Are input policies effective to enhance food security in Kenya? A CGE Analysis

Pierre Boulanger, Hasan Dudu, Emanuele Ferrari, Alfredo Mainar, Ilaria Proietti

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Pierre Boulanger, Hasan Dudu, Emanuele Ferrari, Alfredo Mainar, Ilaria Proietti

European Commission
Joint Research Centre
Institute for Prospective Technological Studies
Seville, Spain

Corresponding author: pierre.boulanger@ec.europa.eu
European Commission–JRC–IPTS, Edificio Expo. c/ Inca Garcilaso, 3, 41092 Seville, Spain
Tel.: +34 954 480 588

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Abstract

Food security remains a key challenge in many Sub-Saharan African countries and in Kenya in particular. Despite the astonishing improvement achieved in the last decades, still a relevant share of the population lives below the minimum level of dietary energy consumption. Kenya addresses this concern with a noteworthy policy mix, aiming at giving to the agricultural sector a leading task in improving food security. In this paper, through a Computable General Equilibrium (CGE) model specifically modified for the context of developing country analyses, we address the impacts of three input policy options with reference to increases in fertiliser use, seed quality and irrigation investment. For the purpose of the study, a desegregated version of a 2014 Social Accounting Matrix (SAM) has been developed for Kenya. First results of simulated policy changes present overall positive effects on key food security aggregates related to food availability and access. Nevertheless a more careful analysis at regional and household type levels is required in order to draw wide-ranging policy recommendations.

1. Introduction

"*Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO, 1996). Adopted at the World Food Summit, this definition remains the most widely cited, albeit different definitions of food security have been proposed over time.

Even if not exclusively, agriculture is a key sector when dealing with the issue of food security. As is the case for most Sub-Saharan African countries, agriculture is the backbone of Kenya's economy, and the key sector in its development strategy. The agricultural sector contributes 30% of GDP of the country, around 65% of exports and almost 80% of Kenyans are employed, at least part-time, in agriculture (KNBS, 2015a). Given the climatic differences among Kenyan regions, while some of them have yield abundant surpluses, the whole productivity in the country is rather low. This is mainly due to semi-arid and arid land which covers most of the country where rainfall is less and less predictable. Irrigated land represents a marginal part of arable land, i.e. in 2013 irrigated agriculture accounted for only 2.4% of the cultivated area according to FAO (2016). In addition, innovative inputs are still lagging behind, so that most farmers cannot reap the benefit of modern seeds, adequate fertilisers and other technologies. As a result, the country is prone to frequent food shortages.

While agricultural productivity is stagnating and the urban sector is not yet able to provide employment to people moving from rural to urban contexts, Kenya's population is growing. The demographic development is posing a major challenge to food security in the country, as in the whole African continent.

In order to analyse some alternative policy priorities to improve foods security in Kenya, this paper develops a modelling framework using a general equilibrium approach, taking into account the specificities of the Kenyan economy (e.g., high rates of subsistence and small-holder farming, multi-output structure of production, endogenous labour supply decision of households, segmented labour markets, migration etc…). Indeed a Computable General

Equilibrium (CGE) model is calibrated to an original disaggregated 2014 Social Accounting Matrix (SAM) for Kenya. This latter comprises 54 activities producing 70 commodities using 3 types of labour (skilled, unskilled and semi-skilled) in 10 regions (30 labour accounts), 3 types of capital (agricultural, non-agricultural and livestock) and land. It includes an enterprise account and 24 household accounts (rural and urban households in 7 regions and 10 urban households in 2 metropolitan areas which are further disaggregated according to expenditure quintiles). The regional disaggregation follows agro-ecological zones classification and main metropolis, i.e. Nairobi and Mombasa.

The paper is organised as follows. Section two introduces main policy issues related to the development of the agricultural sector in Kenya. Section three presents the methodology, i.e. main novelties of the CGE model and database preparation. Section four describes the policy simulations, section five analyses first results while section six provides some concluding remarks.

2. Input Policy Issues

In June 2008, the government launched the Kenya Vision 2030 as the new long-term development blueprint for the country. Vision 2030 identified agriculture as one of the key sectors to deliver a 10% annual economic growth rate envisaged under the economic pillar. Agricultural sector benefits from a new strategy document, the Agricultural Sector Development Strategy (ASDS), which sets the vision to achieve an average growth rate of 7% per year. This new strategy has also taken into account regional and international initiatives such as the Comprehensive African Agricultural Development Programme (CAADP), which recognizes agriculture's contribution to accelerated economic growth in African countries, and the Millennium Development Goals (MDGs) in which the United Nations member countries pledged to reduce extreme hunger and poverty by 2015. The development of the sector is pursued through strategic objectives which are increasing productivity, commercialization and competitiveness of agricultural commodities and firms, developing and managing key factors of production.

ASDS individuated several key constraints and challenges for the Kenyan agriculture, the lack of public resource devoted to the sector by the government being critical. In 2003 under the Maputo Declaration, African Heads of State committed to allocate 10% of annual budgets to the agricultural sector. Kenya has not yet achieved this target. Indeed, this sector was receiving 4.5% of the budget in 2008. This insufficient allocation has reduced human resources and delivered services by public institutions (Government of Kenya, 2010a). The list of additional constraints remains substantial. Among them, the most important are reduced effectiveness of extension services, low absorption of modern technology and high cost of inputs, limited capital and access to affordable credit, losses due to pests and diseases, low and declining soil fertility. Last but not least, the agriculture is suffering from a chronic inadequacy of infrastructure (e.g., marketing, storage, water storage, roads, etc.).

Nevertheless, opportunities that can be exploited to build a robust and dynamic agricultural sector can be individuated. ASDS lists a series of them, mainly abundant human resources and potential for increasing production, irrigation, yields and value added.

The strategy clearly identifies some of the key issue for the Kenyan agriculture. Very similar conclusions are reached by other policy documents stipulated by the Kenyan government. The National Food and Nutrition Security Policy (FNSP) (Government of Kenya, 2011) outlines the range of priority areas and principles for government interventions to ensure *all* citizens' right and access to food, to achieve adequate nutrition for optimum health of Kenyans; to increase the quantity and quality of food available, accessible and affordable to all Kenyans at all times; and to protect vulnerable populations using innovative and cost-effective safety nets linked to long-term development. Very similar to the ASDS conclusions, the FNSP recognises as key issues the increased funding to the food and agriculture sectors to 10% of the national budget, the promotion of food storage, support of investment in infrastructure to enable food to move quickly and at a reasonable cost, the facilitation of the competitiveness of Kenya's agriculture sector (regional trade and standard harmonisation), the support of water harvesting through water storage facilities, increased funding for expansion of irrigated agriculture and drought management, particularly in arid and semi-arid lands which comprise some 80% of the country and has the highest rate of food insecurity. Indeed the United Nations categorises Kenya as chronically water-scarce country. Almost 40% of Kenya population lack access to safe water, and more than 70% do not have adequate sanitation (World Bank, 2014). The cost of investments required to increase the rate of access to clean water and sanitary services in the region to the level foreseen by the MDGs is estimated to be around 180 million euros (Rift Valley Water Services Board, 2007). On the other hand, less than 20 thousand of 5.6 million hectares of arable lands were irrigated in 2012 in Kenya (KNBS, 2014) while the potential for irrigation adds up 690 thousand hectares (National Irrigation Board, 2014). Increasing irrigation capacity in the country is a priority of policy makers, with Kenya undertaking 120 development projects to increase the irrigation area by 540 thousand hectares. Interestingly, Kenya plans to spend more than 1.7 billion euros on irrigation projects (Water Resources Management Authority, 2013). The requirement for significant investments raises the question of prioritization, which requires economic analyses of different investment plans that are likely to have impacts beyond the agricultural sector.

