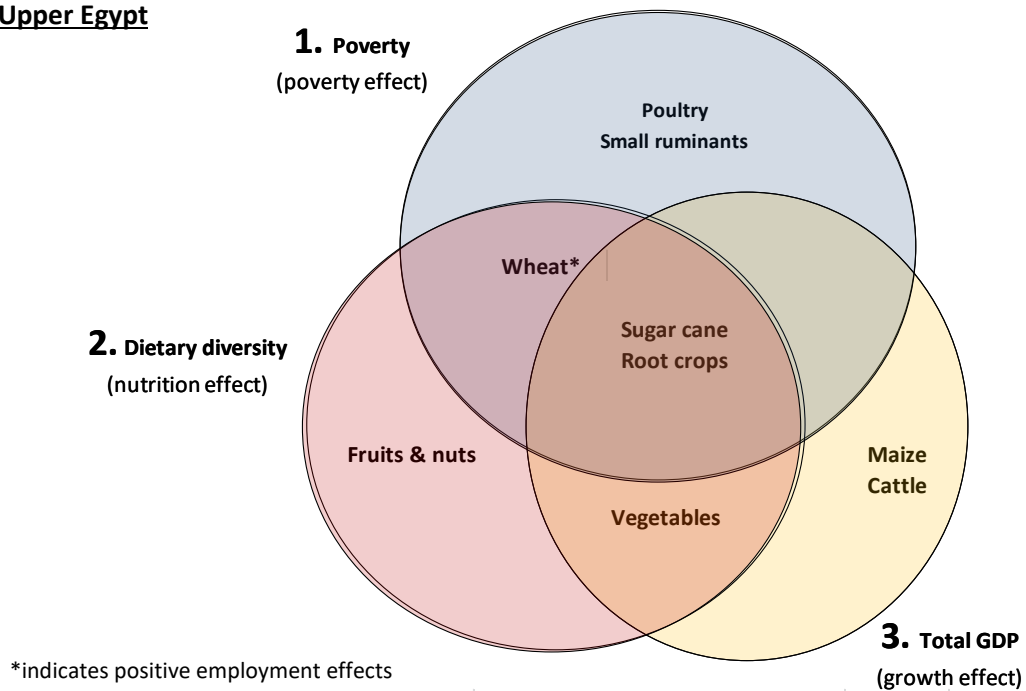
In order to summarize and synthesize the regional findings, we provide a ranking of the top activities per region in terms of their poverty, growth, and dietary diversity impacts, while also highlighting those that have employment effects (wheat) (Figure 6). There are several key observations and messages that emerge from this comparison.

Figure 6: Value chains with strong poverty, nutrition, economic growth, and employment effects, by region

