

Constructing a SAM for Egypt (2008/09) Introducing Water and Irrigation Seasonality

Rehab Osman*
Emanuele Ferrari**
Scott McDonald***

Abstract

Analysing agricultural and irrigation policy for Egypt within a CGE modelling framework has been constrained by lack of data. The available Egyptian SAMs do not provide adequate information on seasonal agricultural and irrigation activities. This paper describes the construction process for a SAM for Egypt (2008/2009). The SAM introduces irrigation water as a separate production factor. Furthermore, it provides detailed representation for the agricultural activities and factors across different irrigation seasons. This new SAM allows accurate assessment for a wide range of agricultural and irrigation policies within a CGE . modelling framework

بناء مصفوفة حسابات اجتماعيه لمصر 2009/2008 تقديم مياه ومواسم الري

رحاب عثمان
ايمانويل فيراري
سكوت ماكدونالد

ملخص

إن مشكلة عدم توافر البيانات تعد من أهم العوائق في سبيل إجراء تحليل لسياسات الزراعة والري في إطار نماذج التوازن العام الحسابيه. فما زالت مصفوفات الحسابات الاجتماعيه المتوفره عن الاقتصاد المصري تفتقر إلى المعلومات الضرورية عن أنشطة الري والزراعة. ومن ثم، تقدم هذه الورقه شرحاً تفصيلياً لعملية بناء مصفوفة حسابات اجتماعيه لمصر عن عام 2008\2009. تبرز هذه المصفوفه مياه الري كعنصر مستقل من عناصر الإنتاج. كما تقدم المصفوفه عرضاً تفصيلياً للأنشطة ولعناصر الإنتاج الزراعيه خلال مواسم الري المختلفه. وبهذا نتيج هذه المصفوفه الجديده المجال لإجراء تقييم دقيق لمدى واسع من سياسات الري والزراعة في إطار نمذجة التوازن العام الحسابيه.

* Corresponding Author; Postdoctoral Research Fellow (Economics), Department of Accounting Finance and Economics, Faculty of Business, Oxford Brookes University, Wheatley Campus, Oxford, OX33 1HX, UK, Tel: +44 (0)1865 485964, rosman@brookes.ac.uk; and Lecturer (Economics), Institute of African Research and Studies, Cairo University, Giza, 12613, Egypt

** Scientific Officer, European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS), Edificio Expo, Inca Garcilaso 3, 41092 Seville, Spain, Tel: +34 954-488461, Emanuele.Ferrari@ec.europa.eu

*** Visiting Professor, Institute of Agricultural Policy and Markets, University of Hohenheim, 70593 Stuttgart, Germany, Scott.Mcdonald@uni-hohenheim.de

1. Introduction

Agriculture and irrigation in Egypt have very distinct seasonal patterns. Egypt follows a multi-cropping system that permits planting up to three crops per annum. Planting takes place during three rotations or irrigation seasons: winter (November–May), summer (May–September) and Nili, i.e., Nile flood (September to November). The main crops are wheat, berseem⁽¹⁾ and broad-beans (in the winter season), cotton, sugar cane and rice (in the summer season), maize and millet are flood crops. This seasonal irrigation system helps in improving land productivity. For example, cultivating berseem in winter improves the soil quality before the soil-demanding cotton is being planted in summer. Most crops are not region-specific with the exceptions of sugarcane, which is mainly planted in Nile Valley, and rice which is planted in Nile Delta.⁽²⁾

Nile is the main source of freshwater in Egypt, with a share of more than 95%. Agriculture is the main consumer for fresh water resources. It consumes about 85% of the annual total water resource. Virtually 80% of irrigation requirements are met by Nile water.

Conducting thorough agricultural and irrigation policy analyses requires detailed data on production by crop and irrigation season. Preferably, data on different types of irrigation water utilized over irrigation seasons are also crucial. To the best of our knowledge, no social accounting matrix (SAM) constructed for Egypt, to date, has provided such detailed representation of agricultural activities and factors across irrigation seasons. Despite its importance, no distinction has been made yet between irrigation water and land in existent SAMs for Egypt. This study provides a new SAM that fills these gaps in the literature by introducing irrigation water as a separate production factor and segmenting agricultural activities as well as land and water across different irrigation seasons.

This paper describes the process of constructing a SAM for Egypt for 2008/09. The SAM is constructed in order to serve several research purposes, among which are examining agricultural and irrigation policies within a CGE framework. In this context, the SAM introduces irrigation water as a separate production factor. Furthermore, it provides a detailed representation of agricultural activities and factors across irrigation seasons.

The rest of the paper is structured as follows. Section 2 provides brief overviews for the SAM as a database and as a modelling framework. It also reviews the previous SAMs for Egypt and the exiting gaps in relevant empirical work. Section 3 describes different data sources used to construct the macro SAM. Section 4 explains the evolution

of the SAM structure over the course of the construction process. Section 5 informs how the discrepancies between sources are dealt with for each component of the final micro SAM. Section 6 describes the balancing process and the employed programme. Section 7 discusses limitations and future work.

2. SAM: Overview and Egypt Experience

A SAM provides a consistent framework, within which flows of expenditure and income for the different agents in the economy at hand are recorded. A SAM is a square matrix where each agent is represented by a column and a row that record, respectively, the account's expenditures and receipts. Table 1 portrays schematic structure for a SAM.

As such, SAMs serve as the typical database required for calibrating Computable General Equilibrium (CGE) models.⁽³⁾ "The relationship between SAMs and models is twofold. On the one hand, modeling is a major area of application of SAMs ... On the other hand, models are important as a formalization of particular conceptual frameworks. Without such frameworks, data gathering is largely an empty exercise", (Pyatt & Round, 1985, p. 8).