A key element of the Kenyan Agricultural policy is to expand the use of fertilizers and hybrid seeds, especially among smallholder farmers (Morris, et al., 2007; Schroeder, et al., 2013). The liberalization of fertilizer markets in 1990s has been successful in achieving this aim up to a certain point (Freeman and Omiti, 2003). Fertilizer use increased by more than 50% between 2000 and 2010 (Ariga and Jayne, 2011) while fertilizer use per hectares of arable land continued to increase with an impressive rate of 73% between 2010 and 2013 (World Bank, 2014), supported by the National Accelerated Agricultural Inputs Access Program (NAAIAP) (Ariga and Jayne, 2011). The prices of fertilizer have fallen drastically; by almost 50% between 1990 and 2007. Even after the price increase in 2008, due to the upsurge in world prices, they remained lower than pre-1995 levels (Ariga and Jayne, 2011).

The increase in fertilizer use has mostly been sustained by the imports (Ariga and Jayne, 2011), which renders the Kenyan fertilizer markets more vulnerable to fluctuations in international markets. Increasing domestic production of the fertilizer appears as an option to improve food security in the country. In this respect, Kenyan government has launched a public-private partnership project of roughly 1.1 billion euros fertilizer plant to be constructed in Eldoret in the framework of a fertilizer cost reduction strategy aiming at *"stabilizing fertilizer prices and making fertilizer more accessible through local manufacturing, blending and bulk procurement*" (Andae, 2015). Furthermore, another factory which would cost about 0.9 million euros is also being constructed in Nakuru by the private sector. These two factories have a combined capacity of 350.000 tonnes of production which would cover about 70% of the current fertilizer use in Kenya.

Increasing the quality of the seeds used by small-holder farmers is also a policy priority for Kenya (Government of Kenya, 2010b). Quality seeds are known to increase household income by increasing yields and reducing related risks. Using quality seeds with adequate fertilizers are expected to significantly increase yields. However, as for fertilizer, access to quality seed is a major problem for smallholder farmers. The slow introduction of new varieties, high prices for hybrid seeds, poor marketing infrastructure, low research and development activities are among the major factors that inhibit the use of quality seeds, with farmers mostly using home grown seeds. Although 62.6% of maize and 75% of wheat farmers use improved seeds, the most popular varieties are as old as 25 years and hence are likely lost their superior qualities.

In addition to above mentioned key input challenges, other critical issues rely on the development of infrastructure, and the access to regional and international markets. Indeed, poor rural roads and other physical infrastructure have led to high transport costs for agricultural inputs and products, clearly jeopardising the ability of farmers to be competitive. Rural infrastructures are not only in poor condition and inadequate for the development of the rural economy, but also unevenly distributed over the country, leaving some potentially important agricultural regions with little or no coverage. Adequate investments in railway, road, water supply, transport and storage infrastructures in rural areas are recognised to be critical for stimulating increased agricultural, livestock and fish production, marketing, value added addition and trade. Finally, a well-functioning agricultural extension service operated by both public and private sectors is critical to increase agricultural productivity, improve incomes and reduce food insecurity.

Based on the policy issues developed above, the scenarios simulated in this paper contemplate increased use of fertilizers, certified seeds and irrigation. Before explaining in the shocks introduced in each scenario in detail, next section clarifies the modelling strategy.

3. Modelling strategy

The model used in this study is a comparative static variant of the STatic Applied General Equilibrium model (STAGE) (McDonald, 2007) specifically extended for the context of the developing countries (STAGE-DEV).[1] The model is thus calibrated to 2014 Kenya SAM that is built for the purpose of this study.

[1] STAGE model is an open source model and codes can be downloaded from www.cgemod.org.uk or available by request from the developer. STAGE_DEV, the variant of STAGE applied for this study, is fully documented in Ferrari and McDonald (2016).

3.1 STAGE-DEV: A STatic Applied General Equilibrium model for Developing Countries

To properly model agriculture and food security issues in Sub-Saharan African (SSA) countries, a model should be able to depict the dual roles of semi-subsistent agricultural households, which play the non-separable double role of producers and consumers. Other SSA peculiarities a model should rigorously tackle relate with structural rigidities in economies, especially labour market and factor segmentation; high level of unemployment/under employment, particularly in rural areas; high use of time for non–productive activities (i.e., fetching water); substantial population and labour force migration, etc.

The introduction of a Home Production for Home Consumption (HPHC) module within STAGE is a crucial added value of the STAGE-DEV. Indeed HPHC is explicitly modelled to account for the non-separability of the dual roles of producers and consumers.[2] The consumption is modelled with Constant Elasticity of Substitution-Linear Expenditure System (CES-LES) nested structure that allows substitution between "broad" commodity groups (i.e. in the top nest) which are subject to subsistence consumption constraints, while at the lower level households can substitute between the component commodities (e.g., HPHC and consumption from market) of the "broad" commodity groups.

In addition, we model small-holder agricultural production by exploiting the multiple-output structure of STAGE. The original STAGE model allows for a simple modelling of multiple product activities through an assumption of fixed proportions of commodity outputs by activities. This represents a by-product assumption, with commodities differentiated or undifferentiated by the activities that produce them, using CES aggregation to define composite variants of differentiated commodities produced domestically (the same as in Lofgren et al., 2002). STAGE_DEV, based on Ferrari and McDonald (2014), adds the option that activities can vary their output mixes in response to changes in commodity prices, by introducing CET functions that modify the shares of commodity outputs in response to price changes. The formulation adopted, following Punt (2013), allows the user to define activities for which commodities are differentiated or not and activities that produce fixed or variable output mixes.

Furthermore, an endogenous labour supply decision of households is introduced as "quasi-activities of leisure" that produce "quasi-commodities of leisure" for each household type (not activated in the present simulations). These activities use only labour from the paired households and the leisure quasi-commodity is consumed only by the same households. A satellite account keeps track of factor ownership, such that labour available to households for activities within the production boundary, i.e., labour sold on the labour market, plus labour used to produce leisure. Following the standard logic behind the CGE models, the price of leisure commodity is defined by its costs (which is the cost of labour used to produce it) and hence labour commodity can be assigned an unambiguous price and hence valuation. Thereafter leisure is treated as a standard commodity in the model. Lastly, the labour market closures are extended to include labour used by the leisure quasi-activity.

