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Agriculture for Development in Iraq?

Estimating the Impacts of Achieving the Agricultural Targets of the National Development Plan 2013–2017 on Economic Growth, Incomes, and Gender Equality

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ABSTRACT

This paper estimates the potential effects of achieving the agricultural goals set out in Iraq's National Development Plan (NDP) 2013–2017 using a dynamic computable general equilibrium model. The findings suggest that raising agricultural productivity in accordance with the NDP may more than double average agricultural growth rates and add an average of 0.7 percent each year to economywide gross domestic product during the duration of the plan. As a consequence, the economy not only diversifies into agriculture, but agricultural growth also lifts growth in the food processing and service sectors. Achieving the yield targets for cereals (especially wheat) and for fruits and vegetables will have the largest impact on economic growth and household incomes. Household incomes will rise by an estimated 3.3 percent annually. This increase in household incomes will benefit the poorest households and female-headed urban households the most due to a combination of lower food prices and higher incomes from labor and land. Reaping these benefits from agricultural growth will critically depend on the implementation of policies and investments to ensure that additional agricultural produce can be marketed efficiently domestically and compete with imports.

Keywords: Iraq, agriculture, economic growth, poverty, gender, dynamic computable general equilibrium, Middle East and North Africa (MENA)

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1. INTRODUCTION

Iraq is an oil-rich lower-middle-income country. Economic growth has averaged 7.1 percent over the past five years, compared with 4.5 percent in the Arab world as a whole. Meanwhile, several social indicators related to education and healthcare are above the Arab average (World Bank 2014a). However, conflict, weak governance, and excessive dependence on oil pose significant challenges to Iraq's socioeconomic development. Average per capita incomes in Iraq are only about one-third of the Arab world's average, and 19.8 percent of Iraqis were classified as poor in 2012 according to the official poverty line (World Bank 2014a). Iraq was ranked 132nd out of 187 countries in the 2011 Human Development Index (UN 2012). Iraq also has a very low employment rate; only 42 percent of adults participate in the labor force (Iraq, Ministry of Planning 2013). In addition, Iraq has one of the world's lowest labor participation rates for women. Only 10.9 percent of women work for a wage, and 15 percent participate in the labor market, compared to 75 percent labor market participation for men (OECD 2012; UN Assistance Mission for Iraq 2013). According to the Social Institutions and Gender Index of the Organization for Economic Co-operation and Development, Iraq ranked 59th out of 86 countries in 2012. In general, gender inequality is widely seen as an obstacle to Iraq's development (OECD 2012; UN Assistance Mission for Iraq 2013).

Despite these challenges, the country has great potential for development. In fact, the Iraqi National Development Plan (NDP) lays out ambitious targets for the period from 2013 to 2017 and aims to (1) diversify the economy and accelerate growth in promising sectors such as industry, energy, agriculture, and tourism; (2) make income generation and poverty reduction a central goal for national development; and (3) specifically strengthen the capacities of women and youth to contribute to the labor market and society (Iraq, Ministry of Planning 2013, 27).

In the 2013–2017 Iraqi NDP, agriculture is one of the key sectors identified for accelerating non-oil growth, raising incomes, and improving income distribution and gender equality. Globally, agricultural growth has been shown to be an important driver of poverty reduction and job creation, especially among the rural poor (Diao et al. 2007; World Bank 2008; Breisinger et al. 2011). In addition, if agricultural development can improve the allocation of resources within households, it will likely lead to better health and nutrition outcomes for children as well (Duflo 2012). These improved outcomes, in turn, will also potentially contribute to broad-based and pro-poor economic development (Boyden and Dercon 2012; Hoddinott et al. 2011). However, those pro-poor effects can vary widely across countries and regions. For example, Breisinger et al. (2012) show that the pro-poor effects of agricultural growth vary among world regions and may be less significant in Arab countries. Such differences in the role of agriculture are due primarily to the relative size of the agricultural sector in the economy, the agricultural sector's growth potential and structure, agriculture's linkages with other sectors, and the share of poor people working in agriculture. In addition, the direction and magnitude of changes in relative prices as a consequence of agricultural growth matter. Because there are multiple interactions at play between the different sectors and markets, relative prices (of factors and commodities) are likely to change, which impacts people differently. For example, a decrease in agricultural prices may benefit net-food-consuming households, whereas it may hurt agricultural producers.

In Iraq's case, there are many reasons to believe that the country's agricultural potential is great. Iraq was once one of the *breadbaskets* of the Middle East, and in fact today the yield gaps, understood as the differences between actual or observed yields and simulated potential yields in a given area (Nin-Pratt et al. 2011), remain very significant. Crop yields in Iraq today are low by any international comparison (FAO 2012). This is due, in part, to the effects of prolonged wars, civil strife, sanctions, droughts, and deteriorated infrastructure for input production and research and extension services (Bishay 2003; World Bank 2014b). While the country's agricultural potential and agriculture's important role in development have been well known for years, previous governments have, like those of many other countries, focused more on industrial development. However, the 2007/2008 and 2011 world food crises brought agricultural development back to the center stage of national strategic considerations, particularly in Arab countries

(Woertz 2013). In fact, in its recent 2013–2017 NDP, the Iraqi government emphasizes the role of agriculture and presents concrete goals and associated investments.

Against this backdrop, the objective of this paper is to analyze whether, and to what extent, achieving the NDP's agricultural targets might help accelerate economywide growth, raise household incomes, and affect household income distribution in Iraq. To do so, this paper uses a dynamic computable general equilibrium (DCGE) model. Key features of this model (the first of its kind for Iraq) are the detailed disaggregation of the agricultural sector and the disaggregation of households and the labor market by gender.