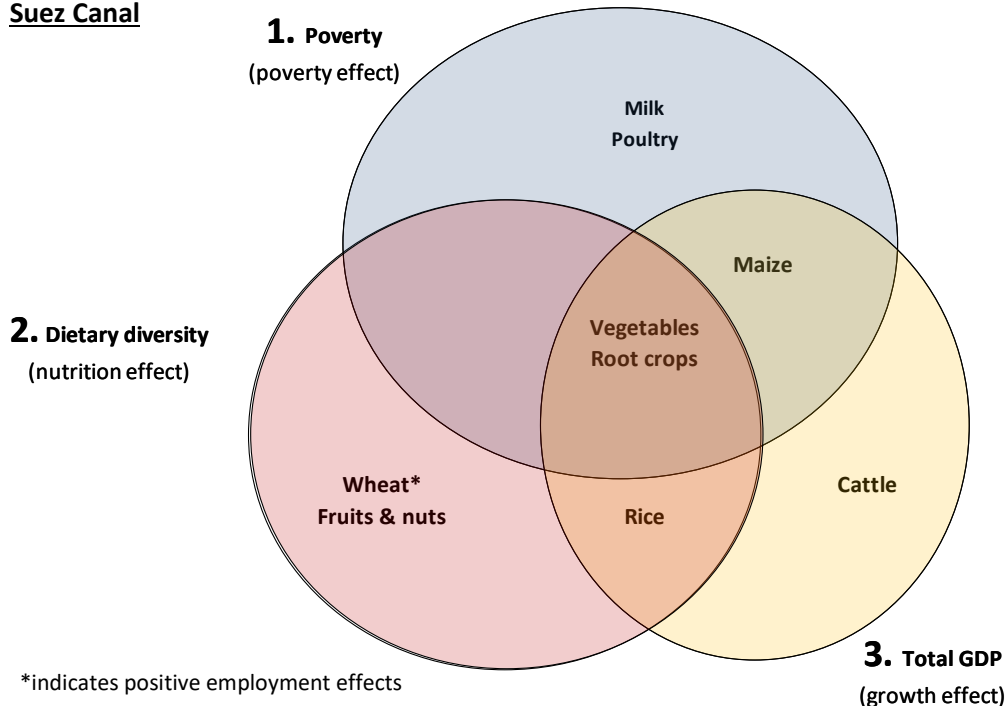
Lower Egypt



Upper Egypt



Suez Canal



Source: AIDA model

It is clear that no single sub-sector is best at achieving all the examined development outcomes at the same time. However, if we rank the subsectors according to the different development outcomes (poverty, growth, dietary diversity, and employment) and then list the top 5 sub-sectors within their circles, several patterns emerge.

- No value chain is in the top-five on all indicators. Wheat is the only job creating value chain but is not very effective in generating growth and reducing poverty.
- The root crops sub-sector is consistently among the top five crops for poverty reduction, GDP growth, and dietary diversification in all three regions. Vegetables underperforms on poverty reduction in Lower and Upper Egypt, while sugarcane, which is only produced in Upper Egypt, underperforms at the national level. The underperformance of vegetables with regard to poverty reduction can be traced to its high negative employment effects (Table 6), particularly on non-educated and primary educated labor, which affect poor households. Sugarcane, on the other hand, benefits from strong forward linkages to sugar refining. Almost 100 percent of sugarcane output enters sugar refining as an intermediate input.
- Other cross-regional patterns show that wheat, vegetables, and fruits and nuts consistently fare high on improving dietary diversity, our nutrition indicator, whereas poultry is good for poverty reduction in all regions, and maize and rice increase growth in all regions where they are grown.

These results also highlight the importance of regionalizing development strategies. In addition to obvious regional differences that are driven by differences in natural conditions and other circumstances, e.g., rice is mainly grown in Lower Egypt and sugarcane in Upper Egypt, our results suggest setting region-specific priorities depending on the most important development goals in each. However, Figure 6 does not convey the relative strengths of the agricultural value-chains across outcome indicators. For example, the fruits and nuts sub-sector is far more effective at

diversifying diets than is poultry. Such a strong effect might outweigh concerns about this value-chain's weaker poverty effects.

5 CONCLUSIONS AND POLICY RECOMMENDATIONS

Most of the literature and development projects have focused on the “business” case for agricultural value chain development. This paper highlights the importance of considering the “development” case and to analyze value chains within the broader context of the agri-food system, regional economies, and the national economy. We show that there are several key economy-wide transmission channels that determine the impacts that would be achieved through promoting more productive agricultural value chains. The first channel is the initial domestic output price response in the agricultural sectors, which mainly differ depending on the size of the increase in output, the tradability of the commodity on international markets, and the demand from households and enterprises. Second, other things being equal, the stronger are the forward and backward economic linkages of a value chain, the stronger are the economy-wide growth effects that come from an increase of production. Third, the economy-wide, net employment effects matter for household incomes, poverty, and dietary diversity.

Results for Egypt show that all agricultural value chain development generates economy-wide growth as well as growth in the agri-food system. Because of their strong linkages to vegetables processing and high trade margins, vegetables come out on top in all three regions (Lower Egypt, Upper Egypt, and Suez). Root crops and livestock sectors are also growth enhancing with relatively little difference between sectors and regions.