[2] The nested production structure is presented in Figure A.1 (in Appendix).

The model also introduces household migration and factor segmentation. Both use the same method, a generalisation of the method by McDonald and Thierfelder (2009), used in Polaski et al., (2009), further refined by Flaig (2014) and Aragie (2015). Migration and segmentation account for persistent urban-rural and regional wage differentials, farm and off-farm wage disparity and continuous urban-rural and internal migration. In both cases, physical units of labour are allowed to transit across regions and/or skill types according to constant elasticity labour supply functions. The factor ownership matrix is updated after the simulation to accommodate migration and segmentation effects.

3.2 A disaggregated SAM for Kenya in 2014

The CGE model developed in this study needs to be calibrated to a specific SAM that requires an *ad hoc* structured database. In this sense, we estimated a virtually new SAM for Kenya (base year 2014) with an unusual structure, incorporating specific accounts for the treatment of HPHC (Aragie (2015), McDonald (2010)) and a high level of regionalization based on agro-economic zoning and social characteristics. Accordingly, it would be feasible to address specific issues such as semi-subsistence economic systems, agricultural production, mobility of factors, and other elements with a regional dimension.

In order to develop an original SAM, we used data from different sources and applied updates in specific structural relationships. This generated new original values, consistent with latest available national statistics, in particular those related to the value added and its functional distribution among the SAM’s different accounts. Therefore the 2014 Kenya SAM is a novel contribution as it is estimated from the new rebased National Accounts (including a short version of Supply and Use Tables) for Kenya (KNBS, 2015a, 2015b) as well as the micro-data from Kenya Integrated Household Budget Survey (KIHBS) 2005/06 (KNBS, 2007). We have also used other relevant databases related to agriculture (Government of Kenya, 2015), and labour markets (KNBS (2015a, 2015b), to update and use auxiliarily the production structure of previous SAMs elaborated by the International Food Policy Research Institute (IFPRI), i.e. (Kiringai et al. (2007), Thurlow et al. (2007), Thurlow and Benin (2008)).

The SAM is based on the standard structure that considers activities and commodities separately. However, there are peculiarities that make Kenya SAM 2014 deviate from the other classical structural assumptions. The structure of the SAM is summarised in Table A.1 (in Appendix).

HPHC concept is introduced in the SAM by assuming that each household also has a "productive activity". Besides the classic Representative Household Groups (RHG) that collect household behaviour as consumers of goods and services and as providers of factors of production (and receptor-contributors of transfers), in the Kenya 2014 SAM new accounts are presented showing the behaviour of households as units of production of commodities. These accounts incorporate the economic behaviour of households as producers of food commodities (agricultural and livestock products for food) as well as cash crops. This requires also separate accounts for commodities produced by these households for own consumption (HPHC as input or as a final product) and other marketed commodities (produced both by households and by conventional productive activities). Rows of these commodity accounts reflect HPHCs use as intermediate inputs in the productive activities of households and their consumption in final demand of households (RHG). Their row sums must be equal to the sums of the columns that summarize the contributions of the activities of households to each of these goods. Similarly, columns of the households activities show how they use inputs (HPHC and marketed), while rows show the destination of their production as inputs, own-consumption goods or marketed commodities. It is necessary to point out that households considered as producers have been broken down regionally (according to the criteria that we will mention later), while commodities produced are taken at national level in unique accounts. The breakdown of commodities and activities is summarised in Table A.2. (in Appendix).

The regional breakdown in the 2014 Kenya SAM is based on agro-ecological characteristics. Thus, the country has been divided into seven agro-ecological zones, in addition to the two major metropolises, i.e., Nairobi and Mombasa. Based on previous studies (Mabiso et al. (2012), Thurlow and Benin (2008), Kiringai et al. (2006)) and own assumptions, these agro-ecological zones have been formed to distinguish the characteristics of the primary sector production in different regions of the country, enabling specific analysis of the effects of different policies focusing on territories, products or specific activities. The nine regions considered are (i) Nairobi, (ii) Mombasa, (iii) High Rainfall, (iv) Semi-Arid North, (v) Semi-Arid South, (vi) Coast, (vii) Arid North, (viii) Arid South, and (ix) Turkana.[3] This regional breakdown has been applied to both households, as productive units or activities, and households, as institutional units.

In terms of agricultural production, the SAM accounts for three types of production agents. There are 9 household agricultural activities (one per each AEZ region) that produce 18 "subsistence commodities" not marketed and consumed at home and 17 marketed crops. Three regional households produce only one or more of the 6 exported crops (cotton, sugar, coffee, tea, tobacco and other crops manly flowers). Then, the business enterprise sectors which at national level produces food and cash crops. These activities represent the market oriented larger holder producers.

In order to form the RHG, households as institutions have been further disaggregated into rural and urban, according to the area of residence, moreover the two metropolises, Nairobi and Mombasa, have been broken down by income quintiles. As a result, the 2014 Kenya SAM contains 24 RHG, a number allowing for a good analysis of redistributive aspects and specific impact of different policies.

According to the classification of work, there are three types of labour in the SAM: skilled, semi-skilled and unskilled labour. Each labour factor is also regionalized, giving the nine regions of reference plus a rest of the world account. Hence, the SAM takes into account 30 different types of labour.

[3] The administrative county of Turkana is treated separately to be consistent with the regional scope of the study. Nevertheless data for Turkana are scarce (170 observations out of 13,212 for the whole country), jeopardising robustness of both results and analyse for this area.

In summary, the 2014 Kenya SAM consists of 192 accounts: 54 activities (12 of them accounts of households as producers) producing 52 marketed and 18 HPHC commodities using 3 types of labour (skilled, unskilled and semi-skilled) in 10 regions (30 labour accounts in total), 3 types of capital (agricultural, non-agricultural and livestock) and land. Regarding taxes and subsidies, 5 types of taxes has been disaggregated: direct, indirect, sales, factors and imports taxes. Also, 24 regionalized RHG has been obtained. Finally respective accounts for margins, saving-investment, enterprises, government and rest of the world are also included.

4. Scenarios

In order to analyse the effects of changes in input policies on agricultural sectors and the Kenyan economy in the framework of food and nutrition security, we simulate three scenarios, i.e., increased use of fertilizers, certified seeds and irrigation.

In the fertilizer scenario, the overall efficiency of agricultural production is increased by 5%, which is the average expected increase in the overall efficiency of agricultural production under adequate fertilizer use consistent with the increase in yields reported in Ariga and Jayne (2011). The overall efficiency of fertilizer production is also increased by 30% which is the expected increase in the domestic production after the completion of two new fertilizer factories (Andae, 2015). To simulate the effect of new factories on the overall economy and to account for the costs of these projects, the capital use in fertilizer sector is assumed to increase by 30% which corresponds to the share of investments for these factories in the overall capital stock of the sector. Lastly, overall investment is increased by the amortization, which we assume to be 5% of the total cost of factories that amounts to 125 billion KSh.

