European
Commission

JRC SCIENCE FOR POLICY REPORT

Policy options to support the Agriculture Sector Growth and Transformation Strategy in Kenya

A CGE analysis

P. Boulanger, H. Dudu, E. Ferrari,
A.J. Mainar Causapé

J. Balié, L. Battaglia

2018

Joint
Research
Centre

EUR 29231 EN

Contact information
Name: Emanuele Ferrari
Address: Isla de la Cartuja, Edificio Expo, c/Inca Garcilaso – 41092 Seville (Spain)
Email: Emanuele.Ferrari@ec.europa.eu
Tel.: +34-954488252

JRC Science Hub
https://ec.europa.eu/jrc

JRC111251

EUR 29231 EN

Print	ISBN 978-92-79-85949-6	ISSN 1018-5593	doi:10.2760/091326
PDF	ISBN 978-92-79-85950-2	ISSN 1831-9424	doi:10.2760/109614

Luxembourg: Publications Office of the European Union, 2018

How to cite this report: P. Boulanger, H. Dudu, E. Ferrari, A.J. Mainar Causapé, J. Balié, L. Battaglia, *Policy options to support the Agriculture Sector Growth and Transformation Strategy in Kenya. A CGE Analysis*, EUR 29231, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-85949-6, doi:10.2760/091326, JRC111251

Policy options to support the Agriculture Sector Growth and Transformation Strategy in Kenya. A CGE Analysis.
This report provides scientific evidence supporting policy options for the new *Agriculture Sector Growth and Transformation Strategy* in Kenya. A Computable General Equilibrium (CGE) model specifically modified for the context of Kenya is used to address the impacts of six policy options. For the purpose of the study, a disaggregated version of a 2014 Social Accounting Matrix (SAM) has been developed for Kenya. Multi-sectoral analytical tools are used to describe the Kenyan economy and indicate which agri-food value chains present the greatest impact in terms of output, employment and value added. Modelling results of policy reforms are then presented, discussed and used to draw policy implications.

Contents

Acknowledgements

The authors would like to thank all colleagues from FAO, JRC-Seville and Nairobi who contributed to this study, especially Emerta Aragie, Leopold Ghins, Martina Sartori and Andrea Ferrero.

We would also like to acknowledge the continuous support of JRC.D.4 Head of Unit Giampiero Genovese.

Truthful thanks go to members of the Task Force established by the Kenyan Ministry of Agriculture, Livestock and Fishery and in particular to Mulat Demeke for his endless effort to foster exchange between all the institutions involved in the project.

Authors

Pierre Boulanger, Hasan Dudu, Emanuele Ferrari and Alfredo Mainar Causapé are with the European Commission, Joint Research Centre, Economics of Agriculture (JRC.D.4, Seville).

Jean Balié and Lucia Battaglia are with the Food and Agriculture Organization of the United Nations, Monitoring and Analysing Food and Agricultural Policies (FAO-MAFAP, Roma).

Executive summary

The Ministry of Agriculture, Livestock and Fisheries (MoALF) of the Kenyan government is thoroughly reviewing its Agriculture Sector Growth and Transformation Strategy (ASGTS) to update it to fit the new global dynamics of the agricultural sector. A new ASGTS and a new National Agricultural Investment Plan will be established as guidelines for the period 2018-2030. MoALF is performing a consultative process to receive contributions from relevant stakeholders, following an approach that proved effective in preparing agricultural growth and transformation strategies under similar frameworks. A modelling exercise to explore ex-ante socioeconomic impacts of alternative agricultural growth and development options was recommended to support the final decision of MoALF.

Policy context

Agricultural policies, in particular extension services, irrigation investments, rural infrastructure and input subsidies in Kenya have been developed around the main objectives of growing productivity and increasing farmers' income. Within this framework, several policies have been formulated and implemented to introduce stability in agricultural output, to commercialise and intensify production, and to promote appropriate and participatory policy formulation and environmental sustainability. Nevertheless, the Kenyan government is still failing in its commitment to the Comprehensive Africa Agricultural Development Programme with regard to the proportion of public budget to be devoted to agriculture.

Key conclusions

This report provides a quantitative assessment of policy options to support the new ASGTS in Kenya. Despite the fact that, as with all modelling exercises, the outcomes should be considered with extreme caution and should in no way be considered forecasts of any future impacts of simulated shocks, the report shows that increasing resources for agricultural and rural development in Kenya will be generally positive for its economy, and that this approach might have relevant positive impacts on economic growth and food security. Scenarios combining different policies reveal an increase in the gross domestic product (GDP) projected by the base scenario in 2030. These scenarios could guarantee an incremental growth of the Kenyan GDP of a decimal point every year.

Main findings

Scenarios project significant impacts on the production of agricultural commodities. A scenario that subsidises input has the most positive effect on food staples, whereas one that supports irrigation is seen to benefit marketed and exported crops. Agricultural production reacts differently to different policy changes across different regions, but the variability is rather limited.

The value added in agriculture has the greatest increases under the irrigation scenario, and still significantly in the combined scenarios where the policy mix is less biased towards large agricultural farms, to the detriment of smallholders. Kenya is traditionally an agri-food importing country, with export income relying mostly on tea. Under most scenarios, there is an increase of net imports that is considered in line with the projected increase in wealth.

Simulated scenarios show the capacity to create rural jobs and absorb a significant number of workers coming from urban areas. This could be interpreted as an indication that the policy measures simulated have the potential to slow down the urbanisation process.

Irrigation – showed the highest magnitude on agri-food production (especially towards cash crops) and exports. Investment in irrigation has also shown the highest impact on boosting absolute and per capita GDP growth.

Input subsidies – showed the greatest effect on production increases for subsistence farmers and food staples.

Extension – marginally benefits agricultural productivity and contributes significantly to poverty reduction. The analysis showed that investments in extension boost food crops production and incomes of semi-arid and high rainfall areas of Kenya.

Rural roads – boost agriculture value added, mainly of cash crops. Unlike most other policy interventions, investments in rural roads noticeably benefit both agricultural and non-agricultural sectors by helping reduce transaction costs.

Rural health and education – showed only marginal effects on agricultural production, but – not surprisingly – had the highest positive impact on employment generation and wage increases for skilled workers.

Trade liberalisation – benefits the whole agricultural sector, but showed slightly more positive effects on export crops than on food staples.

Related and future Joint Research Centre work

Enhancing the analysis of demography, nutritional indicators, inclusion of water indicators and connections with other sectors, environmental indicators and Sustainable Development Goal indicators will be critical work together with the coverage of other countries, starting with Senegal and Ethiopia.

1 Introduction

Kenya Vision 2030 identified agriculture as a key sector, which is expected to drive the economy to a projected annual growth of around 10%. Agriculture is therefore central to the achievement of 'a globally competitive and prosperous country with a high quality of life by 2030' (Government of Kenya, 2007). Agriculture is also expected to deliver on Kenya's regional and global commitments, such as the Comprehensive Africa Agricultural Development Programme (CAADP), African Union Agenda 2063 and the Sustainable Development Goals (SDGs).

The Ministry of Agriculture, Livestock and Fisheries (MoALF) of the Kenyan government developed the Agriculture Sector Development Strategy (ASDS) 2010-2020. However, ASDS has been recently defined as non-compliant with the new constitutional framework of the country. Thus, the government decided to thoroughly review the whole strategy and update it to fit the new global dynamics of the agricultural sector.

Consequently, a new Agriculture Sector Growth and Transformation Strategy (ASGTS) and a new National Agricultural Investment Plan (NAIP) will be established for the period 2018-2030. To draft these documents, the ministry embarked on a process of consultation to take advantage of contributions from a number of stakeholders, an approach that had already proved effective in preparing agricultural growth and transformation strategies under similar frameworks.

In preparing to adopt the ASGTS and NAIP documents, a modelling exercise to explore ex-ante social economic impacts of alternative agricultural growth and development options was recommended to support the final decision of MoALF.

A task force with thematic working groups has been created within the new strategy. The expertise of the European Commission (through its in-house scientific service, the Joint Research Centre (JRC) and the Economics of Agriculture Unit) and the Food and Agriculture Organization (FAO) of the United Nations (through its Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme) have been requested for joint technical support to analyse alternative strategic interventions for the agricultural sector using economic simulation modelling tools.

Under Administrative Arrangement JRC No. 33272-2013-10 DEVCO 325-863 between the Directorate-General (DG) for International Cooperation and Development (DEVCO) – EuropeAid and DG JRC, the JRC is committed to providing: (i) support for the improvement of information systems on agriculture, nutrition and food security, (ii) policy and economic analysis to support policy decision-making processes and (iii) scientific advice on selected topics concerning sustainable agriculture and food and nutrition security. Policy design tools for the agricultural sector and for food and nutrition security will be made available to policy makers. These tools also allow policy makers to better understand the potential impacts of policies and capture good practices, which, in turn, allow policy decisions to be based on thorough analysis. Under this framework, the Economics of Agriculture Unit of the Sustainable Development Directorate is responsible for elaborating on the methodology and tools used for the analysis of national and regional economic systems, including the assessment of the sustainability of policies in the sectors of agriculture, social transfers and the fight against food and nutrition insecurity. The resulting analyses support the EU institutions, DG DEVCO and the partner countries in formulating policies and programmes related to sustainable agriculture and food and nutrition security through the provision of demand-driven technical and scientific advice. Among scientific tools, economic simulation models are used to represent the complex economic reality in a simplified form and reveal the interrelationships between economic variables. They can be applied to quantify the impacts of policy changes (i.e. ex-ante policy analysis).

For its part, the MAFAP programme is implemented by the FAO in collaboration with the Organisation for Economic Co-operation and Development (OECD) and national partners in participating countries. The programme seeks to establish country-owned and sustainable systems that will monitor, analyse and reform food and agricultural policies to enable more effective, efficient and inclusive policy frameworks in a growing number of countries. As such, it promotes the use of a set of indicators that help improve understanding of how different policies work in various contexts and how they affect agricultural value chain dynamics and production incentives in different countries. In addition, as part of its mandate, the MAFAP programme intends to support decision makers in partner countries, such as Kenya, to articulate alternative policy options leading to sustainable policy reforms. To do that, the programme seeks to actively engage with policy makers to ensure the analytical results and recommendations feed into national policy processes. To guarantee that the policy analysis results are country owned, the MAFAP programme pursues to also engage national stakeholders and development partners in policy dialogues, as part of a more inclusive policy reform process. As a result, an array of partnerships arises on an issue-by-issue basis between national stakeholders and various agricultural policy research institutes, such as the JRC or advocacy organisations. This active engagement process extends to the private sector, farmers, civil society, donors and other stakeholders with a view to supporting a robust, inclusive and sustainability policy dialogue around key food and agricultural policy reform opportunities.

This report is organised as follows: section 2 provides the policy context; section 3 explains the methodological approach of the report, i.e. social accounting matrix, multiplier analysis and the general equilibrium model, and a few caveats associated with this kind of analysis; section 4 describes the scenarios (policy options) suggested to support the new ASGTS in Kenya; section 5 and 6 provides results of the value chain analysis and of the model respectively, section 7 offers a discussion and section 8 concludes with some policy implications.

2 Policy context

The policy context of this report is structured around four topics: agricultural sector, irrigation, agriculture extension services and rural infrastructures.

2.1 Agricultural sector

Agricultural policies in Kenya have been developed around the main objectives of increasing productivity and income growth. Within this framework, several policies have been formulated and implemented to introduce stability in agricultural output, to commercialise and intensify production, and to promote appropriate and participatory policy formulation and environmental sustainability.

The Economic Recovery Strategy (ERS) 2003-2007 was drafted with these aims as a background and was centred on the development of the three main sectors (i.e. agriculture, manufacturing and services) of the economy. The strategy involved several interventions in the agriculture sector, the main ones being providing a single enabling legislation, rationalising roles and functions of agricultural institutions, developing the irrigation schemes across the country, strengthening extension services and increasing smallholder access to credit.

Within this context, in 2004 MoALF drafted and endorsed the Strategy for Revitalising Agriculture (SRA), spanning up to 2014, that aimed to create a vibrant, business-oriented agricultural sector, producing jobs in rural areas and participating in regional and international trade.

In June 2008, after a year-long political crisis, the newly elected government launched Kenya Vision 2030 as the strategic document for Kenya's economic and social development. The main objective of the strategy was to transform Kenya into 'a newly industrialising, middle income country providing a high quality of life to all its citizens in a clean and secure environment' (Government of Kenya, 2007). In this document, agriculture is considered a strategic sector for the achievement of the 10% annual growth rate target through the transformation of smallholder agriculture from subsistence to commercially oriented and modern agriculture.

The endorsement of the vision was followed by a review of the SRA that led to the development and approval of the ASDS 2010-2020, the main objective of which is to achieve a food secure and prosperous nation by 2020. The strategy identifies four major challenges for Kenyan agriculture: persistent low productivity; sub-optimal land use mainly related to the growth of the population; inefficient markets due to insufficient storage capacity and poor access to markets; and the low levels of value addition and largely informal value chains. With the aim of addressing these challenges, the ASDS sets out strategic objectives for each agriculture sub-sector and lists six major intervention areas: irrigation and water management, land use, the development of northern Kenya, natural resource management, the development of river basins, and forestry and wildlife.

The ASDS provided the basis for the implementation of the CAADP Compact and the formulation of the Medium Term Implementation Plan (MTIP) 2010-2015 that was developed to ensure the implementation of the ASDS. The MTIP was revised in 2013 and included a 'Results Framework' based on six pillars: (i) increasing productivity and commercialisation, (ii) promoting private sector participation, (iii) promoting sustainable land and natural resources management, (iv) improving agricultural services, (v) increasing market access and trade, and (vi) promoting effective sector coordination and implementation.

2.2 Irrigation

Most of Kenya's land is arid and semi-arid; only about 17% of the land has high or medium potential for intensive crop cultivation. The majority of the smallholder farms rely on rain-fed cultivation; the utilisation of irrigation systems is way below its potential, with less than 7% of the cropped land under irrigation. The recurrent cycles of droughts and floods of the past years have represented a significant threat to crop cultivation and livestock rearing and management; they have led directly to poor agricultural performance and to severe famines. The high reliance on rain-fed agriculture, vulnerable to weather variability, leads to fluctuations in production. These trends have negatively affected agricultural incomes and hence investments in rural areas and are seen as one of the major reasons for persistently high levels of food insecurity.

Responsibilities for the irrigation sector in Kenya are shared among (i) MoALF, responsible for production activities under irrigation, (ii) the Ministry of Water and Irrigation (MoWI) in charge of managing the irrigation schemes and of water delivering services, and (iii) the Ministry of Regional Development Authorities, accountable for the majority of dam construction in the country.

This configuration has been in place since 2005 when the reforms included in the Water Act separated 'water resources management and development' from 'water delivery services' through the creation and institutionalisation of parastatal agencies, the main one being the National Irrigation Board (NIB). Established in 1966, the NIB is a semi-autonomous agency operating within MoWI with the main task of managing the country's major irrigation and drainage infrastructures. With the devolution initiated in 2013, the irrigation mandate has been divided between national and county governments. Water remains a national resource and the service delivery is now a county responsibility; whenever water crosses county boundaries, the national-level institutions are called upon to intervene to regulate water service provision.

In terms of policies, irrigation is identified as a key factor in the intensification of production and the increase in productivity of land throughout the main agriculture policy documents. The key objectives of the ASDS to improve productivity through irrigation are the expansion of land under irrigation, the importance of the public–private partnerships and the promotion of a multi-sectoral approach for enhanced innovations, research and technology adoption. The Kenya National Water Master Plan 2030 is included in Kenya Vision 2030 and aims to present a framework for water resources development and management consistent with the country's social and economic development activities. One of the objectives of the plan is to increase the area under irrigation to 1.2 million hectares (from around 160.000 in 2013). In September 2016, the Water Act was presented and approved by the Cabinet; the main purpose of the act is to adapt national water management to the decentralised structure in place since the approval of the Constitution of Kenya 2010.

2.3 Agriculture extension services

The provision of agriculture extension services has been identified as important for sustainable agriculture development and growth, both by the literature ((Aker, 2011) (Ramos-Sandoval, García-Álvarez-Coque, & Mas-Verdú, 2016)) and by agriculture policy documents. In Kenya's economy, extension services play an important role in the processes of technology transfer and knowledge sharing, and in linking the farmer to other actors along the value chains. Since the 1980s, the public sector in Kenya has been the main actor in the provision of extension services. However, the low level of budgetary allocations to extension services has hampered the effectiveness of traditional public extension systems, and these have gradually become unsuited to the evolving needs of modern agricultural practices. For this reason, in 2001, MoALF formulated and implemented the National Agricultural Extension Policy (NEAP) to guide improvements in delivery of extension services. The policy foresees the coexistence of three different models of extension services delivery. The first model refers to the provision of free public extension services, mostly to smallholder farms engaged in growing staple foods and minor cash crops across all the agro-ecological zones. The second model is commodity based and is implemented through the action of government parastatals, out-grower companies and cooperatives. The beneficiaries are mainly cash-crop farmers and the services provided involve production, processing and marketing techniques, since the activities along commercial crop value chains are often vertically integrated. The third model is focused on the provision of services by private companies, non-governmental organisations (NGOs), community-based organisations (CBOs) and faith-based organisations (FBOs).

In 2012, a review of the NAEP and of the situation with regard to extension services highlighted the need for a higher degree of coordination between public and private interventions and for a more comprehensive approach to the provision of agricultural extension services. For this reason, in 2012, MoALF formulated the National Agricultural Sector Extension Policy (NASEP), a new policy that adopts a sector-wide approach and defines the role of the public and private sectors in the provision of extension services.

2.4 Rural infrastructures

The literature and the agriculture policy documents unanimously identify rural infrastructures (e.g. roads) as a key factor in improving livelihood conditions in rural areas and accelerating the agricultural development process. Agricultural infrastructure has the potential to transform traditional agriculture or subsistence farming methods to give a more modern, commercially based and market-oriented farming system.

The SRA identified the role of cooperative societies as fundamental in the promotion of marketing and rural infrastructures. Within the broad objective of Kenya Vision 2030 to achieve a more commercially oriented agricultural system, the promotion and development of a good system of rural infrastructures assumes a crucial role. For this reason, one of the main objectives of the ASDS is to restructure the role of cooperative societies and increase the allocations of public expenditure for ‘rural railways, roads, water supply, transportation, storage, cattle dips, rural markets, electrification, communications, water management schemes, stockholding grounds, stock auction markets, stock routes and abattoirs’ (Government of Kenya, 2010).

3 Modelling and database

This section explains the methodological approach of the report: the development of the social accounting matrix (SAM), the multiplier analysis and the development of a tailored general equilibrium model for Kenya.

3.1 A social accounting matrix for Kenya for 2014

For the purpose of this study, a SAM had to be calibrated to the specific requirements of the model employed (Mainar Causapé et al., 2018). A virtually new SAM for Kenya (base year 2014) was developed with an original structure. The 2014 Kenya SAM is a novel contribution, as it is estimated from the latest re-based national accounts (including a short version of supply and use tables) for Kenya (Kenya National Bureau of Statistics, 2015a, 2015b), including micro data from the latest Kenya Integrated Household Budget Survey (KIHBS), 2005-2006 (Kenya National Bureau of Statistics, 2007). Other relevant databases related to agriculture (Government of Kenya, 2015) and labour markets (Kenya National Bureau of Statistics, 2015a, 2015b) were shown to be important for updating the production structure of previous SAMs elaborated by the International Food Policy Research Institute (IFPRI) by Kiringai et al. (2007), Thurlow et al. (2007), and Thurlow and Benin (2008), used as auxiliary information when needed.

The new SAM, although based on a standard structure, deviates from other classical SAMs in terms of structural assumptions. The Home Production for Home Consumption (HPHC) concept is introduced in the SAM by assuming that each household has a corresponding 'productive activity'. As well as the classic representative household groups (RHGs) that incorporate household behaviour data in terms of consumers of goods and services and providers of factors of production (and receptor-contributors of transfers), the 2014 Kenya SAM has accounts that show the behaviour of households as units of production. These accounts incorporate the economic behaviour of households in terms of producers of food commodities (agricultural and livestock products for food) as well as cash crops. This requires separate accounts for the commodities produced by these households for their own consumption (HPHC as input or as a final product) commodities to be marketed (produced both by households and by conventional productive activities). Rows of these commodity accounts reflect HPHC uses as intermediate inputs in the productive activities of households and their consumption in final demand of households (in RHGs). The individual sums of the rows must be equal to the sums of the columns that summarise the contributions of the activities of households to each of these goods. Similarly, columns of household 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. Households considered producers have been broken down regionally, while commodities produced are homogenous at national level. The breakdown of commodities and activities is summarised in Annex 1a.

The regional agricultural breakdown in the 2014 Kenya SAM is based on agro-ecological characteristics. The country has been divided into seven agro-ecological zones (AEZs), in addition to the two major metropolises, Nairobi and Mombasa. Based on previous studies (Mabiso et al., 2012; Thurlow and Benin, 2008; Kiringai et al., 2006) and own assumptions, AEZs distinguish 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. 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 relate to three types of production agents. There are nine agricultural household activities (one per each of the AEZs) that produce 18 'subsistence commodities' not marketed and consumed at home and 17 marketed crops. Three regional households produce one or more of the six exported cash crops (cotton, sugar, coffee, tea, tobacco and other crops, mainly flowers). Finally, the business enterprise sector produces food and cash crops at the national level. These activities represent the market-oriented larger holder producers.

The RHGs 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 into income quintiles. As a result, the 2014 Kenya SAM contains 24 RHGs, a number that allows a good analysis of the redistributive aspects and specific impacts of different policies.

According to the classification of work by education, there are three types of labour in the SAM: skilled, semi-skilled and unskilled labour. Each labour factor is also regionalised (nine regions of reference plus a rest of the world account, making 10 regions in total); the SAM therefore takes into account 30 different types of labour.

In summary, the 2014 Kenya SAM consists of 200 accounts: 55 activities (12 of them accounts of households as producers) producing 53 marketed and 18 HPHC commodities using three types of labour (skilled, unskilled and semi-skilled) in 10 regions (30 labour accounts), three types of capital (agricultural, non-agricultural and livestock), two types of land (irrigated and non-irrigated) and four types of investment goods (road, irrigation, other infrastructure and other goods) plus a single savings account. Regarding taxes and subsidies, five types of taxes have been disaggregated: direct, indirect, sales, factors and imports taxes. In addition, 24 regionalised RHGs have been obtained. Finally, accounts for margins, enterprises, government and the rest of the world are also included. An abbreviated version of the SAM is presented in Annex 1b[1].

3.2 The multipliers methodology

Based on the original Kenya SAM produced by the JRC, output, employment and value added multipliers can be used as an analysis tool to assess the wealth-generating properties of economic sectors.

Assuming Leontief technologies (i.e. fixed prices, no substitution elasticities), multipliers are based on the SAM Leontief inverse $M = (I-A)^{-1}$, where each element m_{ij} in M depicts the output requirements of account i to increase final demand of account j by one unit and, employing the same logic, the input requirements of account i to produce one unit by account j. These are so-called output multipliers. The employment multipliers are the result of a new diagonal matrix E, containing priors on the ratio of the number of jobs per unit of output value. This matrix is multiplied by the part of the Leontief inverse M_a that incorporates the rows corresponding to the productive accounts and the columns corresponding to commodities. When the final demand (by increasing exports, household consumption or investment) of a commodity is exogenously increased, the analysis of the employment multipliers reveals the number of jobs created (or loss if the shock is negative) in the economy obtained via the matrix E. The expression of the employment multiplier, M_e, is the following:

$$M_e = E * M_a \qquad (1)$$

Each element in M_e is the increment in the number of jobs of the account i when the account j receives a unitary exogenous injection (final demand in this case). The sum of the columns gives the global effect on employment resulting from an exogenous increase in demand. The rows show the increment in employment that each account undergoes when the rest of the accounts receive an exogenous monetary unit. In other words, the

[1] Complete database can be downloaded from DataM portal https://datam.jrc.ec.europa.eu/datam/perm/od/2f0d7a66-93fd-4ecb-9b45-879a83ab3cba/download/dataset.zip

multipliers reveal the number of additional jobs per million of additional output from each activity. More specifically, the employment multipliers calculate the resulting 'direct', 'indirect' and 'induced' ripple effects resulting from an increase or decrease in output value in activity 'j'. Thus, the direct employment effect is related to the output increase in the specific shocked activity 'j', the indirect employment effect is the result of an exogenous shock in other activities linked through production relationships (intermediate consumption), while the induced employment effect is driven by changes in household labour income which drives changes in household consumption for sector 'j'.

Using a vector of value added ratios instead of the jobs or employment vector, value added multipliers are obtained. Using the abovementioned multipliers technique, output, demand and supply values and value chains are estimated, providing the distribution of generated value added embodied in final demand shocks.

3.3 The computable general equilibrium model

The model used for this study is a recursive dynamic single-country computable general equilibrium (CGE) model. This version is an extended version of the model documented in Aragie et al. (2017) which several enhanced features: recursive dynamic version, handling of migration flows, impacts of investments on physical and human capital, demographics, modelling of nested production and international trade in the context of the developing countries. Aragie et al. (2017), starting from McDonald (2007), incorporate a series of additional behavioural relationships that better account for economic relationships in developing countries, in particular in the least developed and Sub-Saharan African countries. To properly model agriculture and food security issues in Kenya, the model depicts key structural characteristics of the economy and of the agricultural sector. Among them, one of the most relevant is the dual role of semi-subsistent agricultural households, which play the non-separable double role of producers and consumers. Other additions to the model, including nested consumption function, endogeneity of the functional distribution of income, domestic migration and factor market segmentation, are fully documented in Aragie et al. (2017).

The use of recursive dynamics in the model takes into account not only physical capital accumulation due to investments but also the evolution of birth and death rates and thus the demographic profile of the country (i.e. population and labour force) and human capital (i.e. labour productivity) due to spending on health and education services; transformation of rain-fed land to irrigated land due to investments on irrigation infrastructure; increase in labour, fertiliser and seed productivity due to spending on extension services; and fall of trade margin costs due to investment in infrastructure and roads. The death rate decreases as per capita health spending increases (see Annex 3, Equation (1)), while birth rate decreases with increasing per capita spending on education (see Equation (2)). The updated death and birth rates are then used to calculate the number of people in each age group in each period. The updated demographic numbers are then used to calculate labour force numbers. Once new labour force numbers are calculated, per capita health and education spending are once again used to update labour productivity data (see Equation (3)).

The model allows for linking different investment types with different capital factors. The model distinguishes the investments for roads, irrigation and other infrastructure from the other investments. The higher the return for a capital investment, the more funds it receives from an investment type. The investment in roads is distributed to agricultural and non-agricultural capital according to their initial shares in total capital stock and their returns. Further, the trade and transport margins are reduced as more investment is allocated to building roads (see Equation (4)). The investments for irrigation transform rain-fed land to irrigated land under the assumption that the cost of transformation of one hectare of rain-fed land into irrigated land costs 300,000 KSh (You, Xie, Wood-Sichra, Guo, & Wan, 2014). Investments in other infrastructure are added to the non-agricultural capital stock, while other investments (e.g. in machinery or other buildings) are distributed among livestock, agricultural capital and non-agricultural capital according to their initial shares and returns (e.g. the higher the return of a capital type, the higher the investment they receive).

To explicitly incorporate the issues discussed above and, in particular, HPHC into an analytical model, a consistent way to organise the information in the underlined database should be found. This requires introducing additional sets of columns and rows as sub-columns and sub-rows as explained above.

The migration flows and labour market segmentation in the model are enhanced to take into account the response of households and labour types to the differences in household income, wages and public spending in different regions (see Equations (5)-(8)). As household income, wages or public spending increase in a region, more people migrate to that region.

The production side of the model is enhanced to allow for completely flexible constant elasticity of substitution (CES) nesting. The production tree used in the model is shown in Annex 2, Figure 27. The intermediate inputs (apart from seed) are perfectly complementary (i.e. under a Leontief production function). Seeds and other intermediate inputs are perfectly complementary, but household-produced seeds and commercial seeds (i.e. bought from market) are imperfect substitutes (i.e. under a CES production function). Different labour and capital types are imperfect substitutes, allowing producers to switch to less expensive available labour or more productive labour or capital types. Different fertiliser types are perfectly complementary and no substitution is required between them. The composite fertiliser is also a perfect complement for water and irrigated land, implying that producers cannot substitute these three factors of production. The composite factor that is composed of water, irrigated land and fertilisers is an imperfect substitute for irrigated land and thus a producer can switch between irrigated and non-irrigated production. Finally, land, labour, capital and intermediate input composites are combined with a CES production at the top nest and hence are all imperfect substitutes. The structure of production in the other sectors is quite standard: intermediate input composite, labour and capital are imperfect substitutes. However, intermediate inputs are combined in a Leontief nest, i.e. they are perfect complements (see Annex 2, Figure 28).