The impacts on employment are more mixed and in general reflect the expected movement of labor out of agriculture and into other sectors. While productivity-driven agricultural growth leads to a reduction in employment in the agricultural sector, results show that agricultural growth can create new and better jobs in and beyond the agri-food system.

The results also show that productivity-driven agricultural growth in all crop subsectors, except for maize, improves nutrition, while growth in the livestock sub-sectors can worsen nutrition. The example of potentially negative livestock-led growth on nutrition shows that growth acceleration in single sectors can have negative effects, highlighting the importance of a system or, in our case, an economy-wide analysis to guide investments in agricultural value chains.

Consistent with the development economics literature, growth in all agricultural sectors is pro-poor. However, the size of the impact depends on various factors, such as if poorer households engage in production in the value chain and earn higher farm revenues; if poorer workers are employed in downstream processing and trading and earn higher wages; or if poorer households consume the final product at lower prices.

It is clear that no single sub-sector is best at achieving all the development outcomes examined, and their ranking differs across sub-national regions. We find, for example, that while improving productivity of wheat creates jobs, the sub-sector is not very effective in generating growth and reducing poverty. Root crops are consistently among the top five crops for poverty reduction, GDP growth and dietary diversification in all three regions, while vegetables underperform on poverty reduction in Lower and Upper Egypt. Sugarcane benefits from strong forward linkages to sugar refining; almost 100 percent sugarcane output enters sugar refining as intermediate input. Other cross-regional patterns show that wheat, vegetables, and fruits and nuts consistently fare high on improving nutrition, whereas poultry is good for poverty reduction in all regions. Maize and rice increase growth in all regions where they are grown.

As such, results from this paper may provide a useful decision support for the government and its international partners to select value chains depending on their priority development outcomes.

Several recommendations for policy emerge from this paper:

- Agriculture-led growth in the food system is important, but not necessarily sufficient for accelerating economic transformation in middle-income countries. Additional growth in other sectors is also needed to absorb labor from agriculture and increase demand for higher value agri-food products and services.
- When designing agricultural strategies and projects, it is critical to take a multi-sector development perspective. Focusing only on one value chain can have unintended negative effects on key development outcomes, such as nutrition.
- Development and agricultural strategies should be regionalized. In addition to obvious regional differences that are driven by variation in natural conditions and other circumstances, e.g., rice is mainly grown in Lower Egypt and sugarcane in Upper Egypt, our results suggest setting region-specific priorities depending on key development goals.
- The findings support the current focus of many development partners on high value crops. However, there is mounting evidence that the focus on high value *exports* may not be sustainable. Especially smallholders often stop producing after export-support projects end due to high recurrent costs that often come with the high quality requirements of export markets (Holzapfel and Wollni 2014). More attention to production for domestic markets and improving quality standards more gradually may be advisable, especially in a middle-income country like Egypt with rapidly growing food demand.
- The government and its partners should support the transformation of the agriculture, food policy, and business environment. As the macroeconomic environment has substantially improved in Egypt, now sector policies and performance need to follow to support agri-food system development, such as through a thorough review of agricultural investments, subsidies and other policies.
- There is an urgent need for systemic change to improve agricultural extension services, irrigation, and markets (Abdelaziz et al. 2016), potentially by leveraging digital innovations that can help to overcome some of the obstacles that have hindered change in the past.