In the seed scenario, the productivity of commercial seeds in the agricultural sector is increased by 10% as suggested by the yield difference between hybrid and non-hybrid seeds by Ariga and Jayne (2011). Furthermore, a hypothetical 5% subsidy paid directly by the government account is introduced on certified (or commercial) seed use. Lastly, an investment of 100 billion Ksh is assumed. This would be required in order to introduce and foster the use of new seed varieties. Therefore, the investment account is increased by the amortization of this investment, i.e. by 5 billion KSh.

In the irrigation scenario, irrigation investments are simulated through a larger usage of irrigation water in the agricultural activities. First, the agricultural productivity is boosted by 5% which corresponds to the average increase in crop yield weighted by the irrigated area, as suggested by You et al. (2014). Afterwards, the production of water available for irrigation is increased by 20%. To simulate the effects of investments and to account for their costs, the capital stock in water production sector is augmented by 30%, and the total investment is increased by the amount of amortization of the cost of investments which is assumed to be 92 billion KSh, following You et al. (2014).

5. Results

The complexity of the CGE model and Kenyan economic specificities render unwieldy a thorough discussion of the whole model results. Thus, we focus on changes in some key aggregates related to food availability and access. The result section, unless otherwise stated, presents percentage changes from the three scenarios in comparison with a status quo situation (i.e. base run). Lately, we provide some information on changes in caloric, protein and fat consumption by regionalized RHG.

All three scenarios increase the agro-food production significantly, especially cash crops under both fertilizer and irrigation scenarios (Table 1). On the one hand, sugarcane, coffee and tobacco turn out to be the most benefiting sectors from the expansion of fertilizer production and irrigation, as these activities use relatively more fertilizer and water. On the other hand, production of beef, dairy and fish, which use crops as intermediate inputs, benefits from the seed scenario most.

The effects of the shocks are not same for the self-consumed production and the market oriented production. Actually, the relative small increase in total production under the seed scenario is mostly due to the significant decline in HPHC oriented production. Small farmers shift their production (and hence consumption) to market oriented production when enhanced seeds are available, thus causing a decline in HPHC production. That is introduction of better seeds allows small farmers to be competitive and produce for the market. In contrast, when further fertilizer or irrigation schemes become available, both HPHC and market oriented production upsurge. This is directly related to higher use of home grown seeds rather than commercial one in HPHC oriented production. Hence when commercial seeds become more fecund, market oriented production – which has a relative advantage over HPHC oriented production due to higher rates of commercial seed utilization – expands at the cost of HPHC oriented production.

Table 1. Production by commodity, orientation and scenario (base in billion Ksh)

	Total Production				HPHC				Marketed			
	Base	Fertilizer	Seed	Irrigation	Base	Fertilizer	Seed	Irrigation	Base	Fertilizer	Seed	Irrigation
		percentage change				*percentage change*				*percentage change*		
Maize	256	4.5	1.5	3.6	50	6.5	-4.5	5.3	206	4.1	3.0	3.2
Wheat	36	7.9	1.2	6.7	6	13.1	-11.2	11.0	30	6.8	3.9	5.8
Rice	7	7.9	0.3	6.3	1	12.1	-14.9	9.4	6	6.9	3.6	5.6
Other cereals	45	6.3	0.2	5.1	8	10.3	-9.8	8.5	37	5.3	2.5	4.3
Roots & tubers	162	7.9	2.8	6.3	47	9.5	1.1	8.5	115	7.3	3.5	5.4
Pulses & oil seeds	159	7.1	3.1	5.8	39	8.1	1.7	7.1	120	6.8	3.5	5.4
Fruits	202	6.8	2.9	4.6	41	9.4	-1.0	8.2	161	6.1	3.9	3.7
Vegetables	138	8.0	2.9	6.2	28	9.5	-2.1	8.1	111	7.7	4.1	5.7
Cotton	2	14.2	1.4	18.7					2	14.2	1.4	18.7
Sugarcane	34	37.2	1.3	41.6					34	37.2	1.3	41.6
Coffee	20	45.6	1.5	48.8					20	45.6	1.5	48.8
Tea	250	23.5	1.7	29.2					250	23.5	1.7	29.2
Tobacco	7	46.3	1.1	50.1					7	46.3	1.1	50.1
Others crops	15	6.4	0.0	6.0					15	6.4	0.0	6.0
Beef	168	6.9	3.7	5.0	30	13.9	9.6	11.3	138	5.4	2.4	3.6
Dairy	126	6.7	4.5	4.9	23	10.4	10.2	8.4	103	5.9	3.2	4.1
Poultry	25	4.8	2.5	2.4	5	8.4	4.6	7.1	20	3.9	1.9	1.2
Sheep, goat and lamb for slaughter	46	7.2	3.8	5.1	8	12.7	11.1	9.7	38	6.0	2.2	4.0
Other livestock	24	8.2	3.6	6.3	4	21.1	6.9	16.7	20	5.3	2.9	4.0
Fishing	29	5.3	5.9	2.7	5	13.9	10.6	10.6	23	3.5	4.9	0.9
Meat & dairy	208	2.3	0.6	0.8					208	2.3	0.6	0.8
Grain milling	175	4.0	1.4	2.8					175	4.0	1.4	2.8
Sugar & bakery & confectionary	50	7.3	3.8	5.2	1	10.1	11.8	7.8	48	7.2	3.6	5.2
Beverages & tobacco	168	6.8	3.4	4.7	4	9.8	10.3	7.6	164	6.7	3.2	4.6
Other manufactured food	13	7.8	8.4	5.9	0	8.1	8.6	5.8	13	7.8	8.4	5.9
Total	2363	8.8	2.5	8.1	300	9.8	1.3	8.2	2063	8.6	2.6	8.1

Source: Model Results

As expected, increasing agricultural production results in the decline of the consumer price index (CPI) of agro-food commodities in all three scenarios, with in larger magnitude under the irrigation one, with agricultural prices declining more. The CPI of food decreases in all scenarios, indicating relatively better access to food (Table 2). Further, the CPI decline is slightly more prominent for rural households and regions that are dominated by rural households such as semi-arid North. That means access to better agricultural inputs and irrigation increases the access to food of the households in relatively poorer regions.