The first SAMs constructed for Egypt was for 1975 (Taylor L. , 1979a), 1976 (Eckaus, McCarthy, & Mohie-Eldin, 1981) and 1979 (Ahmed, Bhattacharya, Grais, & Pleskovic, 1985). The SAMs were constructed to serve several research projects between Cairo University on one side and MIT, USAID and the World Bank on the other. These projects focus mainly on assessing macroeconomic effects of changes in food subsidies and in domestic and world energy prices.⁽⁴⁾

Table 1: Conventional SAM Structure

	Commodities	Activities	Production Factors	Households	Enterprises	Government	Taxes	Savings / Investment	Trade Margins	ROW	TOTAL
Commodities		Use Matrix		Private Consumption		Public Spending		Investment Spending	Exports of T&T Margins	Exports	Commodity Demand
Activities	Supply Matrix										Domestic Supply
Production Factors		Factor Remunerations									Factor Income
Households			Distribution of Factor Income	Transfers	Distribution of Cooperate Income	Transfers				Remittances from Abroad	Household Income
Enterprises			Distribution of Factor Income			Transfers				Transfers	Cooperate Income
Government			Distribution of Factor Income				Taxes			Grants, Loans	Public Revenues
Taxes	Sales Tax	Production Tax	Tax on Factor Income	Personal Income Tax	Cooperate Income Tax						Tax Revenues
Savings / Investment				Private Savings	Cooperate Savings	Government Savings		Changes in Stock		Foreign Savings	Savings
Trade Margins	Imports of T&T Margins										Income from T&T Margins
ROW	Imports		Distribution of Factor Income	Remittances to Abroad		Interests on Foreign Debt					Spending Abroad
TOTAL	Commodity Supply	Production Cost	Factor Expenditures	Household Expenditure	Co-operate Spending	Government Spending	Taxes	Investment	Expenditure on T&T Margins	Income from Abroad	

Source: Compiled by the authors.

The 80s witnesses outstanding progress regarding data availability. As a result, the Central Agency for Public Mobilization and Statistics (CAPMAS) has constructed series of SAMs for Egypt for years 1983/84, 1986/87 and 1989/90.⁽⁵⁾

More recently, IFPRI (2002) has constructed a SAM for Egypt for 1996/97. It contains 14 sectors, among which 6 are agricultural. The SAM distinguishes urban and rural households by income quintile allowing for income distribution and inequality analysis.

With an objective of estimating employment and income multipliers, particularly in food industries, Qadry, Bahloul & Maki (2005) have developed a SAM for Egypt for 2000/2001. The SAM contains 35 activities/commodities, among which 2 are agricultural and 4 are food processing industries. It also distinguishes 10 households by income quintile.

Egypt was firstly introduced into the Global Trade Analysis Project (GTAP) Database in its version 7, which is referenced to 2004.⁽⁶⁾ The SAM is based on the Egyptian National Accounts for 2003–2004. The 32 national account sectors are mapped to the 57 GTAP sectors. The SAM was then updated to be referenced to both 2004 and 2007 in GTAP8.⁽⁷⁾

3. Data Sources and the Macro SAM

Building a SAM requires collecting data from various sources. Table 2 summarizes the main data sources used in this study. The core structure of the SAM is based on Supply/Use Tables for the Egyptian economy for 2008/2009 (CAPMAS, 2010).

It is worth noting here that the most recent Supply/Use Tables for the Egyptian economy are issued for 2010/2011 (CAPMAS, 2013). The study, however, refrained from adopting 2010/2011 as a reference year. After the January 25 Revolution, the Egyptian economy has experienced serious fluctuations. According to the Central Bank of Egypt (CBE, 2011), capital inflows dropped drastically from US\$ 7.9 billion in 2009/2010 to record an outflow of US\$ 2.6 billion in 2010/2011. Likewise, foreign direct investment suffers a sharp reduction of 68 percent. The adverse political economic climate generates outstanding contractions in the overall economic activities with a real GDP growth rate of less than 2 percent. From this perspective, it is believed that economic analysis based on 2010/2011 database would lead to flawed inferences about the Egyptian economy.

The CAPMAS issues two Supply/Use Tables: for both economic activities and organizational sectors. The former consists of 17 non-financial activities and 10 commodities. The latter comprises of five domestic institutions: non-financial enterprises, financial and insurance enterprises, general government, non-profit institutions serving households (N.P.I.S.H) and a representative household. Furthermore, it represents capital formation, exports/imports, transportation and trade margins and net taxes, tariffs and subsidies.

Table (2): Data Sources

Data Type	Data Source	Year
Production Flows	Supply and Use Tables (2010)	2008/2009
Agricultural Production Flows (by Crop and Season)	Bulletin of Agricultural Statistics, (January 2012) and (September 2012)	2010/2011
Irrigation Water Requirements	Annual Bulletin of Irrigation and Water Resources Statistics (December 2009)	2008
Institutional Transfers	National Accounts (2011)	2008/2009
Tax Payments	Supply and Use Tables (2010) and National Accounts (2011)	2008/2009
Trade Flows	Egyptian Foreign Trade Statistics (2008-2009)	2008, 2009

In addition, data for institutional accounts are sourced from the National Accounts for 2008/2009 (MOP, 2011).⁽⁸⁾ Ministry of Planning (MOP) issues annual and quarterly National Accounts, including accounts for 24 activities and 6 institutions.

Data for detailed agricultural crops by irrigation season are compiled from the most recent issues of Bulletin of Agricultural Statistics, (MALR, 2012a) and (MALR, 2012b). Besides, data on agricultural cost and return is the most recent issues of Bulletin of Agricultural Prices, Costs and Net Returns, (MALR, 2011a) and (MALR, 2011b).

Data on water requirements are compiled from the Annual Bulletin of Irrigation and Water Resources Statistics, 2008 (CAPMAS, 2009).⁽⁹⁾ It is worth highlighting here that water requirement refers to blue water only. These detailed data allow segmenting irrigation water and irrigated land by season; i.e. winter, summer, Nili as well as year-round

In the Supply/Use Tables, agricultural, forestry and fishery products are grouped into one commodity account. More disaggregated agricultural trade data are required in order to match the agricultural crop activity accounts. Agricultural trade data, compiled from the Egyptian Foreign Trade Statistics (Ministry of Industry and Foreign Trade, 2008–2009), are used to disaggregate the ‘Agricultural, forestry and fishery’ account into 7 agricultural commodity accounts.

Table 3 portrays the final balanced macro SAM for Egypt 2008/2009. Egypt’s GDP (at factor cost) was 1,042.2 billion LE. Agriculture accounts for more than 10 percent of GDP and employs 8 percent of the labour force. The economy has also strong industrial base, forming 40 percent of GDP, of which 30 percent is sourced from manufacturing activities. Services are the main productive activity, contributing almost half of total GDP. Public services account a sizable share of GDP (more than 7 percent). Furthermore, public employment constitutes a substantial share of total labour force; i.e. 36 percent.