REFERENCES

- Abdelaziz, F., P. Al-Riffai, C. Breisinger, P.A. Dorosh, O. Ecker, H. El-Didi, H. El-Enbaby, J.L. Figueroa, L. Kenawy, J.L. Leroy, N. Minot, D.J. Spielman, J.-F. Trinh Tan, and X. Zhang. 2016. *Prioritizing development policy research in Egypt: An innovative approach to inform IFPRI's Egypt Strategy Support Program*. Egypt SSP Working Paper 1. Washington, D.C. and Cairo, Egypt: International Food Policy Research Institute (IFPRI).
- Benfica, R., B. Cunguara, and J. Thurlow. 2019. "Linking agricultural investments to growth and poverty: An economywide approach applied to Mozambique." *Agricultural Systems*, 172: 91-100.
- Breisinger, C., and X. Diao. *Economic transformation in theory and practice: What are the messages for Africa?*. IFPRI Discussion Paper 797. Washington, DC: International Food Policy Research Institute.
- CAPMAS (Central Agency for Public Mobilization and Statistics). 2019. Online population count. <https://www.capmas.gov.eg/>. Accessed 2/27/2019.
- CAPMAS (Central Agency for Public Mobilization and Statistics) and International Food Policy Research Institute (IFPRI). Forthcoming. *A Regionalized 2015 Social Accounting Matrix for Egypt*.
- Cervantes-Godoy, D., and J. Dewbre. 2010. *Economic Importance of Agriculture for Poverty Reduction*. OECD Food, Agriculture and Fisheries Working Paper 23. OECD Publishing
- Chen, K.Z., T.A. Reardon, and D. Hu. 2015. *Linking smallholders with rapidly transforming markets: Modernizing smallholder agriculture through value chain development in China*. Report to IFAD. Rome: International Fund for Agricultural Development.
- Dawoud, S.D.Z. 2014. "Econometric analysis of the changes in food consumption expenditure patterns in Egypt." *Journal of Development and Agricultural Economics*, 6 (1): 1-11.
- Diao, X. and J. Thurlow. 2012. "A Recursive Dynamic Computable General Equilibrium Model." In *Strategies and Priorities for African Agriculture: Economy-wide Perspectives from Country Studies*, edited by X. Diao, J. Thurlow, S. Benin, and S Fan. Washington DC: International Food Policy Research Institute.
- Diao, X., P.B.R. Hazell, D. Resnick, and J. Thurlow. 2007. *The role of agriculture in development: Implications for Sub-Saharan Africa*. IFPRI Research Report 153. Washington, DC: International Food Policy Research Institute.
- Diao, X., F. Cossar, N. Houssou, and S. Kolavalli. 2014. "Mechanization in Ghana: Emerging demand, and the search for alternative supply models." *Food Policy*, 48: 168-181.
- Ecker, O., and C. Breisinger. 2012. *The food security system: A new conceptual framework*. IFPRI Discussion Paper 1166. Washington, DC: International Food Policy Research Institute.
- El-Enbaby, H., J.L. Figueroa, H. ElDidi, and C. Breisinger. 2016. *The role of agriculture and the agro-processing industry for development in Egypt: An overview*. Egypt SSP Working Paper 3. Cairo: International Food Policy Research Institute.
- FAO (Food and Agriculture Organization of the United Nations). 2013. *Climate Smart Agriculture Sourcebook*. Rome: FAO.
- Kanter, R., H.L. Walls, M. Tak, F. Roberts, and J. Waage. 2015. "A conceptual framework for understanding the impacts of agriculture and food system policies on nutrition and health." *Food Security*, 7 (4) 767-777.
- Holzappel, S. and M. Wollni. 2014. "Is GlobalGAP certification of small-scale farmers sustainable? Evidence from Thailand." *Journal of Development Studies*, 50 (5): 731-747.
- McMillan, M., D. Rodrik, and C. Sepúlveda. 2017. *Structural change, fundamentals, and growth: A framework and case studies*. NBER Working Paper Series 23378. Cambridge, MA: National Bureau of Economic Research.
- Nin-Pratt, A., H. El-Enbaby, J.L. Figueroa, H. ElDidi, and C. Breisinger. 2017. *Agriculture and economic transformation in the Middle East and North Africa: A review of the past with lessons for the future*. IFPRI Food Policy Report. Washington, DC: International Food Policy Research Institute.
- Pauw. K. and J. Thurlow. 2015. "Prioritizing Rural Investments in Africa: A Hybrid Evaluation Approach Applied to Uganda." *European Journal of Development Research*. 27 (3): 407-424.
- Ruttan, V.W. 2002. "Productivity growth in world agriculture: sources and constraints." *Journal of Economic Perspectives*, 16 (4): 161-184.
- Thurlow, J., J. Randriamamonjy, and T. Benson. 2018. *Identifying priority value chains in Tanzania*. Feed the Future Innovation Lab for Food Security Policy Research Paper 106. East Lansing, MI and Washington, DC: Michigan State University and International Food Policy Research Institute.
- ul Haq, Z. 2012. *Food value chain analysis: A review of selected studies for Pakistan and guidelines for further research*. Pakistan Strategy Support Program Working Paper 10. Washington, D.C.: International Food Policy Research Institute.