Table 2. Consumer Price Index, by household type, region and scenario

	Base	Fertilizer	Seed	Irrigation
			percentage change	
Food	1.10	-0.85	-0.63	-1.04
by household type				
Urban	1.12	-0.74	-0.60	-0.95
Rural	1.09	-0.89	-0.65	-1.05
by region				
Nairobi	1.13	-0.69	-0.57	-0.91
Mobosa	1.12	-0.71	-0.58	-0.91
High Rainfall	1.10	-0.84	-0.63	-1.00
Semi-Arid North	1.09	-1.04	-0.77	-1.24
Semi-Arid South	1.10	-0.92	-0.62	-1.08
Coastal	1.10	-0.86	-0.62	-1.03
Arid North	1.14	-0.95	-0.71	-1.15
Arid South	1.12	-0.99	-0.69	-1.19
Turkana	1.11	-1.14	-0.75	-1.36

Source: Model Results

The share of imports in domestic supply sheds some light on the country’s ability to feed its population with its domestic production. A reduction of this ratio indicates an improvement in self-sufficiency. As presented in Table 3, there is an improvement for almost all commodities. Of special interest, a larger proportion of cereals, fruits and vegetables, beef and poultry are now produced domestically. In particular, the most relevant staple food, maize which was already largely produced domestically (91%), faces a further improvement of the ratio of between 2.4 and 3.2%. Small declines for meat and dairy are observed for fertilizer and irrigation scenarios where expansion in market oriented production is not enough to supply enough intermediate inputs for these sectors in the form of feedstock to allow them to expand their production to maintain the increasing domestic demand. Nevertheless, the initial imports of these commodities are close to zero so changes are almost irrelevant.

Table 3. Share of imports in domestic supply of food by commodity and scenario

	Base	Fertilizer	Seed	Irrigation
		percentage change		
Maize	8.4	-2.4	-3.2	-2.4
Wheat	55.8	-1.2	-1.4	-1.2
Rice	80.8	-0.5	-0.6	-0.5
Other cereals	6.6	-1.8	-3.5	-1.8
Roots & tubers	0.1	-1.2	-3.1	-1.6
Pulses & oil seeds	44.6	-0.7	-1.8	-0.8
Fruits	1.7	-1.4	-3.1	-1.9
Vegetables	0.6	-2.6	-3.6	-3.0
Sugarcane	47.2	-2.5	-0.1	-2.7
Others crops	23.8	-1.1	1.0	-1.5
Beef	0.0	-0.5	-3.1	-0.9
Dairy	0.2	-0.9	-3.0	-1.3
Poultry	4.1	-1.0	-2.8	-1.7
Sheep, goat and lamb for slaughter	0.0	-1.4	-3.1	-1.8
Other livestock	0.3	-0.5	-3.1	-0.9
Meat & dairy	0.2	1.2	-1.2	1.5
Grain milling	3.1	-0.3	-1.6	0.1
Sugar & bakery & confectionary	11.1	-1.9	-2.7	-1.9
Beverages & tobacco	1.8	-1.6	-2.7	-1.7
Other manufactured food	80.8	-0.7	-0.9	-0.7

Source: Model Results

The share of HPHC in total food consumption is presented by commodity in Table 4a and by household type in Table 4b. The base-year level clearly underlines that HPHC is a rural phenomenon while urban households mostly rely on food available on the market (e.g., in Arid North, the share of HPHC in total food consumption is 7.98% for rural households and 1.54% for urban households). Interestingly, these shares increase for all scenarios and commodities, except the share for beef, sheep, goat and lamb for slaughter, other livestock and fishing. Again, this can be explained by the insufficient increase in market oriented production. Changes in cereals are higher for the seed scenario, while there are larger share in other field crop, vegetables, fruits, dairy and poultry under the irrigation scenario. When looking at these shares by type of households, the direction of results is globally similar across scenarios. Changes reflect mainly agricultural specificities (specialisation, cost structures, productivity, soil quality, etc.) of each RHG.

Table 4a. Share of HPHC in total food consumption, by commodity and scenario

	Base	Fertilizer	Seed	Irrigation
		percentage change		
Maize	16.45	0.30	0.43	0.41
Wheat	2.04	0.62	1.01	0.83
Rice	0.09	0.62	1.54	0.80
Other cereals	6.75	0.17	0.44	0.66
Roots & tubers	25.80	1.51	0.70	2.28
Pulses & oil seeds	15.56	1.51	0.77	1.91
Fruits	16.84	2.39	1.04	3.83
Vegetables	18.15	1.59	0.82	2.48
Beef	0.39	-0.25	-1.11	-1.84
Dairy	4.23	1.27	0.05	2.19
Poultry	23.34	2.56	0.60	4.21
Sheep, goat and lamb for slaughter	0.46	-0.70	-0.38	-0.88
Other livestock	2.29	0.32	-0.59	0.86
Fishing	0.88	1.84	-0.43	2.72
Sugar & bakery & confectionary	0.21	0.94	0.39	0.95
Beverages & tobacco	0.71	1.33	0.42	1.87
Other manufactured food	0.98	1.17	0.32	2.29

Source: Model Results

Table 4b. Share of HPHC in total food consumption, by household type (except Nairobi and Mombasa) and scenario

	Base	Fertilizer	Seed	Irrigation
		percentage change		
High Rainfall - Rural	13.32	0.49	0.09	0.49
High Rainfall - Urban	2.97	-0.18	-0.39	-0.01
Semi-Arid North - Rural	17.44	1.11	0.58	1.26
Semi-Arid North - Urban	1.71	-1.04	-0.83	-0.52
Semi-Arid South - Rural	8.69	-0.64	-0.67	-0.67
Semi-Arid South - Urban	1.78	-0.29	0.11	-1.14
Coast - Rural	6.87	-1.20	-0.99	-0.99
Coast - Urban	1.73	-2.05	-1.39	-0.56
Arid North - Rural	7.98	-0.36	-0.67	-0.39
Arid North - Urban	1.54	-0.72	-0.51	-0.70
Arid South - Rural	8.40	-0.48	-0.17	-0.56
Arid South - Urban	1.82	-0.19	-0.28	-0.20
Turkana - Rural	3.31	-0.83	-0.14	-0.79
Turkana - Urban	0.04	0.12	0.18	-0.20

Source: Model Results

Lower income households spend a larger share of their income on food. The share of food consumption expenditures in total consumption tends to face higher decreases for richest households in Nairobi and Mombasa (Table 5). When there is a decrease in the share of food consumption in the total consumption, the magnitude is the highest for the irrigation scenario. It seems that rises of the share of food consumption are mostly due to the shifting of production from HPHC commodities to marketed commodities and cash crops. Indeed, the marketed commodities are substituted with the HPHC relatively more as under all scenarios the production shifts significantly to the cash crops and marketed agro-food commodities. As a result, households in affected regions are able to consume more marketed food commodities; causing an increase in households' food bill.