4. Evolution of the SAM Structure

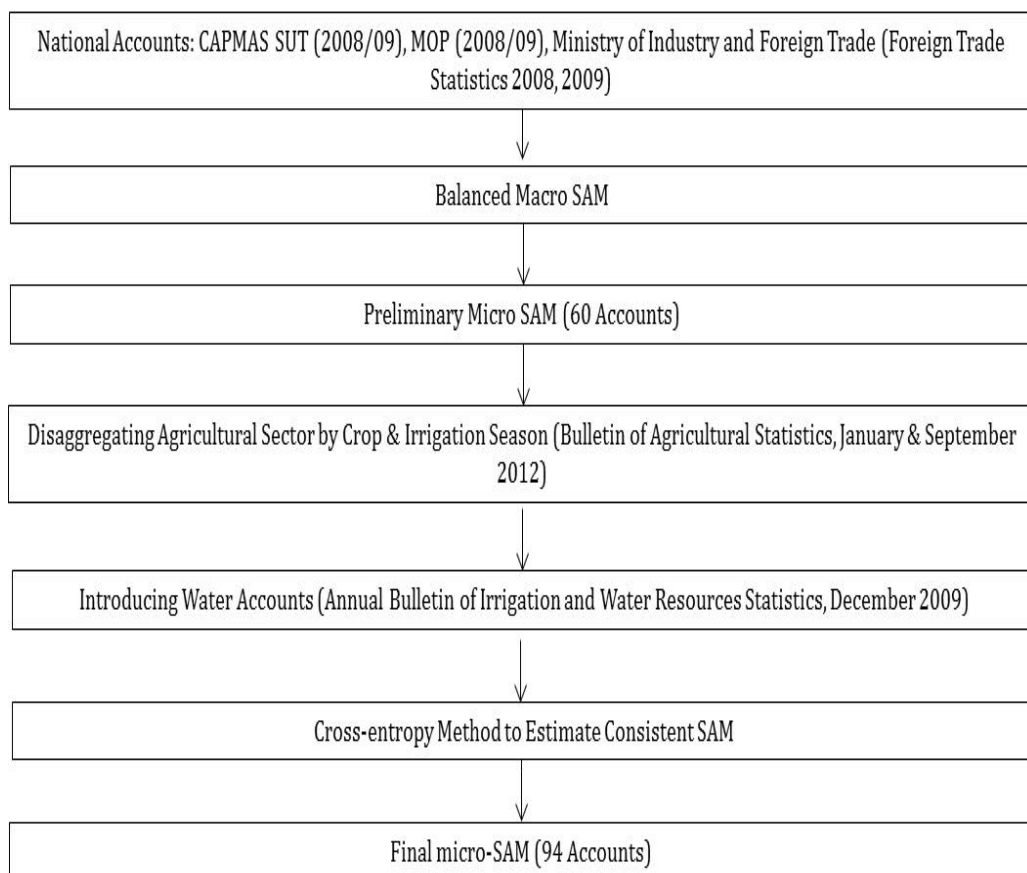
Constructing the Egyptian SAM takes place into three main and interlinked steps: compiling and balancing the preliminary SAM; disaggregating some accounts and constructing the proto SAM; and re-balancing and estimating the final SAM. A GAMS-coded programme is used in all these steps; this is described later in Section Error! Reference source not found..

A preliminary SAM is firstly compiled from different data sources and basic balancing procedures are conducted. The study, then, proceeds with adapting the SAM’s outline. This is done by disaggregating existing accounts and adding new accounts in a way that serves the underlying research objectives. At this stage of the SAM development, a proto SAM required by the used balancing programme is already generated. Subsequently, the final SAM is re-balanced and estimated. Figure 1 depicts the process of constructing the Egyptian SAM for 2008/2009.

(Table 3): Macro SAM for Egypt 2008 / 2009, Billion LE¹⁰

	Commodities	Activities	Labour	Capital	HH	N.P.I.S.H	Gov	Direct Taxes	Indirect Taxes	Enterprises	S/I	Trade Margins	ROW	TOTAL
Commodities		756.04			825.15	5.65	124.04				207.21	154.72	258.89	2331.71
Activities	1859.18													1859.18
Labour		264.14												264.14
Capital		807.69												807.69
HH			264.14	268.53			62.08			291.45			23.20	909.40
N.P.I.S.H				0.20						6.34			0.70	7.24
Gov				4.36				86.30	57.87				9.56	158.09
Direct Taxes					14.00					72.30				86.30
Indirect Taxes														57.87
Enterprises	26.56	31.31		476.10									4.28	480.38
S/I					55.78	1.59	-28.03			110.29			67.58	207.21
Trade Margins	154.72													154.72
ROW	291.24			58.50	14.46									364.21
TOTAL	2331.71	1859.18	264.14	807.69	909.40	7.24	158.09	86.30	57.87	480.38	207.21	154.72	364.21	

Figure 1: Process of Constructing the Egyptian SAM



4.1 Compiling and Balancing the Preliminary SAM

The preliminary SAM is mainly based on the Egyptian National Accounts. The preliminary SAM contains 60 accounts: 32 activities, 10 commodities, 2 production factors (labour and capital), 5 domestic institutions, 8 taxes and 3 accounts for savings/investment, trade margin and rest of the world, Table A 1.

In the preliminary SAM, agricultural activities and commodities are highly aggregated; each is represented by only one account. Also, it contains 16 non-financial non-agricultural activities. Furthermore, 2 financial activities and 10 public activities are classified.

Three new activity accounts are introduced to the preliminary SAM. The first one represents Suez Canal. Suez Canal is represented separately in the National Accounts whereas it is lumped in the 'Transportation and Storage' account in the Supply/Use Tables. Total intermediate demand by Suez Canal, derived from the National Accounts, is divided into intermediate demand for the individual 10 commodities using their shares in intermediate demand by the 'Transportation and Storage' activity account. These shares are directly calculated from the Use Table. The computed intermediate commodity inputs for the Suez Canal activity account are then subtracted from intermediate demand by 'Transportation and Storage'. Likewise, primary inputs and taxes/subsidies on production for Suez Canal are directly derived the National Accounts. In the Supply Table, 'Transportation and Storage' activity produces only one commodity; i.e., 'Distributive trade Services'. Therefore, 'Distributive trade Services' commodity supplied by Suez Canal activity is calculated and deducted from total supply by 'Transportation and Storage' activity.