The paper is organized as follows: Section 2 provides an overview of the structural characteristics of the Iraqi economy based on a new social accounting matrix (SAM) for 2011. Section 3 describes the main features of the model. Section 4 assesses the impact of alternative agricultural growth options based on the NDP, considering how the economy responds to these scenarios in terms of macroeconomic effects, economic structure, and household incomes. Section 5 concludes.

2. THE ROLE OF AGRICULTURE AND HOUSEHOLDS IN THE IRAQI ECONOMY

The Role of Agriculture in the Economy

Iraq is a typical case of an oil-based economy, with more than 38 percent of gross domestic product (GDP) generated by the mining sector (mainly oil). Together with the public service sector—which is financed primarily by oil revenues—the mining sector accounts for most of Iraq's GDP (60.9 percent), leaving agriculture with less than 10 percent of GDP (Table 2.1). Within agriculture, the cereals subsector makes the largest contribution to GDP, followed by fruits and vegetables and livestock. The food processing sector, which has strong linkages to the agricultural sector, contributes 0.3 percent to GDP.

While Iraq's high dependency on oil can be a curse or a blessing, one of the common development challenges linked to the oil sector is the sector's low labor intensity (0.7 percent of total mining value added, in the case of Iraq, Table 2.1), or, in other words, the oil sector provides few jobs relative to its size. In contrast, the relatively smaller agriculture and food processing sectors are very labor intensive (62.8 percent and 60.1 percent of sector value added, respectively) and significantly exceed the average economywide labor intensity (32.0 percent of total value added). Within agriculture, cereal production employs the most people relative to its added value, followed by fruits and vegetables and livestock.

Oil also dominates international trade, which is characterized by an extremely large mining role (98.2 percent of total exports) and a large role for industrial and agricultural goods in imports. Agricultural and processed food imports make up 27.3 percent of total imports, and about one-third of all agricultural and food goods are imported (import penetration in Table 2.1). Agricultural and food exports are negligible and concentrated in the vegetable sector. This high share of food imports and small share of food exports suggest—given competitive pricing and quality—potential for substituting food imports and increasing exports by accelerating domestic agricultural production.

Table 2.1 Economic structure of Iraq

Activity	Share in GDP	Labor	Share in exports	Exports intensity	Share in imports	Import penetration
Agriculture	9.7	62.8	0.1	0.2	14.0	12.7
Cereals	4.1	80.7	0.0	0.1	5.1	13.0
Fruits & vegetables	3.3	51.0	0.1	0.6	3.8	11.3
Other crops	1.7	51.3	0.0	0.0	2.4	13.7
Livestock	0.6	36.2	0.0	0.0	2.6	13.3
Industry	46.2	11.0	99.9	53.1	85.9	39.0
Mining	38.1	0.7	98.2	92.0	0.1	0.5
Food processing	0.3	60.1	0.0	0.0	13.3	20.4
Services	44.0	47.4	0.0	0.0	0.1	0.1
Total	**100.0**	**32.0**	**100.00**	**22.9**	**00.**	**16.4**

Source: Debowicz (2013).

Note: Import penetration is defined as a sector's import value divided by the sector's domestic absorption. Export intensity is defined as a commodity's export value divided by the commodity's domestic output.

As discussed in the introduction, the labor market is dominated by male labor, and female participation rates are low. Table 2.2 shows that this general pattern can be found in all economic sectors. Yet there are several sectors in which the share of women is higher than in others. For example, the SAM shows that agriculture and services (particularly public services) are the activities with the highest share of women, consistent with United Nations estimates (UN Assistance Mission for Iraq 2013). On the other end of the spectrum is oil, a traditional male business, and even other industrial employment such as food

processing is largely dominated by men. Most women's income in the public sector goes to skilled employees (those who finished secondary education), while, unlike for men, the share of women working in agriculture is about equally split between unskilled and skilled workers (unskilled workers are those who did not finish primary school).

Table 2.2 Labor by sector, gender, and skill level

Activity	Female	Female unskilled	Female semi-skilled	Female skilled	Male	Male unskilled	Male semi-skilled	Male skilled	Total
Agriculture	11.9	5.0	1.4	5.5	88.1	30.0	32.0	26.2	100.0
Industry	2.2	0.5	0.5	1.2	97.8	33.9	44.9	19.0	100.0
Mining	6.4	0.0	0.4	6.0	93.6	7.1	32.9	53.5	100.0
Oil refining	0.7	0.0	0.0	0.7	99.3	3.0	25.0	71.3	100.0
Food processing	2.4	0.7	0.9	0.8	97.6	55.0	28.3	14.3	100.0
Construction	1.2	0.4	0.4	0.4	98.8	40.1	48.5	10.1	100.0
Other industry	5.7	0.8	1.3	3.5	94.3	23.0	44.7	26.6	100.0
Services	15.3	0.6	1.6	13.2	84.7	15.5	35.0	34.1	100.0
Electricity and water	7.6	2.3	0.2	5.0	92.4	7.1	28.8	56.5	100.0
Trade and transport	4.3	0.5	0.8	3.0	95.7	24.8	51.6	19.3	100.0
Other services	17.1	0.5	1.7	14.8	82.9	14.9	33.5	34.5	100.0

Source: Debowicz (2013).