In this version of the model, modelling of international trade flows is also enhanced, introducing exports and imports from African countries and the rest of the world separately into the SAM. With regard to modelling, a two-level Armington specification accounts for exports and imports from African countries and the rest of the world as imperfect substitutes for each other, while the composite imports and exports are imperfect substitutes for domestic supply and demand. That is, the model first determines the amount of consumption from domestic supply and composite imports according to a CES function and then composite imports are distributed according to the source. For exports, the model first determines the amount of supply to the domestic markets and to composite exports and then distributes the composite exports to different destinations (e.g. African countries and the rest of the world). This specification allows trade liberalisation scenarios with African countries to be modelled.

3.4 Caveats and limitations

This study is based on simulations performed using a CGE economic model. This type of model provides a conceptual framework that allows a representation of the economy in an effective but schematic and simplified manner. Since models cannot reproduce reality in its full complexity, they often have shortcomings and limitations that should be taken into account when interpreting the results. On the other hand, the additional use of linear models and multipliers entails other types of limitations linked to the strong restrictions imposed, being precise to interpret their results with caution, using their descriptive character as a first analysis to be able to obtain from them relevant information.

It should also be underlined that the quality of the model output is directly related to the input data. The effort expended in the production of an accurate and updated database is huge; nevertheless, missing data, datasets not available to the public and the availability of older surveys (i.e. the KIHBS) might bias some of the final results. Whereas calibration procedures allow key exogenous variables, such as production, trade or GDP, to be matched, the parameters, in particular the behavioural elasticities, often remain unchanged over time in the models. Despite relying on a very detailed database, one of the main limitations relates to the coverage and the disaggregation of the AEZs, the agricultural products and the household disaggregation used by the CGE model. The model works with representative household types and farms, so very little can be said in terms of income distribution and income inequality, and nothing at all can be said in terms of intra-household distribution.

In addition, the results of the scenarios are linked to the parameters associated with the shocks imposed on the model (e.g. how much does an investment of 1 million KSh reduce road construction trade margins?; how much does 1 million KSh spent on education increase labour productivity or reduce the birth rate?). Not all parameters can be econometrically estimated and, despite the fact that some of them are available in the literature, scenarios should be interpreted more as a way of understanding the forces that each shock unleashes than as ‘true’ numbers or predictions in relation to a given policy.

The JRC and FAO-MAFAP teams constantly strive to increase the scope and quality of the models employed for policy analysis. Indeed, the teams are currently enhancing modules to improve, among other elements, the analysis of demography, nutritional indicators, the inclusion of water indicators and connections with other sectors, environmental indicators, and Sustainable Development Goal (SDG) indicators. Nevertheless, it should be emphasised that only the economic impacts of the analysed shocks are fully depicted by the model. However, other impacts, such as environmental or social impacts, are only partially taken into account (i.e. the migration module accounts only for the economic motives behind migration, while the reality is that there are certainly other, non-economic reasons behind the decision to migrate, which the model cannot take into account)

4 Policy scenarios

The model is designed as a tool to conduct policy experiments, in which a reference scenario is first simulated over a future period and then, after changing one or more policy settings, new scenarios incorporating these changes are modelled over the same period. The comparison of the scenarios with the baseline at a given point in the simulation period, usually in terms of percentage differences, establishes the direction and relative magnitude of any impacts on all the endogenous variables of the change that is depicted in the hypothetical scenario at that point in time. Although the model can be used to project individual values of particular variables, it must be stressed that simulation models are not designed to predict economic trends in the future (i.e. for forecasting). The strength of simulation models is their ability to describe the mechanisms that drive departures from that baseline and can be ascribed to a policy change. Given the very large number of assumptions, estimated or calibrated parameters, and stylised specification features that the model assembles, each of which is plausible up to a certain probability (which is unknown), it is difficult to establish exact confidence intervals or margins of error around individual projected numbers.

This analysis proposes six scenarios, which are defined below. Table 1 summarises the main features of the considered scenarios, including the value of the shocked variables in the base year (2014), in the baseline and in the different scenarios.

The scenarios have been constructed in a theoretical way to show the forces that each shock is able to unleash within the Kenyan economy. Scenarios cannot be considered realistic but only provide an indication to policy makers of the impacts of a selected policy choice. Scenarios do not consider any international shocks (e.g. changes in trade policies, changes in other international or non-Kenyan policies, changes in world prices), but only domestic policy changes.

All scenarios assume that the government devotes 10% of its budget to agricultural and or rural related activities. One less realistic aspect of the first six scenarios is the fact that the simulation assumes that the whole budget increase is used for a single measure (extensions, input subsidies, irrigation, rural road and education and health). In reality, this is politically unsustainable as, for example, an increase in expenditure in extension is currently leading to a linear reduction in expenditure for health, education and other public goods. However, the simulation proves to be useful for showing policy makers the impacts of the shocks in isolation and highlighting that the trade-offs behind each public expenditure decision are inevitable. Therefore we present two combined scenarios (agriculture and rural economy), which look towards a more realistic way of distributing public money. And last, trade liberalisation of agricultural trade between Kenya and other African countries is simulated by assuming bilateral tariff reductions.

It should be underlined that all scenarios except trade liberalisation are budget neutral. When the government is modelled to increase a given recurrent public expenditure (i.e. on extension services, health, education or subsidies), all the other expenditures are reduced proportionally to keep the government savings fixed as a given (initial) share of GDP. When the government is simulated to increase investment types (i.e. capital expenditures such as investments on irrigation or road), the simulated government savings are increased, via a reduction in public expenditure, to finance the new investments. Government savings are kept as a constant share of GDP; if a policy shock increases GDP, it gives the government policy scope to spend more money.

Table 1: Scenario schematic description (scenarios on columns, policy variables on rows)

	Baseline Values		Scenarios								
	2014	2030	Extension	Input subsidy	Output subsidy	Irrigation	Road	Education & Health	Agriculture	Rural Economy	Trade Lib.
Extension public expenditures	**23.5 billion KSh**	**Endogenous increase to 55 billion KSh**	**10% of government budget**	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	**3.3 % of government budget**	Endogenous following base trend	No change
Input subsidies	**0.2 billion KSh**	**0.2 billion KSh**	0.2 billion KSh	**10% of government budget**	0.2 billion KSh	0.2 billion KSh	0.2 billion KSh	0.2 billion KSh	**3.3 % of government budget**	0.2 billion KSh	No change
Output subsidy	0	0	0	0	**10% of government budget**	0	0	0	0	0	No change
Irrigation investment	**0.14 billion KSh**	**Endogenous increase to 0.36 billion KSh**	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	**10% of government budget**	Endogenous following base trend	Endogenous following base trend	**3.3 % of government budget**	Endogenous following base trend	No change
Road investment	**81.3 billion KSh**	**Endogenous increase 210 billion KSh**	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	**10% of government budget**	Endogenous following base trend	Endogenous following base trend	**3.3 % of government budget**	No change
Education public expenditures	**192 billion KSh**	**Endogenous increase to 546 billion KSh**	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	**5 % of government budget**	Endogenous following base trend	**3.3 % of government budget**	No change
Tariffs & export prices	-	-	-	-	-	-	-	-	-	-	**20% cut**
Health public expenditures	**130 billion KSh**	**Endogenous increase to 370 billion KSh**	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	Endogenous following base trend	**5 % of government budget**	Endogenous following base trend	**3.3 % of government budget**	No change

Source: Own elaboration

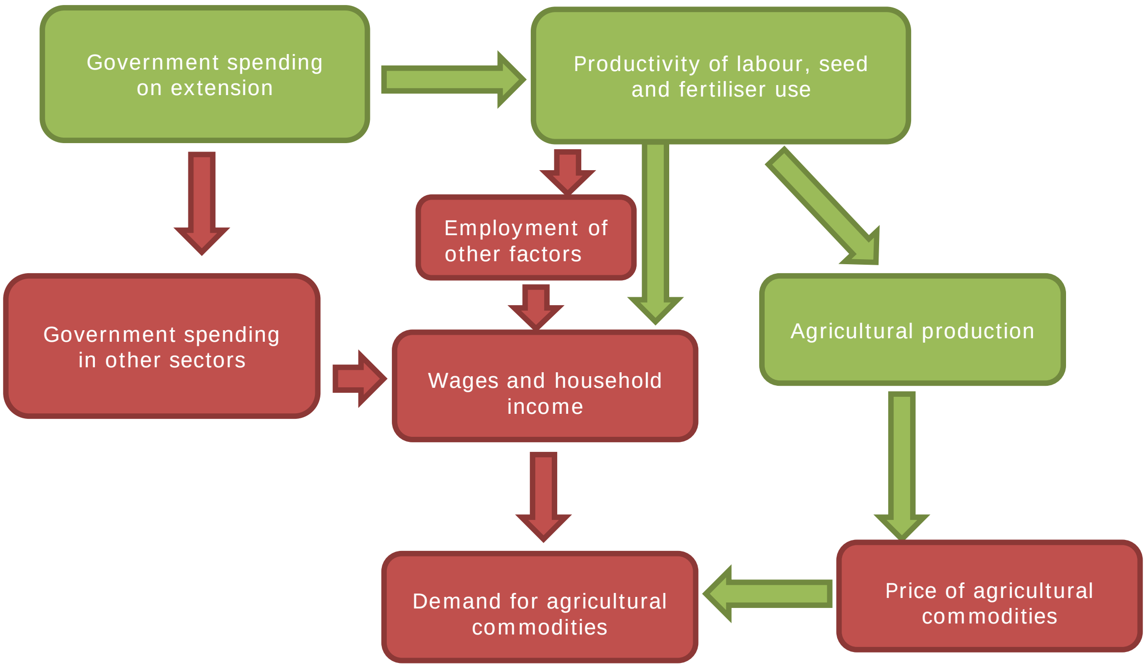
4.1 Extension

Whereas agricultural extension failed to attract substantial funding, it has been used by various governments to meet expanding demands for food and to cope with the declining availability of land and water resources. Recently, a new wave of research has emerged to generate information on the likely transient and sustainability effects on agricultural production. The recent level and trend in public expenditure on farm extension and training (19.3 billion KSh) from MAFAP (MAFAP and JRC, 2017) has been incorporated into the SAM. The model has been extended to include feedback from changing expenditures on elasticity to corresponding changes in the productivity of labour and of input use (fertilisers and seeds). Elasticity of agricultural productivity to extension coverage is obtained from the literature (Pauw & Thurlow, 2013). Any evidence of higher elasticity will lead to a call for increased budgetary allocation.

To perform this scenario, an extension services activity has been introduced into the SAM to produce extension services. The cost structure of extension activity is assumed to be identical to that of education activity. The production of extension services is solely purchased by government. The change in government spending on extension services triggers a productivity increase in agricultural production through labour, fertilisers and seeds. It is assumed that spending on extension services will allow farmers to use fertiliser and seeds in a more efficient way and also increase their farms' productivity.

Under this scenario, government expenditure on extension services is gradually increased up to 10% of the government budget, starting from the initial level of current Kenyan government budget spending mentioned above.

Figure 1: Main channels of expected impact of increasing extension spending



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

Source: Own elaboration

4.2 Subsidies

The Kenyan National Cereals and Produce Board (NCPB) is currently spending a relevant amount of money on production subsidy in the country. However, it is not yet clear if staple production is responding to these subsidies; in fact data shows that maize production is rather declining. On the other hands, it is not yet clear if smallholders are the real targets for price subsidy.

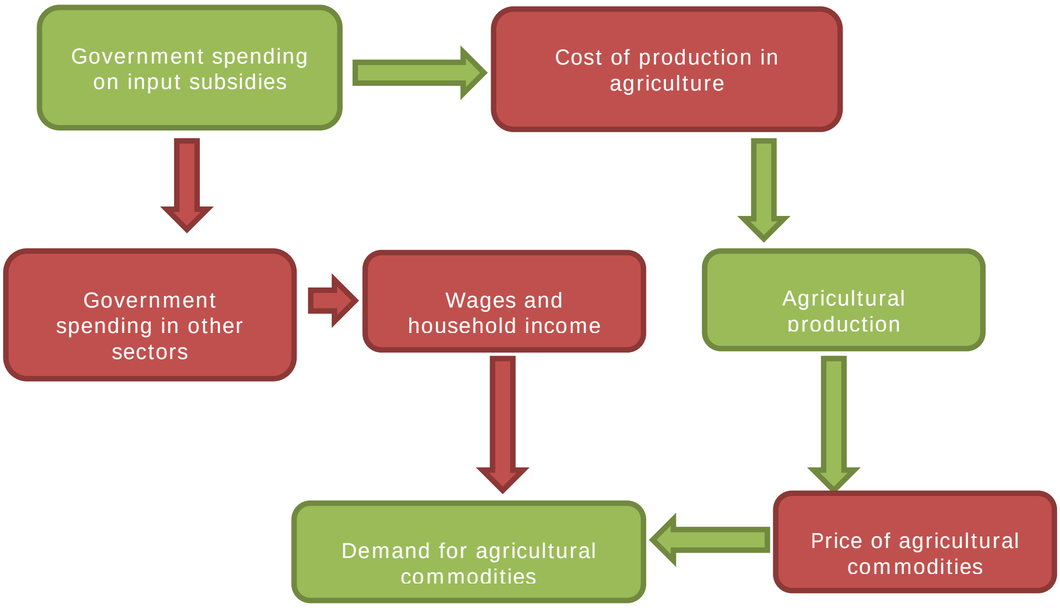
In the current simulation approach, subsidies to farmers can take two forms: production/activity subsidy and input (fertilizers and seeds) subsidy. Current data on the level and trend of these two classes of farm subsidies are readily available from MAFAP's public expenditure data (MAFAP and JRC, 2017).

4.2.1 Input subsidy

The use of modern agricultural inputs was fundamental during the green revolution. The Government of Kenya has, to a certain extent, been supporting farmers with subsidised inputs and input marketing systems. Such support to the farm input market, summarised here as input subsidy, enables farms to buy intermediate inputs at prices lower than the market price. This decreases the cost of production for all farms but the impact is more likely to be higher for the farms that use more fertilisers and commercial seeds. As in other scenarios, the cost of subsidy is financed by reducing government expenditure. This has a contractionary impact due to the budgets cut (particularly in education and health) needed to fund the subsidy programmes. The final effect will again depend on several dynamics that interact within the general equilibrium setting.

In the experiments, two strategic inputs, fertiliser and commercial seeds, are subsidised. Under this scenario, the government expenditures in input subsidies are gradually increased up to 10% of the government budget, starting from an initial level of 200 million KSh as reported by the MAFAP analysis (MAFAP and JRC, 2017) of current Kenyan government budget spending and gradually going up to 10% of the total government budget.

Figure 2: Main channels of expected impact of increasing input subsidy



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

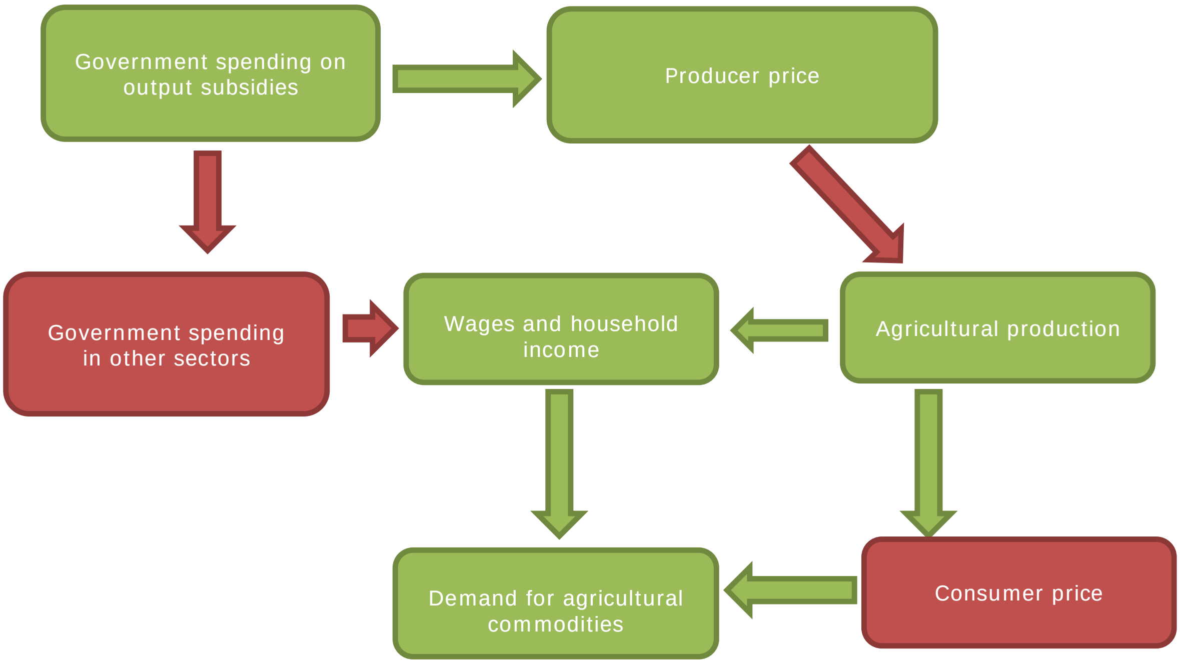
Source: Own elaboration

4.2.2 Output subsidy

Production subsidies are implemented in the model as subsidies to producing households, interdependently from what they produce. Subsidies provide the farmers a mark-up on the average price per unit of composite output they produce (sum of all different commodities produced). That is, farmers receive a higher price for their product than what is paid by the consumer. This creates incentives to produce more but is limited with the increase in the demand. Further the cost of subsidy is financed by decreasing government spending and thus the policy also has a contractionary effect on the economy. The final effect will depend on the interaction of several dynamics such as the cost structure of the activity, the elasticity of demand to price and income changes, competitiveness of the activity in the factor and input markets, etc.

Under this scenario, subsidies to small-holder producers, which do not exist in the baseline, are increased up to 10% of the government budget (starting from zero).

Figure 3: Main channels of expected impact of increasing output subsidy



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

Source: Own elaboration

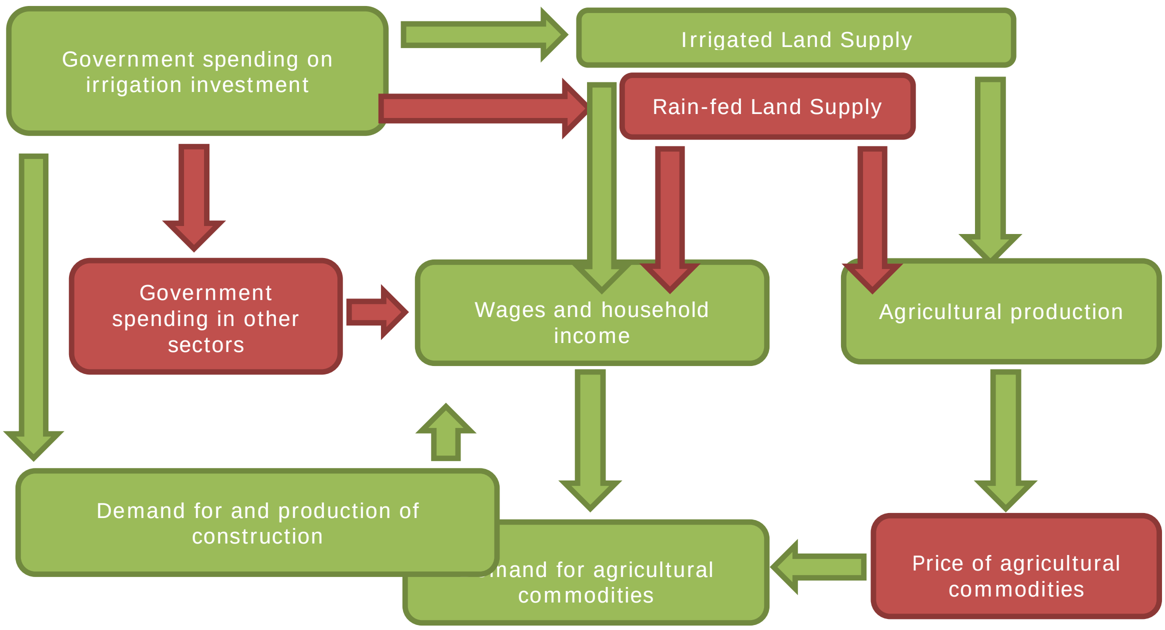
4.3 Irrigation

The Kenyan government has invested in large-scale irrigation but the benefits, in terms of increased production or increased area under irrigation, are still lacking. Evidence of the impacts of increased investment in irrigation is still missing.

Despite the potential for development, only a limited proportion has been realised, making irrigation development in Kenya one potential strategic intervention area that could accelerate agricultural growth. An important question is how to determine the extent of the irrigation development that could be realised from the funds assumed. Employing the information in You et al. (2014) on large-scale irrigation development in Kenya as the basis, the extra hectares of farm land that could be irrigated were computed. The irrigation investments are linked to the transformation of rain-fed land to irrigated land by assuming that the cost of transforming rain-fed land to irrigated land is around 300,000 KSh per hectare (You et al., 2014). Following the irrigation investments, the immediate impact of this scenario is to increase the supply of irrigated land and hence reduce the amount of non-irrigated land. Since irrigated land is more productive, this causes an enhancement of productivity and so production increases in all sectors. However, as in the previous scenarios, the impact is higher for the production activities that use relatively more irrigated land. Finally, again as in the previous scenarios, the investment is financed by increasing public savings through a reduction in government expenditure and, as such, it has a contractionary effect. However, the irrigation investments increase the demand for construction services, which in turn creates an expansionary impact.

Under this scenario, the investments in irrigation (which mainly uses the construction sector) are gradually increased up to 10% of the government budget. The investment is financed by an equivalent increase in government savings. We also compare the irrigation development for small holder farmers and commercial farms (i.e. large farms) in two sub-scenarios presented in Annex 4. The scenario does not account for environmental issue such us water availability which is taken as granted or other non-economic related issues.

Figure 4: Main channels of expected impact of increasing irrigation investments



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

Source: Own elaboration

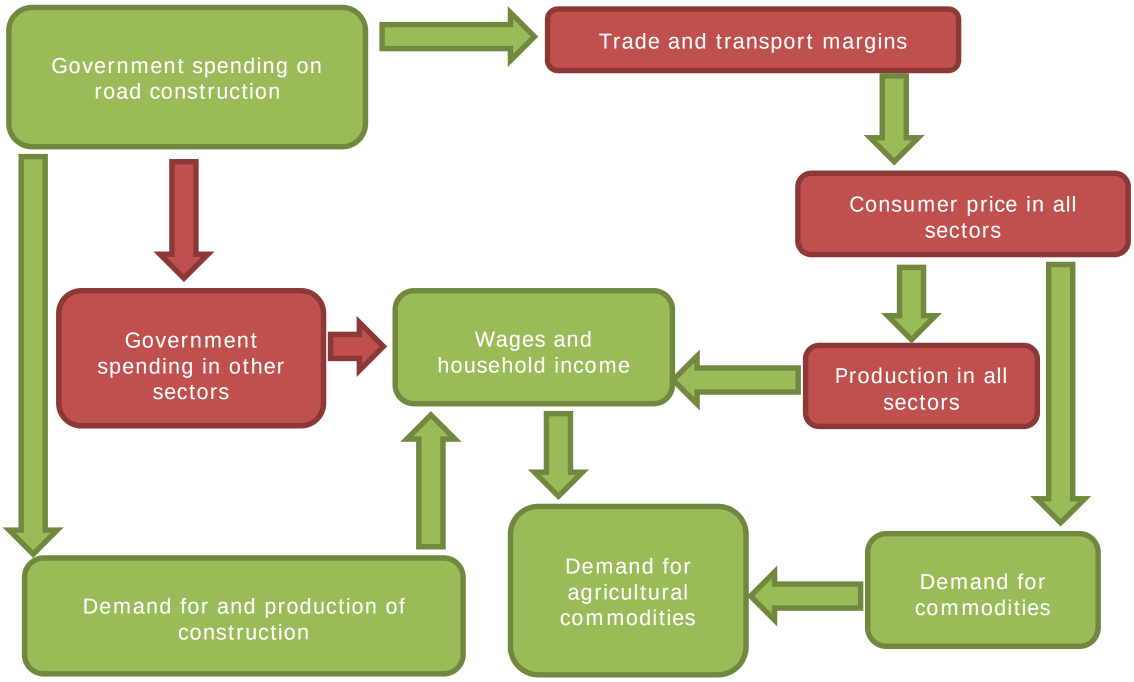
4.4 Rural roads

Investment in rural roads lowers the cost of bringing agricultural and food products (among others) to the market for all agri-food sectors. The model has been modified to include feedback from changes to the value of investment in roads to changes to the marketing margins. An estimate on the link between rural infrastructure and marketing margin for African countries shows elasticities of 0.19 for the agricultural sector and 0.15 for the non-agricultural sector (Schürenberg-Frosch (2014)). These values were used to derive the reduction in trade and transport margins in the agricultural and non-agricultural sectors, respectively. The simulation provides information on which sectors/regions would benefit most from improvements in road infrastructure.

Under this scenario, as in the previous scenarios, investment in road building has both expansionary and contractionary impacts. The former follows from the need to finance the investments by increasing the government allocations to these investments through reductions in expenditure and hence has a negative impact on aggregate demand; the latter follows from the increasing demand of the construction sector, which in turn has a second-order expansionary impact.

Under this scenario, the investments in road (which mainly uses the construction sector) are gradually increased up to 10% of the government budget. The investment is financed by an equal increase in government savings.

Figure 5: Main channels of expected impact of increasing road investments



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

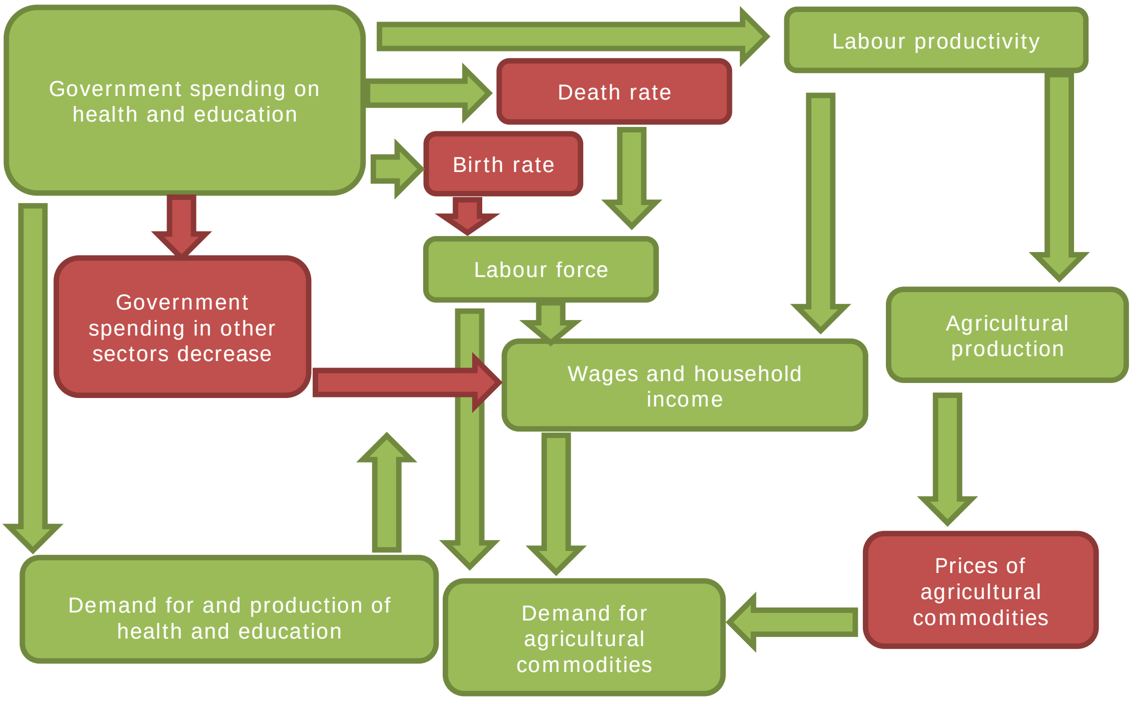
Source: Own elaboration

4.5 Rural health and education

The importance of health and education cannot be overemphasised. The model has been modified to explicitly take into account the link between public health and education spending and improving human capital and demographic change. Labour productivity, death rates and birth rates are a function of health and education spending. Specifically, higher education expenditures are linked to an increase in labour productivity and a decrease in birth rate, while higher health expenditures are linked to a decrease in the death rate. The simulation increases the budget for health and education spending. The increase in spending on education and health services is financed by reducing government expenditure on other commodities (i.e. government reallocation of budget).