Moreover, two new accounts for activities run by N.P.I.S.H and by subsistence households are included. It is worth noting here that N.P.I.S.H is represented by two accounts. The former represents N.P.I.S.H as a producing unit whereas the latter is an institution account where N.P.I.S.H's income and expenditure are booked.

4.2 Disaggregating the Agricultural Sector

At this stage of the SAM development, the agricultural activity and commodity accounts are dis-aggregated. Extremely detailed data for 309 different crops across the three irrigation seasons are compiled and are treated outside the SAM framework. For each crop, data on labour payments, irrigated land rent, total cost, total revenue and net return are compiled per land area unit. Intermediate inputs are calculated as a residual from total cost after factor payments. Total cost is then calculated using information on total cultivated area for each crop across irrigation seasons. It is worth noting here that irrigated land rent implicitly includes water rent. The next Sub-section illustrates how this production payment is dealt with.

These 309 crop accounts are, then, classified into 22 agricultural crops cultivated during the three seasons as well as perennial crops, see Table A 2. It is worth noting here that agricultural activities are Nile-dependent and are located in the Nile valley and Nile delta. Subsequently, the agriculture activity account in the preliminary SAM ('Agriculture, forestry and fishing') is disaggregated and classified by agricultural crop and irrigation season. The remaining agricultural activities are, then, lumped in an additional activity account; 'Other agricultural products, forestry and fishing'.

Likewise, the agricultural commodity account is disaggregated into 7 commodities, see Table A 3Table. This is based on the classification used by the Egyptian Foreign Trade Statis-

tics (Ministry of Industry and Foreign Trade, 2008–2009). The convention is to allow activities to produce multiple commodities and commodities to be produced by several activities.

4.3 Introducing Factor Accounts for Agriculture

Production factor accounts are also adapted to serve the agricultural and irrigation policy analyses. Three development steps are conducted for the agricultural factor accounts. Firstly, capital account is segmented into capital and irrigated land. Secondly, irrigation water is introduced as a separate production factor. In addition, water and irrigated land are segmented by irrigation season; i.e. winter, summer, Nili as well as year-round. The next are detailed explanations of these development steps.

Detailed data on cultivated land area and water used in irrigation are compiled from (CAPMAS, 2009). This data on land and water requirement covers 36 crops over irrigation seasons: 16 crops in winter, 11 crops in summer, 7 crops in Nili and 2 year-round crops.⁽¹¹⁾

Using this information on physical water and land usage, land/water ratios are calculated for each crop across irrigation seasons. These ratios are, subsequently, used to compute water rent and, as such, to deduct it from land rent. Detailed description of the treatment of water and land production factors is provided in Sub-section 5.1.

It is worth recalling here that detailed agricultural data by crop and season are compiled for Nile-dependent activities only. In other words, the SAM does not represent seasonal accounts for crops cultivated outside the Nile Valley and Nile Delta. Transaction values for non-Nile dependent agricultural activities are lumped together with other agricultural activities in one account – ‘Other agricultural products, forestry and fishing’. This residual account represents all agricultural activities cultivated outside the Nile Valley and Nile Delta using other sources of irrigation water rather than Nile.

4.4 Balancing and Estimating the Final SAM

The proto SAM is balanced and, hence, the final SAM is estimated. The final SAM contains 94 accounts: 54 activities, 16 commodities, 10 factors, 5 institutions, 6 tax instruments as well as trade margin, savings/investment and rest of the world accounts.

5. Constructing the Micro SAM

5.1 Activities and Commodities

Compiling data from different sources require carrying out some data manipulations and adopting several assumptions. Firstly, transaction values abstracted from the Supply/Use Tables differ than those of National Accounts. Transactions booked in the

Use Table are valued in basic prices whereas market prices are used in the Supply Table. Nonetheless, according to the National Accounts, both taxes on production and on products are recorded for the activity column accounts. In order to preserve consistency of the SAM framework, indirect taxes on commodity sales are to be deducted from the activity column accounts and then to be re-booked into the commodity column accounts.

In the SAM, each activity produces several commodities. Presumably, an activity produces differentiated commodities, which are supplied to different markets. This structure conforms to the Law of One Price (LOOP). LOOP infers that in each row of a SAM, there can only be one price and that the prices of each and every row are uniquely determined.⁽¹²⁾ As such, mapping linkages from each activity account to the corresponding commodity accounts are required for computing sales tax paid by each commodity account. Commodity supply values are used to calculate the commodity/activity shares, which are then used for mapping purposes.

Secondly, the Supply/Use Tables do not differentiate between operating surplus and mixed income. Shares of wage, operating surplus and mixed income in total value added are calculated from the National Accounts (MOP, 2011). They respectively constitute 25, 45 and 31 percent of total value added (basic prices). These shares are used to decompose operating surplus into return to capital and mixed income. Mixed income represents the remuneration for work done by owners and their families that cannot be separately identified from the return to owners as entrepreneurs. Mixed income is particularly relevant to agricultural households where paid workers account for a small share of total agricultural labour. The return to capital is, then, decomposed into return to land and return to capital.

Thirdly, no charge is levied on the use of irrigation water in Egypt. In other words, there is no market value for irrigation water. In practice, required water provisions are secured for irrigated land given the cropping pattern and irrigation season. It is, thus, plausible to assume that irrigation water rent is already embodied in land rent. Hence, data on physical water requirements, differentiated by crop and season, are used to calculate water/land ratios. These ratios are then used to deduct computed values for water rent from irrigated land total payments.⁽¹³⁾

Fourthly, in the course of the SAM construction process, 22 irrigated crops are distinguished based on detailed data on irrigated crops. These sub-sectors represent seasonal crop activities. Original agricultural intermediate demand value is spread across the new agricultural activities. For this purpose, commodity shares for the original agricultural intermediate demand are used.