The Agricultural Sector in Iraq: A Closer Look at Yields

Given existing land and water constraints, agricultural growth will need to come primarily from increases in productivity. A closer look at crop yields for Iraq's most important crops, wheat and barley, reveals that crop production in Iraq is undisputedly low (FAO 2009, 2012; Bishay 2003; Schnepf 2004), especially in relation to the nation's food demand. However, due to data challenges, there is not necessarily a unified view on crop yield trends, particularly for wheat and barley, over the past several decades. A 2003 needs assessment study carried out jointly by the United Nations Development Group and the World Bank asserts that Iraq's agricultural sector has been in decline since the 1980s and is underperforming. The assessment claims that in the period 1988–2003 agricultural production, on average, declined by about 1.1 percent annually, and per capita agricultural production declined by roughly 3.9 percent annually (UN and World Bank 2003). The assessment notes that the production of key cereal crops such as wheat, barley, and rice suffered dramatically during this time. In support of these findings, the Food and Agriculture Organization of the United Nations (FAO 2009) states in its agricultural overview of Iraq that average crop yields for wheat fell by 11 percent between 2002 and 2007, and average crop yields for barley fell by 21 percent during this same time period.

In contrast, more recent FAO statistics (FAO 2013) show that although these crop yields have experienced significant and frequent dips, overall, yields for both wheat and barley have followed something of an upward path since the turn of the century. In addition to challenges related to data, possible explanations for the increase in yields include subsidies for seed and greater use of improved wheat seeds.

Wheat and barley are two of Iraq's chief crops, accounting together for almost half of the country's total cultivated cereal area (31.4 percent and 15.7 percent, respectively, of all cultivated cereal crops). Much of Iraq's northern and central rainfed harvested land areas are used for wheat and barley

production (see Table 2.3 for a breakdown of Iraq's yields by key crops). Fruits and vegetables make up 15.2 percent of the total land cultivated, leaving about one-third of cultivated land to other crops.

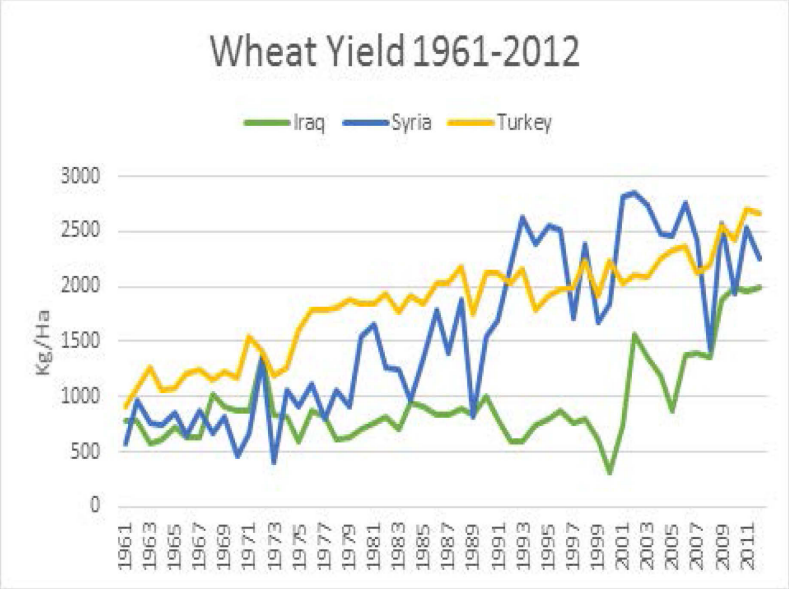
Table 2.3 Yields of main crops in Iraq

Crop	Area harvested (hectares)	Total area harvested (%)
Cereals	2,015,790	52.7
Wheat	1,200,000	31.4
Barley	6000,000	15.7
Vegetables and fruit	581,070	15.2
Other crops	1,224,766	32
Total area	3,821,626	100

Source: FAO (2013).

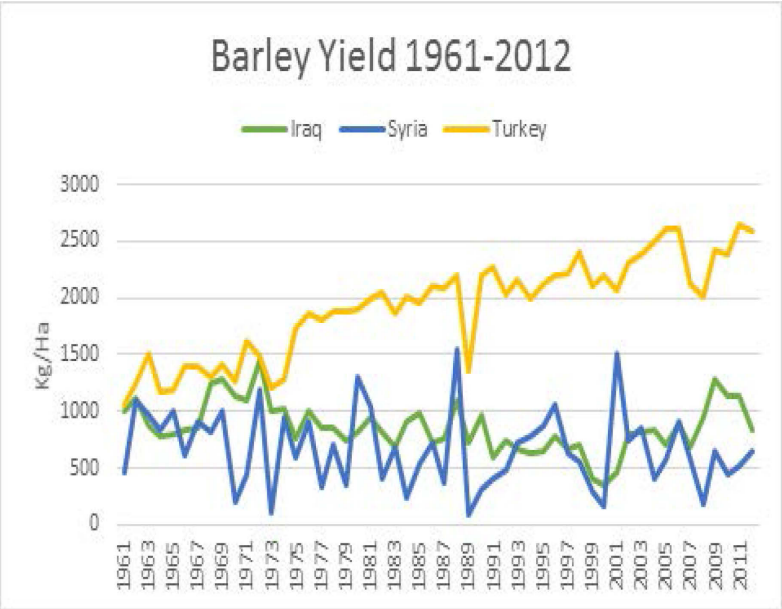
A comparison of Iraq's wheat and barley yields from 1961 to 2012 with yields from Iraq's two northern neighbors, Syria and Turkey, shows mixed results (Figures 2.1 and 2.2). For wheat yields, Turkey demonstrates a better performance overall, showing the most consistency with its steady increase in yields since 1961. Iraq, despite increasing yield rates over the last decade or so, shows significant room for improvement. Though Syria began outperforming Iraq in the mid-1970s, of the three countries, Syria has experienced the most erratic history of wheat crop yields, with frequent dips and surges along the country's overall trend toward increased yields. For barley yields, there is not quite the same gap in performance between Iraq and its two northern neighbors. Since the 1960s, Iraq has performed slightly better than Syria. Though barley yield trends in both countries show either no or negative improvement over the past half-century, Iraq's yields have been far less erratic than those recorded in Syria. Turkey, however, has achieved steady growth in its barley crop yields and remains the dominant producer among the three countries, outperforming Syria and Iraq in both barley and wheat yields.

