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Investing in the Agri-food System for Post-COVID-19 Recovery

An economywide evaluation of public investments in Egypt

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This note presents the results of an evaluation of public investment options for Egypt's agri-food system. Nine agriculture-related public investments are considered, including targeting public spending to expand farm production, e.g., irrigation improvements, input subsidies, agricultural research, and extension, and to promote downstream agro-processing and marketing. The outcome indicators considered are economic (GDP) growth, incomes of the poor, job creation, and dietary diversity. IFPRI's Rural Investment and Policy Analysis (RIAPA) economywide model is used for the evaluation because it captures linkages between sectors, households, and rural-urban economies and measures changes within and beyond the agri-food system. RIAPA is linked to the Agricultural Investment and Data Analysis (AIDA) module that tracks investment impacts and costs over time. The ranked results of the public investment options considered, summarized in the table here, can help prioritize agri-food system investments for post-COVID-19 recovery.

Rank	Equal weights	GDP bias	Poverty bias	Employment bias	Dietary diversity bias
1	Crop R&D	Crop R&D	Crop R&D	Extension services	Extension services
2	Extension services	Greenhouses	Extension services	Crop R&D	Crop R&D
3	Greenhouses	Extension services	Greenhouses	Land reclamation	Greenhouses
4	Livestock R&D	Land reclamation	Agro-industries	Livestock R&D	Livestock R&D
5	Land reclamation	Livestock R&D	Land reclamation	Input subsidies	Input subsidies
6	Agro-industries	Input subsidies	Input subsidies	Agro-industries	Agro-industries
7	Input subsidies	Agro-industries	Livestock R&D	Horticulture	Irrigation
8	Horticulture	Horticulture	Horticulture	Irrigation	Horticulture
9	Irrigation	Irrigation	Irrigation	Greenhouses	Land reclamation

An evaluation of public investment options for Egypt's agri-food system (AFS) was conducted by the International Food Policy Research Institute (IFPRI) in collaboration with the Ministry of Agriculture and Land Reclamation of the government of Egypt and the Food and Agriculture Organization of the United Nations (FAO). A range of agriculture-related public investments are considered, including spending to expand farm production, e.g., irrigation improvements, input subsidies, research, and extension, and to promote downstream agro-processing and marketing. The outcome indicators considered in evaluating the relative impact of each option are economic growth, incomes of the poor, job creation, and dietary diversity. IFPRI's Rural Investment and Policy Analysis (RIAPA) economywide model is used for the evaluation because it captures linkages between sectors, households, and rural-urban economies and measures changes within and beyond the AFS. RIAPA is linked to the Agricultural Investment and Data Analysis (AIDA) module that tracks investment impacts and costs over time. The ranking of the investment options by outcome indicator can help prioritize agri-food system investments for post-COVID-19 recovery.

Section 1 of this note situates agriculture within the national economy, as captured in the RIAPA model. Section 2 describes AIDA and the evaluation procedure used. Section 3 outlines the model's baseline expectations through 2030, and Section 4 presents the evaluation results. The final section provides a prioritized list of investments that varies by the importance attached to different outcomes.

1. COVID-19 and agriculture in the Egyptian economy

The COVID-19 crisis will lead to a significant decline in Egypt's GDP during the 4th quarter (April to June) of the 2019/20 fiscal year. Agriculture is the most resilient sector of Egypt's economy. The impacts of the pandemic on Egypt's agri-food system are expected to be less severe than on other elements of the economy. Most damage will occur in nonfarm components of the agri-food system due to falling consumer demand. Although higher-income households face the largest income losses, lower-income households also will see their incomes decline significantly.[1]

Not only is agriculture playing a stabilizing role during the COVID-19 crisis, the agri-food system is also well positioned to support post-COVID economic recovery. Agriculture generated 12 percent of national GDP in 2015, 25 percent of total employment, and 4 percent of export earnings. Crops are the largest agricultural subsector, followed by livestock. While fruits and vegetables are major agricultural exports, Egypt is, overall, a net importer of food and agricultural products. The country's main source of export earnings are mining (crude oil), manufacturing (textiles and clothing), tourism, and transport services, i.e., the Suez canal. Some agricultural output is supplied to downstream agro-processing, but these manufacturing subsectors together generate only 4 percent of GDP, employment, and exports. Egypt imports many of its manufactured goods, especially equipment and vehicles. Almost three-fifths of GDP is generated by services, which is dominated by wholesale and retail trade and the government.