It is worth mentioning here that, during the SAM balancing process, the transaction values for the agriculture activity account in the preliminary SAM (‘Agriculture,

forestry and fishing'), presented in the preliminary SAM, are used to control the values for the disaggregated agricultural crop accounts; this will be explained later in detail.

Table (4): Main Agricultural Crops, 2010/2011

	Cultivated Land		Water Requirements			Production	
	Area (1000 feddan)	Share %	Water Usage (million m3)	Water / Land Ratio	Water Intensity (million m3/1000 ton)	Production (1000 ton)	Yield (ton/ feddan)
Winter Field Crops							
Wheat	3133	20.07	4,556	0.15	0.54	8493	2.71
Cereals	170	1.09	199	0.12	0.72	275	1.62
Sugar Beet	362	2.32	514	0.14	0.07	7486	20.68
Fodders	2040	13.07	9,391	0.46	0.19	50613	24.81
Fibbers	16	0.10	27	0.17	0.68	40	2.50
Medical & Aromatic Plants	48	0.31	61	0.13	0.29	214	4.46
Vegetables	965	6.18	1,144	0.12	0.10	11228	11.64
Summer Field Crops							
Rice	1410	9.03	10,839	0.77	1.91	5667	4.02
Other Crops	2129	13.64	6,461	0.3	0.96	6716	3.15
Sugar Cane	326	2.09	2,766	0.85	0.18	15765	48.36
Cotton	520	3.33	1,038	0.2	1.22	853	1.64
Fodders	702	4.50	1,530	0.22	0.21	7130	10.16
Oily Crops	273	1.75	361	0.13	1.21	298	1.09
Medical & Aromatic Plants	24	0.15	61	0.25	0.29	208	8.67
Vegetables	1539	9.86	1,679	0.11	0.11	14607	9.49
Nili Field Crops							
Rice	3	0.02	1	0.04	0.10	9.7	3.23
Other Crops	360	2.31	1,563	0.43	1.56	999.2	2.78
Fodders	82	0.53	0	0	0.00	653.3	7.97
Oily Crops	3	0.02	1	0.06	0.77	1.3	0.43
Medical & Aromatic Plants	0.7	0.00	82	11.81	410.00	0.2	0.29
Vegetables	226	1.45	578	0.26	0.26	2244	9.93
Year-round Crops							
Fruits	1277	8.18	4,197	0.33	0.41	10144	7.94

Source: The Central Agency for Public Mobilisation and Statistics (CAPMAS, 2009) and Ministry of Agriculture and Land Reclamation - MALR (2012a) and (2012b).

As presented in Table 4, winter and summer are the main agricultural seasons. Winter and summer crops contribute 36 and 31 percent of total agricultural products respectively. Summer crops (i.e. rice, sugar cane and other crops) are high water-intensive. These three activities utilize the bulk of irrigation water available in the summer. In contrary, winter crops are not water-intensive. Medical plants and other crops cultivated in the Nili season are also highly water-intensive.

5.2 Institutional Accounts

Four domestic institutions are represented in the micro SAM: financial and non-financial enterprises, N.P.I.S.H and a representative household. In addition to government, the SAM includes 8 accounts representing different tax and subsidy instruments. Investment expenditures and savings by different institutions are recorded in the savings/investment account. Transactions with the rest of the world are booked in the rest of the world and margins on trade and transportation accounts.

Taxes and Subsidies

Six tax instruments (i.e. sales tax, production tax, production subsidy, direct taxes on personal and on factor incomes and tariffs) are represented separately in the SAM. In the final SAM, direct tax on factor income is the main source of tax revenue, accounting for 50 percent. It is worth noting here that factor income taxes are paid by both financial and non-financial enterprises. Net production taxes form 22 percent of total tax revenues. The rest of tax revenue is originated equally from sales tax, tax on personal income and tariff.

A salient feature of public budget is government production subsidies. More than half of subsidies are directed to manufacturing activities. Other main subsidised sectors are agriculture, trade and transportation sectors. Each absorbs roughly 10 percent of total production subsidies. In 2008/2009, the economy endures fiscal deficit equivalent to 18 percent of total public revenue.

Transfers

Transfers data are extracted from the Egyptian National Accounts (MOP, 2011). For each institution, paid and received transfers are recorded without specifying recipients or benefactors. In order to overcome this limitation, net transfers are disaggregated and re-distributed among institutions in such a way that maintains aggregated net transfers for individual institutions.

According to OECD data, Egypt is the second largest aid recipient in the world. In 2008/2009, the government received 9.56 billion LE as transfers from abroad. These foreign transfers account for 6 percent of total government revenue.

Households receive 24 billion LE as remittances from abroad, which is equivalent to 3 percent of total personal income, whereas they remit 15 billion LE abroad. They also receive social insurance benefits and pensions from the government worth 62 billion LE.

Trade Balance

Table 5 presents trade by commodity in value and percentage terms. The economy is highly dependent on trade. Export and import ratios to GDP are 23 and 26 percent respectively. In addition, it reports trade deficit equivalent to 3 percent of GDP. It is worth noting here that, in general, small economies tend to have large trade openness ratios.

Egypt is the world's largest wheat and wheat flour importer in the world. Almost 18 percent of wheat demand is met by importing. Rice is the main export commodity. Roughly, 13 percent of domestic output value of rice (worth 1.56 billion LE) is directed to export. Among other main exports are cotton, potatoes, vegetables and fruits. Egypt is a net food products importer. It imports sugar, vegetable oils, and dairy and meat products.

Table (5): Trade Balance 2008/2009, Billion LE

	Imports		Exports	
	Value	%	Value	%
Wheat	9.82	3.37	0.02	0.01
Cereals	4.82	1.66	0.06	0.02
Rice	0.05	0.02	1.56	0.60
Vegetables	2.11	0.72	4.12	1.59
Fruits	0.91	0.31	3.44	1.33
Beverages	12.43	4.27	3.31	1.28
Ores, Minerals, Gas	18.63	6.40	53.17	20.54
Food Products	30.53	10.48	20.95	8.09
Other Transportable Goods	68.68	23.58	47.57	18.37
Metal Products, Machinery, Equipment	114.34	39.26	22.93	8.86
Construction	1.45	0.50	3.75	1.45
Trade	4.83	1.66	87.05	33.62
Financial Services	0.50	0.17	1.50	0.58
Business Services	12.93	4.44	7.70	2.98
Social Services	9.21	3.16	1.77	0.68

6. Cross Entropy Methodology

A stochastic version of the cross-entropy (CE) methodology is used to balance the preliminary SAM and estimate the final SAM.⁽¹⁴⁾ The CE is a GAMS-coded programme based on Bayesian estimations for balancing the SAMs; see Golan et al. (1994) and Robinson et al. (2011). The programme commences from a prior unbalanced SAM, which entries might be inconsistent and measured with error. It employs subsequent iterations until reaching a consistent and balanced SAM. In the course of this iteration process, changes occur in row/column entries until equating their totals. At the end of the iteration process, the programme locates the cells in the balanced SAM with large differences, in both absolute and percentage change terms, compared to their prior SAM entries. Assigning cells with less reliable information for such changes is, thus, more plausible.