Figure 2.1 Wheat yield comparisons: Iraq, Syria, and Turkey, 1961–2012



Source: FAO (2013).

Figure 2.2 Barley yield by comparisons: Iraq, Syria, and Turkey, 1961–2012



Source: FAO (2013).

Given the comparable agroecological conditions found in Iraq, Syria, and Turkey, these differences in yield suggest large room for improvement in agricultural productivity in Iraq. While there is not much literature on estimated yield gaps in Iraq, it is known that significant gaps exist in the dry areas that stretch across the Middle East and North Africa (MENA). A 2011 assessment carried out by the International Center for Agricultural Research in the Dry Areas (ICARDA) on wheat yield gaps in Morocco, Syria, and Turkey indicates that there is significant potential to increase wheat yields in the West Asia and North Africa (WANA) region, which includes Iraq. ICARDA's research finds that wheat yields can be increased by 1.6–2.5 times in Morocco, 1.7–2.0 times in Syria, and 1.5–3.0 times in Turkey (Pala et al. 2011).

Iraqi Household Characteristics

Iraq's population is urbanized, with 21.3 million of its total 30.1 million population (Table 2.4), or 71 percent of all Iraqis, living in urban areas. According to the World Bank, population growth averaged 2.5 percent annually between 2009 and 2013 (World Bank 2014a). About 10 percent of households are headed by women (de facto), with a higher share of female-headed households in urban than in rural areas. Per capita incomes are higher in urban areas, and the poorest households in rural and urban areas earn on average about one-third the amount that the richest households in those respective areas earn. Female-headed households on average have higher per capita incomes than the average male-headed household, which is consistent with other MENA countries.

Overall, Iraqi households receive more than half of their income from labor, 39 percent from capital, 3.5 percent from land, 6.1 percent from social transfers, and less than 1 percent from remittances (Table 2.4). Rural households receive a higher share of their income from labor, agricultural capital, and land, whereas urban households' income from nonagricultural capital is higher. Female-headed households are generally not very different in terms of income sources. However, while these households do receive a higher share of their income from female labor, it is noteworthy that they also receive a significant share of their income from male labor (from male family members).

Table 2.4 Income composition by representative household group

Household group	Populations (millions)	Per capita income (millions)	Labor	Female labor	Male labor	Capital	Ag capital	Other capital	Land	Social transfers	Remittances	Total
Total	30.1	15.5	51.6	13.9	37.6	38.7	1.4	37.3	3.5	6.1	0.1	100.0
Rural	8.8	12.0	51.1	13.8	37.3	26.8	6.0	20.8	15.1	6.9	0.1	100.0
Urban	21.3	17.0	51.7	14.0	37.7	41.2	0.4	40.8	1.0	6.0	0.1	100.0
Rural female-headed	0.6	14.2	51.2	16.3	34.8	28.5	4.7	23.8	12.6	7.7	0.1	100.0
Rural male-headed quintile 1	3.8	8.9	53.9	13.4	40.6	24.3	6.9	17.4	16.1	5.7	0.1	100.0
quintile 2	1.9	11.7	51.1	12.7	38.5	26.5	6.3	20.1	15.6	6.7	0.1	100.0
quintile 3	1.3	13.9	52.7	14.7	38.1	25.4	5.3	20.0	13.8	8.0	0.1	100.0
quintile 4	0.8	16.9	41.2	10.3	30.9	30.5	7.6	23.0	20.1	8.1	0.1	100.0
quintile 5	0.4	23.2	53.9	17.8	36.1	29.7	3.8	25.9	10.1	6.2	0.1	100.0
Urban female-headed	2.3	17.8	58.8	22.6	36.2	32.7	0.2	32.5	0.7	7.8	0.1	100.0
Urban male-headed quintile 1	3.6	9.9	67.6	16.9	50.7	25.5	0.3	25.2	0.8	6.0	0.0	100.0
quintile 2	4.1	12.1	62.5	14.1	48.4	30.0	0.2	29.8	0.5	6.9	0.1	100.0
quintile 3	4.2	14.9	54.5	12.0	42.5	37.1	0.4	36.7	1.1	7.2	0.1	100.0
quintile 4	3.9	18.5	51.7	12.0	39.6	40.8	0.2	40.6	0.5	7.0	0.1	100.0
quintile 5	3.2	31.3	3.3	13.2	0.1	50.7	0.6	50.0	1.5	4.4	0.1	100.0

Source: Debowicz (2013).

In terms of household expenditures (Table 2.5), rural households spend a significantly higher share of their income on food than urban households (33.3 percent for rural and 19.6 percent for urban). Consistent with Engel's law, the share of income spent on food generally decreases the richer households become, and this trend can be observed in both rural and urban households. Female-headed households in rural areas spend a higher share of their income on food than the average rural household.

Table 2.5 Household expenditures (share in total expenditures)

Household group	Cereals	Fruits and vegetables	Other crops	Food processing	Other industry	Services	Total
Rural	1.9	14.1	1.2	16.0	16.9	49.8	100.0
Urban	0.9	7.4	0.7	10.6	13.4	67.0	100.0
Rural female-headed	2.0	15.4	1.3	14.5	16.4	50.5	100.0
Rural male-headed quintile 1	2.2	19.3	1.7	19.1	15.8	41.9	100.0
quintile 2	1.7	14.3	1.3	16.5	17.2	49.0	100.0
quintile 3	1.9	12.2	1.1	16.6	18.6	49.6	100.0
quintile 4	1.7	9.8	0.8	13.2	18.3	56.2	100.0
quintile 5	1.5	6.8	0.5	9.8	15.9	65.6	100.0
Urban female-headed	0.9	8.1	0.7	11.9	14.1	64.3	100.0
Urban male-headed quintile 1	1.2	14.9	1.4	15.4	13.5	53.6	100.0
quintile 2	1.2	11.2	1.1	14.3	14.2	58.1	100.0
quintile 3	1.0	9.2	1.0	13.7	14.6	64.6	100.0
quintile 4	0.9	7.2	0.6	11.8	14.9	64.6	100.0
quintile 5	0.7	3.7	0.2	6.2	11.6	77.6	100.0

Source: Debowicz (2013).