Table 5. Share of food consumption in total consumption, by household type and scenario

	Base	Fertilizer	Seed	Irrigation
		percentage change		
Nairobi - Q1 (richest)	21.47	-0.13	-0.32	-1.97
Nairobi - Q2	39.68	-0.19	-0.32	-0.77
Nairobi - Q3	40.34	-0.16	-0.27	-0.63
Nairobi - Q4	37.95	0.10	-0.15	-0.37
Nairobi - Q5 (poorest)	49.70	-0.07	-0.17	-0.41
Mombasa - Q1 (richest)	41.07	0.04	-0.12	-0.70
Mombasa - Q2	38.89	0.12	-0.05	-0.63
Mombasa - Q3	49.76	0.13	0.00	0.01
Mombasa - Q4	48.12	0.30	0.10	0.00
Mombasa - Q5 (poorest)	50.23	0.33	0.21	0.27
High Rainfall - Rural	46.60	1.14	0.54	1.10
High Rainfall - Urban	32.32	2.45	1.62	2.29
Semi-Arid North - Rural	52.02	3.67	2.49	4.16
Semi-Arid North - Urban	40.92	-0.05	-0.26	-0.96
Semi-Arid South - Rural	49.98	0.00	-0.34	-0.21
Semi-Arid South - Urban	44.12	0.02	-0.25	-0.90
Coast - Rural	56.96	-0.14	-0.19	-0.27
Coast - Urban	54.21	0.03	-0.15	-0.59
Arid North - Rural	59.70	-0.57	-0.16	-0.63
Arid North - Urban	54.83	1.49	-0.08	1.17
Arid South - Rural	65.60	0.09	-0.03	-0.07
Arid South - Urban	65.02	0.06	0.02	-0.05
Turkana - Rural	80.90	0.11	0.04	0.12
Turkana - Urban	47.55	0.94	0.59	0.82

Source: Model Results

Table 6. Calorie, protein and fat intake per capita by household type and scenario

	Calories			**Protein**			**Fat**		
	Fertilizer	Seed	Irrigation	Fertilizer	Seed	Irrigation	Fertilizer	Seed	Irrigation
	percentage change			*percentage change*			*percentage change*		
Nairobi - Q1 (richest)	2.55	0.99	-2.82	2.47	0.97	-2.92	2.54	0.98	-2.95
Nairobi - Q2	2.18	0.94	0.31	2.10	0.93	0.23	2.19	0.94	0.26
Nairobi - Q3	2.13	0.95	0.63	2.06	0.95	0.55	2.17	0.97	0.60
Nairobi - Q4	2.76	1.01	1.22	2.67	0.99	1.10	2.84	1.02	1.20
Nairobi - Q5 (poorest)	1.96	1.04	0.69	1.89	1.04	0.60	1.97	1.06	0.64
Mombasa - Q1 (richest)	2.34	1.09	-0.55	2.16	1.05	-0.68	2.24	1.04	-0.66
Mombasa - Q2	2.44	1.13	-0.32	2.29	1.11	-0.47	2.40	1.10	-0.44
Mombasa - Q3	2.15	1.12	1.80	2.01	1.11	1.64	2.15	1.10	1.77
Mombasa - Q4	2.53	1.19	1.18	2.44	1.21	1.02	2.64	1.22	1.13
Mombasa - Q5 (poorest)	2.15	1.20	1.97	2.02	1.24	1.82	2.26	1.27	2.07
High Rainfall - Rural	5.15	1.49	4.37	5.09	1.50	4.30	5.81	1.63	4.96
High Rainfall - Urban	5.12	2.35	2.69	4.74	2.32	2.25	5.13	2.35	2.54
Semi-Arid North - Rural	8.01	3.07	7.83	7.46	2.87	7.31	9.19	3.41	9.08
Semi-Arid North - Urban	3.42	0.97	-0.18	3.33	0.95	-0.26	3.43	0.96	-0.29
Semi-Arid South - Rural	4.64	0.86	3.83	4.79	0.88	3.95	5.68	1.02	4.69
Semi-Arid South - Urban	3.36	0.96	-0.47	3.36	0.97	-0.54	3.52	0.99	-0.57
Coast - Rural	2.10	0.92	1.18	2.18	1.00	1.19	2.67	1.14	1.51
Coast - Urban	2.57	1.09	-0.56	2.52	1.11	-0.68	2.63	1.10	-0.68
Arid North - Rural	4.54	0.97	4.13	4.36	1.07	3.95	4.21	1.15	3.81
Arid North - Urban	8.29	1.11	6.82	8.95	1.21	7.38	9.24	1.20	7.63
Arid South - Rural	2.53	1.08	1.39	2.69	1.19	1.50	2.83	1.22	1.58
Arid South - Urban	1.94	1.24	1.28	1.92	1.32	1.23	1.93	1.26	1.24
Turkana - Rural	2.91	1.35	3.18	3.20	1.52	3.52	3.39	1.51	3.72
Turkana - Urban	2.54	1.23	1.46	2.58	1.41	1.48	2.67	1.22	1.54

Source: Model Results

Based on linear conversion with data from KNBS (2015a), percentage changes in per capita calorie, protein and fat intake is positive for each of the RHG in both fertiliser and seed scenarios (Table 6). By contrast, with the irrigation scenario changes are slightly negative for urban households in Semi-Arid North, Semi-Arid South, and Coast areas. In Nairobi and Mombasa, richest households also face deterioration in calorie, protein and fat intake. The negative changes in richest households nutrition is directly related to a relative decline in food consumption. Under the irrigation scenario, the costs of the investments are mostly financed by an increase of 11% in enterprise savings. This reduces the income distributed from enterprises to the households by 6.3%. Since most of enterprises' income is distributed to the richest households in metropolitan areas, respective households' income declines. Because income effect dominates price effect of the expansion in agro-food products these households are worse off. In other words, the cost of investments are mostly paid by richest households and this causes their consumption (and hence welfare) to decline. As a result nutritional values for these households also worsen.

6. Concluding remarks

This paper provides a quantitative assessment of three input policy options to improve food security in Kenya. Simulations focus on an increase in fertiliser use, seed quality and irrigation investment. To evaluate such input policy options, we propose two methodological enhancements. First, we use a CGE model that fits key developing country specificities for example the own supply of food by semi-subsistence households and their multiple commodity production activities (through the *Home Production for Home Consumption* module and the multiple-output structure of STAGE-DEV model, respectively). Second, we calibrate the CGE model to an original disaggregated 2014 SAM for Kenya.

The three simulations are performed autonomously and their features are rather different. Nevertheless all converge towards an overall improvement of main food security indicators, despite dissimilarities between both regions and household types. In order to better understand the drivers of these differences, additional researches are needed, especially before any rigorous recommendations for an optimal policy mix.

Furthermore, future investigation shall entail additional policy simulations, especially addressing the lack of access to input and output markets (e.g., investments on physical infrastructure). Additionally the impact of an improved extension services shall be included. Indeed the National Agricultural Sector Extension Policy (NASEP) puts ambitious targets for enhancing extension services. Last but not least, future modelling improvement shall better tackle the issue of nutrition, particularly through the development of a module for STAGE-DEV model able to analyse changes in calorie and micronutrient intake. Linking the CGE model with micro analysis techniques such as microsimulations has in the nutrition area a promising field of development as it might help in analysing policy impacts at both representative and single household level.

7. References

Andae, G., 2015. Cheap fertiliser beckons as Toyota kicks off Sh123bn Eldoret factory, Business Daily, Sept. 3, [Online] Available at: http://www.businessdailyafrica.com/Toyota-kicks-off-Sh123bn-Eldoret-factory/-/539546/2857566/-/13jxoc0z/-/index.html [12 Jan. 2016].