RIAPA is an economywide model (Text Box 1). Its core database is a social accounting matrix (SAM) that captures all income and expenditure flows between all economic actors in the country, including producers, consumers, government, and the rest of the world (Text Box 1). Egypt's model uses a SAM for 2015 that separates the economy into 69 sectors and 4 subnational regions, Upper Egypt, Greater Cairo, North West, and North East.[2] Table 1 describes RIAPA's base-year production and trade.

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[1] Breisinger, C., M. Raouf, M. Wiebelt, A. Kamaly, and M. Karara. 2020. *Impact of COVID-19 on the Egyptian economy: Economic sectors, jobs, and households*. Middle East and North Africa Regional Program Policy Note 06. Cairo: International Food Policy Research Institute. https://ebrary.ifpri.org/digital/collection/p15738coll2/id/133764

[2] Egypt's SAM was jointly developed by IFPRI and the Central Agency for Public Mobilization and Statistics (CAPMAS). See https://www.ifpri.org/publication/first-regionalized-social-accounting-matrix-egypt-2015-nexus-project-social-accounting .

Text Box 1: The Rural Investment and Policy Analysis (RIAPA) model

RIAPA is a computable general equilibrium (CGE) model that simulates the functioning of a market economy, including markets for products and factors (i.e., land, labor, and capital). RIAPA measures how impacts are mediated through prices and resource reallocations, and ensures that resource and macroeconomic constraints are respected, such as when inputs or foreign exchange are limited. RIAPA provides a consistent "simulation laboratory" for quantitatively examining the policy impacts at national, sub-national and household levels.

RIAPA divides the economy into sectors and household groups that act as individual economic agents. Producers maximize profits and supply output to national markets, where it may be exported and/or combined with imports depending on relative prices, with foreign prices affected by exchange rate movements. Producers combine factors and intermediate inputs using sector-specific technologies. Wheat farmers, for example, use a unique combination of land, labor, machinery, fertilizer, purchased seeds, etc. Workers in RIAPA are divided by education levels, and agricultural capital is separated into crop and livestock categories. Labor and capital are in fixed supply, but less-educated workers are treated as underemployed. Producers and households pay taxes to the government, who uses these and other revenues to finance public services and social transfers. Remaining revenues are added to private savings and foreign capital inflows to finance investment, i.e., investment is driven by levels of savings. RIAPA is dynamic, with past investment determining current capital availability. Finally, RIAPA tracks changes in incomes and expenditures for different household groups, including changes in food and nonfood consumption across the income distribution and in different regions of the country.

Table 1. Structure of Egypt's economy, 2015

	Share of total (%)					
	GDP	Employ-ment	Exports	Imports	Exports / output (%)	Imports / demand (%)
All sectors	100.**0**	100.**0**	100.**0**	100.**0**	7.5	12.8
Agriculture	11.7	25.4	4.3	6.7	2.6	8.6
Crops	6.3	14.9	4.3	6.5	4.7	14.2
Livestock	4.3	9.5	0.0	0.2	0.0	0.7
Forestry	0.1	0.1	0.0	0.0	0.0	0.0
Fishing	1.1	0.9	0.0	0.0	0.0	0.0
Industry	31.3	24.8	48.6	67.9	7.2	17.3
Mining	9.1	0.3	14.4	5.9	16.2	11.8
Manufacturing	16.1	11.0	32.7	59.7	7.9	23.3
Agro-processing	3.7	3.5	4.4	7.4	4.2	12.0
Other manufacturing	12.4	7.5	28.3	52.3	9.2	27.1
Other industry	6.1	13.5	1.5	2.3	0.9	2.3
Services	57.0	49.8	47.1	25.5	8.9	7.8
Trade and hotels	17.8	14.2	16.3	5.3	10.0	5.5
Transport services	7.8	8.4	25.3	11.2	35.6	28.4
Finance & business	16.0	4.7	4.3	7.7	2.9	8.0
Government services	13.1	18.9	1.2	1.2	1.0	1.6
Other services	2.4	3.7	0.0	0.0	0.0	0.0

Source: Egypt RIAPA-AIDA model.