3. A DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR IRAQ

To estimate the impact of achieving the NDP's agricultural growth targets, we use a DCGE model to assess how these changes affect the macroeconomy, different economic sectors, factor markets, and the incomes of households divided into different household groups. The DCGE model used is consistent with the neoclassical general equilibrium theory and follows a standard specification as documented in Diao and Thurlow (2012). The following description thus mainly focuses on the Iraq-specific features of the model. In general, the Iraq-specific model aims to reflect the realities on the ground as closely as possible.

The DCGE model is calibrated to a 2011 SAM for Iraq—that is, the model's base year is consistent with the structure of the Iraqi economy in 2011. Based on this SAM, the DCGE model includes 26 production sectors: 15 agricultural sectors, 2 mining sectors (oil and the rest), 3 industrial sectors, and 6 service sectors (Table A.1 in Appendix). The 26 sectors produce 26 different goods and services (commodities) for domestic and international markets. Each producer maximizes profits subject to a set of input and output prices assuming constant returns to scale in the production function. To guide the ease with which factors can be substituted, we choose an elasticity of 2.0. Factors of production include labor, capital, and land. More specifically, production factors are split into six categories of labor: three levels of skill and gender (male and female). Each type of labor is allowed full mobility among domestic activities and with its supply growing consistent with population growth (2.5 percent). The capital stock is segmented into agricultural capital, oil capital, and other capital to reflect its sector-specific nature. All types of capital earnings are endogenously determined every year as the capital stock of the previous year minus depreciation plus gross investment. Land is defined as land used only in agriculture and is fully mobile across agricultural subsectors, that is, farmers can switch from one crop to another from one year to another.

Factor incomes are distributed to households, in addition to other incomes that households receive, including transfers from the government and remittances. Households then either save or spend their incomes following a linear expenditure system. Income elasticities reflect differences between different types of households in comparable Arab countries and are based on Breisinger et al. 2013. These elasticities range from, for example, 0.3 for cereals for the richest households to 1.1 for banking services for the poorest households. To capture the heterogeneity in the income and expenditure patterns of Iraqi households, the DCGE model includes 12 household groups. The model identifies those headed by women in rural and urban areas (2 household groups) and splits the rest of the (male-headed) households according to (1) per capita expenditure quintiles and (2) urban or rural location (resulting in 10 household groups). While the split by quintile and rural/urban location can provide insights into poverty effects by area, the disaggregation by gender can help offer insights into distributional effects. As can be seen from Table 2.4, female-headed households represent about 10 percent of the population, and most of them reside in urban areas. Consistent with other countries in the MENA region, the per capita income levels of female-headed households are higher in both rural and urban areas.

The difference between endogenous domestic and fixed world market prices determines international trade. To guide the ease with which commodities are traded, we use trade elasticity estimates based on the Global Trade Analysis Project, with some upward adjustments to potentially capture some of the informal (and unreported) trade and thus avoid unrealistic price spikes as a consequence of increased domestic agricultural production. To check the robustness of these assumptions, we conducted sensitivity analysis on the trade elasticity parameters (Table A.2 in the appendix). The sensitivity tests suggest that our results hold even if trade elasticities are changed by +/- 50 percent. The macroeconomic closures we used are the following: fixed foreign savings, with the real exchange rate playing the role of the equilibrating variable; savings-driven investment; and endogenous public savings. The consumer price index is the model's numeraire.

To calibrate the model to produce a baseline or business-as-usual scenario against which we compare the other scenarios, we used total factor productivity growth rates at the sector level. Given the erratic path of sectoral production in Iraq's recent past,[1] we calibrated the parameters of the model against the average growth rates of Arab countries in the last 20 years (4.5 percent economywide growth annually, with relatively higher growth in services, industry, and agriculture, in that order). Population grows at 2.5 percent, consistent with the average of 2009 to 2013 (World Bank 2014a).

As with any other model, the Iraq DCGE model has weaknesses. One of them is that DCGE models in general are very data intensive, which can be constraining in countries with limited or discontinuous sources of statistical data such as Iraq. For example, because of the lack of data the Iraq DCGE model does not explicitly capture differences in agroecological conditions such as those between the northern and southern parts of Iraq. Yet, a major strength of this type of model is that it can reconcile data from different sources, such as balance-of-payments data, national accounts, agricultural data, and household surveys. The data we used for the DCGE were collected from national and international sources and were validated during an expert meeting in January 2014 (ICARDA 2014). None of these data limitations, all of which apply to the DCGE model presented in this paper, are likely to alter the key messages.

[1] Due to various conflicts, annual growth rates were extremely volatile during the 1990s and 2000s.