Aragie, E., 2015. Climate Change and Semi-subsistence Agricultural Households, Ph.D Thesis, Oxford: Oxford Brookes University.

Ariga, J. and Jayne, T., 2011. Fertilizer in Kenya : Factors Driving the Increase in Usage by Smallholder Farmers. In: Yes Africa Can: Success Stories from a Dynamic continent. Washington DC: World Bank.

FAO, 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action, World Food Summit, Nov. 13-17, Rome.

FAO, 2016. AQUASTAT, Food and Agriculture Organization of the United Nations (FAO), [Online], Available at: www.fao.org/nr/aquastat [16 Feb. 2016].

Ferrari, E. and S. McDonald., 2014. STAGE_AGR A Static Applied General Equilibrium Model for Agricultural Policy Analyses: Technical Documentation, mimeo.

Ferrari, E. and McDonald, S., 2016. STAGE_DEV: A Static Applied General Equilibrium Model for Developing Countries, Technical Documentation, mimeo.

Flaig, D., 2014. Factor Mobility and Heterogeneous Labour in Computable General Equilibrium Modelling, Ph.D thesis, Stuttgart: Hohenheim University.

Freeman, H. and Omiti, J., 2003. Fertilizer use in semi-arid areas of Kenya: analysis of smallholderfarmers' adoption behavior under liberalized markets, *Nutrient Cycling in Agroecosystems*, 66: 22-31.

Government of Kenya, 2010a. Agricultural Sector Development Strategy 2010-2020, Nairobi: Ministry of Agriculture.

Government of Kenya, 2010b, National Seed Policy, Nairobi: Ministry of Agriculture.

Government of Kenya, 2011. National Food and Nutrition Security Policy, Nairobi.

Government of Kenya, 2015. Economic Review of Agriculture 2015-16, Nairobi: Ministry of Agriculture Livestock and Fisheries.

KNBS, 2007. Kenya Integrated Household Budget Survey (KIHBS) 2005-06, Nairobi: Kenya National Bureau of Statistics.

KNBS, 2014. Statistical Abstract 2013, Nairobi: Kenya National Bureau of Statistics.

KNBS, 2015a. Economic Survey 2015, Nairobi: Kenya National Bureau of Statistics.

KNBS, 2015b. Statistical Abstract 2015, Nairobi: Kenya National Bureau of Statistics.

Kiringai, J., Thurlow, J. and Wanjala, B., 2006. A 2003 Social Accounting Matrix for Kenya, Nairobi and Washington D.C.: Kenya Institute for Public Policy Research and Analysis (KIPPRA) and International Food Policy Research Institute (IFPRI).

Kiringai, J., Wanjala, B., Waiyaki, N., Mutunga, C., Njenga, G. and Nafula, N., 2007. Social Accounting Matrix for Kenya: Methodological Note, KIPPRA, Nairobi: Kenya Institute for Public Policy Research and Analysis (KIPPRA).

Lofgren, H., R. Harris, and S. Robinson, 2002. A Standard Computable General Equilibrium (CGE) Model in GAMS. Washington D.C.: International Food Policy Research Institute.

Mabiso, A.; Pauw, K.; Benin, S., 2012. Agricultural Growth and Poverty Reduction in Kenya: Technical Analysis for the Agricultural Sectoral Development Strategy (ASDS) – Medium Term Investment Plan (MTIP), ReSAKSS Working Paper 35, Washington DC: International Food Policy Research Institute (IFPRI).

McDonald, S., 2007. A Static Applied General Equilibrium Model: Technical Documentation STAGE Version 1: July 2007, Oxford Brookes University, mimeo.

McDonald, S., 2010. Modelling Households as Joint Producers and Consumers, Paper prepared for the 13th Global Economic Analysis Conference, "Trade for Sustainable and Inclusive Growth and Development", Bangkok, Thailand, [Online], Available at: https://www.gtap.agecon.purdue.edu/resources/download/4960.pdf [12 Dec. 2014].

McDonald, S. and Thierfelder, K., 2009. STAGE_LAB: An applied general equilibrium model with enhanced labour markets: technical documentation, Oxford Brook University, mimeo.

Morris, M., Kelly, V., Kopicki, R. and Byerlee, D., 2007. Fertilizer Use in African Agriculture, Washington DC: World Bank.

National Irrigation Board, 2014. Expanded Irrigation Programme, [Online], Available at: http://goo.gl/VdKGNn [12 Dec. 2014].

Polaski, S., Ferreira Filho, J.B.S, Berg, J, McDonald, S., Thierfelder, K., Willenbockel, D. and Zepeda, E, 2009. Brazil in the Global Economy: Measuring the gains from trade, Washington DC: Carnegie Endowment for International Peace.

Punt, C. 2013 Modelling multi-product industries in computable general equilibrium (CGE) models. Dissertation presented for the degree of Doctor of Philosophy in Agriculture (Agricultural Economics) in the Faculty of AgriSciences at Stellenbosch University.Rift Valley Water Services Board, 2007. Strategic Plan July 2006-June 2015, Nairobi: Rift Valley Water Services Board.

Schroeder, C. et al., 2013. Potentials of Hybrid Maize Varieties for Small Farmers in Kenya, *African Journal of Food, Agriculture, Nutrition and Development*, 13(2): 7562-7586.

Thurlow, J., Kiringai, J. and Gautam, M., 2007. Rural Investments to Accelerate Growth and Poverty Reduction in Kenya, IFPRI Discussion Paper 00723, Washington DC: International Food Policy Research Institute (IFPRI).

Thurlow, J. and Benin, S., 2008. Agricultural Growth and Investment Options for Poverty Reduction in Kenya, Preliminary report prepared for Kenya's Comprehensive Africa Agricultural Development Programme (CAADP), Washington DC: International Food Policy Research Institute (IFPRI).

Water Resources Management Authority, 2013. Project on the Development of the National Water Master Plan 2030: Final Report, Sectoral Report, Vol. 4, Nairobi: Japan International Cooperation Agency.

World Bank, 2014. World Development Indicators, [Online], Available at: http://goo.gl/6wNq1W [12 Dec. 2014].

You, L., Xie, H., Wood-Sichra, U., Guo, Z. and Wang, L., 2014. Irrigation potential and investment return in Kenya, *Food Policy,* 47: 34-45.