USDA (United States Department of Agriculture). 2018. "Ag and Food Sectors and the Economy." USDA ERS - Ag and Food Statistics. October 17, 2018. Accessed January 16, 2019. <https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/>.

World Bank. 2007. *World Development Report 2008: Agriculture for Development*. Washington, DC.: World Bank.

About the Author(s)

Clemens Breisinger is the program leader for the Egypt Strategy Support Program of the International Food Policy Research Institute (IFPRI) and a Senior Research Fellow in Development Strategy and Governance Division (DSGD) of IFPRI, based in Cairo. **Mariam Raouf** is a Research Associate in the Egypt Strategy Support Program of IFPRI, based in Cairo. **James Thurlow** is a Senior Research Fellow in DSGD of IFPRI, based in Washington, DC. **Manfred Wiebelt** is a Senior Research Fellow and Professor of Economics at the Kiel Institute for the World Economy.

Acknowledgments

This paper has been presented at several events and has benefitted from comments and assistance from various people. We are grateful to comments on this paper from participants at the joint Ministry of Agriculture and Land Reclamation, Ministry of Investment and International Cooperation and World Bank workshop on 13 December 2018 in Cairo, which included the participation of H.E. the Minister of Agriculture Abu Steit; participants at the IFPRI-Egypt Seminar on Advancing the Food System for Growth, Job Creation and Better Nutrition in Egypt on 20 December 2018 in Cairo; and participants at the regional management meeting of the Food and Agriculture Organization of the United Nations (FAO) on 4 February 2019. Specifically, we thank Rui Benfica, Dina Saleh, and Abdelkarim Sma of the International Fund for Agricultural Development (IFAD); Julian Lampietti, Madhur Gautam, and Fatma El Zahraa Yassin Aglan, all of the World Bank, Donato Romano of the University of Florence, and Nadia Blackton and Kenneth Dunn of the United States Agency for International Development (USAID) for useful comments and suggestions. We thank Mai Mahmoud of IFPRI for valuable research assistance.

Funding for this paper was graciously provided by the International Fund for Agricultural Development (IFAD) and the CGIAR Policies, Institutions and Markets (PIM) Collaborative Research Program under the Agriculture Investment for Development Analyzer (AIDA) project. The support of these institutions is gratefully acknowledged.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
1201 Eye Street, NW | Washington, DC 20005-3915 USA
T: +1.202.862.5600 | F: +1.202.862.5606
Email: ifpri@cgiar.org | www.ifpri.org

IFPRI-EGYPT
World Trade Center, 1191 Corniche El Nile, Cairo, Egypt
T: +20(0)22577612
<http://egyptssp.ifpri.info/>

The Middle East and North Africa Regional Program is managed by the Egypt Strategy Support Program (Egypt SSP) of the International Food Policy Research Institute (IFPRI). The research presented here was conducted as part of the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI. This publication has been prepared as an output of Egypt SSP. It has not been independently peer reviewed. Any opinions expressed here belong to the author(s) and do not necessarily reflect those of IFPRI, PIM, or CGIAR.

Copyright © 2019, Remains with the author(s). All rights reserved.