Under this scenario, government expenditures in health and education are gradually increased up to 10% of the government budget.

Figure 6: Main channels of expected impact of increasing health and education expenditure



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact.

Source: Own elaboration

4.6 Combined scenarios

In the two combined scenarios, we simulate different combinations of the interventions described above.

4.6.1 Agriculture-focused scenario

As in the previous scenarios, 10% of the national budget is allocated among policy options, with a higher share allocated to those aimed at improving agricultural production. In particular, a third of the budget is allocated to irrigation investments, a third to input subsidies to fertilisers and seeds, and a third to extension services. The shocks are implemented as described above.

4.6.2 Rural-economy-focused scenario

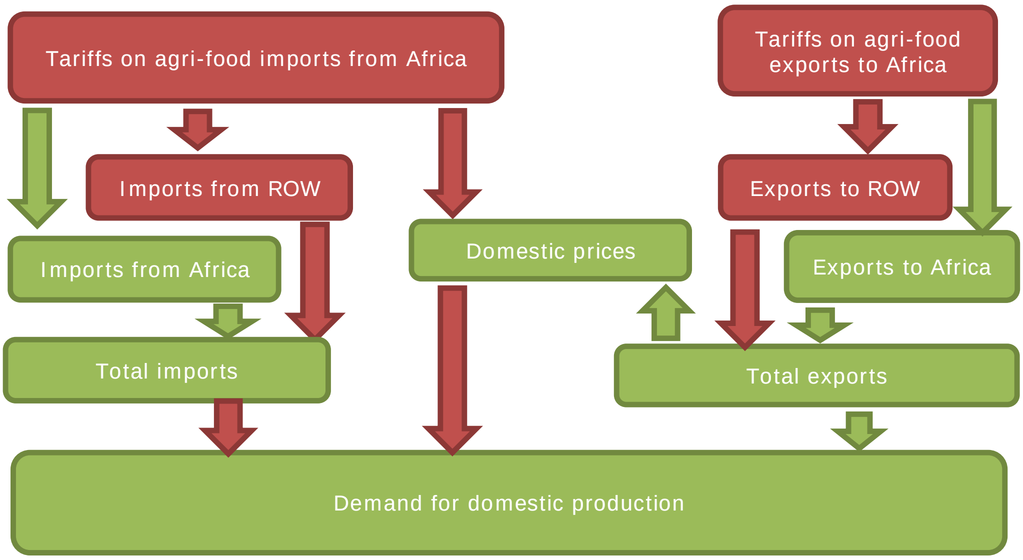
As in the previous scenarios, 10% of the national budget is allocated among policy options, with a higher share allocated to those aimed at developing the rural economy. In particular, a third of the budget is allocated to rural roads, a third to public expenditures on health and a third to public expenditures on education. The shocks are implemented as described above.

4.7 Trade liberalisation with African countries

Under this scenario, a hypothetical liberalisation of agricultural trade between Kenya and other countries is simulated. The trade flows and other transactions between Kenya and other African countries are separated from the rest of the world in the SAM and the model. That is, African countries are treated as a separate trade partner in the SAM. In the context of the model, we also treat the imports from African countries and the rest of the world as imperfect substitutes by using a two-level nested Armington specification. The second-level nest combines imports from African countries and the rest of the world; in the first-level nest, the composite imports are combined with demand for domestic production. We simulate a 20% decrease in the tariffs imposed by Kenya on imports from other African countries for agricultural and food commodities.

We also apply different specifications for exports to African countries and exports to the rest of the world. The exports are driven by a constant elasticity of transformation (CET) function, which implies that the supply to domestic markets and the rest of the world are imperfect substitutes. However, to account for the bilateral nature of the simulated trade liberalisation (i.e. if Kenya lowers the tariffs imposed on imports from the other African countries, those countries are also likely to reduce the tariffs they impose on Kenyan exports), we assume that exports to other African countries are driven by an export demand function that responds to price falls due to the removal of tariffs on Kenyan exports. That is, Kenyan exports become less expensive for other African countries and demand from these countries for Kenyan products increase as a result of bilateral trade liberalisation. In the simulation, we assume that reducing tariffs on Kenyan exports would cause a 20% decrease in the price of Kenyan export commodities.

Figure 7: Main channels of expected impact of trade liberalisation scenario



Note: The green boxes/arrows represent an increase/positive impact and the red boxes/arrows represent a decrease/negative impact. ROW, rest of world.

Source: Own elaboration

5 Social accounting matrix analysis

This section presents a description of the Kenyan economy, focusing on the agricultural and food value chains, based on the existing SAM, developed by the JRC. Well-known multi-sectoral analytical tools, such as linear multipliers, key sectors analysis, structural path analysis (SPA) and value chain participation, were used for this purpose.
This analysis helps to rank the relative importance of agricultural and food industry sectors in terms of growth and job generation, to determine key sectors of the Kenyan economy. Impacts on output, employment and value added, which are caused either directly (from final consumption in the same sector) or indirectly (from final consumption in other sectors) were then quantified. This analysis shows which value chains have the greatest impact in terms of output, employment and value added.

5.1 Multiplier and backward linkage analysis

The analysis of multipliers can provide an initial overview of the potential of economic sectors to generate output, employment and value added. Although assumptions are made to estimate the multipliers and therefore their exact values are subject to variability and must be taken with some caution, the validity and comparability of multiplier analysis and its usefulness in multi-sectoral qualitative analysis is clear, and its usefulness for the ex-ante evaluation of policies is significant.

By adding multiplier values by commodity columns and dividing by the average value for all sectors (using, in this case, domestic supply weights to avoid scale effects), we obtain what are termed 'backward linkages'. These provide a direct comparability among sectors on the capacity and potential to create wealth and employment. Table 2: and Table 3 show the values of multipliers and the backward linkages. In fact, the backward linkages are a simple transformation of the multiplier values, which allow a better comparison between sectors, but both measures can be used.

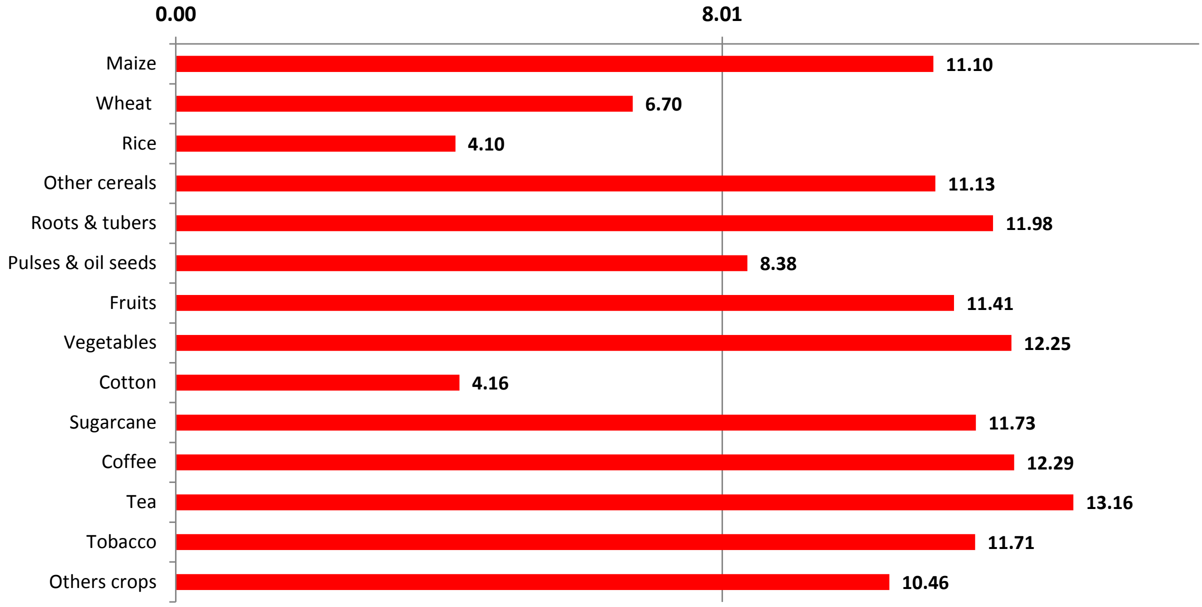
Focusing on the analysis on the backward linkages, maize multipliers clearly have values above the average among food crops, as is also the case for fruit and vegetables. On the other hand, wheat (0.70, 0.84 and 0.74) and, more significantly, rice (0.43, 0.51, and 0.45) have weaker impacts on the economy, in terms of production and employment, and value added. With regard to cash crops, **tea and coffee show values clearly greater than average**, particularly tea (1.21, 1.64 and 1.36). Sugarcane values are around average in terms of output (0.99) and value added (1.06), but are significantly higher for employment (1.46). Tobacco clearly surpasses the average employment value (1.46), but is less significant in terms of output (0.80) and value added (0.80). For cotton, values (0.36, 0.52 and 0.40) are significantly below the average.

Table 2: Linear multipliers and backward linkages of primary sector and food industry commodities, 2014

	Multipliers			Backward linkages		
	Output	Employment	Value added	Output	Employment	Value added
Maize	2.97	11.10	1.85	1.17	1.39	1.25
Wheat	1.79	6.70	1.10	0.70	0.84	0.74
Rice	1.10	4.10	0.66	0.43	0.51	0.45
Other cereals	3.01	11.13	1.88	1.19	1.39	1.27
Roots & tubers	3.17	11.98	1.98	1.25	1.49	1.33
Pulses & oil seeds	2.16	8.38	1.35	0.85	1.05	0.91
Fruits	3.12	11.41	1.96	1.23	1.42	1.32
Vegetables	3.17	12.25	1.97	1.25	1.53	1.33
Cotton	0.92	4.16	0.59	0.36	0.52	0.40
Sugarcane	2.52	11.73	1.57	0.99	1.46	1.06
Coffee	2.74	12.29	1.72	1.08	1.53	1.15
Tea	3.07	13.16	2.02	1.21	1.64	1.36
Tobacco	2.04	11.71	1.19	0.80	1.46	0.80
Other crops	3.09	10.46	2.06	1.22	1.30	1.39
Beef	3.15	17.30	1.95	1.24	2.16	1.31
Dairy	3.15	16.13	1.94	1.24	2.01	1.30
Poultry	2.98	17.58	1.85	1.17	2.19	1.24
Sheep, goat,…	3.08	16.78	1.88	1.21	2.09	1.26
Other livestock	3.12	17.10	1.90	1.23	2.13	1.28
Fishing	3.09	16.74	1.92	1.22	2.09	1.29
Forestry	2.86	12.43	1.95	1.13	1.55	1.31
Meat	2.99	10.51	1.43	1.18	1.31	0.96
Grain milling	2.77	9.01	1.33	1.09	1.12	0.89
Sugar & bakery …	2.52	9.99	1.50	0.99	1.25	1.01
Beverages/tobacco	2.82	10.14	1.67	1.11	1.27	1.12
Other manuf. food	1.89	9.07	1.09	0.74	1.13	0.74
Average / Global value	2.54	8.01	1.49	---	---	---

Source: Own elaboration

Figure 8: Employment multipliers for agricultural commodities (average: 8.01)



Source: Own elaboration

All livestock products show major backward linkages in Kenya's economy. In all cases, values are higher than average, that is, in terms of output (around 1.2), value added (around 1.3) and, especially, employment, where they are double the average. This is also the case for the fishing and forestry sectors, although in the latter the employment multiplier is 1.55 times the average.

As regards the agri-food industry sectors, value added values are around the average (with meat, grain milling and other manufactured foods below the average), and are very close to the average in terms of output, although the backward linkages are noteworthy in employment, at around 1.3 (excluding grain milling, which is 1.12).

One important issue is the fact that **employment multipliers (and therefore the backward linkages) of livestock commodities (including fisheries) are much higher than food and cash crops, as well as other sectors of the economy**. Livestock products generate a greater production of all the primary sectors, thus obtaining a greater multiplier effect. In addition, the main activities linked to livestock activities present a much higher intensity in the use of the labour factor (measured as jobs per unit of output) than that of crops. This intensity is caused not only by the characteristics of the sector, but also by its close links with small farms' economies that combine several agricultural activities, expanding the effect on the employment of these activities.

For the other sectors of the economy of Kenya, the multipliers of the 'manufactures commodities' are lower than the average, with backward linkages of less than 1 for output and employment, and value added. 'Construction' is slightly above the average in terms of output and value added, but only 0.79 for employment. Something similar is observed for the services sectors, although with slightly higher values. Only trade, which is almost twice the global average, and 'other services' show linkages of employment above the unit.

Table 3: Linear multipliers and backward linkages of manufactures, services and other sector commodities, 2014

	Multipliers			Backward linkages		
	Output	Employment	Value added	Output	Employment	Value added
Mining	1.67	3.88	0.93	0.66	0.48	0.63
Textile & clothing	0.87	3.39	0.45	0.34	0.42	0.30
Leather & footwear	1.88	4.55	0.88	0.74	0.57	0.59
Wood & paper	1.91	5.27	0.89	0.75	0.66	0.60
Printing – publishing	1.47	3.66	0.67	0.58	0.46	0.45
Petroleum	0.54	1.25	0.22	0.21	0.16	0.15
Chemicals	0.51	1.50	0.24	0.20	0.19	0.16
Fertilisers	0.79	2.19	0.41	0.31	0.27	0.28
Metals and machinery	0.53	1.46	0.22	0.21	0.18	0.15
Non-metallic products	1.98	4.32	1.19	0.78	0.54	0.80
Other manufactures	1.33	4.40	0.64	0.52	0.55	0.43
Water	3.12	9.09	1.89	1.23	1.13	1.27
Electricity	2.49	4.54	1.43	0.98	0.57	0.96
Construction	2.70	5.70	1.38	1.06	0.71	0.93
Trade	2.74	14.29	1.57	1.08	1.78	1.05
Hotels	2.47	6.54	1.36	0.97	0.82	0.92
Transport	2.72	5.91	1.66	1.07	0.74	1.12
Communication	3.10	6.33	1.46	1.22	0.79	0.98
Finance	2.90	6.25	1.66	1.14	0.78	1.11
Real estate	2.51	4.62	1.79	0.99	0.58	1.21
Other services	2.82	11.31	1.78	1.11	1.41	1.20
Administration	2.71	5.74	1.59	1.07	0.72	1.07
Health	2.86	6.10	1.71	1.12	0.76	1.15
Education	3.03	7.04	1.84	1.19	0.88	1.24
Average / Global value	2.54	8.01	1.49	---	---	---

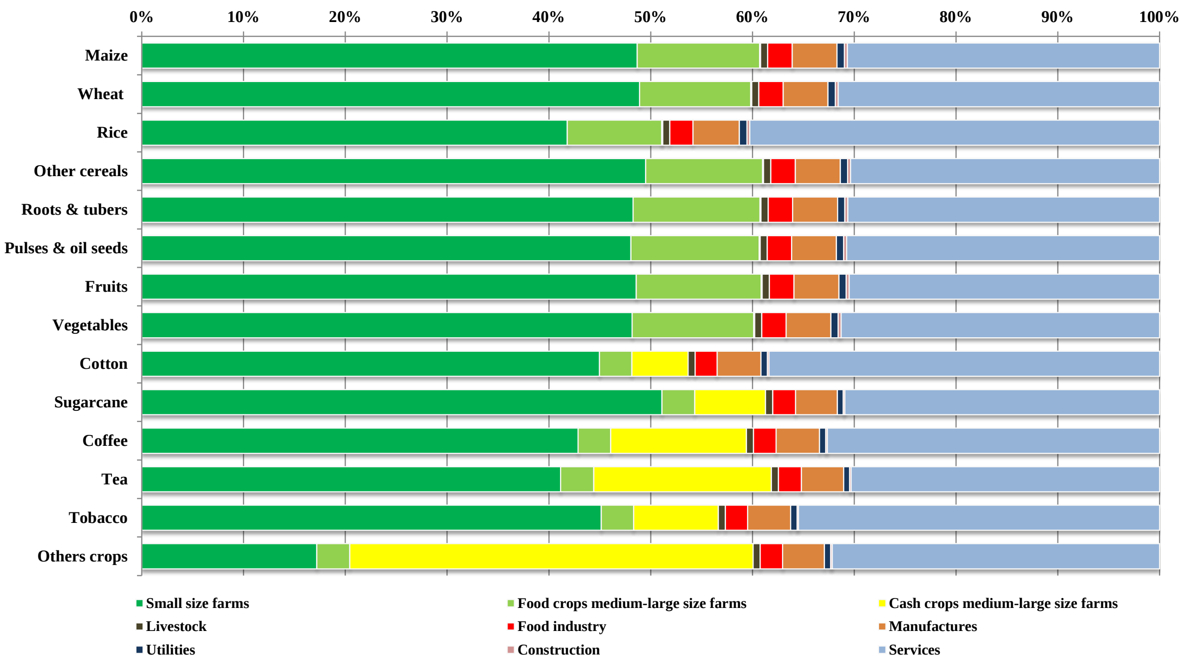
Source: Own elaboration

5.2 Value chain analysis

The analysis of the value chain of a product provides information about the activities that ultimately benefit, either directly or indirectly, from an exogenous increase in demand for a specific commodity. The increase in the exogenous demand for a product or service and the domestic production needed for its supply, irrespective of the quantity imported, propels not only the direct demand of factors of production needed to produce a given product (which forms what might be called the ‘direct added value effect’), but also the demand for intermediate inputs in other sectors. Domestically produced inputs have their own demand of factors and intermediate inputs in an endless cycle that results in the embodied value added, linked to any exogenous demand injection. In this way, we obtain information on how economic shocks in one sector can directly impact the same sector or indirectly impact other, related sectors.

It is particularly interesting to analyse this distribution in the primary sector because of its relevance to Kenya’s economy. **The value added generated in Kenya’s economy by agricultural products essentially remains in the agricultural sectors themselves**, with rates of around 60%. However, it is very significant that around 30% of the total value added is created in the services sectors. This value increases to reach almost 40% for some cash crops. The relative importance of the trade and distribution sectors for such products explains why such an important share of value added is indirectly created in the services sectors.

Figure 8: Distribution by groups of activities of embodied value added in agricultural commodity demand, 2014



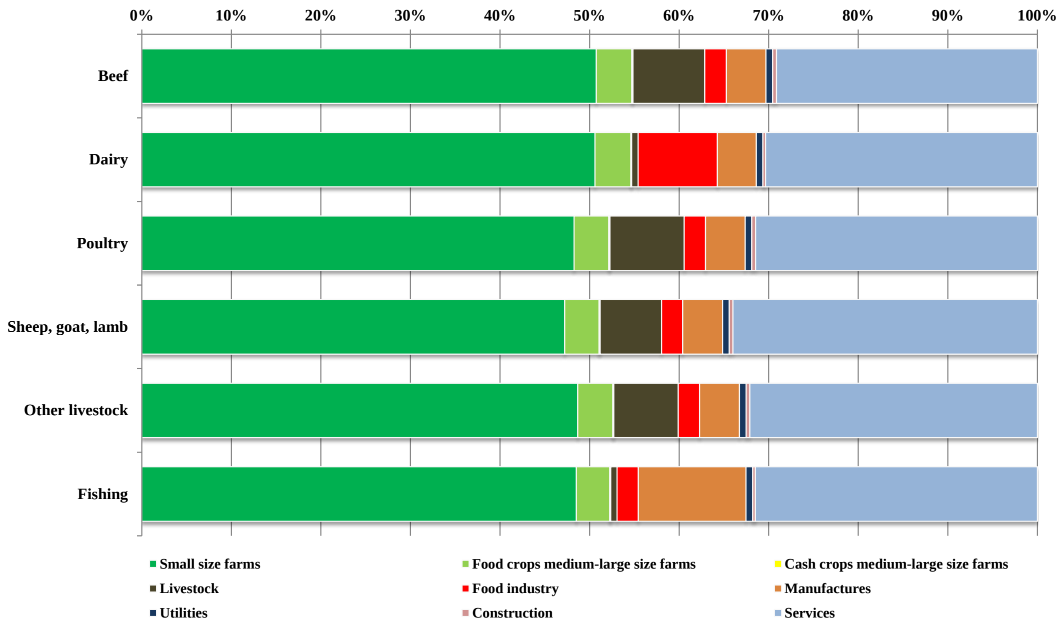
Source: Own elaboration

For food crops, about 50% of the value added generated is allocated to small farms (family farms or farms with some degree of cooperative), with the exception of rice cultivation, where this rate is just above 40%. The rest of the value added embodied in primary sectors (around 10%) is allocated to large or medium-sized farms, with shares of over 5% for manufacturing.

For **cash crops**, although the total percentage for the primary sector is similar to other agricultural sectors, significant differences are observed in the distribution rates of their value added. **In the production of cash crops, a greater share of value added is allocated to large agricultural farms**, to the detriment of small farms. This more unequal distribution of value added between large and small farms for cash crops results from the typology of the product; it is particularly significant that, in Kenya, except for the crops listed in ‘other crops’, a major participation of small farms in value added is maintained. This pattern can be explained by the specific characteristics of Kenyan products, such as tea and coffee, where small farms cultivate the product for larger companies, which then process that product for subsequent use in the food industry.

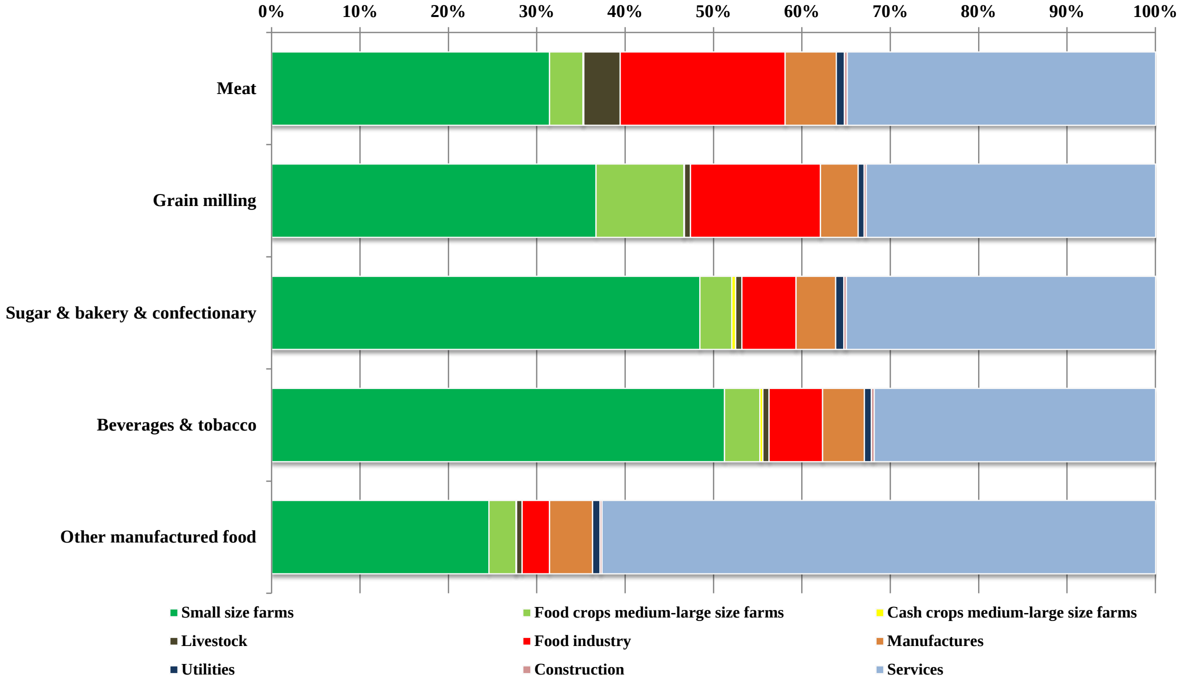
For livestock products and fisheries, the contribution of the primary sector as a whole is between 55% and 60%, and it is particularly relevant that the majority of the embodied value added (over 50%) is allocated to small farms, while the proportion allocated to commercial farms is between 5% and 10% in terms of livestock and slightly less than 5% in terms of food crops. Again, the services sectors' share in value added is greater than 30%.

Figure 9: Distribution by groups of activities of embodied value added in livestock commodity demand, 2014



Source: Own elaboration

Figure 10: Distribution by groups of activities of embodied value added in food industry commodity demand, 2014



Source: Own elaboration

In the agri-food industry, meat demand generates around 40% of its embodied value added in the primary sector, with a participation of more than 30% of small agricultural activities, while 5% is allocated to livestock farms. The meat sector allocates slightly more than 18% of the produced value added to itself, with more than one third of the total going into services.

Small farms have increased their participation in terms of the main processed products (bakery, beverages and tobacco), to the detriment of the agri-food industry and food crop holdings. However, all the goods included in 'other manufactured food' generate more than 60% of their embodied value added in the services sector, not reaching 30% agricultural products and with low participation of the agri-food industry.

Finally, in all other sectors of the economy, a very significant proportion of the embodied value added is allocated to services. This proportion is obviously even greater for the services sectors themselves. Manufactures and construction sectors' own weights vary between 25% and 40%. It is necessary to highlight, as for services, the relatively high (between 15% and 20%) contribution of the primary sector, especially small farms, to total value added generated by manufacturing and services activities, resulting from the significant weight in the total production and the income of the farming and food sectors.

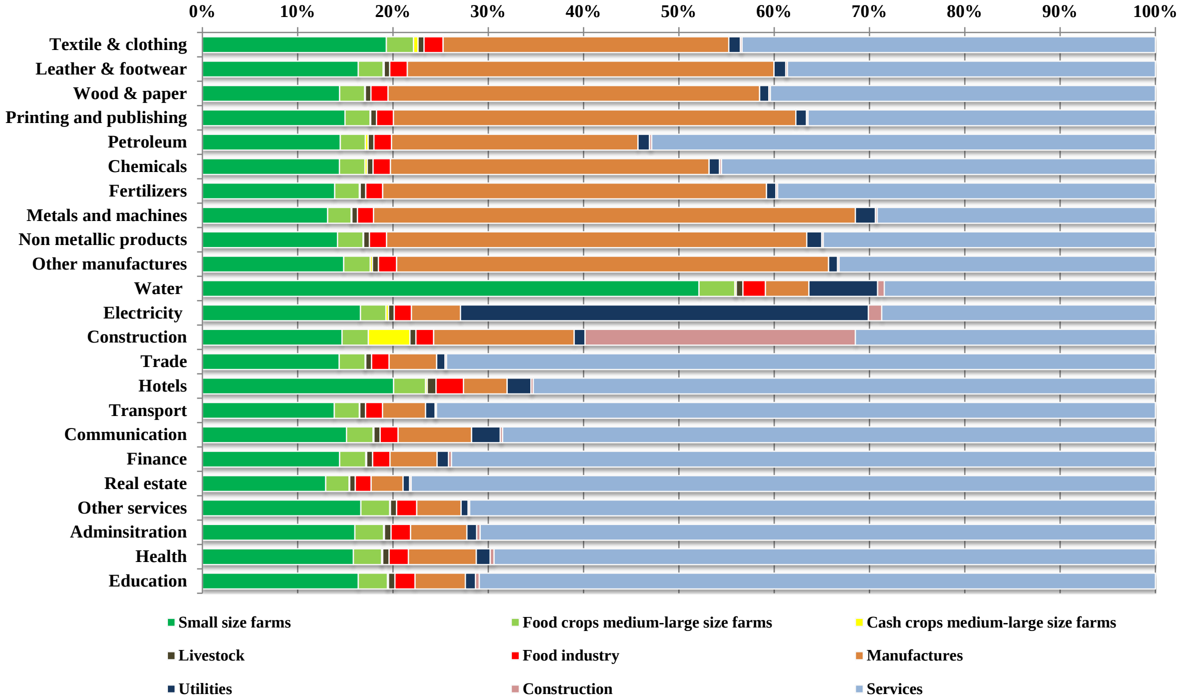
An additional extension of the value chain analysis is the estimation of the number of jobs generated by exogenous shocks both directly and indirectly. In the case of Kenya, **the distribution of employment embodied in final demand is similar to that of the value added** with some very significant differences(2):

2 It is necessary to keep in mind that, here, embodied values are quantified. They do not reflect the direct effects but, rather, the effects generated through the value chain of the economy and its inter-sectoral linkages. In the case of agricultural or food commodities, the productive chains produce the main backward effects on activities (small or medium-sized farms) that, although having similar ratios of value added to output, use very different intensities of labour (measured as 'jobs per unit of output'). It must also be considered that the employment measured corresponds to jobs, not to their remuneration (which is the part

- In general, large farms account for a larger share of employment generation, most notably in relation to agricultural products for export.
- The participation of livestock farming in employment embodied in the demand for primary commodities is much more significant, especially in terms of livestock products (contrary to what is observed for added value).
- The previous point also applies, albeit to a lesser extent, to the agri-food industry, particularly in terms of dairy products and, to a lesser extent, processed foodstuffs.
- The share of employment allocated to the services sector is generally smaller than it is for value added.