4. ASSESSING THE IMPACTS OF SUBSECTOR AGRICULTURAL GROWTH

Scenarios

As part of its five-year agenda, the recently released Iraq NDP 2013–2017 highlights some of the areas that are of strategic importance for enhancing the ability of the agricultural sector to make progress toward productivity-led growth. Table 4.1 shows the expected yields as described in the plan. For example, the plan targets a wheat harvest of 558 kilograms per dunam (1,000 square meters) for 2013, growing to 765 kilograms per dunam in 2017. This translates into an implicit annual growth rate of 8.2 percent.[2] To analyze how such a change in yields might impact the economy, households, and the agricultural sector as a whole, we imposed this annual growth rate onto the DCGE model as an annual change in total factor productivity. We carried out an analogous process for the other crops. For crops that are present in the model but not explicitly included in the plan, we take the growth figure from crops for which there are data and that have similar characteristics based on consultations with key stakeholders from the Ministry of Agriculture and Ministry of Planning (ICARDA 2014). For example, as shown in Table 4.1, we use the growth rate of maize yields for other grains. For livestock, in light of the plan's information on sheep and goats (Iraq, Ministry of Planning 2013), 7.0 percent total factor productivity growth is assumed, plus similar growth in fodder crops. For all crops without information in the NDP, we assumed a 5.0 percent annual growth rate.

Table 4.1 Expected harvest in Iraqi National Development Plan 2013–2017, implicit annual growth rate (kilograms per dunam), and translation into modeled crops

Plan	Model	2013	2017	Implicit annual growth rate
Wheat	Wheat	558	765	8.2
Rice	Paddy	800	1,195	10.6
Barley	Barley	243	281	3.7
Maize	Corn, other grains	1,011	1,502	10.4
Tomato	Tomato	4,500	7,804	14.8
Potato	Potato	4,596	8,013	14.9
Onion	Tubers and bulbs	77	89	3.7

Source: Iraq, Ministry of Planning (2013) and own calculations.

To assess the effects of achieving these yield targets, we set up six scenarios. Each allows the total factor productivity of agricultural activities to grow consistently with the harvest growth rates for agricultural products expected by the NDP. Namely, these scenarios involve achieving yield targets in (1) wheat; (2) other cereals (barley, rice, maize, and other cereals); (3) fruits and vegetables (potato, tomato, onion, other vegetables, and fruits); (4) industrial and other crops; (5) livestock; and (6) combined agriculture (scenarios 1–5 combined).

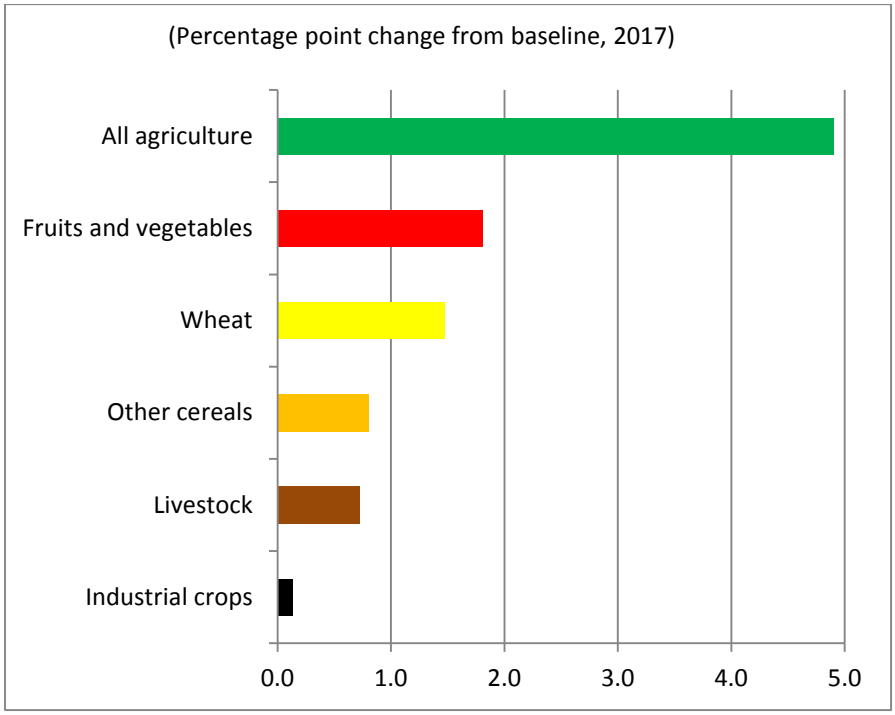
Results

The effect of raising agricultural productivity is an increase in agricultural GDP. Depending on the subsectors' relative size, the yield growth rate (see Tables 2.1 and 2.5), and changes in relative agricultural and factor prices, the contributions of different crops and livestock to economic growth vary. Results show that achieving the yield targets for all cereals combined (wheat and other cereals) by 2017,

[2] Agricultural yields differ significantly within Iraq. For example, the productivity for many crops, including wheat and potatoes, is higher in northern Iraq than in the south. However, because of the lack of data, this paper cannot take these differences into account.

for example, would lead to an average annual increase in agricultural GDP of 4.9 percentage points between 2013 and 2017, whereas wheat-led growth alone would add an average 1.5 percentage points to agricultural growth annually (Figure 4.1). Achieving the yield targets for fruits and vegetables would add an estimated 1.8 percentage points to annual agricultural growth. Livestock and industrial and other crops would add 0.7 and 0.1 percentage points, respectively.

Figure 4.1 Agricultural growth acceleration (average annual percentage point change from baseline), all simulations



Source: DCGE model (2014).

Such agricultural growth also has positive effects on the Iraqi economy as a whole. Achieving all the agricultural goals (scenario: combined agriculture) would add an estimated 0.7 percent to the country's total GDP each year between 2013 and 2017 (Table 4.2). Private consumption is estimated to grow by an additional 1.2 percent annually and investment by 0.5 percent.[3] Given the import-competing character of domestic agricultural production, agricultural output growth allows for a reduction in Iraq's imports, where the rate of import growth decreases by 1.0 percentage point annually. This, in turn, lowers the real exchange rate and drives resources toward the production of nontradable commodities. In addition, the food processing sector is one of the main beneficiaries of agricultural growth, due to forward linkages. An increased supply of (agricultural) inputs at lower prices leads to an estimated 3.3 percentage point annual growth in the food processing sector. Consequently, agricultural productivity enhancements not only allow for a diversification of the economy by increasing the share of agriculture in national production; they also encourage diversification by increasing the share of (nontradable) services and food processing.