The programme allows specification of prior estimates of the standard error for: (1) cell entries, expressed either as values or column coefficients, (2) column sums, (3) various macro aggregates, and (4) macro aggregates from a standard macro-SAM aggregated from the micro-SAM, or from a user-defined aggregate SAM. The errors on cell entries can be specified as additive or multiplicative. Fixed constraints are achieved by setting standard errors to zero. The estimation procedure minimizes the cross-entropy measure of the distance between prior coefficients and the new estimated coefficients, given a choice of constraints imposed on the basis of prior knowledge.

As aforementioned, during the second stage of constructing the Egyptian SAM, the agriculture activity/commodity accounts are disaggregated by crop. Detailed agricultural information compiled from various sources is used for this purpose. "It is highly desirable that a SAM should be consistent with the national accounts; and an aggregate SAM is a particular way of representing the national accounts within a matrix framework. This is sometimes referred to as a 'macro SAM', although it has few of the socio-economic details and features of a true meso-level SAM" (Round, 2003, pp. 14–15). For precise match with the original Supply/Use Table, the transaction values for the aggregated activity/commodity accounts that represent agriculture forestry and fishing are used as upper limits for the transaction values in the corresponding disaggregated agricultural activity/commodity accounts. The only exception is agricultural trade transactions which are collected separately as aforementioned.

In the final Egyptian SAM, nine entries are subject to large value deviations in comparison to their prior entries. These entries are domestic supply (of 'Manufacturing'); capital factor income distributed to financial enterprise and to household; financial and non-financial enterprise savings; household consumption (of 'Food products', 'Manufacturing' and of 'Trade services'); and trade margin exports. Besides, three entries show large percentage changes relative to their pre-balancing values. Financial enterprise savings as well as private domestic and foreign consumption (of 'Fruits') have to be reduced by virtually 30 percent each for the programme to balance the SAM. Only financial enterprise savings experience large value and percentage changes.

7. Limitations and Future Work

One of the main limitations with the current SAM is the lack of data on groundwater used for irrigation purposes. Ground water is the second largest water source available for irrigation. It accounts for 8% of the total irrigation water and groundwater-dependent agricultural activities attributes to 11% of total irrigated agricultural production. It is thus particularly important for extending the SAM in such a way that represents detailed seasonal accounts for non-Nile dependent agricultural activities.

Egypt faces shortage of fresh water resources, the problem which is expected to escalate under the current population growth rate. It is against this background that optimizing the use of non-conventional sources of water is a promising research area. Egypt is privileged by long coastlines of both the Red and Mediterranean seas. Introducing new water production technologies and developing exiting ones (i.e. desalination) has great potentials for development. This requires further work on both data collection and model development fronts. Data on available water sources (e.g., sewage water and brackish water) as well as their effectiveness in irrigation are required.

In the Egyptian context, water availability and distribution varies across different regions. Therefore, spatial heterogeneity that distinguishes different irrigation zones according to water supply/demand and agricultural production technology would be of a great interest.

Footnotes

(1) Berseem is an Egyptian clover used for fodder.

(2) The Nile Delta is located in Northern coast of Egypt. It is one of the world's largest river deltas with 160 km of length, 240 km of coastline and 25000 km² of area. The Nile Delta is among the most density populated agricultural areas in the world. Virtually, 40 million Egyptians, half of the total population, live in the Nile Delta. Furthermore, it is known by its fertile land. The Nile Delta solely constitutes more than of two third of the total agricultural areas in Egypt.c

(3) For a detailed description of SAMs, see (Pyatt, 1988). One of the earliest applications of SAMs to developing countries is provided by (Pyatt & Round, 1977).

(4) Examples of these CGE models are (Taylor L. , 1979b), (McCarthy, 1983) and (Pleskovic, 1989).

(5) See CAPMAS (1989), (1991) and (1995).

(6) GTAP is coordinated by the Center for Global Trade Analysis, Department of Agricultural Economics at Purdue University, West Lafayette, USA. See the Center for Global Trade Analysis, <https://www.gtap.agecon.purdue.edu/>

(7) For detailed description, see Light (2006) and (2008).

(8) Raw data are in million LE whereas transaction values embodied in the final SAM are in billion LE. In the course of SAM construction, a scaling factor of 1000 is used.

(9) Raw data for agricultural areas are in feddan. Feddan is a non-metric measurement unit of land area used in Egypt, inter alia. A feddan is equivalent to 1.037 acres or 0.420 hectares.

(10) LE is the abbreviation of the French caption of the Egyptian pounds – livre égyptienne.

(11) These two activities are mainly located in five governorates outside the Nile Valley and Nile Delta: Giza, New Valley, Matruh, North Saini and South Saini.

(12) For detailed description of LOOP, see (McDonald, 2007)

(13) For more detailed description on Supply/Use Tables for water, see United Nations (2012).

(14) For detailed information on Cross Entropy, see Robinson, Cattaneo & El-Said (1998) and Robinson & El-Said (2000).