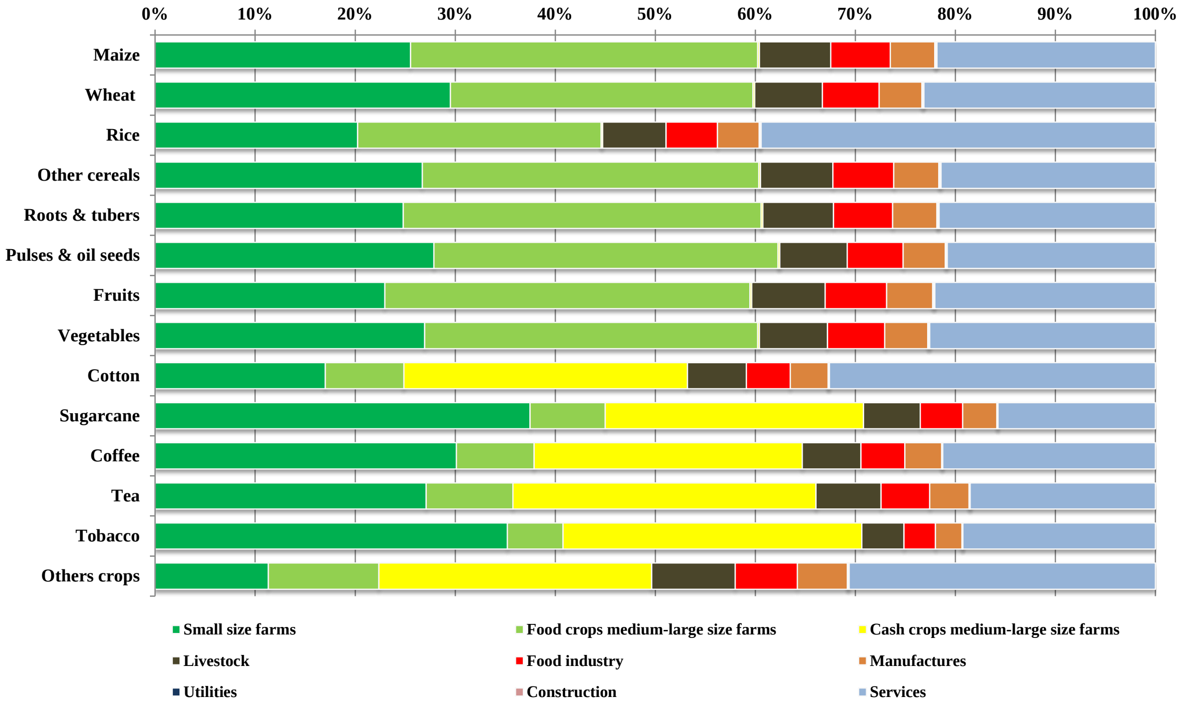
of the labour considered as part of the value added). In small farms, most of the employment corresponds to the owners of the farms that receive most of the added value.

Figure 11: Distribution by groups of activities of embodied value added in rest of sectors commodities demand, 2014



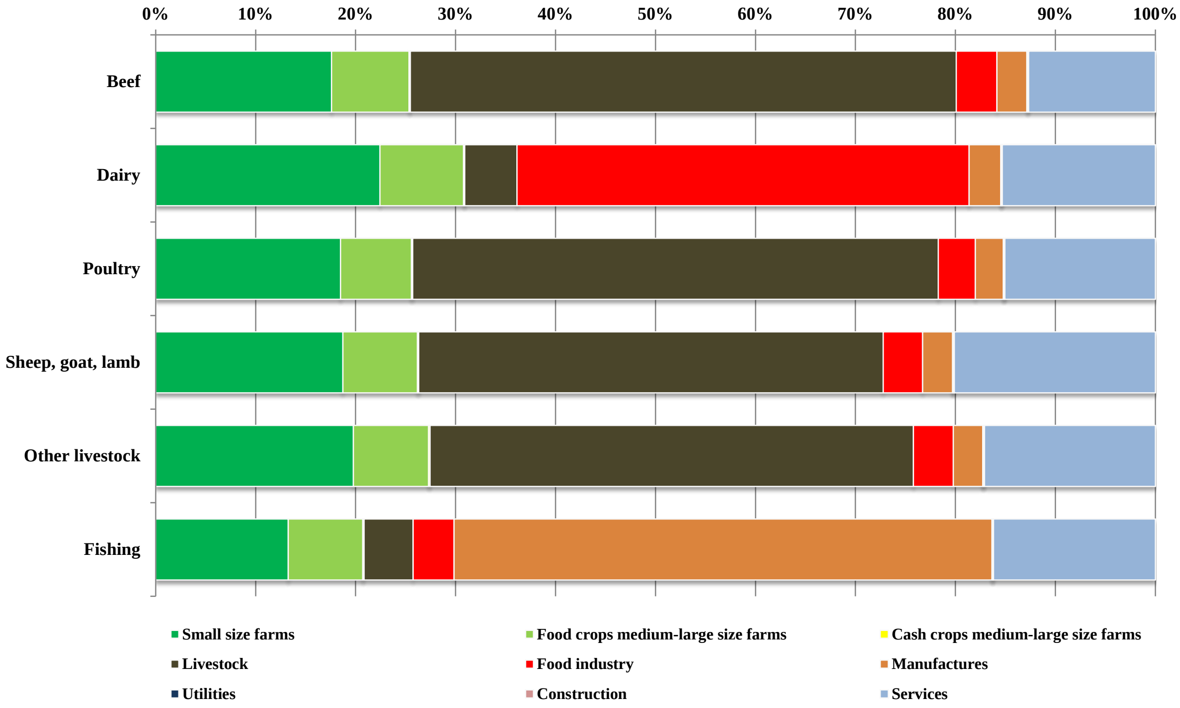
Source: Own elaboration

Figure 12: Distribution by groups of activities of embodied employment in agricultural commodities demand, 2014



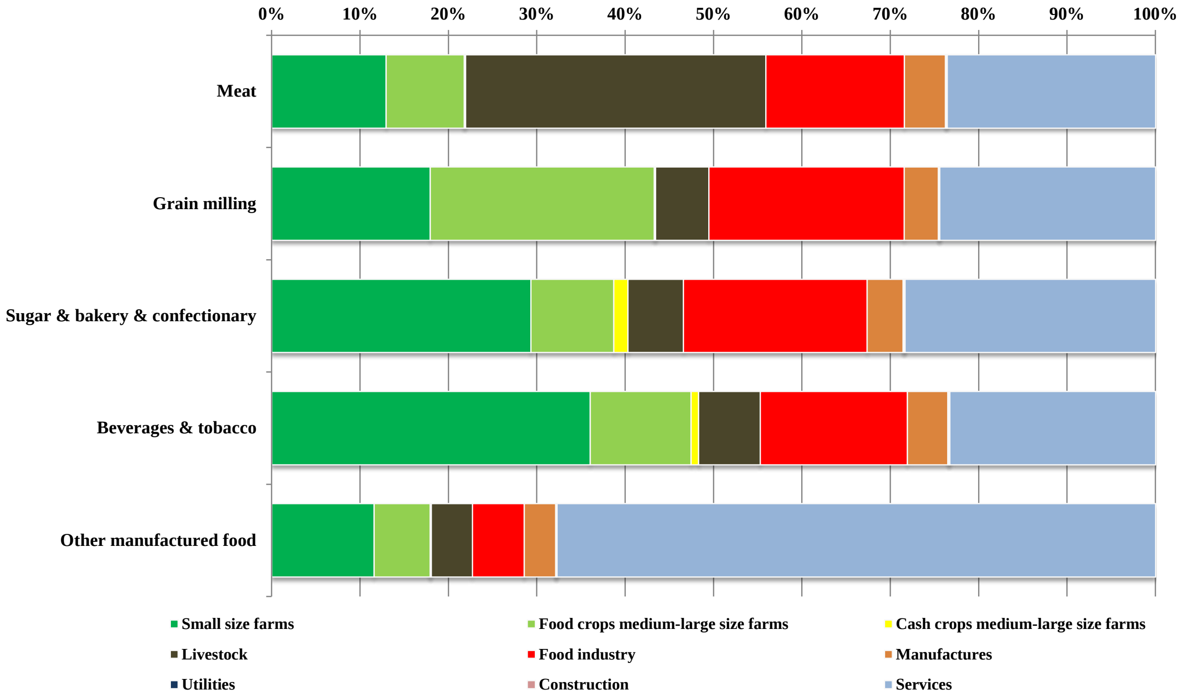
Source: Own elaboration

Figure 13: Distribution by groups of activities of embodied employment in livestock commodities demand, 2014



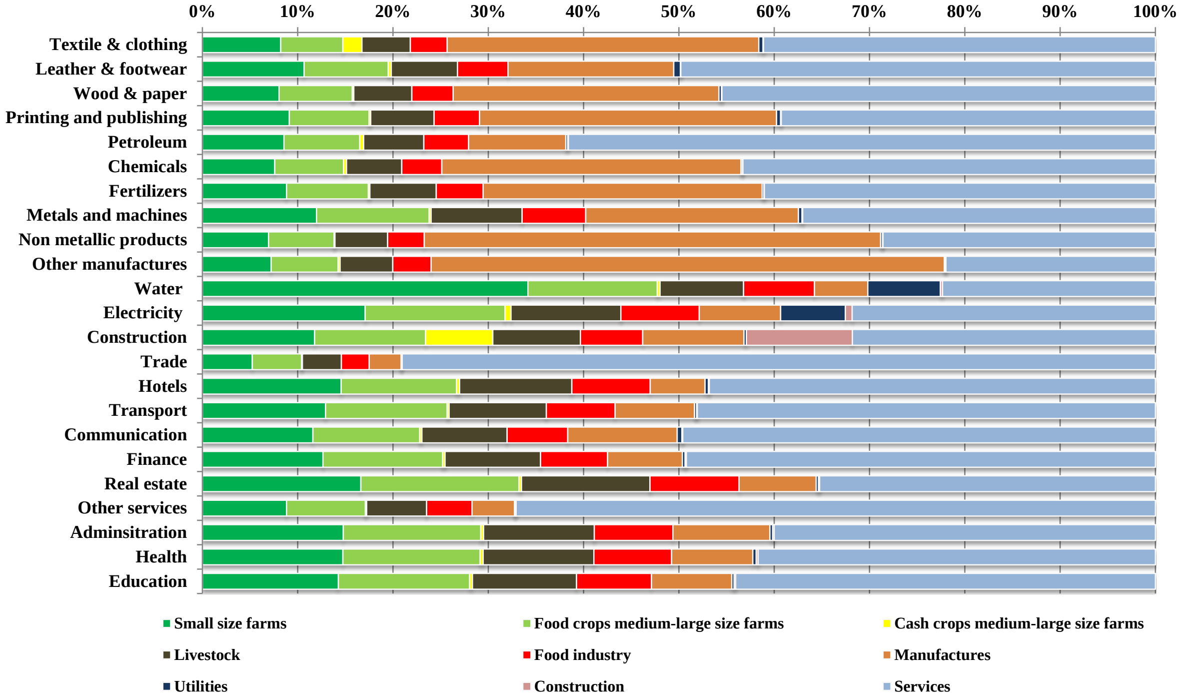
Source: Own elaboration

Figure 14: Distribution by groups of activities of embodied employment in food industry commodities demand, 2014



Source: Own elaboration

Figure 15: Distribution by groups of activities of embodied value added for other sectors' commodity demand, 2014



Source: Own elaboration

5.3 Structural path analysis

The multiplier and value chain analysis is complemented by a more detailed description of the transmission mechanisms of the described effects. This can be done by applying SPA. Using this technique, the effects between commodity demand and the generated value (output, employment, value added, etc.) can be decomposed between the different paths that link both accounts. For Kenya's economy, the main paths have been calculated for each of the outputs (these links can be extended to employment and value added) and for income multipliers. Those corresponding to the highest multipliers generated by agricultural and food commodity demand are presented below.

Table 4**:** shows how possible shocks in **tea demand (either through investment exports or in other ways) would generate the largest increases in the income of rural households in Kenya (global multiplier effect of 1.63)**. This global effect comes from the confluence of several transmission paths, including those presented in the table, that together show 76% of the overall effect (the remaining 24% is given by the infinity of different paths with less specific weight). Thus, it can be seen that 40.9% of the overall effect (1.63) of tea demand on the income of these households is given through a mechanism of this type: the demand for tea induces an increase in the production of this commodity by rural households (considered as small farms) that causes a higher remuneration of the land factor, which assumes an increase in the income of this type of household.

As shown in Table 4**:** , **other crops, beef, roots and tubers, and dairy products are the commodities that have the greatest effect on the income of rural households**. Transmission mechanisms can be generalised, with a greater or lesser contribution to the overall effect, in terms of the initial effect on the output, either of households as producers (small farms) or the activities themselves (medium-large farms). Finally, this increase has an impact on the income of rural households either through remuneration to capital or land use or through the payment of labour factor. In general, the main paths described in Table 4 cover 60-70% of the global effects in each case, with the remaining 30-40% defined by other indirect means.

With regard to urban households (Table 5**:**), agricultural or food commodities whose demand could generate greater increases in household incomes, are those derived from forestry, other crops and fishing, with multipliers of 1.19, 0.93 and 0.93, respectively. The transmission paths are mainly defined by increases in the output (from households as producers or from corporate activities themselves) that result in increases in household income through the remuneration of capital and labour factors. However, unlike in the case of rural households, the effects are blurred between a greater number of indirect paths, describing only the sum of the most significant 30% of the overall effects (except for forestry, where they represent 64.7% of the total).

Finally, Table 6**:** shows the main effects of the demands for agricultural and food commodities and these kinds of activities. The results show direct relationships between commodities and activities, with direct correspondence, either as households (small farms) or as corporate activities themselves (medium-large farms). However, the effects of the 'demand for processed food and livestock' on 'crops of all types' are also notable, although these effects are relatively small.

Table 4: Main effects of agricultural and food commodities on rural households income

Global effects (multipliers)		Pole 1		Pole 2		Pole 3		Pole 4	Total effect	% total / global
Tea	**1.63**	Tea	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.666	40.9%
		Tea	--->	Tea (activ.)	--->	Land non-irrigated	--->	Rural HH	0.473	29.0%
		Tea	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.047	2.9%
		Tea	--->	Tea (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.030	1.8%
		Tea	--->	Tea (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.028	1.7%
Others crops	**1.62**	Others crops	--->	Others crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.989	61.1%
		Others crops	--->	Others crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.138	8.5%
Beef	**1.60**	Beef	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.675	42.2%
		Beef	--->	Livestock (activ.)	--->	Livestock	--->	Rural HH	0.203	12.7%
		Beef	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.188	11.7%
		Beef	--->	Livestock (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.062	3.9%
		Beef	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.051	3.2%
Roots & tubers	**1.59**	Roots & tubers	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.600	37.8%
		Roots & tubers	--->	Food crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.317	19.9%
		Roots & tubers	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.167	10.5%
		Roots & tubers	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.045	2.9%
		Roots & tubers	--->	Food crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.022	1.4%
Dairy	**1.58**	Dairy	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.661	41.9%
		Dairy	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.184	11.7%
		Dairy	--->	Dairy (activ.)	--->	Livestock	--->	Rural HH	0.182	11.5%
		Dairy	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.050	3.2%
		Dairy	--->	Dairy (activ.)	--->	Unskilled labour	--->	Rural HH	0.027	1.7%
Fruits	**1.57**	Fruits	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.633	40.4%
		Fruits	--->	Food crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.278	17.7%
		Fruits	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.176	11.2%
		Fruits	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.048	3.1%
		Fruits	--->	Food crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.020	1.2%
Vegetables	**1.57**	Vegetables	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.620	39.6%
		Vegetables	--->	Food crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.263	16.8%
		Vegetables	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.173	11.0%
		Vegetables	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.047	3.0%
		Vegetables	--->	Food crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.019	1.2%
Other livestock	**1.53**	Other livestock	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.608	39.7%
		Other livestock	--->	Livestock (activ.)	--->	Livestock	--->	Rural HH	0.172	11.2%
		Other livestock	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.169	11.0%
		Other livestock	--->	Livestock (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.053	3.5%
		Other livestock	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.046	3.0%
Sheep, goat and lamb for slaughter	**1.50**	Sheep, goat and l	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.568	37.8%
		Sheep, goat and l	--->	Livestock (activ.)	--->	Livestock	--->	Rural HH	0.160	10.6%
		Sheep, goat and l	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.158	10.5%
		Sheep, goat and l	--->	Livestock (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.049	3.3%
		Sheep, goat and l	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.043	2.9%
Fishing	**1.49**	Fishing	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.636	42.5%
		Fishing	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.177	11.8%
		Fishing	--->	Fishing (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.088	5.9%
		Fishing	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.048	3.2%
		Fishing	--->	Fishing (activ.)	--->	Unskilled labour	--->	Rural HH	0.027	1.8%
		Fishing	--->	Fishing (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.023	1.6%
Poultry	**1.49**	Poultry	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.566	37.9%
		Poultry	--->	Livestock (activ.)	--->	Livestock	--->	Rural HH	0.201	13.5%
		Poultry	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.157	10.5%
		Poultry	--->	Livestock (activ.)	--->	Semi-Skilled Labour	--->	Rural HH	0.062	4.2%
		Poultry	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.043	2.9%
Other cereals	**1.49**	Other cereals	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.625	41.9%
		Other cereals	--->	Food crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.230	15.4%
		Other cereals	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.174	11.6%
		Other cereals	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.047	3.2%
		Other cereals	--->	Food crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.016	1.1%
Maize	**1.46**	Maize	--->	Households as acitiv.	--->	Land non-irrigated	--->	Rural HH	0.592	40.4%
		Maize	--->	Food crops (activ.)	--->	Land non-irrigated	--->	Rural HH	0.251	17.1%
		Maize	--->	Households as acitiv.	--->	Livestock	--->	Rural HH	0.165	11.3%
		Maize	--->	Households as acitiv.	--->	Capital (agricultural)	--->	Rural HH	0.045	3.1%
		Maize	--->	Food crops (activ.)	--->	Capital (agricultural)	--->	Rural HH	0.018	1.2%

Source: Own elaboration

Table 5: Main effects of agricultural and food commodities on urban households income

Global effects (multipliers)		Pole 1		Pole 2		Pole 3		Pole 4	Total effect	% total / global
Forestry	**1.19**	Forestry	--->	Forestry (activ.)	--->	Capital (agricultural)	--->	Urban HH	0.740	62.0%
		Forestry	--->	Forestry (activ.)	--->	Semi-Skilled Labour	--->	Urban HH	0.032	2.7%
Others crops	**0.93**	Others crops	--->	Others crops (activ.)	--->	Capital (agricultural)	--->	Urban HH	0.213	22.8%
		Others crops	--->	Others crops (activ.)	--->	Land non-irrigated	--->	Urban HH	0.082	8.8%
Fishing	**0.93**	Fishing	--->	Fishing (activ.)	--->	Capital (agricultural)	--->	Urban HH	0.135	14.5%
		Fishing	--->	Households as acitivities	--->	Capital (agricultural)	--->	Urban HH	0.092	9.9%
		Fishing	--->	Households as acitivities	--->	Land non-irrigated	--->	Urban HH	0.056	6.0%
		Fishing	--->	Fishing (activ.)	--->	Unskilled labour	--->	Urban HH	0.018	1.9%
		Fishing	--->	Households as acitivities	--->	Livestock	--->	Urban HH	0.014	1.5%
		Fishing	--->	Fishing (activ.)	--->	Semi-Skilled Labour	--->	Urban HH	0.010	1.1%
Sheep, goat and laml	**0.87**	Sheep, goat and lamb (slaughter)	--->	Households as acitivities	--->	Capital (agricultural)	--->	Urban HH	0.082	9.4%
		Sheep, goat and lamb (slaughter)	--->	Households as acitivities	--->	Land non-irrigated	--->	Urban HH	0.050	5.7%
		Sheep, goat and lamb (slaughter)	--->	Livestock (activ.)	--->	Semi-Skilled Labour	--->	Urban HH	0.022	2.5%
		Sheep, goat and lamb (slaughter)	--->	Households as acitivities	--->	Livestock	--->	Urban HH	0.012	1.4%
		Sheep, goat and lamb (slaughter)	--->	Livestock (activ.)	--->	Livestock	--->	Urban HH	0.011	1.2%
Dairy	**0.87**	Dairy	--->	Households as acitivities	--->	Capital (agricultural)	--->	Urban HH	0.096	11.0%
		Dairy	--->	Households as acitivities	--->	Land non-irrigated	--->	Urban HH	0.058	6.7%
		Dairy	--->	Dairy (activ.)	--->	Unskilled labour	--->	Urban HH	0.018	2.1%
		Dairy	--->	Households as acitivities	--->	Livestock	--->	Urban HH	0.014	1.7%
		Dairy	--->	Dairy (activ.)	--->	Livestock	--->	Urban HH	0.012	1.4%

Source: Own elaboration

Table 6: Main effects of agricultural and food commodities on agricultural output

Global effects (multipliers)				Pole 1		Pole 2		Pole 3		Pole 4	Total effect	% total / global
Others crops	--->	**Others crops (activ.)**	**0.96**	Others crops	--->	Others crops (activ.)					0.956	100.0%
Grain milling	--->	**Grain milling (activ.)**	**0.95**	Grain milling	--->	Grain milling (activ.)					0.955	100.0%
Forestry	--->	**Forestry (activ.)**	**0.80**	Forestry	--->	Forestry (activ.)					0.801	100.0%
Sugarcane	--->	**Households as acitivi**	**0.73**	Sugarcane	--->	Households as acitivities					0.730	100.0%
Tea	--->	**Households as acitivi**	**0.64**	Tea	--->	Households as acitivities					0.639	99.8%
Coffee	--->	**Households as acitivi**	**0.60**	Coffee	--->	Households as acitivities					0.598	99.8%
Tobacco	--->	**Households as acitivi**	**0.50**	Tobacco	--->	Households as acitivities					0.504	99.9%
Tea	--->	**Tea (activ.)**	**0.40**	Tea	--->	Tea (activ.)					0.396	100.0%
Roots & tubers	--->	**Food crops (activ.)**	**0.39**	Roots & tubers	--->	Food crops (activ.)					0.318	81.7%
Fruits	--->	**Food crops (activ.)**	**0.35**	Fruits	--->	Food crops (activ.)					0.281	80.2%
Vegetables	--->	**Food crops (activ.)**	**0.34**	Vegetables	--->	Food crops (activ.)					0.263	76.7%
Maize	--->	**Food crops (activ.)**	**0.32**	Maize	--->	Food crops (activ.)					0.262	81.9%
Coffee	--->	**Coffee (activ.)**	**0.32**	Coffee	--->	Coffee (activ.)					0.317	100.0%
Other cereals	--->	**Food crops (activ.)**	**0.31**	Other cereals	--->	Food crops (activ.)					0.226	73.2%
Beef	--->	**Livestock (activ.)**	**0.24**	Beef	--->	Livestock (activ.)					0.237	97.1%
Poultry	--->	**Livestock (activ.)**	**0.24**	Poultry	--->	Livestock (activ.)					0.226	93.1%
Dairy	--->	**Dairy (activ.)**	**0.23**	Dairy	--->	Dairy (activ.)					0.228	100.0%
Pulses & oil seeds	--->	**Food crops (activ.)**	**0.22**	Pulses & oil seeds	--->	Food crops (activ.)					0.180	80.6%
Cotton	--->	**Households as acitivi**	**0.22**	Cotton	--->	Households as acitivities					0.215	99.8%
Beverages & tobacco	--->	**Beverages & tobacco**	**0.22**	Beverages & tobacco	--->	Beverages & tobacco (activ.)					0.215	100.0%
Other livestock	--->	**Livestock (activ.)**	**0.21**	Other livestock	--->	Livestock (activ.)					0.193	91.4%
Sheep, goat and lamb (slaughter)	--->	**Livestock (activ.)**	**0.20**	Sheep, goat and lamb (slaughter)	--->	Livestock (activ.)					0.181	91.5%
Fishing	--->	**Fishing (activ.)**	**0.20**	Fishing	--->	Fishing (activ.)					0.198	100.0%
Grain milling	--->	**Food crops (activ.)**	**0.18**	Grain milling	--->	Grain milling (activ.)	--->	Maize	--->	Food crops (activ.)	0.069	38.5%
				Grain milling	--->	Grain milling (activ.)	--->	Wheat	--->	Food crops (activ.)	0.035	19.5%
				Grain milling	--->	Grain milling (activ.)	--->	Other cereals	--->	Food crops (activ.)	0.016	8.9%
Sugar & bakery	--->	**Sugar & bakery & cor**	**0.17**	Sugar & bakery	--->	Sugar & bakery (activ.)					0.167	100.0%
Tobacco	--->	**Tobacco (activ.)**	**0.16**	Tobacco	--->	Tobacco (activ.)					0.163	100.0%
Sugarcane	--->	**Sugarcane (activ.)**	**0.16**	Sugarcane	--->	Sugarcane (activ.)					0.162	100.0%
Wheat	--->	**Food crops (activ.)**	**0.15**	Wheat	--->	Food crops (activ.)					0.104	70.0%
Meat & dairy	--->	**Grain milling (activ.)**	**0.15**	Meat & dairy	--->	Meat & dairy (activ.)	--->	Grain milling	--->	Grain milling (activ.)	0.081	55.4%
Dairy	--->	**Food crops (activ.)**	**0.12**	Dairy	--->	Dairy (activ.)	--->	Maize	--->	Food crops (activ.)	0.008	6.6%
Beef	--->	**Food crops (activ.)**	**0.12**	Beef	--->	Livestock (activ.)	--->	Maize	--->	Food crops (activ.)	0.006	4.7%
Other livestock	--->	**Food crops (activ.)**	**0.12**	Other livestock	--->	Livestock (activ.)	--->	Maize	--->	Food crops (activ.)	0.005	4.0%
Sheep, goat and lamb (slaughter)	--->	**Food crops (activ.)**	**0.11**	Sheep, goat and lamb (slaughter)	--->	Livestock (activ.)	--->	Maize	--->	Food crops (activ.)	0.004	3.8%
Beverages & tobacco	--->	**Food crops (activ.)**	**0.11**	Beverages & tobacco	--->	Beverages & tobacco (activ.)	--->	Fruits	--->	Food crops (activ.)	0.006	5.2%
Poultry	--->	**Food crops (activ.)**	**0.11**	Poultry	--->	Livestock (activ.)	--->	Maize	--->	Food crops (activ.)	0.005	4.8%
Beverages & tobacco	--->	**Grain milling (activ.)**	**0.11**	Beverages & tobacco	--->	Beverages & tobacco (activ.)	--->	Grain milling	--->	Grain milling (activ.)	0.011	10.4%

Source: Own elaboration

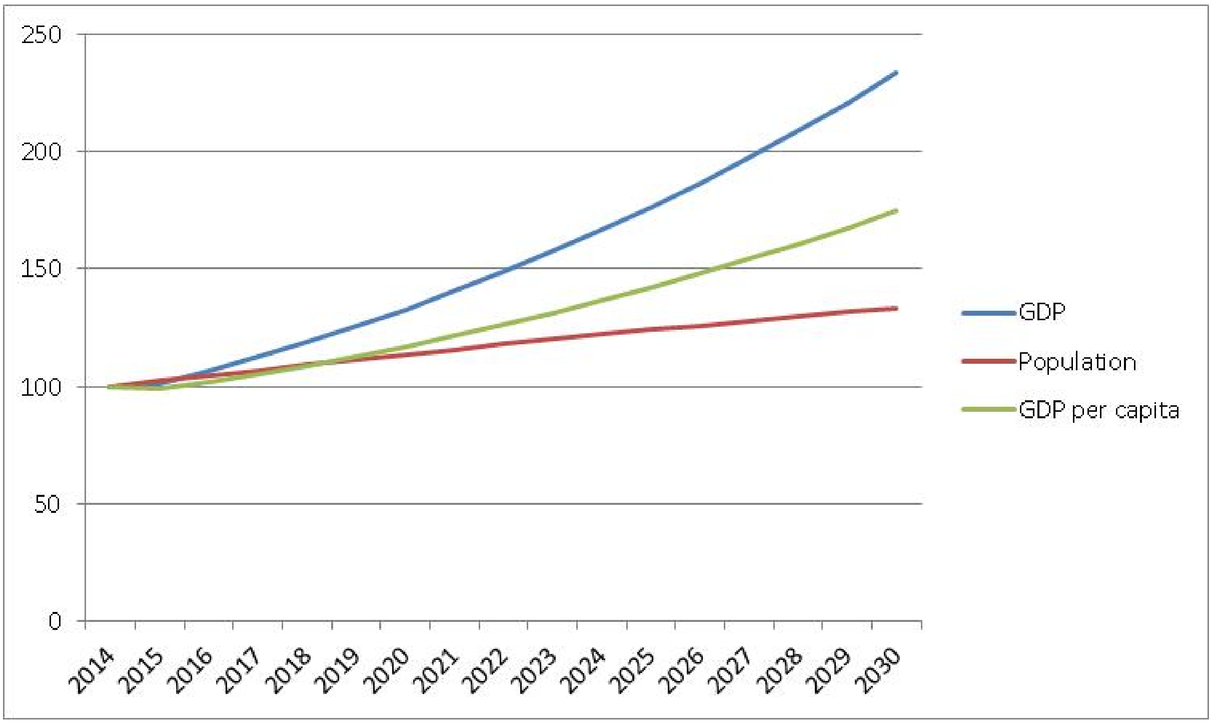
6 Computable general equilibrium model analysis

This section sheds some light on the baseline, prior to the presentation of the results from the recursive dynamic CGE model.