Agriculture's role in the economy extends beyond the sector itself, with many industrial and service sectors forming parts of AFS. Table 2 uses the national SAM to estimate the share of total GDP and employment in Egypt's AFS in 2015. Agriculture and agro-processing together account for 16 and 29 percent of GDP and employment, respectively. These sectors use domestically-produced inputs, such as fertilizer and animal feed, whose production creates additional value-added and jobs within AFS. An even larger AFS component is moving agriculture-related products between farmers,

processors, and markets. Households also consume food services or meals prepared outside the home, such as at restaurants. In total, AFS accounts for 27 and 38 percent of national GDP and employment, respectively. A larger share of the economy and workforce depend on the AFS than the sectoral share of agriculture alone would suggest.

Table 2. Egypt's agri-food system – GDP and employment, 2015

	Share of national total (%)	
	GDP	Employment
National economy	100.0	100.0
Agri-food system	26.5	38.4
Agriculture	11.7	25.4
Agro-processing	3.8	3.7
Input production	1.9	1.4
Trade and transport	7.3	6.1
Hotels & food services	1.8	1.9

Source: Egypt RIAPA-AIDA model.
Notes: Agro-processing includes foods, beverages, tobacco; food services include meals prepared away from the home (e.g., restaurants and hotels).

RIAPA includes a detailed representation of agriculture, including 21 subsectors covering crops, livestock, forestry, and fishing. Cereals (mainly wheat and maize) and horticulture (fruits and vegetables) each generate about a fifth of total agricultural GDP, and together, over three-quarters of total crop GDP. Livestock is dominated by cattle for meat and dairy, with smaller contributions from poultry and small ruminants. Fisheries is a small but important sector that consists mainly of aquaculture. Agriculture's economic structure is important in determining the impact of different investments based on the subsectors that they affect. However, as mentioned above, the linkages between individual agricultural subsectors and the rest of the economy may be even more important in determining the economywide impacts of investments, especially their ultimate effects on consumers and poor households.

RIAPA contains 15 representative household groups in each subnational region. These are separated into rural and urban consumption quintiles, with rural households further separated into farm and nonfarm groups. Table 3 describes households' income and consumption patterns. Egypt's population of 89 million people consume, on average, USD 2,717 of goods and services per person each year (at market exchange rates and without adjusting for purchasing power parity). Consumption levels are lower in rural areas and among the poor. Poor households spend more of their earnings on food and less on processed products. Starches from cereals and roots dominate consumption by the rural poor, whereas nonpoor and urban households consume more dairy, meat, fish, and eggs. Finally, poor rural households, on average, rely more on incomes from farming and less-educated labor, suggesting that agriculture and the rural nonfarm economy play key roles in the livelihoods of the poorest households. To reduce poverty, farm incomes must rise or farm households must find alternative or additional nonfarm work.

Table 3. Consumption and income of Egyptian households, 2015

	National	Rural	Rural poor	Urban
Population (millions)	88.9	50.9	25.8	38.0
Consumption per capita, annual (USD)	2,717	1,958	1,238	3,734
Food group consumption share (%)				
Cereals and roots	10.9	14.3	17.6	8.0
Vegetables	12.3	13.3	13.1	11.5
Fruits	6.9	6.8	5.8	7.0
Meat, fish, and eggs	29.0	27.0	25.2	30.7
Milk and dairy	14.0	12.1	10.9	15.6
Pulses and oilseeds	4.6	5.2	5.7	4.0
Other foods	22.3	21.3	21.6	23.2
Food prepared within household consumption share (%)	29.1	32.6	38.0	26.7
Processed food consumption share (%)	65.1	60.2	60.2	69.2
Total household income share (%)				
Crop land returns	1.7	3.6	4.2	0.4
Labor remuneration	28.7	33.2	36.1	25.7
Less-educated workers	7.9	12.3	18.5	4.9
Better-educated workers	20.8	20.9	17.6	20.7
Enterprise earnings	56.2	43.8	43.0	64.7
Other sources	13.3	19.3	16.6	9.2

Source: Egypt RIAPA-AIDA model.
Notes: Food consumption excludes meals prepared outside the household. Processed foods exclude foods processed *and consumed* within the household. Better-educated workers are those who have at least completed primary schooling. Enterprise earnings include gross operating surplus. Other income sources include social and foreign transfers.