References

- Ahmed, S., Bhattacharya, A., Grais, W., & Pleskovic, B. (1985). Macroeconomic Effects of Efficiency Pricing in the Public Sector in Egypt. Washington D.C.: The World Bank.
- CAPMAS. (1989). National Accounts: A Social Accounting Matrix for Egypt 1983–84. Cairo: Central Agency for Public Mobilization and Statistics.
- CAPMAS. (1991). National Accounts: A Social Accounting Matrix for Egypt 1986–87. Cairo: Central Agency for Public Mobilization and Statistics.
- CAPMAS. (1995). National Accounts: A Social Accounting Matrix for Egypt 1989–90. Cairo: Central Agency for Public Mobilization and Statistics.
- CAPMAS. (2009). Annual Bulletin of Irrigation and Water Resources Statistics, 2008. Cairo: Central Agency for Public Mobilisation and Statistics.
- CAPMAS. (2010). Aggregated Supply and Use Tables According To Economic Activities 2008/2009. Cairo: Central Agency for Public Mobilization and Statistics.
- CAPMAS. (2013). Aggregated Supply and Use Tables According To Economic Activities 2010/2011. Cairo: Central Agency for Public Mobilization and Statistics.
- CBE. (2011). Annual Report 2010/2011. Cairo: Central Bank of Egypt.
- Eckaus, R. S., McCarthy, F. D., & Mohie-Eldin, A. (1981). A social accounting matrix for Egypt, 1976. *Journal of Development Economics*, 9(2), 183–203.
- Golan, A., Judge, G., & Robinson, S. (1994). Recovering Information from Incomplete or Partial Multisectoral Economic Data. *The Review of Economics and Statistics*, LXX–VI(3), 541–549.
- IFPRI. (2002). Egypt: Social Accounting Matrix, 1997. Washington, D.C.: International Food Policy Research Institute.
- Light, M. K. (2006). Construction of the Egyptian Social Accounts for GTAP Submission.
- Light, M. K. (2008). Egypt. In B. N. Walmsley, *Global Trade, Assistance, and Production: The GTAP 7 Data Base*. West Lafayette: Center for Global Trade Analysis, Purdue University.
- MALR. (2011a). Bulletin of Agricultural Prices, Cost and Net Returns, Part 1 Winter Crops, 2009/2010. Cairo: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector.
- MALR. (2011b). Bulletin of Agricultural Prices, Cost and Net Returns, Part 2 Summer

24 Rehab Osman
Emanuele Ferrari
Scott McDonald

& Nili Crops and Fruits, 2010. Cairo: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector.

MALR. (2012a). Bulletin of Agricultural Statistics, Part 1 Winter Crops, 2010/2011. Cairo: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector.

MALR. (2012b). Bulletin of The Agricultural Statistics, Part 2 Summer & Nili Crops and Fruit, 2011. Cairo: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector.

McCarthy, F. (1983). General Equilibrium Model for Egypt. In A. C. Kelley, W. C. Sanderson, & J. G. Williamson, Modelling Growing Economies in Equilibrium and Disequilibrium (pp. 71–102). Durham, N.C.: Duke University Press.

McDonald, S. (2007). Prices, Social Accounts and Economic Models. Global Economic Analysis Conference “Assessing the Foundations of Global Economic Analysis”. Indiana: Purdue University.

Ministry of Industry and Foreign Trade (2008–2009). Egyptian Foreign Trade Statistics – Egypt Trade By Commodities. Retrieved 5 15, 2013, from <http://www.tpegypt.gov.eg/Arabic/TradeStatistics.aspx>

MOP. (2011). National Accounts 2008/2009. Cairo: Ministry of Planning.

Pleskovic, B. (1989). Interindustry Flows in a General Equilibrium Model of Fiscal Incidence: An Application to Egypt. *Journal of Policy Modeling* (11), 157–177.

Pyatt, G. (1988). A SAM Approach to Modeling. *Journal of Policy Modeling*, 10(3), 327–352.

Pyatt, G., & Round, J. I. (1977). Social Accounting Matrices for Development Planning. *Review of Income and Wealth*, 23 (4), 339–364.

Pyatt, G., & Round, J. I. (1985). Social Accounting Matrices: A Basis for Planning. Washington, D.C.: World Bank.

Qadry, A., Bahloul, M., & Maki, W. R. (2005). SAM for Egypt: Measuring Employment and Income Impacts of Changing Markets for Egypt’s Food Processing Industries.

Robinson, S., & El-Said, M. (2000). GAMS Code for Estimating a Social Accounting Matrix (SAM) Using Cross Entropy (CE) Methods. Trade and Macroeconomics Division (TMD) Discussion Paper (No 64).

Robinson, S., Cattaneo, A., & El-Said, M. (1998). Estimating a Social Accounting Matrix Using Cross Entropy Methods. TMD Discussion Paper (33).

Robinson, S., Cattaneo, A., & Moataz, E.-S. (2011). Updating and Estimating a Social Accounting Matrix Using Cross Entropy Methods. *Economic Systems Research*, 13(1), 47–64.

Round, J. (2003). Social Accounting Matrices and SAM-based Multiplier Analysis. In P. d. F. Bourguignon, *The Impact of Economic Policies on Poverty and Income Distribution: Evaluation Techniques and Tools* (pp. 14–1 14–20). Washington D.C.: World Bank.

Taylor, L. (1979a). A SAM for Egypt. In L. Taylor, *Macro Models for Developing Countries*. New York: McGraw-Hill Book Co.

Taylor, L. (1979b). Macroeconomics of Egyptian Food Subsidies. In L. Taylor, *Macro Models for Developing Countries* (pp. 58–66). New York: McGraw-Hill.

UN. (2012). System of Environmental-Economic Accounting for Water. New York: United Nations.