6.1 Baseline

The baseline is calibrated from shared socioeconomic pathways (SSPs), specifically SSP2 (Riahi et al., 2017), the so-called middle-of-the-road scenario. **Two main macroeconomic developments (GDP and population) derived from SSP2 are exogenously imposed in the model**. Until 2018, we impose the real GDP growth observed: 5.7%, 5.8%, and 5.5% for 2015, 2016 and 2017 respectively. Then we impose 5.47% GDP growth for the period 2018-2020 and 5.81% for the period 2021-2030. The population growth is assumed to be 2.26% for 2014-2020 and 1.81% for 2021-2030. GDP in 2030 will be almost 2.5 times greater than in 2014, while population will increase by only 1.5 times, allowing a significant increase in per capita GDP (more than 1.5 times the 2014 level) (Figure 16).

Figure 16: GDP, GDP per capita and population index, baseline, 2014 = 100



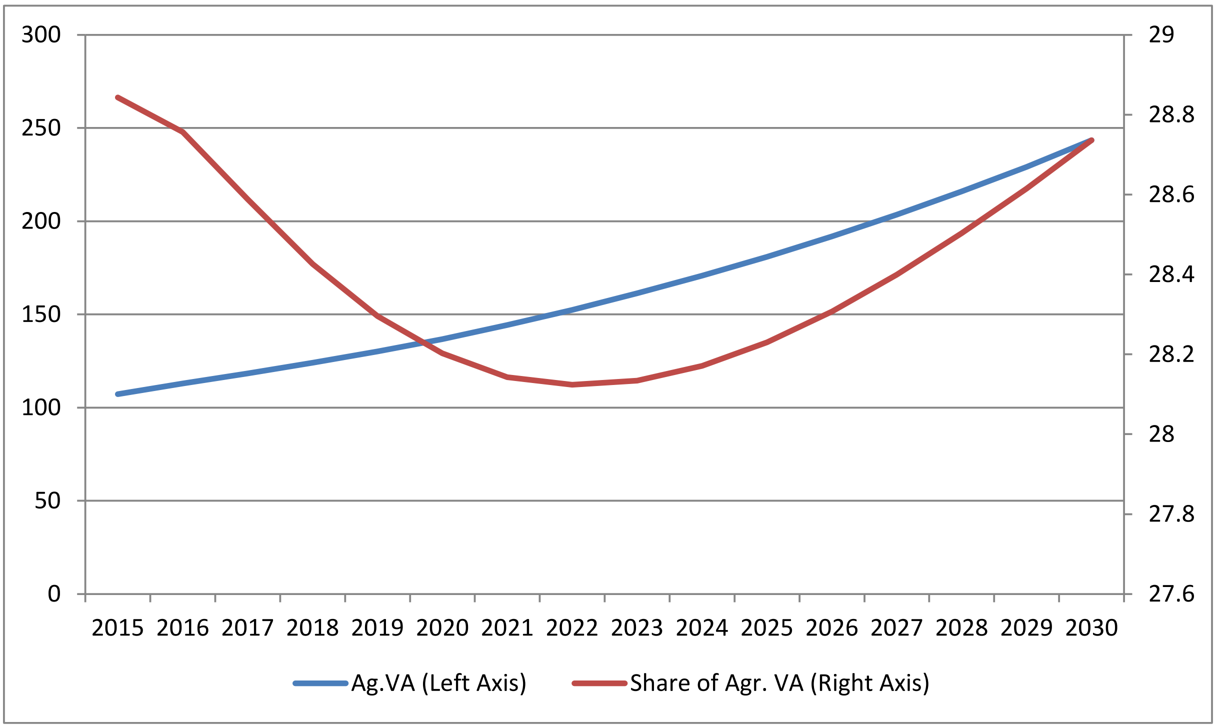
Source: Riahi et al., 2017

In the scenarios, GDP becomes endogenous while a productivity parameter (namely the shift parameter on CES functions for value added) employed to calibrate GDP becomes exogenous. That is, the change in the productivity parameter to replicate the SSP GDP growth in the baseline is imposed exogenously on the model in the scenarios. Thus, the difference in the GDP from baseline is due to policy change in the scenarios.

In addition, in the baseline, the investment is fixed and follows the same rate of growth as GDP (while savings are adjusted endogenously). At the same time, government savings (which, in the case of Kenya, are currently a dissaving or a deficit, are calculated as government income minus total government expenditure) and the current account balance (calculated as imports minus exports minus net transfers from the rest of the world to the country being analysed) are kept as a fixed share of GDP. This means that, given the dynamic of the Kenyan GDP projected in the baseline, government deficit and the current account balance increase in nominal terms but keep a constant ratio with the GDP.

Agricultural value added (endogenously calculated) follows the general growth trend of the GDP but its share in total value added declines by almost 1 percentage point, from 28.6% to 27.6%, by 2025 and then starts to recover. This is because of the evolution of the population over time: there is a flow of migration from rural areas to urban areas based on the income difference and the difference in the per capita spending on health and education. Based on the GDP and population growth assumed for the baseline, the flow starts to slow down after 2025 and the rural population and labour force starts to grow faster. In other words, without any change in policies, the Kenyan rural population is likely to decrease as a result of migration, but the model results suggest that migration due to economic factors is likely to be balanced over time, as newcomers to urban areas would cause a decrease in urban wage rates and per capita public and education spending, which would be reflected in the share of agricultural value added in total value added.

Figure 17: Agricultural value added (left-hand scale) and its share in total value added (right-hand scale), baseline, 2014 = 100



Source: Model results

6.2 Agricultural markets

The policies simulated have significant – sometimes contradictory – impacts on production if one considers the commodity, the activity type or the region. Subsidising input will have the most positive effect on the production of food staples and HPHC, whereas supporting irrigation will benefit marketed and exported crops the most. Subsidising output and improving extension, road infrastructure or education mainly have positive effects on production, particularly those labelled HPHC (Table 7).

The irrigation scenario causes generalised input increase, with agri-food production rising by around 30%. All other scenarios have a similar generalised positive effect on agri-food production, but with a much smaller magnitude. As with the combined scenario focusing on agriculture, the irrigation scenario mostly favours marketed goods.

All scenarios benefit HPHC production, with input subsidies being the most effective. Indeed, starting from an initial level of 0.2 billion KSh and gradually increasing up to 10% of the government budget, input subsidies have the expected effect of increasing production by smallholders, who mainly produce HPHC goods. The same occurs with minor magnitude in the output subsidy scenario. On the other hand, the irrigation scenario, because not specifically targeted at smallholders, will positively affect mostly cash-crop producers and corresponding producing regions (Table 8).

In terms of the marketed commodity dynamics, impacts are very similar to those of HPHC. The results clearly show the trade-off effect between so-called staple and cash crops. In most scenarios, policy measures that improve staple production do so at the expense of cash-crop production and vice versa. This is also due to the requirement for full employment of land in each region. Whenever the production of a group of crops is expanded, land has to be released from other crop types, generating the abovementioned trade-off.

Particular care should be taken when evaluating the education scenario and its apparently marginal effect on agricultural production. One of the effects of increasing expenditure on education and health is a decrease in the labour force (and population) due to improved education outcomes and their related depressing effects on the birth rate (while the positive effects of increased health expenditure on the death rate have a lower impact on the population growth rate).

The road scenario, by reducing the trade and transportation margins of all agricultural commodities, has a significant and positive impact on all sectors. The two combined scenarios show the capacity of different measures to address apparently diverging objectives. In both cases (agriculture and rural) the trade-off between cash crops and staple crops disappear and the positive increase of production is generalised.

Interestingly, the trade liberalisation scenario would benefit the whole agricultural sector, i.e. both food staples and export crops. The latter to a greater extent than the former. The increase in HPHC production is mostly driven by the increasing food staple exports to the other African countries, which increase by 6% and increases trade surplus of Kenya in food staples. Even if most of the exported food staples are produced by commercial farms, as they export more, HPHC production increases to substitute. Manufacturing would be negatively affected, driving a slight negative general effect for the non-agri-food sector.

Another relevant point in terms of production is the positive effect on the food industry of measures that mainly target agriculture. Most of these sectors are positively affected by an increase in agricultural production and by the corresponding decrease in the prices of these commodities, which represent the main input for the agri-food industry. Under the road scenario, these commodities also benefit from the fall of trade and transportation margin costs, so the increase in production is even more pronounced.

Table 7: Home Production for Home Consumption and marketed production, 2030, % change from baseline

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Total agri-food	4,687.51	1.74	3.94	7.75	31.60	3.49	0.49	10.76	1.72	0.53
Home consumed	572.86	3.79	8.22	17.00	2.28	1.78	0.20	3.93	0.91	0.22
Agriculture	554.15	3.76	8.10	16.74	2.24	1.72	0.20	3.90	0.89	0.22
Crops	433.75	3.23	7.13	16.01	2.23	1.54	0.24	3.50	0.83	0.19
Livestock	120.40	5.70	11.59	19.36	2.28	2.39	0.05	5.32	1.09	0.33
Food	18.71	4.71	11.79	24.84	3.23	3.66	0.29	4.88	1.68	0.27
Marketed	4,114.65	1.45	3.34	6.46	35.68	3.73	0.53	11.71	1.83	0.57
Agriculture	2,711.51	1.60	3.46	7.51	50.82	2.55	0.37	16.10	1.26	0.67
Crops	1,718.71	1.84	4.11	9.18	79.14	3.80	0.32	24.47	1.64	0.99
Food staples	1,403.38	2.61	5.27	11.51	1.24	2.28	0.31	2.75	1.11	0.20
Export crops	315.32	-1.56	-1.06	-1.18	425.80	10.59	0.36	121.12	4.01	4.46
Livestock	992.80	1.18	2.34	4.62	1.81	0.38	0.46	1.61	0.61	0.13
Food	1,403.14	1.16	3.12	4.42	6.42	6.00	0.83	3.24	2.93	0.37
Non agri-food	18,045.83	-0.78	-2.25	-2.08	3.42	7.48	0.63	0.76	3.01	0.11
Light manuf.	1,515.24	-2.68	0.33	3.77	13.02	42.65	0.60	4.85	15.95	0.48
Heavy manuf	810.26	-2.43	-2.09	-2.03	1.70	13.16	1.23	-0.53	5.78	0.10
Energy	1,964.11	-1.84	-1.74	0.78	4.95	11.40	0.24	0.68	4.31	0.14
Priv. serv.	8,778.92	0.35	-0.89	-0.77	1.23	2.82	0.81	0.34	1.32	0.08
Pub. serv.	1,885.19	-0.26	-1.40	-3.13	17.18	17.48	0.61	4.54	5.75	0.05

Source: Model results
Note: Base is in billion KSh.

Table 8: Production by regions and activity type, 2030, % change from baseline

		Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Small holders	Nairobi	21.75	-5.8	-0.6	-10.9	8.9	5.2	2.3	0.3	4.0	1.1
	Mombasa	11.90	0.7	-0.1	-2.2	-1.5	4.4	2.3	-0.4	3.2	0.9
	High rainfall	1,813.01	3.4	6.7	16.3	0.7	1.9	0.2	2.8	0.9	0.2
	Semi-arid North	290.33	2.9	6.0	17.9	4.7	1.7	0.1	4.9	0.8	0.2
	Semi-arid South	256.91	5.3	7.1	6.5	0.8	-1.0	-0.1	5.1	-0.3	0.3
	Coastal	274.23	1.8	5.3	12.3	3.1	2.9	0.3	3.6	1.4	0.1
	Arid North	168.25	0.7	1.7	1.2	19.6	5.8	0.4	9.7	2.4	4.1
	Arid South	24.05	0.5	8.2	-10.4	-2.4	1.0	1.0	0.3	1.2	-0.3
Export oriented	High rainfall	48.62	-1.3	-1.0	-1.3	2,630.4	13.7	0.2	730.1	5.0	3.9
	Semi-arid North	0.66	-2.4	-1.5	-2.4	20.8	19.0	0.9	6.8	8.2	17.8
	Semi-arid South	207.53	-1.6	-0.2	-3.3	1.0	7.1	1.2	-0.2	3.2	0.2
Market oriented	Coffee	6.57	-1.7	-1.5	-2.3	-10.1	12.4	0.4	-3.8	4.9	7.4
	Cotton	4.03	-8.9	1.2	12.5	-80.5	83.7	-0.2	-65.3	30.5	-1.3
	Dairy	158.71	-0.5	-0.8	-3.0	0.9	-1.9	0.5	-0.1	0.0	0.1
	Food	991.93	0.4	2.1	0.8	8.9	7.7	1.0	3.5	3.7	0.4
	Livestock	344.11	-0.9	-1.4	-4.8	2.5	-1.0	0.7	0.0	0.3	0.1
	Other crops	19.37	-1.3	-1.2	-1.8	-7.3	12.8	0.3	-1.7	4.5	3.2
	Sugar	3.99	-1.4	-1.0	-0.9	-4.0	5.9	0.3	-1.5	2.2	7.1
	Tea	98.13	-1.4	-1.0	-1.4	36.9	10.1	0.4	16.5	3.8	3.9
	Tobacco	1.20	-1.4	-1.1	-2.4	7.3	13.4	0.6	2.5	5.5	8.0

Source: Model results

Note: Base is in billion KSh See Figure 26 for the map of regions.

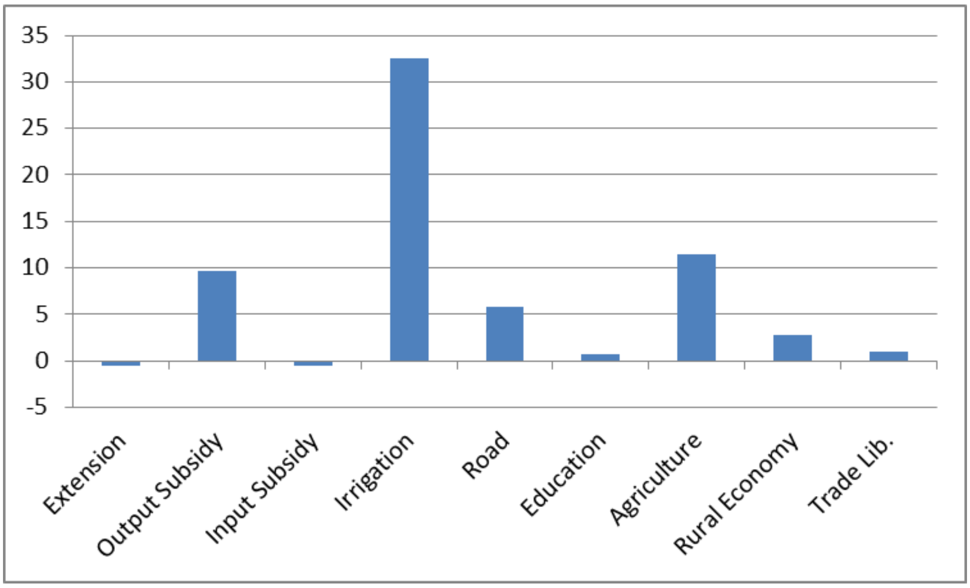
From a regional perspective, the production of agricultural products will react differently to different policy changes, but the variability across regions belonging to the same category (smallholder, export or market oriented) is rather limited (Table 8).

All farms and product categories benefit from lowering the cost of bringing agricultural and food products to the market (road scenario) and improved rural conditions. As expected, both Nairobi and Mombasa will be slightly negatively affected by a combined policy aimed at improving agricultural production (through a mix of support towards irrigation schemes, extension services and input subsidies to fertilisers and seeds) since as government investment shifts to these areas, government spending decreases and this adversely effects the urban households.

All smallholder farms, except those located in Nairobi and Arid South, will increase their agricultural production with inputs at lower prices, whereas export-oriented farms and market-oriented crop production are expected to take advantage of the higher levels of support given to irrigation and road infrastructures. It should be noted that the skyrocketing increase in the 'High rainfall' region under the irrigation scenario is caused by the region's specialisation in tea production, and its relatively low total level of production under the base scenario. The same rationale, of a low initial level of production, also explains the large change in the production of both coffee and cotton under the irrigation and road investment scenarios.

Market-oriented crops in particular will benefit from all policies that improve rural development and agricultural market conditions. With regard to specific crops, tea will benefit the most, whereas the supply of livestock and dairy will be the most negatively affected. On a territorial level, smallholder farms of Turkana are expected to increase their crop production in almost all scenarios (not shown).

Figure 18: Value added in agriculture, 2030, % change from baseline



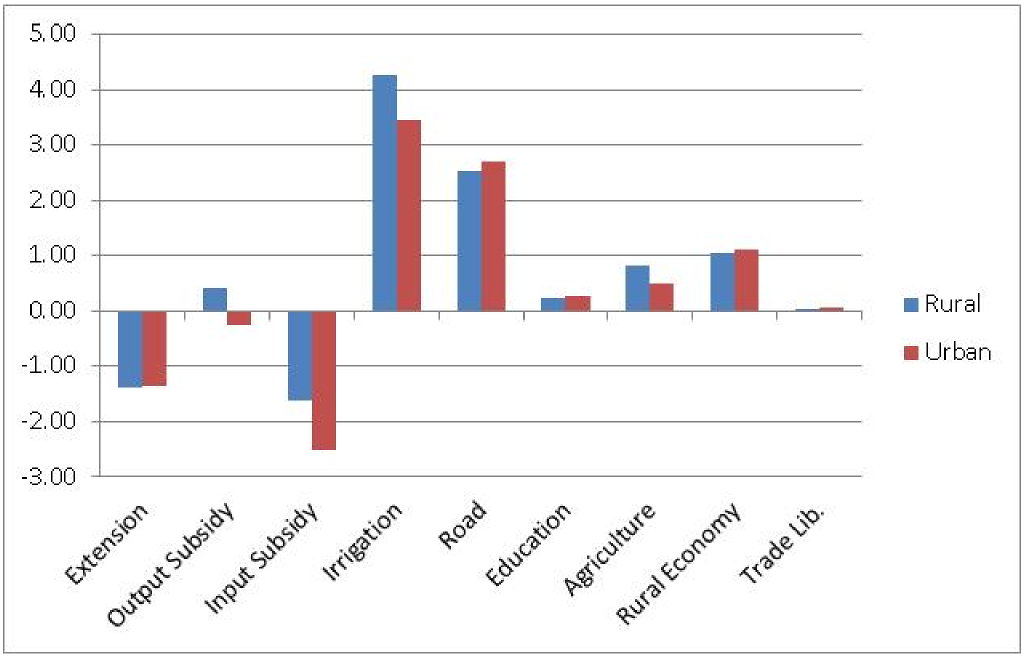
Source: Model results

The creation and distribution of value added are essential features of a successful policy. The value added in agriculture increases the most under the irrigation scenario, but also significantly (above 10%) in the combined scenario, which aims to improve agricultural production through investments in irrigation, roads, and subsidies for fertilisers and seeds. This latter policy mix would be less biased towards the capture of value added by large agricultural farms, to the detriment of smallholders.

The value added generated in Kenya's economy by agricultural products essentially remains within agricultural sectors themselves, with rates of about 60% (see previous value chain analysis). Increasing the value added in agriculture, represented by the sum of the value added of all agri-food sectors, requires more efficient production processes. Lowering the cost of bringing agricultural and food products to the market for all agri-food sectors is also critical. Modelling results confirm – if confirmation is needed – this. Indeed, the value added in agriculture increases the most under the irrigation scenario, but also significantly (above 10%) in the combined scenario, which aims to improve agricultural production through investments in irrigation, roads, and subsidies for fertilisers and seeds.

In addition to the creation of added value, its allocation and distribution are essential. In the food crop sector, about 50% of the value added generated is allocated to small farms (family farms or cooperatives). By contrast, the cash-crop sector shows a different distribution of value added, namely one that favours the large agricultural farms to the detriment of small farms. This bias has to be taken into account given that supporting irrigation will benefit the marketed and exported crop sectors the most.

Figure 19: Purchaser prices of composite commodities, 2030, % change from baseline



Source: Model results

The analysis of prices suggests a general price increase in all scenarios except for the extension and input subsidy scenarios (Figure 19). A decrease in prices is effective for commodities that are exported, whereas prices for those commodities destined for the domestic market increase (Table 9). Investing in the rural economy or road infrastructure contributes to a further integration of one single Kenyan market (with both rural and urban price converge).

The mechanisms behind the price changes are easily identifiable. In the case of the extension scenario, the increased productivity due to higher expenditures in extensions reduces input demand and the production factor to produce the same number of goods. A similar effect is triggered under the input subsidy scenario. The increased subsidy (or decreasing margins) makes smallholders increase (or decrease) the intermediate consumption of fertilisers and improved seeds (cost of transportation), making them more productive, thereby decreasing the final purchaser price.

Table 9: Purchaser Price Index (Index =1, baseline 2014), 2030, % change from baseline

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Maize	1.05	-2.43	1.63	-0.55	9.93	4.45	0.56	1.95	2.06	0.14
Wheat	1.04	-1.36	1.06	3.78	-5.19	0.55	-0.33	-2.48	0.06	-0.07
Rice	1.07	-0.42	0.37	3.29	-7.62	-2.14	-0.57	-2.76	-1.30	-0.61
Other cereals	1.07	-2.56	0.09	-4.11	9.84	4.06	0.58	1.62	1.92	0.17
Roots & tubers	1.29	-2.01	-0.32	-4.82	9.99	3.85	0.59	2.20	1.79	0.16
Pulses & oil seeds	1.13	-1.13	-0.32	-1.88	-1.11	0.54	-0.11	-0.79	0.12	0.04
Fruits	1.28	-2.21	0.00	-2.78	6.31	5.39	0.61	0.66	2.35	0.22
Vegetables	1.34	-2.18	-0.61	-3.01	5.12	3.58	0.47	0.29	1.58	0.53
Cotton	1.34	-0.17	0.09	2.96	-22.43	-1.83	-0.71	-9.61	-1.16	-0.80
Sugarcane	1.24	-0.35	0.21	2.21	-3.39	1.04	-0.56	-0.65	0.20	1.19
Coffee	1.36	0.10	0.24	3.07	-6.94	-8.84	-0.69	-2.10	-4.40	0.20
Tea	2.68	0.75	0.68	3.98	-5.10	-22.89	-0.72	-1.29	-10.91	0.08
Tobacco	1.26	-0.13	0.13	2.32	-5.38	-2.29	-0.61	-1.46	-1.34	0.56
Other crops	3.95	0.88	0.68	4.32	-4.26	-21.89	-0.80	-0.92	-10.64	0.62
Beef	0.86	-0.83	2.15	0.38	8.08	6.95	0.49	2.47	2.83	0.27
Dairy	0.89	-0.82	1.89	2.30	8.48	6.49	0.48	2.67	2.58	0.23
Poultry	1.02	-1.12	-1.98	-3.29	-2.36	5.61	0.33	-1.66	2.16	-0.08
Sheep, goat and lamb for slaughter	1.03	-1.18	1.56	2.42	5.91	5.81	0.42	1.31	2.21	0.24
Other livestock	0.98	-1.57	1.68	-4.14	7.88	4.61	0.42	1.74	1.94	0.33
Meat & dairy	0.98	-0.57	0.11	-0.49	0.84	0.45	0.01	0.09	0.05	-0.02
Grain milling	1.12	-1.02	0.37	-0.07	0.72	0.06	-0.16	-0.27	-0.16	-0.32
Sugar, bakery & conf.	1.49	-0.91	-0.34	-1.10	0.20	-0.71	-0.07	-0.16	-0.47	-0.83
Beverages & tobacco	1.30	-0.92	-0.79	-2.51	1.56	0.83	0.12	-0.01	0.31	-0.17
Other manuf. food	2.11	0.36	0.42	3.36	-5.12	-16.37	-0.69	-1.31	-7.90	-0.46

Source: Model results

6.3 Agricultural trade

Kenya is traditionally an agri-food net-importing country, with exports relying mostly on tea (Table 10). Under all scenarios except the extension and output subsidy scenarios, there is an increase in total imports that should be considered in line with the increase in wealth (Table 11).

Tea is the leading agricultural export commodity, accounting for about half of total Kenyan agri-food exports in 2014, followed by coffee and sugarcane (about 4% each). The aggregate other crops (about 13%) include a variety of horticultural crops, mainly cut flowers, but also avocado, vegetables, macadamia and passion fruits.

The position of the Kenyan economy in the agricultural international markets is expected to improve whereby policy changes strengthen its competitive position, irrespective of the product category. Exports of agri-food products will increase under the policy scenarios that increase profits per unit of output (Table 10).

The impact on imports is consistent with the impact on exports, and is significant for most commodities. Under the irrigation and road scenarios, the imports of most commodities will increase, especially for some 'luxury' goods, such as tea, tobacco and sugar. The support for local production, simulated in the input subsidy scenario, will generate positive effects on local supply, so that domestic production will replace the import of many commodities. Finally, the overall effect on imports in the output subsidy scenario is uncertain, with a negative total driven by the fall in non-food imports.

As expected, the further opening of foreign markets (trade liberalisation scenario) will increase both exports and imports.