2. Measuring investment impacts

Public investments can be evaluated in advance of implementation by using information on past impacts and costs and on future spending projections. AIDA is a forward-looking investment planning tool that combines data from a range of sources, including surveys and monitoring and evaluation studies, to estimate direct investment impacts (Text Box 2). The output of the module is then inputted to RIAPA to estimate the overall economic impact of these investments, including indirect or spillovers effects.

Text Box 2: The Agricultural Investment and Data Analysis (AIDA) module

AIDA is an accounting system that estimates how public spending affects productivity levels in different sectors of the economy. AIDA converts annual expenditures into a stream of investment outcomes using information on unit costs, maintenance needs, and depreciations rates. Investment outcomes are linked to productivity levels using estimated elasticities or impact coefficients. For example, investments in irrigation infrastructure are converted into irrigated land area based on the average cost of irrigating one feddan of land. The productivity gains from new irrigation investments are then calculated based on the estimated yield gains from using newly irrigated land. AIDA tracks the share of farmers with and without new irrigation infrastructure and calculates a weighted average annual productivity level for each crop.

AIDA generates different productivity trajectories for each package of investments. These are imposed on the RIAPA model, which then translates productivity changes into changes in economic growth, employment, household incomes, and dietary diversity. AIDA focus exclusively on public expenditures, whereas RIAPA also evaluates the effects of other macroeconomic and sectoral policies. RIAPA also considers the impacts of financing investments, which reduce the net gains from public interventions.

We consider nine public investment options (Table 4). These range from spending to expand farm production, e.g., land reclamation, irrigation improvements, input subsidies, agricultural research and development, and extension services, to the promotion of downstream agro-processing and marketing. The scenarios are stylized, but the information used in AIDA is based on observed data or expert opinion from the Ministry of Agriculture. The information used to inform the parameters used in AIDA is shown in Table 5.

Table 4. Agricultural Investment and Data Analysis (AIDA) module investment scenarios, 2020 to 2030

Investment Scenario	Description
Land reclamation	Reclamation of uncultivated lands via new water management and irrigation infrastructure and other land improvements, bringing new lands under cultivation.
Irrigation improvements	Investment in improved irrigation infrastructure, water management practices, and local irrigation schemes (canals) leading to more productive crop farming.
Extension services	Increased and better provision of agricultural advisory services to farmers to improve crop and livestock production.
Input subsidies	Provision of subsidies to farmers to reduce the cost and promote greater adoption and application of chemical fertilizers.
Crop research and development (R&D)	Greater spending on the research and development of improved seed varieties and farming practices, leading to higher crop yields.
Livestock research and development (R&D)	Greater spending on the research and development of improved livestock breeds and husbandry practices, leading to higher productivity (meat, eggs, and dairy).
Agro-industries	Infrastructure and marketing support to downstream agro-processing activities, leading to increased demand and higher productivity for food-related firms.
Horticulture	Targeted investments in horticultural value chains, including cold storage and improved supply logistics, leading to higher productivity for horticultural farmers.
Greenhouses	Subsidies to the construction of greenhouse infrastructure for producing more productive horticulture and other high-value crops.

Source: Authors' compilation.

Land reclamation: The model decides which crops the new lands should be allocated to – primarily cereals, especially wheat. Creating new crop lands will raise GDP by increasing the availability of productive assets and crowding-in some workers from outside of agriculture. However, the output from newly cultivated lands will compete with that produced by farmers on existing lands, thereby driving down prices while also raising farm incomes.

Table 5. Agricultural Investment and Data Analysis (AIDA) module investment parameters

Parameter	Land reclamation	Irrigation improvements	Extension services	Input subsidies	Crop R&D
Annual spending (USD mil.)	164.6	92.1	92.4	9.2	1.6
Investment units	feddan	feddan	feddan	feddan	R&D capital
Cost per unit (USD)	3,150.0	1,800.0	124.2	52.0	2.8
Government cost share (%)	100.0	50.0	75.0	34.0	100.0
Depreciation rate (%)	0.0	5.0	40.0	100.0	2.0
Units	1000 feddan	1000 feddan	1000 feddan	1000 feddan	R&D capital
Current level, 2020	0.1	193.7	1,599.0	4,457.2	212.0
Potential level	1,500.0	5,571.6	5,571.6	5,571.6	360.0
Coverage rate (%)	0.0	3.5	28.7	80.0	58.9
Productivity gain (%)	n/a	25.2	14.0	2.0	4.1
Targeted subsectors	All crops	All food crops, sugarcane, cotton	All food crops, livestock	Cereals	All food crops