Appendix

Table A 1: Accounts for the Preliminary SAM

	Activities		Activities		Commodities		Tax Instruments
1	Agriculture, forestry and fishing	17	Arts, entertainment and recreation	1	Agriculture, forestry and fishery products	6	Direct Taxes on Factor (Enterprises) Income
2	Mining and quarrying	18	Other service activities	2	Ores, minerals and gas	7	Tariffs
3	Manufacturing industry	19	Financial service activities except insurance and activities pension funding auxiliary to financial service and insurance activities	3	Food products, beverages and tobacco; textiles, apparel and leather products	8	Export Taxes
4	Electricity, gas, steam and air conditioning supply	20	Insurance, reinsurance and pension funding, except compulsory social security	4	Other transportable goods, except metal products, machinery and equipment		Institutions
5	Water supply; sewerage, waste management and remediation activities	21	General public services	5	Metal products, machinery and equipment	1	Government
6	Construction	22	Defence	6	Construction services	2	Non-Financial Enterprises
7	Wholesale and retail trade; repair of motor vehicles and motorcycles	23	Public order and safety	7	Distributive trade services; lodging; food and beverage serving services; transport services; and utilities distribution services	3	Financial Enterprises
8	Suez Canal	24	Economic affairs	8	Financial and related services; real estate services; and rental and leasing services	4	N.P.I.S.H
9	Transportation and storage	25	Environmental protection	9	Business and production services	5	HH
10	Accommodation and food service activities	26	Housing and community amenities	10	Community, social and personal services	6	S/I
11	Information and communication	27	Health		Tax Instruments	7	Trade Margins
12	Real estate activities	28	Recreation, culture and religion	1	Indirect Taxes on Commodities	8	ROW
13	Professional, scientific and technical activities	29	Education	2	Subsidies on Commodities		Production Factors
14	Administrative and support service activities	30	Social protection	3	Indirect Taxes on Production	1	Labour
15	Education	31	Activity N.P.I.S.H	4	Subsidies on Production	2	Capital
16	Human health and social work activities	32	Subsistence HH	5	Direct (Personal) Income Taxes		

Table A 2: Mapping between National Accounts and SAM Activity Accounts

No	National Account Sector	No	SAM Activity	SAM Code
1	Agriculture, forestry and fishing	1	Winter Cereal Grains	awWht
		2	Winter Legumes	awCrl
		3	Winter Sugar Beet	awSgb
		4	Winter Fodders	awFdr
		5	Winter Fibers	awFbr
		6	Winter Medical & Aromatic Plants	awMap
		7	Winter Vegetables	awVeg
		8	Summer Rice	asRic
		9	Summer Other Crops	asXcp
		10	Summer Sugar Cane	asSgc
		11	Summer Cotton	asCot
		12	Summer Fodders	asFdr
		13	Summer Oily Crops	asOcp
		14	Summer Medical & Aromatic Plants	asMap
		15	Summer Vegetables	asVeg
		16	Nili Rice	anRic
		17	Nili Other Crops	anXcp
		18	Nili Fodders	anFdr
		19	Nili Oily Crops	anOcp
		20	Nili Medical & Aromatic Plants	anMap
		21	Nili Vegetables	anVeg
		22	Fruits	aFrt
		23	Other agricultural products, forestry and fishing	aXag
2	Mining and quarrying	24	Mining and quarrying	aMin
3	Manufacturing industry	25	Manufacturing industry	aMan
4	Electricity, gas, steam and air conditioning supply	26	Electricity, gas, steam and air conditioning supply	aElc
5	Water supply; sewerage, waste management and remediation activities	27	Water supply; sewerage, waste management and remediation activities	aWtr
6	Construction	28	Construction	aCon
7	Wholesale and retail trade; repair of motor vehicles and motorcycles	29	Wholesale and retail trade; repair of motor vehicles and motorcycles	aTrd
8	Suez Canal	30	Suez Canal	aSuz
9	Transportation and storage	31	Transportation and storage	aTrs
10	Accommodation and food service activities	32	Accommodation and food service activities	aAcm
11	Information and communication	33	Information and communication	aInf
12	Real estate activities	34	Real estate activities	aEst
13	Professional, scientific and technical activities	35	Professional, scientific and technical activities	aBus
14	Administrative and support service activities	36	Administrative and support service activities	aAdm
15	Education	37	Education	aEdu

Table A 2 (cont.)

No	National Account Sector	No	SAM Activity	SAM Code
16	Human health and social work activities	38	Human health and social work activities	aHlh
17	Arts, entertainment and recreation	39	Arts, entertainment and recreation	aEnt
18	Other service activities	40	Other service activities	aSer
19	Financial service activities, except insurance and pension funding Activities auxiliary to financial service and insurance activities	41	Financial service activities, except insurance and pension funding Activities auxiliary to financial service and insurance activities	aFin
20	Insurance, reinsurance and pension funding, except compulsory social security	42	Insurance, reinsurance and pension funding, except compulsory social security	aIns
21	General public services	43	General public services	aPub
22	Defence	44	Defence	aDfn
23	Public order and safety	45	Public order and safety	aSft
24	Economic affairs	46	Economic affairs	aEco
25	Environmental protection	47	Environmental protection	aEnv
26	Housing and community amenities	48	Housing and community amenities	aHos
27	Health	49	Health	aHlg
28	Recreation, culture and religion	50	Recreation, culture and religion	aCul
29	Education	51	Education	aEdg
30	Social protection	52	Social protection	aSrg
31	N.P.I.S.H Activity	53	N.P.I.S.H Activity	aNph
32	Subsistence HH	54	Subsistence HH	aShh

Table A 3: Mapping between National Accounts and SAM Commodity Accounts

No	National Account Sector	No	SAM Commodity	SAM Code
1	Agriculture, forestry and fishery products	1	Durum Wheat	cWht
		2	Cereals	cCrl
		3	Rice in the husk (paddy or rough)	cRic
		4	Edible Vegetables and Certain Root and Tubers	cVeg
		5	Edible Fruits and Nuts; Peel of Citrus Fruit or Melon	cFrt
		6	Coffee, Tea and Spices; Oil Seeds; Fodder; other Vegetable Extracts; Animal or Vegetable Fats and Oils	cXvg
		7	Other agriculture, forestry and fishery products	cXag
2	Ores, minerals and gas	8	Ores, minerals and gas	cMin
3	Food products, beverages and tobacco; textiles, apparel and leather products	9	Food products, beverages and tobacco; textiles, apparel and leather products	cFbt
4	Other transportable goods, except metal products, machinery and equipment	10	Other transportable goods, except metal products, machinery and equipment	cMan
5	Metal products, machinery and equipment	11	Metal products, machinery and equipment	cMtl
6	Construction services	12	Construction services	cCon
7	Distributive trade services; lodging; food and beverage serving services; transport services; and utilities distribution services	13	Distributive trade services; lodging; food and beverage serving services; transport services; and utilities distribution services	cTrd
8	Financial and related services; real estate services; and rental and leasing services	14	Financial and related services; real estate services; and rental and leasing services	cFin
9	Business and production services	15	Business and production services	cBus
10	Community, social and personal services	16	Community, social and personal services	cSer