Table 10: Exports by sectors, 2030, % change from baseline

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Total	3,555.9	-2.5	-0.5	3.3	27.4	20.7	0.1	8.2	7.6	1.2
Non-food	3,010.9	-3.0	-0.8	3.0	-4.3	23.4	0.1	-2.0	8.6	-0.1
Agri-food	545.0	0.3	1.1	5.4	202.1	5.5	-0.1	64.6	1.9	8.8
Food	85.2	2.9	5.4	17.7	-13.4	0.9	-0.5	-2.3	0.1	7.9
Agriculture	459.8	-0.1	0.3	3.1	242.0	6.4	0.0	77.0	2.2	8.9
Food staples	75.1	6.1	7.3	23.9	-21.5	-6.5	-1.5	-3.2	-3.5	8.8
Dairy	1.1	4.4	3.5	21.4	-27.5	-13.0	-2.0	-7.8	-6.0	11.5
Meat	1.2	5.0	5.8	20.0	-19.7	-14.2	-1.7	-3.5	-6.7	23.5
Other livestock	2.7	3.8	2.1	24.8	-27.3	-13.3	-1.9	-7.1	-6.5	9.0
Export crops	379.8	-1.4	-1.1	-1.3	297.6	9.2	0.3	94.0	3.5	8.9
Coffee	22.6	-1.6	-1.3	-1.5	6.8	8.8	0.4	3.1	3.5	10.2
Cotton	0.2	-5.4	-2.1	0.7	8284.3	21.3	-0.2	1034.9	7.1	15.2
Other crops	24.2	-1.4	-1.2	-1.8	-6.9	11.9	0.3	-1.5	4.3	7.2
Sugarcane	22.9	-1.4	-1.4	-0.5	3.5	3.1	0.2	2.1	1.0	11.8
Tea	306.7	-1.4	-1.1	-1.3	363.5	9.5	0.3	115.5	3.6	8.7
Tobacco	3.2	-1.6	-1.4	0.0	-0.8	4.7	0.2	0.1	1.7	14.2

Source: Model results
Note: Base is in billion KSh

Table 11: Imports by sectors, 2030, % change from baseline

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Total	5,236.0	-1.7	-0.3	2.3	18.4	14.1	0.0	5.5	5.1	0.8
Non-food	4,464.0	-1.7	-0.9	2.5	17.0	10.5	-0.3	5.0	3.6	0.5
Agri-food	772.0	-1.7	3.2	1.6	26.5	34.4	1.4	8.6	13.7	2.6
Food	131.1	-1.8	2.1	3.5	23.2	42.6	1.0	8.4	16.5	6.3
Agriculture	640.9	-1.7	3.4	1.2	27.1	32.8	1.5	8.6	13.1	1.8
Food staples	409.3	-0.4	4.1	-2.8	38.2	11.1	2.2	12.1	5.7	1.0
Dairy	0.4	-0.7	3.6	-5.3	45.9	18.2	3.0	14.0	8.5	2.7
Meat	2.2	-1.0	-3.6	-9.3	15.5	21.9	2.7	3.8	9.9	1.1
Other livestock	0.2	-1.0	4.5	-8.1	57.2	20.5	3.1	16.6	9.9	1.7
Export crops	228.9	-3.9	2.2	8.6	7.3	71.6	0.2	2.5	26.3	3.4

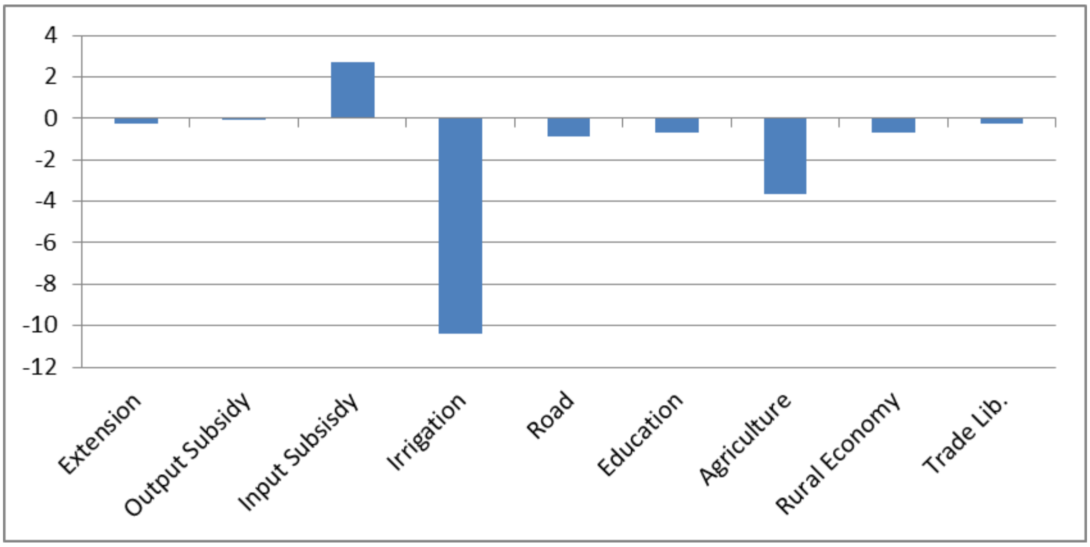
Source: Model results
Note: Base is in billion KSh

Under all scenarios, the nominal exchange rate varies very little, except for the irrigation scenario where its appreciation reaches almost 10%.

The exchange rate is one of the typical macroeconomic closures that are under the control of the model's users. Under the current approach, given that the trade balance is kept fixed as a constant share of GDP, the exchange rate is the endogenous equilibrating variable that keeps the current account balanced. Moreover, the exchange rate can explain (and accentuate) changes in the imports and exports of a country. The exchange rate in the model is expressed in nominal versus international currency. When it falls (or increases) this means that Kenya needs less (or more) domestic currency to buy a unit of international currency or, in other words, the nominal exchange rate appreciates (or depreciates).

Figure 20**:** shows the evolution of the exchange rate, which explains the changes in the imports and exports of a country. Under scenarios where the exports are boosted very positively, as under the irrigation scenario, the exchange rate appreciates so that exports become less competitive and imports more competitive such that the trade balance remains in equilibrium. The opposite occurs when exports are less competitive because of policy scenarios and the exchange rate has to depreciate.

Figure 20: Exchange rate, 2030, % change from baseline



Source: Model results

Table 12: Focus on specific sector: Wheat and Tea, 2030, % change from baseline

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural Economy	Trade Lib.
Wheat										
Production	62.65	3.14	6.45	11.62	-0.11	1.19	0.18	2.77	0.67	0.22
Consumption	133.65	1.98	5.68	7.36	12.68	5.78	0.80	6.07	2.91	0.30
Supply Price	1.01	-2.66	2.38	5.15	0.51	4.15	0.10	-1.48	1.83	0.22
Purchaser Price	1.04	-1.36	1.06	3.78	-5.19	0.55	-0.33	-2.48	0.06	-0.07
Export	1.30	5.85	6.23	16.49	-18.45	-6.00	-0.94	-2.38	-3.08	6.77
Import	72.30	1.02	5.02	3.79	24.10	9.73	1.32	8.90	4.83	0.52
Exports/Production	0.02	2.63	-0.20	4.36	-18.36	-7.11	-1.11	-5.01	-3.72	6.53
Imports/Consumption	0.54	-0.94	-0.63	-3.33	10.14	3.74	0.52	2.67	1.86	0.22
Tea										
Production	239.27	-1.46	-1.07	-1.31	379.01	9.59	0.36	121.01	3.65	4.38
Consumption	5.46	-3.33	-1.93	-3.48	148.55	45.96	0.48	51.76	17.53	15.85
Supply Price	1.26	-0.27	-0.04	2.73	-13.32	-0.88	-0.72	-6.12	-0.72	3.87
Purchaser Price	2.68	0.75	0.68	3.98	-5.10	-22.89	-0.72	-1.29	-10.91	0.08
Export	238.84	-1.45	-1.07	-1.31	379.23	9.56	0.36	121.07	3.64	4.37
Import	5.04	-3.42	-1.97	-3.59	138.81	48.01	0.48	48.35	18.27	16.94
Exports/Production	1.00	0.00	0.00	0.00	0.05	-0.03	0.00	0.03	-0.01	0.00
Imports/Consumption	0.92	-0.10	-0.04	-0.11	-3.92	1.40	0.00	-2.25	0.63	0.94

Source: Model results
Note: Base is in billion KSh

Since effects are commodity specific, case studies are required to better understand (divergent) market dynamics. Table 12 focuses on two opposite commodities: wheat and tea, staple and cash crops.

Wheat is Kenya's most important staple crop after maize; however, Kenya exhibits a structural deficit in this commodity. It imports about 60% of wheat consumed. Extension, output and input subsidy scenarios improve this ratio, the input subsidy scenario being the one that improves the self-sufficiency aggregate the most. It should be noted that wheat production is highly mechanised and input intensive, making it uncompetitive for small-scale farms (Meyer et al., 2016). These small-scale farms benefit the most from the input subsidy scenario. It should be highlighted that for all scenarios except the input and output subsidy and extension scenarios there is a degradation of the self-sufficiency ratio of this staple crop. Indeed, its resources are allocated to other commodities, especially export commodities, such as tea. However, the consumption of wheat is systematically increasing. The same is true for production, except in the irrigation scenario. Indeed, the irrigation scenario distorts market aggregates towards the production of marketed and exported goods, such as tea.

The tea sector is key for the sustainable socioeconomic development of Kenya. It accounts for up to 4% of the country's GDP and generates over 6 million jobs along the value chain. This represents 10% of the population of Kenya, a significant proportion, with associated correlations with potential rural poverty alleviation if the tea sector is developed further. Interestingly, small-scale growers account for about 65% of Kenya's tea production, while the large estates account for 35%. Finally, tea production can have significant positive environmental effects through its actions on carbon sequestration and erosion prevention (FAO, 2015, 2016).

There is a further boom in the production of tea under the irrigation scenario, positive development with the road and agricultural combined scenarios and, to a lesser extent, with the trade liberalisation and rural combined scenarios. Other scenarios have marginal impacts in terms of macro-aggregates. Almost all tea produced is exported.

6.4 Households, job creation and migration

The income to factor represents the sum of the returns paid by all activities to a specific production factor that could be interpreted as a primary income distribution.

Table 13 shows that returns in terms of rural labour are positive under those scenarios that directly increase labour productivity (i.e. extension and education scenarios). On the other hand, rent from land is particularly favoured under the irrigation scenario, but has positive results under all scenarios apart from the extension scenario. In general, most scenarios improve the total income resulting from rural factors.

The pattern is more differentiated when looking at urban factor income. Nevertheless, it can be seen that the two combined scenarios offer a balanced distribution of gains between rural and urban households

Table 13: Income to factors, 2030, billion KSh, change from baseline

		Extens.	Output	Input	Irrig.	Road	Edu.	Agri.	Rural eco.	Trade lib.
Rural	Capital	4	20	9	39	73	0	19	24	4
	Labour	16	-4	-3	-46	-46	44	10	16	0
	Land	-6	58	12	789	36	2	276	15	10
	Livestock	-18	131	-22	82	23	11	16	21	5
	Total	-3	205	-4	864	87	57	321	76	20
		Extens.	Output	Input	Irrig.	Road	Edu.	Agri.	Rural eco.	Trade lib.
Urban	Capital	-2	39	14	78	136	-1	32	44	7
	Labour	-19	-24	-4	-43	-33	33	-18	12	0
	Land	-1	5	1	55	3	0	19	1	1
	Livestock	-2	10	-1	6	2	1	1	2	0
	Total	-23	29	9	95	108	34	34	59	8

Source: Model results

The irrigation scenario has a specific impact on the land factor, decreasing the returns from rain-fed land but causing a boom in returns from irrigated land.

Road and education scenarios in rural contexts have almost opposite effects. Road, by reducing the price of goods, favours land and capital owners most; on the other hand, the education scenario boosts productivity of labour, increasing its returns.

As expected from the description of other results, the irrigation and road scenarios imply the highest increase in total factor income.

With regard to the distribution of the labour factor between rural and urban areas, most of the scenarios simulated show the capacity to create rural jobs and absorb some workers coming from urban areas. This could be interpreted as an indication that the policy measures simulated have the potential to slow down the urbanisation process.

Household consumption expenditure moves the analysis from primary to secondary income distribution. All scenarios increase rural consumption, in particular the consumption of marketed agri-food commodities. A more detailed analysis shows that the High Rainfall and Semi-Arid regions see a general gain in agri-food consumption under all scenarios. In contrast, the arid regions are, in most cases, slightly negatively affected. Policy makers should therefore consider putting the necessary measures in place to compensate inhabitants of these regions.

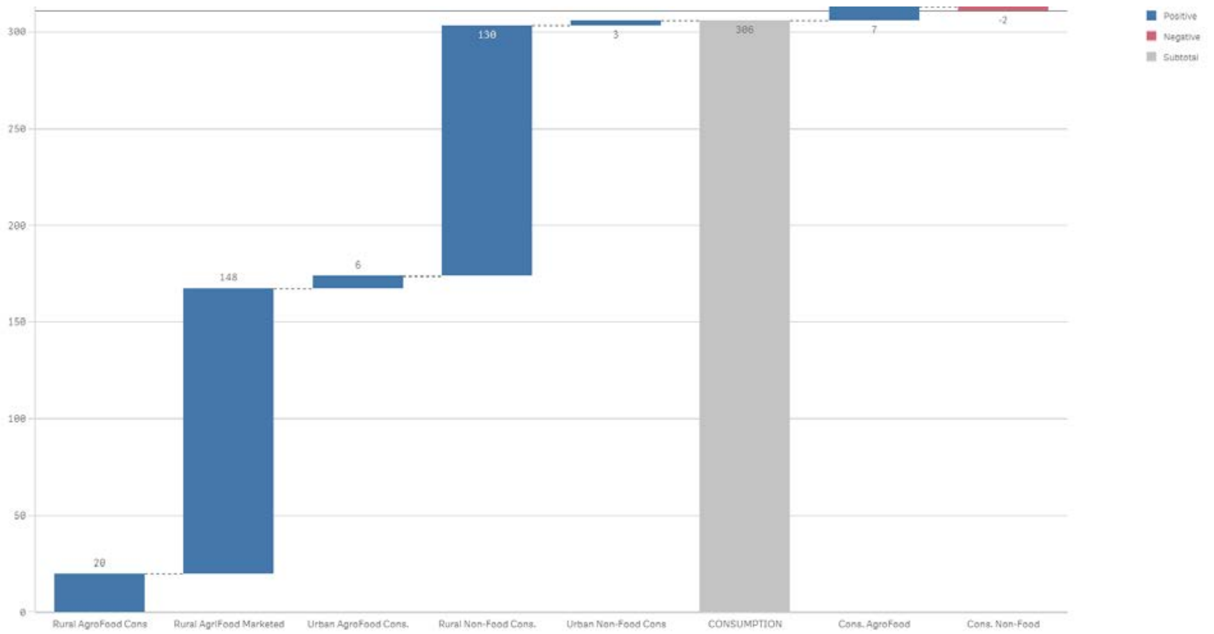
With regard to urban households, scenarios that have specific impacts on agriculture, such as the extension and irrigation scenarios, have negative impacts on agri-food consumption. The road scenario, by improving infrastructure and reducing prices of all commodities for all, is the scenario with the largest impact in terms of urban consumption.

Table 14: Household agri-food consumption, 2030, billion KSh, change from baseline

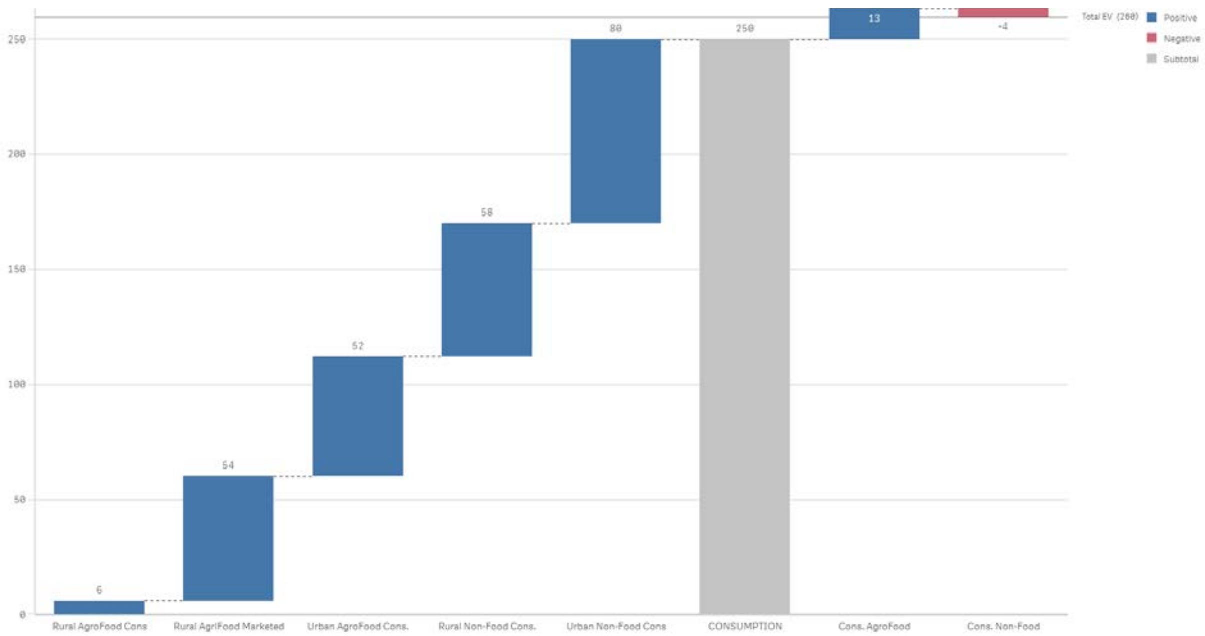
			Extens.	Output	Input	Irrig.	Road	Edu.	Agri.	Rural eco.	Trade lib.
HPHC			2.66	-0.19	-1.66	0.36	-1.52	0.18	2.33	-0.43	-0.04
Marketed		Agri-food	1.21	2.95	3.35	7.51	3.84	0.76	3.79	2.00	0.27
Marketed		Non-food	-1.99	1.71	-1.68	10.66	8.53	0.92	2.84	3.50	0.22
Total Consumption	Rural	Total	-0.30	3.60	-0.14	16.40	4.63	1.05	5.90	2.44	0.34
	Rural	Arid	0.11	-0.90	0.76	-5.46	-0.35	0.64	-1.16	0.47	-0.06
	Rural	High rainfall	-0.37	3.26	-0.13	10.75	5.06	1.05	3.79	2.57	0.34
	Rural	Semi-Arid	-0.12	4.99	-0.25	34.53	3.83	1.08	12.55	2.23	0.39
	Urban	Total	-0.88	0.36	0.70	0.46	8.24	0.57	0.04	3.12	0.10
	Urban	Large cities	-1.28	0.21	0.90	-0.44	8.72	0.59	-0.29	3.33	0.10
	Urban	Arid	-0.22	3.67	0.73	15.98	4.69	0.63	5.93	2.26	0.32
	Urban	High rainfall	-0.67	0.51	0.37	0.47	8.06	0.43	0.00	2.91	0.09
	Urban	Semi-Arid	1.31	-0.36	0.87	3.19	6.14	1.13	1.31	2.82	0.09

Source: Model results

Figure 21: Households consumption expenditures, 2030, % change from baseline



Agriculture – focused scenario



Rural economy – focused scenario

Source: Model results

Figure 21 shows the impact on household consumption of the two combined scenarios. Under the agricultural scenario, both the food and non-food consumption of rural household increase, as they are the main beneficiaries of the policy measures implemented. However, it should be noted that there is a slight decline in urban household consumption. So, although the agricultural scenario increases overall household welfare, it mostly benefits rural households. Considering that the loss of urban households is projected to be rather small, these policies can be considered Pareto efficient. The rural economy scenario, however, increases the consumption of both household types of both food and noon-food commodities. Hence, it can be concluded that the rural economy policy is Pareto improving in terms of consumption.

The per capita welfare per household follows the same pattern as the GDP growth rate, where, under the irrigation and road scenarios, Kenyan households see the most relevant increases: the road scenario has broad positive effects on all households, while, under the irrigation scenario, urban households are negatively affected.

The combined scenarios show once again a similar impact on both household types.

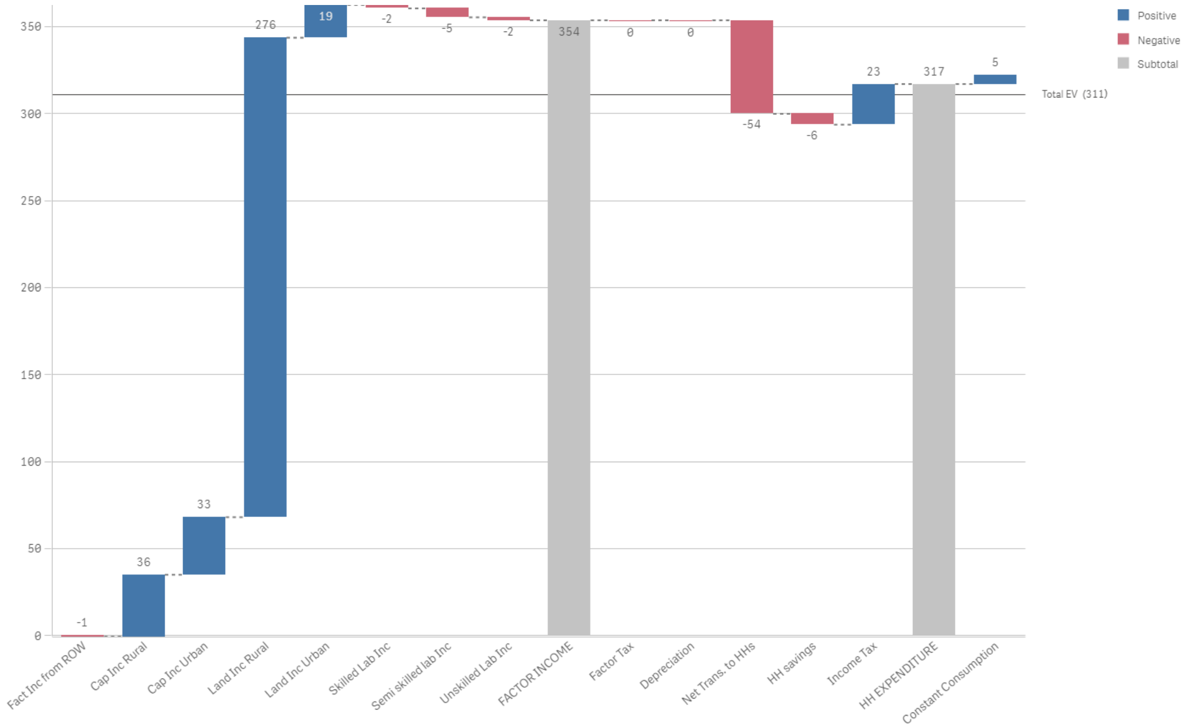
Table 15: Per capita welfare, 2030, billion KSh, change from baseline

	Extens.	Output	Input	Irrig.	Road	Edu.	Agri.
Total	-37,691	70,935	45,337	430,820	395,748	41,198	11,296
Large cities	-51,869	-3,738	22,309	-26,001	192,323	6,855	2,732
Other urban	14,601	20,545	20,724	125,914	148,720	19,285	3,697
Rural	-424	54,128	2,305	330,907	54,705	15,058	4,867

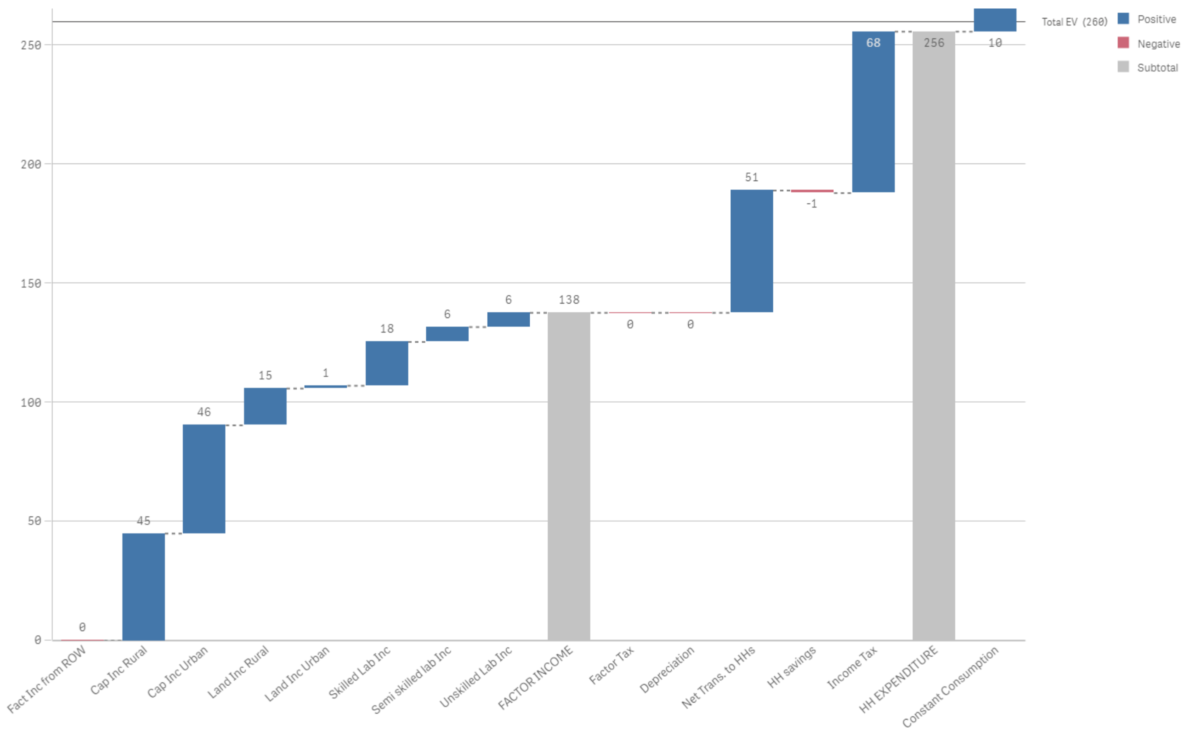
Source: Model results.

The source of household welfare in terms of income is shown in Figure 22. Under the agricultural scenario, most of the benefits for households result from the increase in land income of the rural households, which points to capitalisation of the agricultural support in land asset values. That is, the benefits are most likely to be received by land owners. On the other hand, income for semi-skilled and unskilled labour declines slightly.

Figure 22: Households Equivalent Variation per capita, 2030, million KSh, change from baseline



Agriculture – focused scenario



Rural economy – focused scenario

Source: Model results

Labour mobility and migration due to economic reasons are quite limited compared to the base-line (Table 16). Policy interventions mostly impact labour markets shifting the labour force employed in non-agricultural sectors to agricultural production. Given the full employment assumption, this is expected. Hence the total employment under the scenarios does not change significantly. However, increasing health and education spending and rural economy scenarios are the only simulations where total employment increase. The results reveal that each scenario affects the labour markets through different channels. All policies except the input subsidy increase agricultural employment while impact of increasing extension service spending, education and health spending and trade liberalisation are rather limited. These results suggest that shifting government spending from one policy area to another does not have much job creation potential.

Table 16: Labour mobility across households, 2030, thousand people

	Extens.	Output	Input	Irrig.	Road	Edu.	Agri.	Rural eco.	Trade lib.
Semi-Arid North	21	3	18		17	18		17	16
Semi-Arid South	19	4	17		19	16		17	16
Coast	48	45	47	40	49	47	45	48	47
Arid North	91	103	91	145	106	93	110	97	93

Source: Model results; See Figure 26 for the map of regions

The highest increase in agricultural employment is observed under irrigation expansion, road building as well as the output subsidy scenarios. However, irrigation and road investments increases employment in food production sectors as well; as the falling prices of agricultural commodities (either due to increasing production or falling margins) allows food production sectors to grow. On the other hand, output subsidies impact is rather direct and do not create much employment in food sector.

Comparison of two combined scenarios (i.e. agriculture and rural economy) shows that the former increases employment in agriculture, mostly via semi-skilled and unskilled labour while the latter is more likely to create more skilled jobs in agriculture. Further, agriculture scenario also has very limited impact to create jobs in the food sector while rural economy scenario also creates significantly higher number of skilled jobs in food processing sectors. Finally the agricultural scenario significantly harms the employment in the rest of the economy. On the other hand, the rural economy scenario has a milder adverse effect on the rest of the economy and results in an increase in total employment.

Overall, the model suggests that the simulated scenarios are likely to boost employment in agriculture. However, the policies that link to the other sectors of the rural economy are more likely to help create jobs in non-agricultural sectors, especially in food production sectors. This puts emphasis on the need for a holistic approach in the job creation impacts of the scenarios.

The highest movement between rural and urban areas is observed in the Arid North and coastal regions (Table 17). Unlike other regions, rural households in these regions continue to move to urban areas despite improved economic conditions. The main reason behind this is that in arid North (and partially in the Coast) region, initial data reveal the proportion of land income going into urban households is much higher than that going into rural. In these regions, agricultural policies seem to improve urban income more than rural one, thus increase the rural-urban income spread and boosting urbanisation. In these specific regions, different land tenure policies might have a bigger impact than agricultural policies to curb urbanisation. However in other regions the policies can reduce or keep the migration at the base level.