	Livestock R&D	Agro-industries	Horticulture	Greenhouses
Annual spending (USD mil.)	11.0	6.1	41.8	9.2
Investment units	R&D capital	firm	feddan	feddan
Cost per unit (USD)	7.8	3,000.0	2,500.0	25,200.0
Government cost share (%)	75.0	30.0	75.0	100.0
Depreciation rate (%)	5.0	0.0	40.0	10.0
Units	R&D capital	1000 firms	1000 feddan	1000 feddan
Current level, 2020	175.0	50.0	33.2	35.0
Potential level	500.0	5,000.0	663.1	100.0
Coverage rate (%)	35.0	1.0	5.0	35.0
Productivity gain (%)	4.1	15.0	16.5	50.0
Targeted subsectors	All livestock (meat, eggs, dairy)	Food processing (excl. sugar, animal feed)	Fruits, vegetables (excl. nuts)	Pulses, roots, vegetables

Source: Egypt RIAPA-AIDA model.

Research and development (R&D) for crops and livestock: Egypt already has a research system that has generated a stock of knowledge (capital) around crop varieties and animal breeds with higher genetic gains. IFPRI research on agricultural technologies in Africa and the rest of the world finds that Egypt has currently accumulated about 59 percent of its potential research capital for crops and 35 percent for livestock. Further investments would help close this gap in research capital, leading to higher crop and livestock productivity gains.

Agro-industries: These kinds of nonfarm enterprises include food and agricultural processors within the manufacturing sector. By rough approximation, a USD 3,000 investment in a single food processing firm would raise that firm's productivity by around 15 percent. This investment directly benefits manufacturing firms, but in doing so it generates greater demand for raw agricultural inputs, while also reducing the cost of processed foods for consumers.

Horticulture: Promoting the production and marketing of horticultural products, i.e., fruit and vegetables, is estimated to cost about USD 2,500 per feddan of farmland. The majority of this cost would be borne by the government and would require regular renewal, as reflected in the 40 percent depreciation rate. There is considerable scope to expand this support, given the current 5 percent coverage rate of horticultural farmers. The potential productivity gains for horticultural crops is significant at about 15 percent relative to horticultural farmers who do not receive support.

Greenhouses: The large-scale construction of greenhouses is a significant focus of the government and has the potential to greatly enhance the productivity of higher-value crop production – by an

estimated 35 percent relative to production without using greenhouses. However, the cost of constructing the greenhouses is relatively high, at about USD 25,000 per greenhouse. The government has targeted 100,000 feddans.

AIDA takes the above information and calculates the expected impact on sector productivity levels for each year until 2030. As the population and the economy grow, the government needs to spend more on recurrent spending items, such as extension services, even to maintain existing productivity levels. Financing the cost of these public investments is assumed to crowd-out private investment, such that the benefits reported by RIAPA-AIDA are net benefits after accounting for the negative spillover effects of reduced private investment.

3. Future outcomes under baseline trends

RIAPA first establishes a baseline scenario for the period 2015 to 2030 using projected GDP growth rates from the Economic Outlook (January 2020) of the International Monetary Fund combined with observed patterns of demographic change and economic growth in Egypt since 2012. Table 6 summarizes this "business-as-usual" or baseline scenario for the period 2020-2030, which is the focus period for this analysis. Total population and labor supply grow at 1.6 and 1.4 percent per year, respectively. Crop land area remains unchanged over time, in part because the baseline does not include the effects of land reclamation, which are an investment option considered in the next section. Productivity growth is adjusted to replicate broad trends in sectoral GDP. The table's final two columns compare model outcomes to observed trends. Agricultural GDP continues to grow more slowly than industry and services. Overall, national GDP grows at 5.9 percent per year, which is faster than the population, implying rising GDP per capita.

Table 6. RIAPA-AIDA baseline scenario results, 2020-2030

		Average annual change (%)	
	Initial value, 2020	Baseline scenario	Observed trends
Total population, thousands	94.8	1.6	1.6
Total GDP, % share	100.0	5.9	5.6
Agriculture	11.0	3.5	3.7
Industry	30.3	4.6	4.4
Agro-processing	3.6	4.9	n/a
Services	58.7	6.9	6.7
Labor employment, millions	26.8	1.4	1.6
Crop land, '000 hectares	5.6	0.0	0.0
Capital stock, index	2.0	4.9	4.2
Consumption per capita, USD	3,041	3.5	3.2
Rural households	2,217	3.5	n/a
Urban households	4,121	3.4	n/a

Source: Egypt RIAPA-AIDA model.
Notes: Observed population, GDP, and employment trends are for the period 2012 to 2017.