[3] Government consumption is fixed as part of the model assumptions (see model description).

Table 4.2 Effect on real gross domestic product by sector and aggregate demand components, National Development Plan 2013–2017 (average annual growth rates, change from base in percentage points)

	Scenarios with growth acceleration in :						
Sector	Base	Wheat	Other cereals	Fruits and vegetables	Industrial crops	Livestock	All agriculture
Gross domestic product	4.5	0.2	0.1	0.2	0.0	0.1	0.7
Private consumption	4.9	0.3	0.1	0.4	0.0	0.3	1.2
Investment	7.0	0.3	0.1	0.1	0.0	0.0	0.5
Public consumption	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Export	3.7	-0.2	-0.1	-0.3	0.0	-0.1	0.7
Import (-)	5.5	-0.3	-0.2	-0.4	0.0	-0.1	-1.0
Agriculture	3.1	1.5	0.8	1.8	0.1	0.7	4.9
Industry	3.9	0.0	0.0	0.0	0.1	0.0	0.0
Food processing	3.7	1.3	0.6	1.2	0.1	0.2	3.3
Service	4.8	0.3	0.2	0.3	0.1	0.2	0.9
Real exchange rate (2012 = 1.00)	1.03	1.04	1.03	1.05	1.03	1.04	1.08

Source: DCGE model (2014).

The increase in agricultural growth raises household incomes. These benefits for households are derived from two main sources. First, rapid agricultural growth leads to a decrease in relative agricultural prices, thus raising real household incomes. The magnitude of this change in price depends primarily on the increase in production resulting from yield increases and demand for the additional produce from domestic consumers and international markets.[4] In the case of Iraq and the combined agricultural scenario, the relative price declines most for vegetables (potatoes and tomatoes), by around 25 percent compared to the base, whereas food items that are more easily traded on international markets, such as industrial crops, experience a much smaller decline in prices (between 1.5 and 8.0 percent). The decline in cereal prices lies somewhere in between, with an estimated decrease in price of 11.6 percent for wheat and 1.4 percent for barley. Second, agricultural growth leads to an increase in returns to factors. All types of labor benefit from agricultural growth. Among male labor, the lower-skilled labor categories benefit more, whereas among female labor the higher-skilled labor categories benefit more. Returns to land increase among most crop-led growth scenarios, thus benefitting mainly rural households with land. The exception is returns to land under the fruits and vegetables–led scenario. Because the prices of fruits and vegetables decrease the most as a consequence of rapid yield growth, returns to land decline.

[4] Given that some of the results are influenced by price responses, we conducted sensitivity analysis on trade elasticity parameters. Results from this sensitivity analysis (increasing and reducing the Armington and constant elasticity of transformation elasticities by 50 percent, respectively) shows that the results are robust to changes in these parameters (see Table A.2 in the appendix).

Table 4.3 Per capita income growth (average annual percentage point change from base, 2013–2017)

Household group	Base	Wheat	Other cereals	Fruits and vegetables	Industrial crops	Livestock	Combined agriculture
Total	2.31	0.82	0.40	1.19	0.08	0.72	3.32
Rural	2.27	0.69	0.34	0.49	0.07	0.89	2.41
Urban	2.32	0.85	0.41	1.34	0.08	0.68	3.51
Rural female-headed	2.15	0.64	0.35	0.81	0.08	0.98	2.80
Rural male-headed quintile 1	2.18	0.70	0.35	0.78	0.09	1.22	3.06
quintile 2	2.25	0.72	0.34	0.50	0.07	0.93	2.49
quintile 3	2.22	0.71	0.36	0.44	0.07	0.77	2.28
quintile 4	2.39	0.70	0.31	0.23	0.05	0.50	1.19
quintile 5	2.60	0.62	0.32	0.22	0.05	0.38	1.54
Urban female-headed	2.20	0.79	0.40	1.35	0.08	0.70	3.44
Urban male-headed quintile 1	2.14	0.77	0.40	1.91	0.10	1.18	4.51
quintile 2	2.16	0.82	0.42	1.68	0.09	0.95	4.13
quintile 3	2.16	0.88	0.42	1.51	0.09	0.81	3.87
quintile 4	2.24	0.87	0.42	1.37	0.08	0.68	3.58
quintile 5	2.57	0.88	0.41	0.99	0.06	0.40	2.87

Source: DCGE model (2014).
Note: Results for nonbase simulations are stated as the percentage point difference from the base.

As a result of these income and expenditure effects, household incomes are estimated to increase by an average of 3.3 percent annually between 2013 and 2017. Both rural and urban households benefit from agricultural growth in Iraq (Table 4.3). Rural and urban female-headed households, as well as the poorest households in rural and urban areas, tend to benefit more from decreasing food prices, as they spend a higher share of their income on food (see section above). The poorest households are also those that depend most on income from lower-skilled male labor (for which wages increase the most). Female-headed households benefit from the fact that they receive a relatively large share of their income from (unskilled) male labor and skilled female labor, for which wages increase.

Thus, agricultural growth in Iraq is pro-poor and benefits female-headed households in urban areas. Average annual incomes for the poorest households in urban and rural areas are estimated to rise by 4.5 percent and 3.1 percent, respectively. The benefits from agricultural growth generally decline the richer households become in both rural and urban areas, largely because of the above-described income and expenditure effects. Female-headed households also make gains from agricultural growth, particularly in urban areas. Incomes are estimated to rise by an average of 3.4 percent and 2.8 percent for urban and rural female-headed households, respectively.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper's objective was to analyze the extent to which productivity-driven growth in agricultural subsectors might contribute to accelerating economywide growth, raising household incomes, and affecting household income distribution. To enable this analysis, we used a DCGE model with a detailed representation of the agricultural sector, the gender-disaggregated labor market, and different representative households groups split by location (rural/urban), wealth quintiles, and gender of household head.