Table 17: Labour mobility across households and skill groups, 2030, thousand people change from baseline

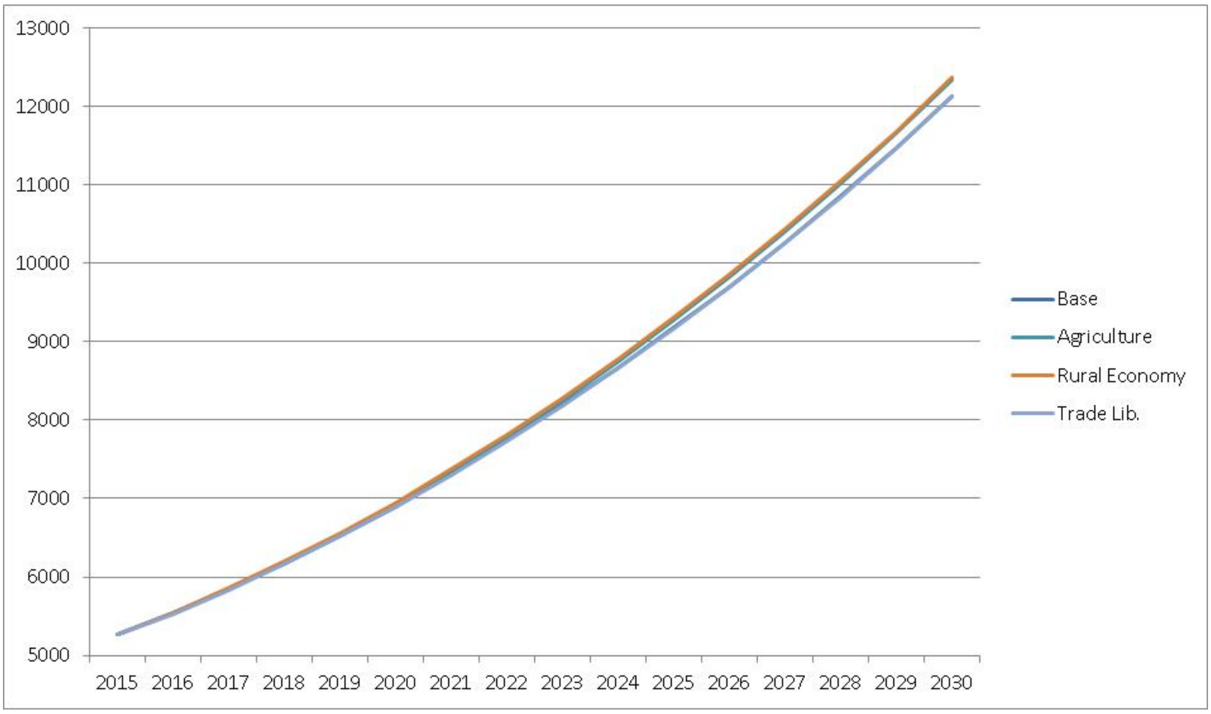
	Extens.	Output	Input	Irrig.	Road	Edu.	Agri.	Rural eco.	Trade lib.
Agriculture	1.0	13.7	-2.7	30.2	15.9	2.1	10.5	7.5	2.9
Skilled labour	-6.4	22.5	13.2	-10.3	47.9	-7.6	-19.0	11.7	1.9
Other labour	1.3	13.4	-3.2	31.5	14.9	2.4	11.5	7.4	2.9
Food production	-5.2	1.9	-4.3	9.2	6.3	3.4	0.2	4.6	1.4
Skilled labour	-4.9	8.5	-0.1	18.6	19.1	1.4	2.4	7.1	2.2
Other labour	-5.2	1.4	-4.6	8.4	5.3	3.5	0.1	4.4	1.3
Other sectors	-0.3	-2.0	0.3	-4.4	-2.4	0.0	-1.5	-0.9	-0.4
Skilled labour	0.0	-0.4	-0.3	0.0	-0.8	0.4	0.2	0.0	0.0
Other labour	-0.4	-3.0	0.7	-6.9	-3.4	-0.2	-2.5	-1.4	-0.6
Total	-0.2	-0.1	-0.1	-0.1	-0.1	0.3	-0.1	0.2	0.0

Source: Model results

6.5 Macroeconomic and public finance

Figure 23**:** shows the GDP trajectory of the baseline and the agriculture, rural economy and trade scenarios. The combined scenarios cause a significant increase in projected GDP from the baseline level in 2030. These scenarios could guarantee an incremental increase of the Kenyan GDP of a decimal point every year, moving the growth trajectory from 5.8 to 5.9% per year. It should be underlined that, in all scenarios, the costs of policy have been adequately taken into consideration so that no 'free lunch' is allowed in the scenario results.

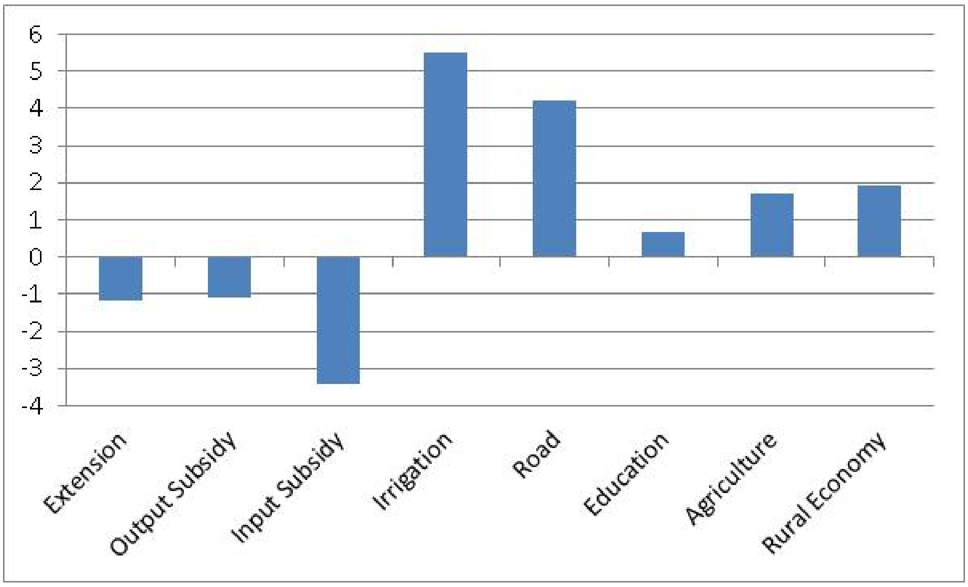
Figure 23: GDP level, selected scenarios, 2014-2030, billion KSh



Source: Model results

The GDP per capita is decreasing under extension, and both subsidy scenarios. Also, the increase in GDP per capita under the health and education spending increase scenario is rather limited. Declining GDP per capita under subsidy scenarios is due to the distortive impact of these policies as they cause economy to move to a second best equilibrium under the distorted price signals (i.e. the resources are not used in the most efficient way as distorted prices attracts them to less efficient sectors, e.g. agriculture).

Figure 24: GDP per capita, 2030, % change from baseline

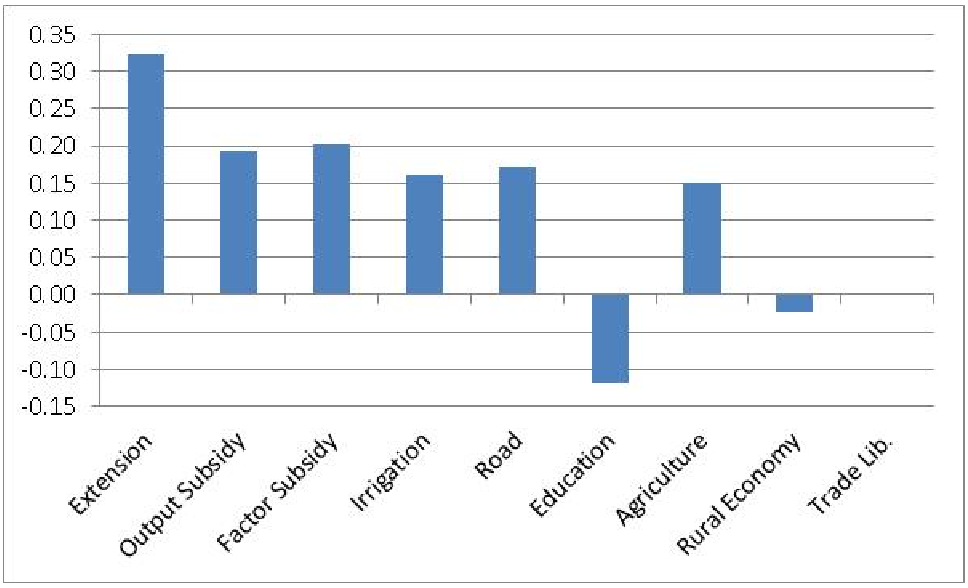


Source: Model results

The highest increase in GDP per capita is observed under irrigation and road scenarios, which introduce a significant amount of investment to the economy. Apparently, the contractionary impact of these policies is well compensated by the expansionary direct and indirect effects. The two combined scenarios reflect the impact of individual policies. Their final impact on GDP per capita is positive but not as high as irrigation and road scenarios.

The dynamic module of the model, with its feedback between health and education and the change in birth and death rate, has a direct endogenous effect on the evolution of the population. When the government increases its expenditure on education and health, the population growth rate diminishes as depicted in the education scenario. However, when expenditure is moved into extension, and expenditure on education and health is reduced, the population growth rate increases compared with the baseline.

Figure 25: Change in the population, yearly % change from baseline



Source: Model results

As discussed above, it is assumed that when the government increases public expenditure on a given sector, expenditures on all the other sectors will be reduced proportionally to keep government savings fixed, as a given (initial) share of GDP. When the government increases investment types (irrigation or road), government savings are increased, via a reduction in public expenditure, to finance the new investments. Government savings are kept as a constant share of GDP; if a policy shock increases GDP, as in the case of the irrigation scenario, where current expenditure should reduce to allow public investments to increase, it gives the government more policy scope to maintain a higher level of public expenditure (Table 18 and Table 19).

Table 18: Government expenditures, 2030, billion KSh

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural economy	Trade lib.
Public admin	1,348	928	1,199	1,185	1,239	1,212	949	1,158	1,044	1,348
Health	428	295	381	376	394	385	669	368	574	428
Education	633	436	563	556	582	569	813	544	733	633
Extension	64	763	57	56	59	57	45	324	49	64
Total	2,472	2,421	2,199	2,173	2,273	2,222	2,477	2,394	2,401	2,472

Source: Model results

Table 19: Government tax revenues and budget, 2030, billion KSh

	Base	Extension	Output Subsidy	Input Subsidy	Irrigation	Road	Education	Agri-culture	Rural economy	Trade lib.
Tariff	475.7	469.9	468.1	473.1	504.2	523.0	473.6	484.7	492.2	469.8
Sales	601.5	596.1	595.9	604.0	625.7	663.8	602.9	610.3	626.0	603.2
VAT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indirect	449.7	446.6	123.5	444.1	465.1	493.4	451.9	454.5	467.1	451.2
Factor use	-0.2	-0.2	-0.3	-316.9	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2
Direct income	1,296.6	1,310.8	1,306.8	1,300.9	1,228.7	1,143.5	1,294.7	1,273.8	1,237.9	1,299.3
Factor income	13.6	13.7	13.5	13.5	13.6	13.5	14.0	13.7	13.9	13.7
Gov. income	2,838.0	2,838.0	2,508.7	2,520.0	2,838.0	2,838.0	2,838.0	2,838.0	2,838.0	2,838.0
Gov. expenditures	3,359.3	3,359.3	3,030.0	3,041.3	3,042.4	3,042.4	3,359.3	3,264.2	3,264.2	3,359.3
Gov. savings	-521.3	-521.3	-521.3	-521.3	-204.4	-204.4	-521.3	-426.2	-426.2	-521.3

Source: Model results

7 Discussion

The proposed policy scenarios assume that the government will devote 10% of its budget to agricultural and/or rural related activities. The simulations are performed autonomously and their features are rather different from each other. Nevertheless, all scenarios provide critical information on impacts with dissimilarities between sectors, regions and household types.

Below a summary of the findings of the report related to the main goals of the strategy that the modelling framework adopted captures. Compared to parallel exercised performed to support the preparation of this strategy, this study provides a comprehensive approach to agricultural and rural development policies (including value chain analysis) grounded on real and updated government expenditures information.

1. Economic growth

Absolute and per capita GDP, against the baseline, show positive and very similar patterns under all scenarios. The irrigation and road scenarios are those whose increase result more pronounced.

The agricultural value added (summing all agricultural crops), given the exogenous assumptions of the baseline, is growing by more than 5% per year, on average. Output subsidies and investments in irrigation and road have the highest impact in boosting agricultural value added.

Combined scenarios

The two combined scenarios cause a significant increase in the GDP projected by the base scenario in 2030. These scenarios could guarantee an incremental increase of the Kenyan GDP of a decimal point every year, moving the growth trajectory from 5.8 to 5.9% a year.

In terms of agricultural growth, the agriculture combined scenario, being design to support agricultural sectors, is the scenario under which agricultural value added increases the most.

2. Poverty reduction

The model is not set to answer precise questions about poverty reduction. A poverty reduction analysis would rely on microsimulations which could have showed detailed results on poverty reduction effects of simulated policies. Unfortunately, the last available household budget survey, on which microsimulations have to be based, is more than 10 years old. Nevertheless, the model can give a few limited hints on the issue of poverty reduction looking at the income, expenditures and welfare changes of different representative household groups within the country.

Looking at household income, expenditure and welfare, a clear pattern can be observed. Extension has limited impacts on income, irrigation and outputs subsidies benefit mainly rural households (and partially urban outside the large cities). Road investments have a more spread benefit to urban and large cities households. Education is more beneficial for households outside the large cities, while trade liberalisation brings balanced welfare and income gains. Again, investments in irrigation and road are the scenarios with the highest overall benefit.

Combined scenarios

The two combined scenarios cause a significant increase in household welfare and income. The agriculture one particularly benefits rural households and has a negative impact on large cities households, which is almost equally spread over all income quintiles. Poorest households in the main cities would be considered those to be partially refunded as a consequence of the agriculture scenario policies. On the other hand, the rural scenario is more balanced. In this case, most advantaged households are those living in the large cities.

3. Job and migration

Regarding the capacity to generate new jobs, employment multiplier analysis shows that agricultural and livestock sectors show, in general, multipliers values above the average of the Kenyan economy. In particular, the values of cash crops (maize, other cereals, roots, fruits and vegetables) and most livestock sectors should be highlighted.

Policy scenarios show the capacity to create rural jobs and absorb a significant number of workers coming from the urban areas. In a way, this can be interpreted as the possibility of the policy measures simulated to slow down the urbanization process.

As highly expected the education scenario is the one with the highest impact in terms of increase wage rate and increased employment opportunity for skilled workers.

The results suggests that agricultural policies can help reducing the migration in most of the regions except Coastal and Arid North, which offer rather limited possibilities for expansion of agricultural production through the simulated policies. Hence in these regions, the policy makers should consider further measures to improve both the living conditions of the rural households and technical conditions of agricultural production.

The model results suggest that the simulated policies will boost the employment in agricultural sectors. The policies that link to the other sectors of the rural economy are more likely to help create jobs in non-agricultural sectors, especially in food production sectors. This puts emphasis on the need for a holistic approach in the job creation impacts of the scenarios.

Improving the road infrastructure is the most effective policy to create skilled jobs both in agriculture and food production sectors. Further its adverse effect on non-agricultural sectors is lower compared to the other scenarios.

Combined scenarios

Both if the combined scenarios increase employment in agricultural sectors. However, rural economy scenario outperforms agriculture focused scenario in two aspects: First, it creates significantly more jobs in food production sector and has a rather limited negative affect on the rest of the economy and second it creates more skilled jobs while agriculture focused scenario shifts agricultural employment toward less skilled labour.

4. Export competitiveness

Kenya is traditionally an agri-food importing country, with export relying on few commodities, especially tea. Under all scenarios but extension and input subsidies, there is an increase of imports that should be considered on line with the increase in wealth.

Under all scenarios, exports of agri-food commodities increase, even with some variability in the magnitude of changes. The extension and more evidently the input subsidy scenario, increase the competitiveness of staple food exports. This looks beneficial for the food industry sector which expands its exports possibility.

A complete different effect is achieved under the irrigation (and partially road) scenarios where traditional export crops become much more competitive than staple and expand their global market significantly.

The trade scenario shows that a deeper African integration represents a great opportunity to expand exports of agri-food commodities.

Combined scenarios

The agriculture combined scenario is clearly driven by the irrigation investment and consequently show a great increase of cash crop exports. On the other hand, the rural economy scenario has not a relevant impact on export competitiveness of the agri-food sector while it helps the overall competitiveness of the country exports.

5. Food security

A first element of food security is food availability. Under all scenarios, domestic production of agriculture and in particular staple food increase. Subsiding input will have the most positive effect on food staples and HPHC production. Some scenarios (improving extension, road infrastructure or education) will mainly scatter positive effects, especially those labelled as HPHC. The agricultural production reacts differently to policy changes in regions but the variability across regions belonging to the same category (small holder, export or market oriented) is rather limited.

In terms of food affordability, scenarios subsidising extension or inputs bring most of food staple prices down. On the other hand, investments in irrigation and road has the effects of reducing significantly the prices of exported corps (which are almost not consumed domestically) at the expense of staple crops and meat commodities which in general become more expensive.

The combination of the above mentioned effects, contribute to an increase in agri-food consumption under all scenarios.

Combined scenarios

The two combined scenarios have very similar impacts in terms of staple production while under the agriculture one, driven by irrigation investments, export crops have a dramatic increase. Prices tend to increase more under the rural scenario while under the agriculture one where the increase due to irrigation investments are mitigated by input subsidies. Consumption of agri-food commodities, as a consequence, increases slightly more under the agriculture scenario than under the rural one.

A part from those relative to these five crucial topics, other key issues should be mentioned as main findings of the study:

6. Value chain

Linear multipliers, key sectors analysis, SPA and value chain participations are used to show which value chains have the greatest impact in terms of output, employment and value added. The analysis can help in identifying which value chains need to be prioritized because of concerns about food safety as well as other issues (e.g. food loss and waste).

In terms of backward linkages (a direct comparability measure among sectors on the capacity and potential to create output and value added), food crops maize and fruit and vegetables show values clearly above average, together with cash crops like tea and coffee. In addition, all livestock sectors show major backward linkages on Kenya economy. On the contrary, rice, wheat and cotton show very limited capacity to create additional output and value added.

Looking more in depth into value chain issue, most of the value added created by agricultural products remains in the agricultural sectors themselves. Also, contribution of primary sector to livestock products and fisheries generation of valued added is significant. This value chains are also observed in employment generation, especially for large farms and most notably for agricultural products for export. Also, the participation of livestock farming in the embodied employment in demand for primary commodities is much more significant, especially in the livestock products.

7. Irrigation

Irrigation stands as one of the most effective policy intervention to improve the livelihoods of rural areas by increasing agricultural production and household income. Inevitably, high rainfall regions which have higher water availability and thus more irrigated land as well as the commercial farms and households that specialize in the production of cash crops (who are also concentrated in the high rainfall regions) turn out to be main beneficiaries of irrigation expansion. Hence, the benefits of irrigation investments are not uniform across households and agricultural activities. The two-sub-scenarios presented in Annex 4 shows that targeting small-holder or large commercial farms have quite different impact on the economy. The main impact channel of the small-scale targeting irrigation expansion is through the increasing food crops production which in turn increases household income in rural areas. In urban areas, the declining food prices improve the welfare of poorer households by allowing them to access cheaper food products thanks to the increasing production. On the other hand, irrigation expansion that target commercial farms specialized in producing cash/export crops mainly improves the welfare of households by increasing the exports and hence allowing Kenya to import more of non-food commodities. This mainly benefits to the richer households in urban areas and rural households of the regions where cash/export crop production is higher (e.g. high rain fed region). Further, small-scale irrigation also improves the availability of water for the households, especially in rural areas, allowing better meeting the domestic needs (human and animals) and sanitation.

It should be taken into account that, particularly large irrigation schemes have suffered, also in the recent past, from: lack of sufficient water to be replicated at a large scale, complex managerial and procurement issues (including wasteful and corrupted use of public resources, possibly, problems of forced displacement and elite capturing most of the benefits. Many of these issues cannot be taken into account by the mode, so policymakers should factor them in a cost-benefit analysis of irrigation investments.

8 Concluding remarks and policy implications

This report provides a quantitative assessment of policy options to support the new Agriculture Sector Growth and Transformation Strategy (ASGTS) in Kenya. Prior to such assessment, it describes the Kenyan economy, with a focus on the agricultural and food value chains, based on a recent and disaggregated SAM developed by the JRC. Linear multipliers, key sectors analysis, structural path analysis and value chain participations are used to this end. Interestingly, they show which value chains have the greatest impact in terms of output, employment and value added.

To evaluate policy options, this report proposes two methodological enhancements. First, it uses a CGE model that fits key developing country specificities, such as the own supply of food by semi-subsistence households and their multiple commodity production activities (through the HPHC module and the multiple-output structure of the CGE model, respectively). Second, it calibrates the CGE model to an original disaggregated and recent SAM for Kenya.

The main findings of the study are the followings:

- Irrigation – showed the highest magnitude on agri-food production (especially towards cash crops) and exports. Investment in irrigation has also shown the highest impact on boosting absolute and per capita GDP growth.
- Input subsidies – showed the greatest effect on production increases for subsistence farmers and food staples.
- Extension – marginally benefits agricultural productivity and contributes significantly to poverty reduction. The analysis showed that investments in extension boost food crops production and incomes of semi-arid and high rainfall areas of Kenya.
- Rural roads – boost agriculture value added, mainly of cash crops. Unlike most other policy interventions, investments in rural roads noticeably benefit both agricultural and non-agricultural sectors by helping reduce transaction costs.
- Rural health and education – showed only marginal effects on agricultural production, but – not surprisingly – had the highest positive impact on employment generation and wage increases for skilled workers.
- Trade liberalisation – benefits the whole agricultural sector, showing slightly more positive effects on export crops than on food staples.

The outcomes of this analysis are comparable to similar previous analyses. The Millennium Institute (2014) showed that increasing the agricultural budget to 10%, as targeted by the CAADP initiative, would significantly improve relevant indicators in the field of agriculture and rural development. This was especially true if agricultural policies were adopted in combination with other relevant policies, such as strengthening governance, which goes beyond the scope of this analysis. In the same way, Ayenew and Arquitt (2017), in an attempt to quantify the impact of an increase of the budget dedicated to agriculture to 10%, found that a combined effort to increase training, irrigation and support to farmers' organisations would be most likely to trigger the best improvements in Kenyan agriculture, while, as in the current study, investment in irrigation is the single policy with the highest potential to increase agricultural production.

It should be underlined that, because of the characteristics of the model, several implications of agricultural policy reforms cannot be accounted in the study but, nevertheless, will generate impacts that policy makers should consider before making their own decisions. These implications include environmental considerations (e.g. effects of fertiliser inputs on soil fertility), water availability, and the sustainable withdrawal of water and other natural resources (particularly relevant for the irrigation scenarios).

Finally, the institutional framework behind any policy reforms or change cannot be taken into account (or only partially with very strong hypotheses and assumptions). Thus, the underlying assumptions behind this study are that the country will undergo a period of political stability that will not negatively affect agricultural reforms, and that reforms will (in the medium term) bring expected results that will not create any policy reversals as a result of frustrated expectations. The uncertainty behind these assumptions might be extremely relevant in defining the final results of any policy reform in any country. In addition, if, to the stability, we add a period of increasingly strengthening institutions and governance, an improving investment environment and other enabling development policies, despite the fact that the model cannot easily and directly quantify those impacts, all results will be positively magnified.

Results, as in any modelling exercise, should be interpreted with extreme caution. In no case should they be considered forecasts of the future impacts of simulated shocks. They should be seen, in the best case, as indications of the potential forces unleashed by each shock simulated in the model. Data scarcity, model parametrisation and scenario design are all elements that will affect the results and should be carefully accounted for before drawing any policy conclusions. Despite the effort to be as close as possible to reality in all of these topics, a model will always be a limited attempt to represent reality and will never be able to reproduce it with all of its nuances, given the huge number of uncertainties and factors that can drive the real impacts of policy on an economy.

That said, based on an assessment of the social and economic impacts of the various policy interventions, this report suggest a number of recommendations to guide the new ASGTS and National Agricultural Investment Plan (NAIP).

1. To envisage the allocation of a greater share of total public resources to the agriculture sector, as part of a broad structural transformation agenda. The level of expenditures in support of food and agriculture still falls short of the 10% target. The increase in GDP obtained from devoting 10% of government budget to agriculture is estimated to stand at around 1.5% of overall GDP by 2030. The effect on agricultural GDP is even more substantial as over sixty-percent of the generated value added remains within agriculture.

2. To accelerate Government investment in the livestock sector. The analysis showed that among the value chains analysed for this study, livestock commodities (incl. fisheries) have the greatest positive impact on employment generation, output and value added.

3. To provide targeted public support to maize, fruits and vegetables. Among the food crops analysed, all three commodities appeared as those where highest gains in terms of job creation and income of rural households were observed.

4. To extend public investments in tea and coffee. Of the cash crops analysed for this study, tea and coffee stood out vis-à-vis their effect on boosting output, value added and exports.

5. To stimulate agricultural productivity in the medium and long run, following a balanced public investment strategy that couples spending in agricultural production with rural infrastructure expenditures. This study showed that a combined scenario in which the government invests in irrigation, roads and subsidies to fertilizers and seeds is the most beneficial in terms of value added. This policy mix is also the least biased towards a certain beneficiary, i.e. both larger farms and smallholders benefit.

References

Aragie, E., Dudu, H., Ferrari, E., Mainar Causape, A., McDonald, S., Thierfelder, K. (2017). STAGE_DEV - A variant of the STAGE model for developing countries, EUR 28627 EN, JRC Technical Report, Publications Office of the European Union, Luxembourg. doi:10.2760/90737

Ayenew, M., Arquitt, S. (2017). Kenya Agricultural Performance and targets, Scenarios and Implications. Changing Course in Global Agriculture (CCGA) Policy Brief, No.2.

FAO (2016). Report of the Working Group on Climate Change of the FAO Intergovernmental Group on Tea, Rome, Italy. http://www.fao.org/3/a-i5743e.pdf

FAO (2015). Kenya's tea sector under climate change: An impact assessment and formulation of a climate smart strategy, Rome, Italy. http://www.fao.org/3/a-i4824e.pdf

Government of Kenya (2015). Economic Review of Agriculture 2015-6, Nairobi, Kenya.

Government of Kenya (2010). Agricultural Sector Development Strategy 2010-2020, Nairobi, Kenya.

Government of Kenya (2007). Kenya Vision 2030 – The Popular Version, Nairobi, Kenya.

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

Kenya National Bureau of Statistics (2015a). Economic Survey 2015, Nairobi, Kenya.

Kenya National Bureau of Statistics (2015b). Statistical Abstract 2015, Nairobi, Kenya.

Kiringai, J., Thurlow, J., Wanjala, B. (2006). A 2003 Social Accounting Matrix for Kenya, Kenya Institute for Public Policy Research and Analysis (KIPPRA), International Food Policy Research Institute (IFPRI), Nairobi, Kenya & Washington, DC, USA. http://www.ifpri.org/dataset/kenya-social-accounting-matrix-sam-2003

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

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), Regional Strategic Analysis and Knowledge Support System (ReSAKSS) Working Paper #35, Washington DC, USA.

MAFAP and JRC (2017) Returns to investments in fertilizers production in Kenya. An analysis in support of the new "Agriculture Sector Growth and transformation Strategy". Policy report by Monitoring and Analysing Food and Agricultural Policies (FAO) and the Joint Research Centre (JRC) of the European Commission.

Mainar-Causapé, A.J., Boulanger, P., Dudu, H., Ferrari, E., McDonald, S. (2018). Social Accounting Matrix of Kenya 2014, EUR 29056 EN, JRC Technical Report, Publications Office of the European Union, Luxembourg. doi:10.2760/852198

Meyer, F., Traub, L.N., Davids, T., Kirimi, L., Gitau, R., Mpenda, Z., Chisanga, B., Binfield, J., Boulanger, P. (2016). Modelling wheat and sugar markets in Eastern and Southern Africa, Regional Network of Agricultural Policy Research Institutes (ReNAPRI), EUR 28254 EN, JRC Technical Report, Publications Office of the European Union, Luxembourg. doi:10.2788/437123

McDonald, S. (2007). A STatic Applied General Equilibrium Model: Technical Documentation STAGE Version 1. Tech. rep. Department of Economics/& Strategy, Oxford Brookes University, UK.

Millennium Institute (2014). T21-Kenya Agriculture, food and Nutrition Security, and rural Poverty Scenarios. Scenario and Policy Reccomendations.