RIAPA measures how the pace and pattern of GDP growth affects household incomes and consumption levels. This is based on the differing resource demands of economic sectors and the factor endowments and consumption patterns of households. Poor and rural households are more dependent on incomes from less-educated workers (Table 3), so expanding production in sectors that employ these workers more intensively, such as farming, is more likely to benefit these kinds of households. Similarly, expanding production and lowering prices of products that poor households consume more intensively than other products raises their total consumption and wellbeing relative to urban and nonpoor households. Although nonagricultural sectors grow faster than agriculture in

the baseline, urban populations are also growing faster, such that consumption growth for rural and urban households is similar in per capita terms. Overall, households in Egypt are expected to be better off in 2030 than they are today, although consumption growth is slower among lower-income households.

Overall, RIAPA-AIDA's baseline scenario captures Egypt's broad economic trends and provides a plausible reference scenario for evaluating different investment options. The baseline does not capture the economic costs of the COVID-19 outbreak in 2020, which will have a dampening effect on the country's immediate prospects, since domestic and global economies will take time to recover. The baseline scenario essentially assumes that Egypt's longer-run economic outlook for 2030 remains largely unaffected by COVID-19.

4. Comparing investment outcomes

The baseline is now shocked with new investments, causing the model to deviate from "business-as-usual". The ranking of investment options is based on their cost-effectiveness in:

1. Raising the incomes of poor households;
2. Diversifying the diets of poor households;
3. Creating off-farm value-added or GDP (as a proxy for agricultural transformation); and
4. Creating jobs for workers in the agri-food system.

We discuss each of these outcomes below.

Table 7 reports household income to public spending elasticities for each investment option. This is the dollar change in the consumption levels of poor households per dollar spent by the government. Land reclamation, for example, raises consumption levels for poor households throughout the country by USD 0.27 for each USD 1.00 spent. This does not imply a negative return since poor households are defined as those in the bottom two quintiles of per capita consumption. The other three quintiles also enjoy higher consumption levels. Poor households are, however, the focus of this outcome indicator. Higher consumption is negatively correlated with poverty, i.e., higher consumption levels for poor households generally implies a lower poverty headcount. Crop R&D and greenhouses are the most effective options for benefiting the poor. Crop R&D ranks highly because it is relatively low cost and generates modest productivity gains across a wide range of products. In contrast, greenhouses are expensive, but their productivity gains are even higher and the resulting food price declines benefit poorer households, as they devote a large share of their incomes to food consumption.

Table 7. Income-spending elasticity results for poor households, 2020 to 2030

Investment option	Change in consumption levels of poor households per dollar of public spending (rank in parentheses)	
	National	Rural
Land reclamation	0.266 (4)	0.058 (5)
Irrigation improvements	-0.124 (9)	-0.107 (9)
Extension services	0.774 (3)	0.386 (3)
Input subsidies	0.070 (6)	0.037 (6)
Crop R&D	1.543 (1)	0.836 (1)
Livestock R&D	0.030 (7)	-0.051 (7)
Agro-industries	0.088 (5)	0.182 (4)
Horticulture	-0.087 (8)	-0.077 (8)
Greenhouses	1.004 (2)	0.423 (2)

Source: Egypt RIAPA-AIDA model.

Table 8 reports dietary diversity to public spending elasticities, which show how effective investments are at diversifying the dietary patterns of households. The analysis focuses on poor rural households (see Table 3). Diversity is measured by expenditures across seven food groups. A positive result implies that increased public spending in an investment option leads to greater diversity, whereas a negative result implies that the investment leads to less diverse diets. Land reclamation does not score highly on this outcome measure, because most of the new cultivated land is used to grow wheat and maize. These are strategic crops and important for reducing hunger. However, increasing cereals supply and lowering prices encourages greater consumption of these products by poor households. This further raises the already high share of cereals in poor households' diets. In contrast, extension services and livestock R&D lead to greater availability of animal-sourced foods, which enhances the dietary diversity of poor rural households.