8. Appendix

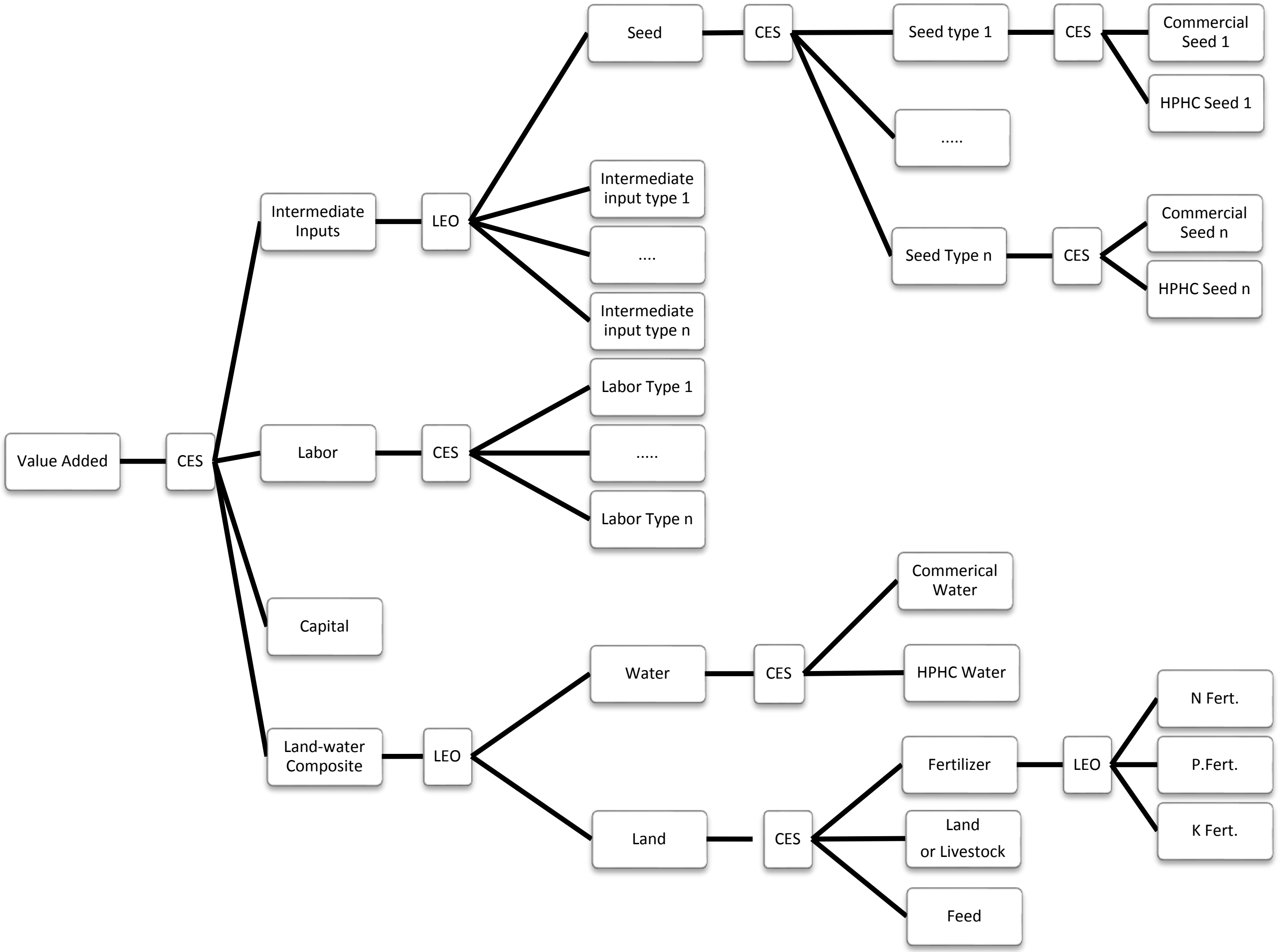

Figure A.1. Production structure

Table A.1. Structure of Kenya SAM in 2014

	ch	cm	m	ahf	ahc	a	flab	fland	flivst	fcap_ag	fcap_na	hh	enter	gov	dirtax	indtax	saltax	facttax	imptax	i_s	row
HPHC commodities (ch)				X								X								X	
Marketed commodities (cm)			X	X	X	X						X		X						X	X
Margins (m)		X																			
Households as activities semi-subsistence (ahf)	X	X																			
Households as activities cash-crops (ahc)		X																			
Activities (a)		X																			
Labour factor (flab)				X	X	X															X
Land factor (fland)				X	X	X															
Livestock (flivst)				X		X															
Capital agricultural (fcap_ag)				X	X	X															
Capital non-agricultural (fcap_na)				X		X															
Households (hh)							X	X	X	X	X		X	X							X
Enterprises (enter)								X			X			X							
Government (gov)															X	X	X	X	X		X
Direct taxes (dirtax)												X	X								
Indirect taxes (indtax)						X															
Sales taxes (saltax)		X																			
Factor taxes (facttax)							X	X	X	X	X										
Imports taxes (imptax)		X																			
Save/Investment (i_s)												X	X	X							X
Rest of the World (row)		X					X					X		X							

Table A.2. Breakdown of commodities and activities

HPHC commodities

- Maize
- Wheat
- Rice
- Other cereals
- Roots & tubers
- Pulses & oil seeds
- Fruits
- Vegetables
- Beef
- Dairy
- Poultry
- Sheep, goat and lamb for slaughter
- Other livestock
- Fishing
- Sugar & bakery & confectionary
- Beverages & tobacco
- Other manufactured food
- Water

Marketed commodities

- Maize
- Wheat
- Rice
- Other cereals
- Roots & tubers
- Pulses & oil seeds
- Fruits
- Vegetables
- Cotton
- Sugarcane
- Coffee
- Tea
- Tobacco
- Others crops
- Beef
- Dairy
- Poultry
- Sheep, goat and lamb for slaughter
- Other livestock
- Fishing
- Forestry
- Mining
- Meat & dairy
- Grain milling
- Sugar & bakery & confectionary
- Beverages & tobacco
- Other manufactured food
- Textile & clothing
- Leather & footwear
- Wood & paper
- Printing and publishing
- Petroleum
- Chemicals
- Fertilizers Nitrogen
- Fertilizers Phosphorus
- Fertilizers Potassium
- Metals and machines
- Non metallic products
- Other manufactures
- Water
- Electricity
- Construction
- Trade
- Hotels
- Transport
- Communication
- Finance
- Real estate
- Other services
- Adminsitration
- Health
- Education

RHG activities (food)

- Nairobi
- Mombasa
- High Rainfall
- Semi-Arid North
- Semi-Arid South
- Coast
- Arid North
- Arid South
- Turkana

RHG activities (cash crops)

- High Rainfall
- Semi-Arid North
- Semi-Arid South

Activities

- Food crops
- Cotton
- Sugarcane
- Coffee
- Tea
- Tobacco
- Others crops
- Livestock
- Dairy
- Fishing
- Forestry
- Mining
- Meat & dairy
- Grain milling
- Sugar & bakery & confectionary
- Beverages & tobacco
- Other manufactured food
- Textile & clothing
- Leather & footwear
- Wood & paper
- Printing and publishing
- Petroleum
- Chemicals
- Fertilizers Nitrogen
- Fertilizers Phosphorus
- Fertilizers Potassium
- Metals and machines
- Non metallic products
- Other manufactures
- Water
- Electricity
- Construction
- Trade
- Hotels
- Transport
- Communication
- Finance
- Real estate
- Other services
- Adminsitration
- Health
- Education