The findings show that raising agricultural productivity according to the Iraqi NDP could more than double the average agricultural growth rates and add an average of 0.7 percent each year to economywide GDP in the period 2013–2017. As a consequence, the economy would not only diversify into agriculture (whose share in GDP would increase), but agricultural growth would also lift growth in the food processing and service sectors. In terms of subsector agricultural growth acceleration, achieving all the yield targets for cereals (particularly wheat) and fruits and vegetables would have the largest impact on economic growth and household incomes. In this situation, household incomes could rise by an additional 3.3 percent on average during the simulation period, compared with a situation in which the yield targets are not achieved. This rise in household incomes would benefit the poorest households and female-headed urban households the most.

Thus, agricultural growth is good for economic growth, for household incomes, and for female-headed households. The results of this study, together with the literature and expert opinion,[5] suggest the following policy priorities to ensure that such positive outcomes materialize:

1. Achieving the yield targets for wheat and for fruits and vegetables will provide the most growth and income enhancement. Therefore, increasing agricultural productivity in these sectors should be a priority. To achieve sustainable yield improvements as outlined in the NDP, a group of experts under the Harmonized Support for Agricultural Development program implemented by ICARDA has identified several urgently needed actions. These actions would involve improved agricultural technology and management, including improved soil watering and nutrient management practices, new agricultural technology for harvesting and postharvest processing, and improved seed varieties. They also include improved water harvesting, greater irrigation efficiency, and expanded implementation of modern irrigation projects—with particular emphasis on modern drip and spray irrigation systems that rely on solar power. These steps would be part of an overall effort to optimally exploit water resources and address issues of water.
2. The success of efforts to rapidly accelerate agricultural growth will critically depend on whether or not additional agricultural produce can be marketed efficiently domestically and compete with imports. The results of this study show that this will be particularly important for fruits and vegetables. To support farmers and traders in this process, improving infrastructure and market information systems will be important for market access and to provide actors along the supply chain with useful information about prices and marketing opportunities (Minot et al. 2010). Another type of policy that would support a rapid increase in agricultural production is trade facilitation. This category includes measures to reduce the transaction costs related to international trade, including excessive documentation requirements, authorizations from multiple agencies, unclear or subjective criteria for the application of duties, and delays and uncertainties related to customs clearance (Minot et al. 2010).

Some of these recommendations are also included in the NDP. It is time to implement them.

[5] See Iraqi experts listed in the acknowledgments.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Accounts in the social accounting matrix for Iraq

Activities and commodities	Activities and commodities (continued)
Wheat	Financial Services and Ownership of Dwellings
Barley	Other Services
Paddy	Electricity and Water
Maize	Construction
Other grains	Trade, Hotels, and Restaurants
Fodder crops	Other Services
Legumes	**Factors**
Industrial crops	Labor unskilled male
Sesame	Labor unskilled female
Other oil crops	Labor semi-skilled male
Potato	Labor semi-skilled female
Other tubers and bulbs	Labor skilled male
Livestock	Labor skilled female
Crude oil	Capital agricultural
Other mining	Capital rest
Oil refining industry	Capital oil
Processed food	Land
Other Manufacturing Industries	Labor aggregate (level 1)
Electricity and Water	Female Labor aggregate (level 2)
Construction	Male Labor aggregate (level 2)
Trade, Hotels, and Restaurants	Capital aggregate (level 1)
Transport, Communications, and Storage	Land aggregate (level 1)
Financial Services and Ownership of Dwelling	**Households**
Other Services	Rural Female-headed Households
Wheat	Rural Quintile 1 Households
Barley	Rural Quintile 2 Households
Paddy	Rural Quintile 3 Households
Maize	Rural Quintile 4 Households
Other grains	Rural Quintile 5 Households
Tomato	Urban Female-headed Households
Other vegetables	Urban Quintile 1 Households
Fodder crops	Urban Quintile 2 Households
Legumes	Urban Quintile 3 Households
Industrial crops	Urban Quintile 4 Households
Sesame	Urban Quintile 5 Households
Other oil crops	Rural Households (aggregate)
Potato	Urban Households (aggregate)
Other tubers and bulbs	**Government and taxes**
Livestock	Government
Crude oil	Activity taxes
Other mining	Direct taxes
Oil Refining Industry	Import taxes
Processed food	Sales taxes
Other Manufacturing Industries	**Other**
Electricity and Water	Saving-investment
Construction	Rest of the World
Trade, Hotels, and Restaurants	Total
Transport, Communications, and Storage	

Source: Debowicz (2013).

Table A.2 Results under different elasticity parameters, agricultural simulation

Sector	Agriculture-led growth (additional growth compared to base		
	Trade elasticities		
	Original	+50%	-50%
		Armington and CET	Armington and CET
Gross domestic product	0.7	0.6	0.8
Private consumption	1.2	1.1	1.1
Investment	0.5	0.2	0.9
Public consumption	0.0	0.0	0.0
Export	-0.7	-1.1	-0.1
Import (-)	-1.0	-1.7	-0.1
Agriculture	4.9	6.3	3.3
Industry	0.0	-0.3	0.3
Food processing	3.3	4.2	2.2
Service	0.9	0.8	0.9
Real exchange rate (2012 = 1.00)	1.1	1.1	1.1

Source: DCGE simulations.

Note: CET = constant elasticity of transformation.

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