Table 8. Dietary-diversity-spending elasticity results, 2020 to 2030

Investment option	Change in dietary diversity index of households per dollar of public spending (rank in parentheses)					
	All		Rural		Poor rural	
Land reclamation	-71.405	(9)	-38.742	(9)	-34.028	(9)
Irrigation improvements	-4.755	(5)	-1.538	(5)	-0.025	(4)
Extension services	40.170	(1)	21.624	(1)	18.990	(1)
Input subsidies	-0.840	(3)	-0.176	(3)	0.320	(3)
Crop R&D	-20.991	(8)	-11.624	(8)	-11.092	(8)
Livestock R&D	16.107	(2)	8.282	(2)	6.608	(2)
Agro-industries	-1.934	(4)	-1.025	(4)	-0.495	(5)
Horticulture	-9.663	(6)	-6.198	(7)	-7.486	(7)
Greenhouses	-10.210	(7)	-3.348	(6)	-1.397	(6)

Source: Egypt RIAPA-AIDA model.
Notes: Dietary diversity is measured by the gap between the real value of consumption across major food groups to a reference diverse diet using a Jensen-Shannon distance measure.

Table 9 reports the agri-food system economic growth and employment effects of the different investment options. The AFS growth elasticity for land reclamation is 3.55, meaning that a one dollar increase in public spending on land reclamation generates USD 3.55 in agri-food GDP. This is similar to a multiplier effect through which investments in farming creating positive growth linkages to the rest of the economy. Crop R&D and greenhouses are the most effective at generating value added in the AFS, because these two interventions benefit cereals or fruits and vegetables, both of which have large existing agro-processing sectors. Fruits and vegetables are also more export-oriented and so face smaller domestic demand and marketing constraints.

Table 9. Economywide growth and employment linkages, 2020 to 2030

Investment option	GDP growth elasticity		Employment elasticity	
Land reclamation	3.55	(4)	0.97	(4)
Irrigation improvements	0.44	(8)	-0.09	(9)
Extension services	4.46	(3)	1.76	(3)
Input subsidies	0.95	(7)	0.12	(8)
Crop R&D	10.06	(1)	3.96	(2)
Livestock R&D	1.40	(5)	0.27	(6)
Agro-industries	0.40	(9)	0.33	(5)
Horticulture	1.11	(6)	0.18	(7)
Greenhouses	7.88	(2)	5.09	(1)

Source: Egypt RIAPA-AIDA model.
Notes: GDP (employment) elasticity is the increase in total GDP (employment) in dollars (workers) per USD 1.00 in public spending.

5. Final assessment

There is no single investment option that is *most* effective at achieving *all* of the development outcomes discussed above. This is clear in Figure 1, which shows each of the investment options ranked initially by their cost-effectiveness in raising incomes of the rural poor. As discussed in the previous section, the poverty effect is the increase in per capita consumption by poor rural households for every dollar spent; GDP and employment effects are the increase in agri-food system GDP and employment, respectively, for every dollar spent; and diet diversity is the change in dietary diversity score per dollar spent. Outcomes are normalized so that the weakest (strongest) investment option is assigned a value of zero (one).

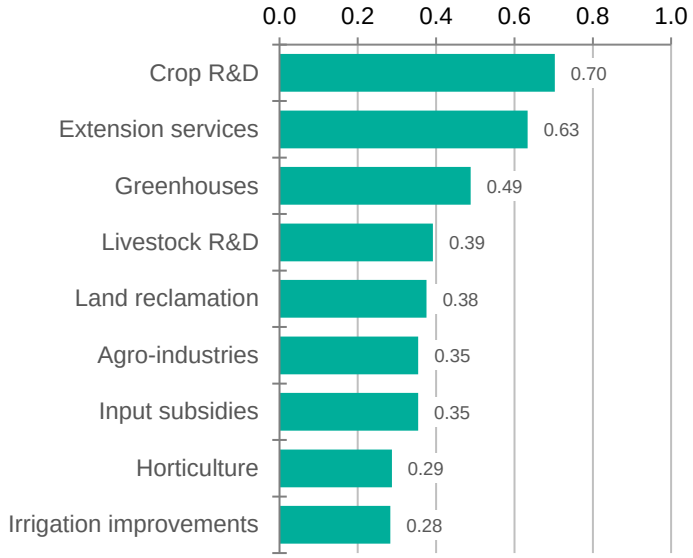
Figure 1. Normalized outcome scores by investment option

Source: Egypt RIAPA-AIDA model.
Notes: Poverty effect is the increase in poor households' income for every dollar spent; GDP and employment effects are the increase in agri-food system GDP and employment, respectively, for every dollar spent; and diet diversity is the change in dietary diversity score per dollar spent. Outcomes are normalized so that the weakest (strongest) investment option is assigned a value of zero (one).

Crop R&D is the most cost-effective investment option in reducing poverty and so it has a score of 1.0. In contrast, irrigation improvements are the least cost-effective and so it is given a value of zero. All other investments are scored in relation to crop R&D, so that greenhouses are 56 percent as cost-effective at raising the consumption levels of poor households as crop R&D. There is some similarity between poverty and GDP effects, in part because household incomes are heavily influenced by the level of GDP in the country. Employment effects do diverge, however, in part because increases in productivity can sometimes be labor shedding. Land reclamation, on the other hand, brings new lands into production and this greatly increases demand for labor to work these new lands. As mentioned earlier, much of the new land is used to grow wheat and maize, which are unfortunately lower-value crops. As such, while the employment effects of land reclamation are strong, its impacts on poverty and GDP are more modest. Finally, land reclamation narrows diets, rather than diversifying them. With the exception of crop R&D, which greatly improves the dietary diversity of poor rural consumers, the other investment options have fairly similar benefits for dietary diversity scores.

The main motivation for normalizing the results is so that the results for each indicator can be combined into a single "composite" score. If each outcome is considered equally important, then a simple average of the four scores for each outcome is appropriate. This result is shown in Figure 2.

Figure 2. Final composite scores for investment options using equal weights



Source: Egypt RIAPA-AIDA model.
Note: Equal weights assigned to each of the four normalized outcome indicators in Figure 2.

Crop R&D has the highest composite score using equal weights, although it is less than 1.0 because it did not achieve the highest scores for the employment and dietary diversity effects – that is, the composite score of 0.70 is an average of 1.00 for the poverty effect, 1.00 for the GDP effect, 0.38 for the employment effect, and 0.43 for the diet diversity effect – see Figure 1). In contrast, irrigation improvements is the lowest ranked investment option, although its score is not zero. This is because, while being least cost-effective at reducing poverty and raising AFS GDP, it did score better than crop R&D for both employment and dietary effects. Overall, crop R&D, extension services, and greenhouses are the three top-ranked investment options if each outcome is considered equally important.

Table 10. Final rankings of policies and investments under different weighting schemes

Rank	Equal weights	GDP bias	Poverty bias	Employment bias	Dietary diversity bias
1	Crop R&D	Crop R&D	Crop R&D	Extension services	Extension services
2	Extension services	Greenhouses	Extension services	Crop R&D	Crop R&D
3	Greenhouses	Extension services	Greenhouses	Land reclamation	Greenhouses
4	Livestock R&D	Land reclamation	Agro-industries	Livestock R&D	Livestock R&D
5	Land reclamation	Livestock R&D	Land reclamation	Input subsidies	Input subsidies
6	Agro-industries	Input subsidies	Input subsidies	Agro-industries	Agro-industries
7	Input subsidies	Agro-industries	Livestock R&D	Horticulture	Irrigation
8	Horticulture	Horticulture	Horticulture	Irrigation	Horticulture
9	Irrigation	Irrigation	Irrigation	Greenhouses	Land reclamation

Source: Egypt RIAPA-AIDA model.
Note: Rankings based on weighted sum of outcome indicators. Equal weighting is one-quarter each; biased weighting favors one indicator (one-half) at the expense of others (equal shares of remaining half).

Table 10 reports the final prioritization of investment options using different weighting schemes for each outcome. The first column assigns equal weights across outcomes (as per Figure 2). However, the other columns give greater weight to a specific normalized indicator. This is done by attributing half of the total weight to one outcome and one-sixth to the other three, thus creating a bias towards a specific outcome. The final analysis suggests that crop R&D and extension services are priority interventions, since these are highly-ranked almost irrespective of how outcomes are weighted. Land reclamation's rank, on the other hand, is highly sensitive to the preferences assigned to different outcomes. It scores highly when employment is considered particularly important, but

falls to the bottom of the investment options when dietary diversity is the primary focus of investment decision-making. Similarly, greenhouses are a clear priority for all but the employment-biased rankings.

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