Riahi, W., van Vuuren, D.P., Kriegler, E., Edmonds, J., O'Neill, B.C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Crespo Cuaresma, J., KC, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., Ebi, K., Hasegawa, T., Havlik, P., Humpenöder, F., Aleluia Da Silva, L., Smith, S, Stehfest, E., Bosetti, V., Eom, J., Gernaat, D., Masui, T., Rogelj, J., Strefler, J., Drouet, L., Krey, V., Luderer, G., Harmsen, M., Takahashi, K., Baumstark, L., Doelman, J.C., Kainuma, M., Klimont, Z., Marangoni, G., Lotze-Campen, H., Obersteiner, M., Tabeau, A., Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, *Global Environmental Change*, 42, 153-168.

Schürenberg-Frosch, H. (2014). Improving Africa's Roads: Modelling Infrastructure Investment and Its Effect on Sectoral Production Behaviour, Development Policy Review, 32(3), 327-353.

Thurlow, J., 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) Roundtable Discussion, International Food Policy Research Institute, Washington DC, USA.

Thurlow, J., Kiringai, J., Gautam, M. (2007). Rural Investments to Accelerate Growth and Poverty Reduction in Kenya, IFPRI Discussion Paper 00723, Washington DC, USA.

You, L., Xie, H., Wood-Sichra, U., Guo, Z., Wan, L. (2014). Irrigation potential and investment return Kenya. Food Policy, 47, 34-45.

List of abbreviations and definitions

AEZ	Agro-Ecological Zones
ASDS	Agricultural Sector Development Strategy
ASGTS	Agriculture Sector Growth and Transformation Strategy
CAADP	Comprehensive Africa Agricultural Development Programme
CES	Constant Elasticity of Substitution
CGE	Computable General Equilibrium
DG DEVCO	Directorate-General for International Cooperation and Development
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
HPHC	Home Production for Home Consumption
IFPRI	International Food Policy Research Institute
JRC	Joint Research Centre
KSh	Kenyan Shilling
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
MAFAP	Monitoring and Analysing Food and Agricultural Policies
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoWI	Ministry of Water and Irrigation
MTIP	Medium Term Implementation Plan
NAIP	National Agricultural Investment Plan
NEAP	National Agricultural Extension Policy
NIB	National Irrigation Board
OECD	Organization for Economic Co-operation and Development
RHG	Representative Household Groups
SAM	Social Accounting Matrix
SDGs	Sustainable Development Goals
SPA	Structural Path Analysis
SRA	Strategy for Revitalizing Agriculture
SSPs	Shared Socioeconomic Pathways
STAGE_DEV	STatic Applied General Equilibrium for DEVelopment

List of figures

List of tables

Annexes

Annex 1: Further consideration about Kenya SAM 2014

Table 20: Kenya SAM 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
- Other 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
- Fertilisers Nitrogen
- Fertilisers Phosphorus
- Fertilisers Potassium
- Metals and machines
- Non-metallic products
- Other manufactures
- Water
- Electricity
- Construction
- Trade
- Hotels
- Transport
- Communication
- Finance
- Real estate
- Other services
- Administration
- 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
- Other 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
- Fertilisers Nitrogen
- Fertilisers Phosphorus
- Fertilisers Potassium
- Metals and machines
- Non-metallic products
- Other manufactures
- Water
- Electricity
- Construction
- Trade
- Hotels
- Transport
- Communication
- Finance
- Real estate
- Other services
- Administration
- Health
- Education

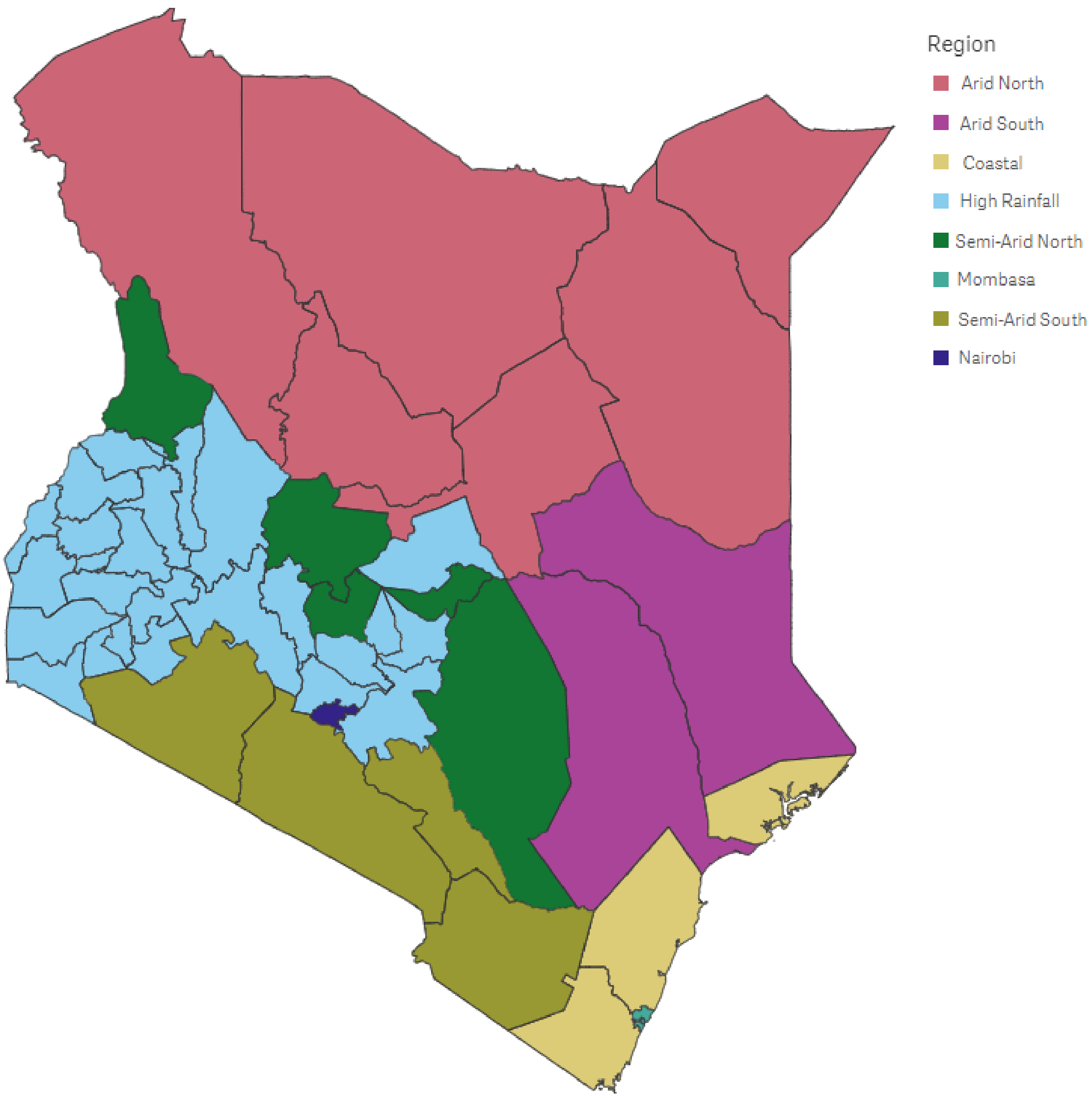
Source: Mainar et al. (2018)

Table 21: Kenya SAM abbreviate version, 2014, thousand million KSh

	ch	cm	m	ahf	ahc	a	flab	fland	flivst	fcap_ag	fcap_na	hh	enter	gov	dirtax	indtax	saltax	facttax	imptax	i_s	row	Total
HPHC commodities (ch)				150.7								161.1								0.9		313
Marketed commodities (cm)			292.5	293.9	50.1	3,158.5						4,162.0		750.4						1,144.2	954.0	10,806
Margins (m)		292.5																				292
Households as activities food (ahf)	312.7	1,045.8																				1,358
Households as activities cash-crops (ahc)		197.7																				198
Activities (a)		7,087.1																				7,087
Labour factor (flab)				92.7	14.6	1,545.9															15.9	1,669
Land factor (fland)				536.2	113.7	206.8																857
Livestock (flivst)				141.2		33.6																175
Capital agricultural (fcap_ag)				98.7	19.3	77.3																195
Capital non-agricultural (fcap_na)				45.1		1,912.3																1,957
Households (hh)							1,600.2	856.1	174.7	195.2	455.4		1,048.5	41.6							324.3	4,696
Enterprises (enter)								0.3			1,501.0			505.4								2,007
Government (gov)															554.0	152.7	207.0	7.9	160.7		25.7	1,108
Direct taxes (dirtax)												311.6	242.4									554
Indirect taxes (indtax)						152.7																153
Sales taxes (saltax)		207.0																				207
Factor taxes (facttax)							6.6	0.3	0.1	0.1	0.9											8
Imports taxes (imptax)		160.7																				161
Save/Investment (i_s)												51.3	715.8	-213.9							592.0	1,145
Rest of the World (row)		1,815					62					10		25								1,912
Total	313	10,806	292	1,358	198	7,087	1,669	857	175	195	1,957	4,696	2,007	1,108	554	153	207	8	161	1,145	1,912	

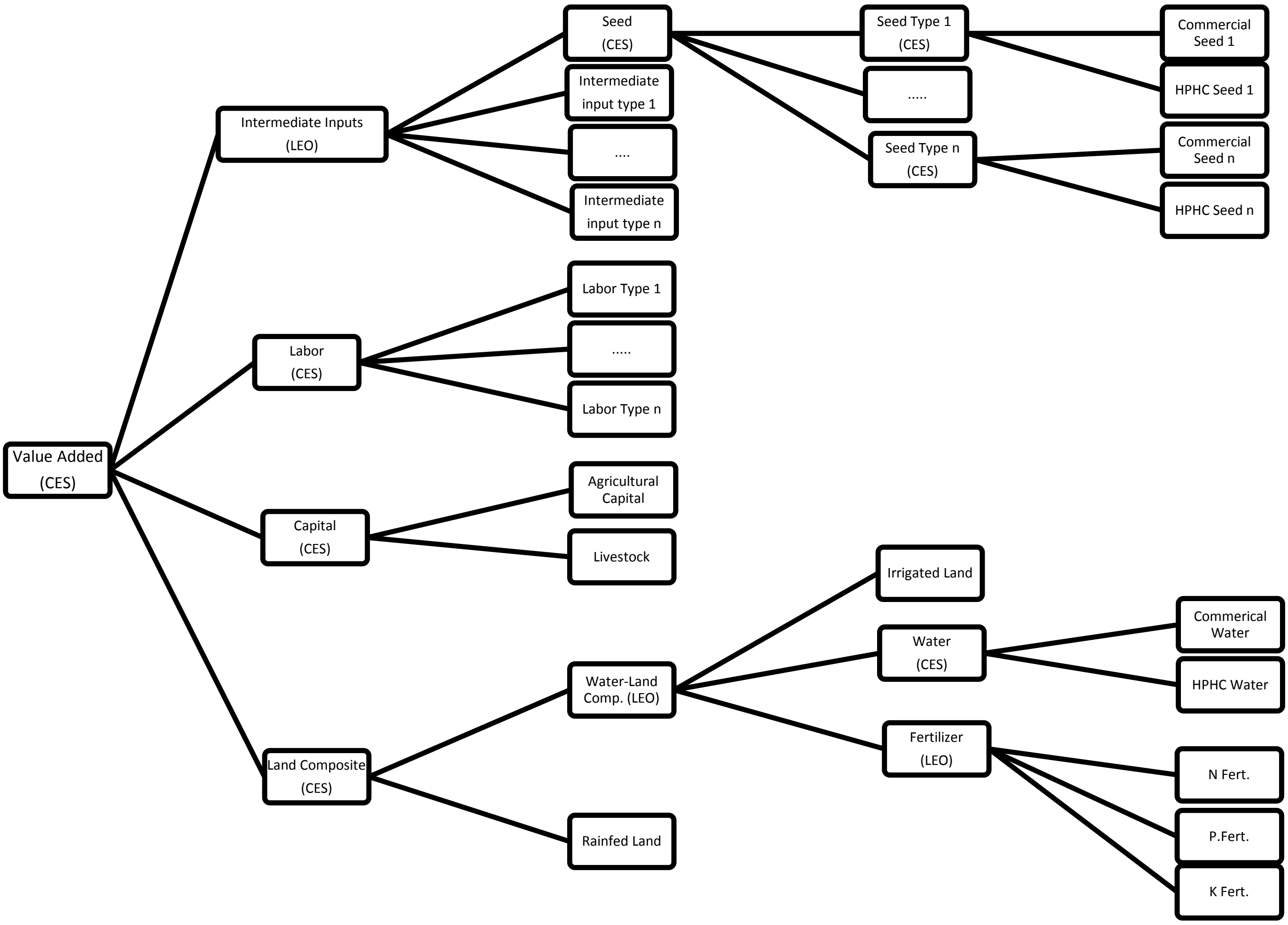
Source: Mainar et al. (2018)

Figure 26: AEZ Regions classification used in the report



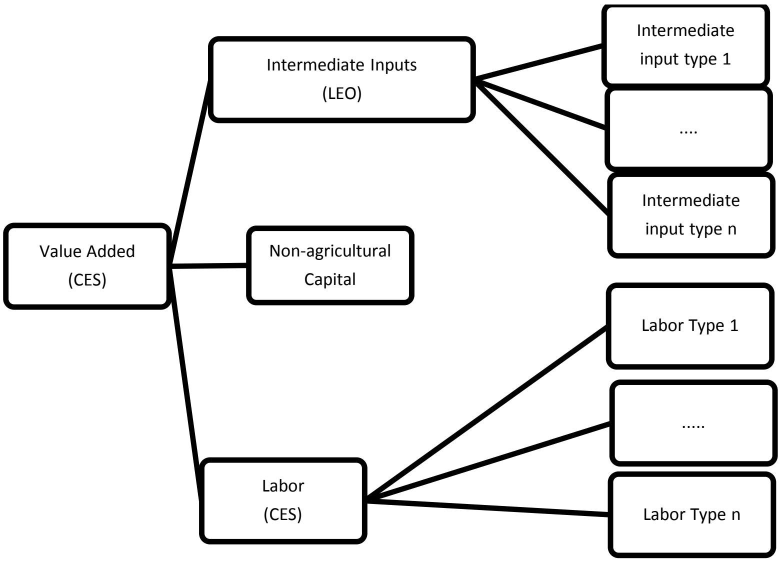
Annex 2: Production structures

Figure 27: Structure of the agricultural production



Source: own elaboration

Figure 28: Structure of production in other sectors



Source: own elaboration

Annex 3: Model Equations

Evolution of death rates:

$$DR_t = DR_{t-1}\left(\frac{\frac{QGD_{t-1,Health}}{popn_{t-1}}}{\frac{QGD_{t,Health}}{popn_t}}\right)^{\mu_{t,DR}} \quad (1)$$

where DR_t is the death rate at time t, $QGD_{t,health}$ is government spending to health services in time t and $\mu_{t,DR}$ is the elasticity of death rate to the changes in government spending on health.

Evolution of birth rates:

$$BR_t = BR_{t-1}\left(\frac{\frac{QGD_{t-1,Education}}{popn_{t-1}}}{\frac{QGD_{t,Education}}{popn_t}}\right)^{\mu_{t,BR}} \quad (2)$$

where BR_t is the birth rate at time t, $QGD_{t,education}$ is government spending to education services in time t and $\mu_{t,BR}$ is the elasticity of birth rate to the changes in government spending on education.

Evolution of labour productivity:

$$ADFH_{L,H,t} = ADFH_{L,H,t-1} + \left(\left(\frac{QGD_{t,Health}}{QGD_{t-1,Health}}\right)^{\mu_{Health,t}} - 1\right) + \left(\left(\frac{QGD_{t,Education}}{QGD_{t-1,Education}}\right)^{\mu_{Education,t}} - 1\right) \quad (3)$$

where $ADFH_{LH,t}$ is the productivity of labour type L owned by household type H, $\mu_{Education,t}$ and $\mu_{health,t}$ are elasticity of factor productivity to the changes in government spending on education and health, respectively.

Evolution of trade and transport margins:

$$TrMar_t = TrMar_{t-1}\left(\frac{QINV_{t-1,road}}{QINV_{t,road}}\right)^{\varepsilon_{ROAD}} \quad (4)$$

where $TrMar$ is trade margin at time t, $QINV_{t,road}$ is investments to build roads at time t, and ε_{ROAD} is elasticity of trade margins to the changes road investments.

Migration flows in the model:

$$FSIM_{t,f,h,f',h'} = FS_{t-1}(h', f')\left(\eta_{t,h,h'}\pi_{t,h,h'}\phi_{t,f,f'}\right)^{\varepsilon_{f,h,f',h'}} \quad (5)$$

where the indices f and h stands for factors (i.e. skilled, semi-skilled and unskilled labour) and households (i.e. according to regions and rural/urban) that receives immigrants respectively, f' and h' are factors and households; t is the simulation period, $FSIM$ is the number of immigrants, FS_{t-1} is the number of people in each household and labour type in the previous time period; η is the migration driver factor based on household income, π is the migration driver factor based on public spending and φ is the is the migration driver factor based on factor prices. ε is the elasticity of migration flows to the changes in migration drivers; The migration drivers are defined as follows:

$$\eta_{h,h',t} = \frac{\dfrac{YH_{t,h}}{\sum_f FSI_{t,h,f}}}{\dfrac{YH_{t,h'}}{\sum_f FSI_{t,h',f}}} \times \frac{\dfrac{YH_{t-1,h'}}{\sum_f FSI_{t-1,h',f}}}{\dfrac{YH_{t-1,h}}{\sum_f FSI_{t-1,h,f}}} \tag{6}$$

$$\pi_{t,h,h'} = \frac{\dfrac{QPub_{t,h}}{\sum_f FSI_{t,h,f}}}{\dfrac{QPub_{h'}}{\sum_f FSI_{t,h',f}}} \times \frac{\dfrac{QPub_{t,h'}}{\sum_f FSI_{t-1,h',f}}}{\dfrac{QPub_{t-1,h}}{\sum_f FSI_{t-1,h,f}}} \tag{7}$$

$$\phi_{t,f,f'} = \frac{\dfrac{\sum_a W_{t,f} FD_{t,f,a}}{\sum_f FD_{t,f,a}}}{\dfrac{\sum_a W_{t,f'} FD_{t,f',a}}{\sum_{f'} FD_{t,f',a}}} \times \frac{\dfrac{\sum_a W_{t-1,f'} FD_{t-1,f',a}}{\sum_{f'} FD_{t,f',a}}}{\dfrac{\sum_a W_{t-1,f} FD_{t,f,a}}{\sum_f FD_{t-1,f,a}}} \tag{8}$$

where YH_h is income of household h, $FSI_{h,f}$ is factor supply (i.e. ownership) of labour type f by household h, $QPub_f$ is household consumption of education and health services, W_f is wage rate for factor f and $FD_{f,a}$ is factor demand (i.e. employment) of factor f by activity a. The three equations above imply that the migration is driven by the change in the per capita household income, per capita consumption of education and health services and average wage rate received by household.

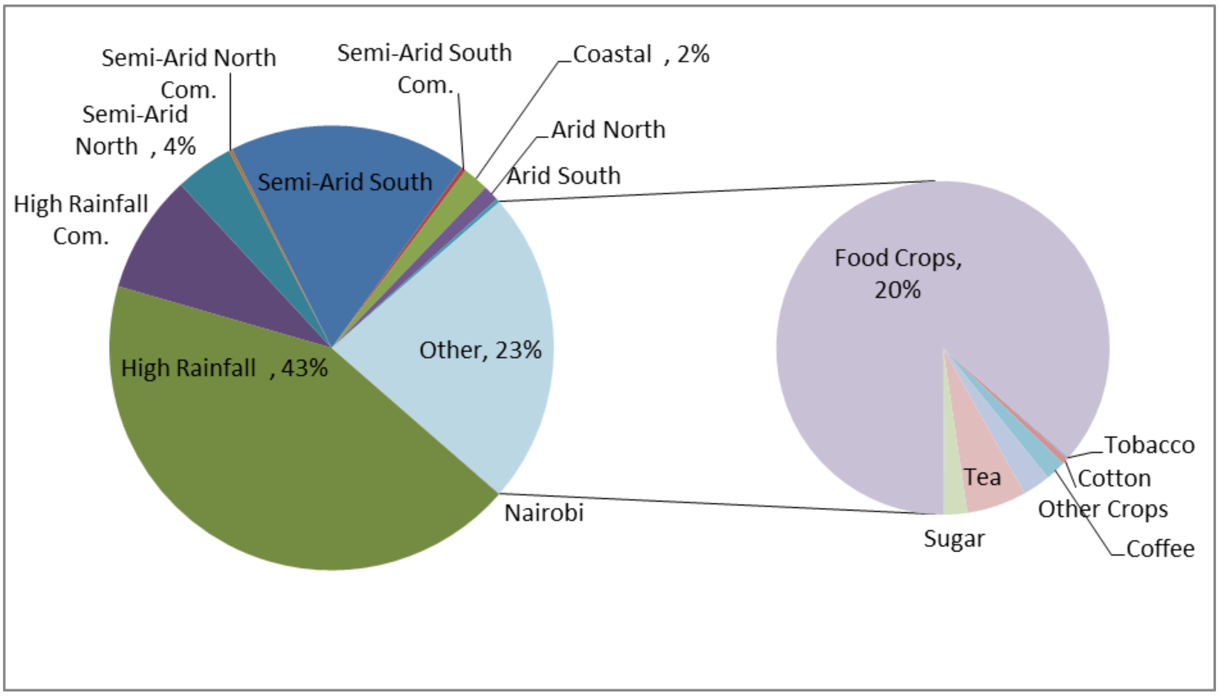
Annex 4: Irrigation for small-holders vs. commercial farms

This annex presents two sub-scenarios to compare irrigation development for small holder and commercial farms (i.e. large farms).

According to the household survey data used to construct the SAM, about 77% of the irrigated land is employed by smallholder farmers (RHGs) while remaining 23% are utilized by commercial farms, generally specialized in production of export crops (Figure 29). High rainfall and semi-arid south regions have the highest share of irrigated land use. More than 50% of the irrigated land is in the high rainfall region, given the higher availability of water resources.

Among the commercial farms, food crop producers use more than 20% of the total available irrigated land (i.e. more than 90% of the irrigated land used by commercial farms). Thus in the base year, irrigation is concentrated on high rainfall region and food crops producing commercial farms, which uses more than 76% of the irrigated land.

Figure 29: Distribution of irrigated land by aggregates, %



Source: Model results

We perform two additional scenarios to distribute investments on irrigation schemes (which equal 10% of the government budget, as in the other scenarios) between two irrigated land types: Irrigated land used by small holder farmers and irrigated land used by commercial farms specialized in production of export crops.

In the SAM we disaggregate the irrigated land into two according the activity that uses irrigated land. Then we perform two simulations: (i) small scale irrigation and (ii) large scale irrigation. In the small scale irrigation scenario we assume that 80% of the investments in irrigation are devoted to expand the irrigated land used by small-holders. The remaining 20% are allocated to expand the irrigated land used by commercial farms. Under the large scale irrigation scenario we reverse the ratios, i.e. 20% are used to expand the irrigated land used by small-holders and 80% to expand the irrigated land used by commercial farms. We report the results as difference of small-scale irrigated simulation from the large scale irrigation scenario to keep the tables and graphs readable.

New irrigated land is distributed across activities and regions according to the initial share in irrigated land use. This assumption is based on two facts, i.e. (i) the activities that already use a higher share of irrigated land are probably located in the regions where water for irrigation is more readily available, and (ii) switching from rainfall agriculture to irrigated agriculture is not costless and hence farmers that are used to irrigated farming are more likely to expand their activities and use more irrigated land compared to the farms that use less irrigated land.

The simulation results are in line with the results of the irrigation scenario reported in the main report, i.e. agricultural production increases with high rainfall region being the main beneficiary. However, the increase in food staple production is significantly higher under the small scale irrigation scenario compared to the large-scale irrigation. That is, expanding the irrigated land for small-holders is more likely to contribute to the food production. Processed food production sectors also expand their production more under the small-scale irrigation scenario by taking advantage of cheaper inputs that would be supplied by small-holder farmers.

On the other hand, investing in large scale irrigation boosts the production of export crops.

As a result, both scenarios improve the Kenyan agriculture through different channels which result in critical different distributional impacts. Small scale irrigation looks more pro-poor since it generates more income for the small holders who are more likely to have less income compared to the commercial farm owners. Additionally by boosting food production (Table 22), small scale irrigation lowers the price of food staples significantly compared to the large scale irrigation (Table 23). As a result, poor households in the urban areas and households in the rural areas who allocate a larger share of their income to food purchases are better-off. Finally this improves food security such as food consumption (Figure 30), throughout the country but most prominently in semi-arid and arid regions.

Table 22: Production under small-scale irrigation scenario, 2030, % change from large scale irrigation

	Production
Agri-food	-0.75
Agriculture	-1.66
Crops	-3.61
Export crops	-42.82
Food staples	2.30
Livestock	2.01
Food	1.45
Non-food	-0.05
HPHC water	7.53

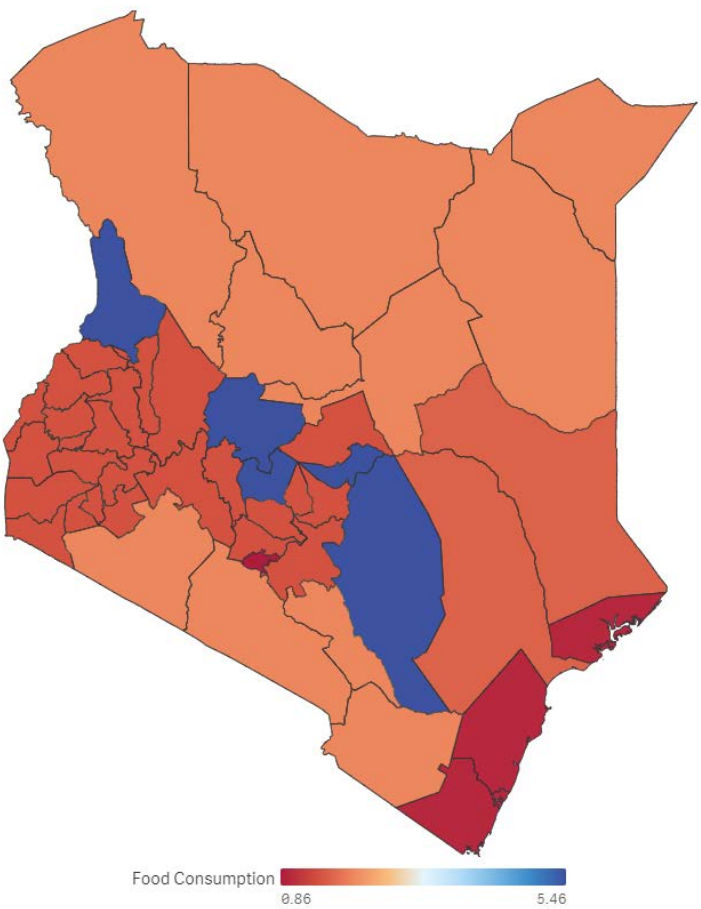
Source: Model results

Table 23: Consumer price index for main commodity and household groups Production under small-scale irrigation scenario, 2030, % change from large scale irrigation

Agricultural	-1.18
Food	-1.15
Rural	-0.96
Urban	-1.46
Arid North	-1.58
Arid South	-1.41
Coastal	-1.14
High Rainfall	-1.08
Mobosa	-1.29
Semi-Arid North	-1.03
Semi-Arid South	-0.73

Source: Model results

Figure 30: Food consumption under small-scale irrigation scenario, 2030, % change from large-scale irrigation



Source: Model results

The large scale irrigation scenarios impact is mainly through international trade where the boost in the production of the export commodities increases the income from exports and allows importing more non-agri-food commodities (Table 24). This increases income of farm holdings which are specialized in export commodities. Furthermore, the increase in imports generates a fall on price levels of non-food items which eventually makes relatively richer households for whom these commodities represents a higher share of household spending.

Lastly, small-scale irrigation also boosts the water available for the household use (i.e. home-produced-home-consumed water) compared to the large scale irrigation, indicating further benefits for households to meet domestic needs (human and animals) and sanitation.

Table 24: Trade indicators under small-scale irrigation scenario, 2030, % change from large scale irrigation

	Export (%)	Import (%)	Trade balance (billion KSh)
Total	-2.37	-1.37	-1.01
Agri-food	-26.38	-1.91	-99.69
Agriculture	-34.12	-2.23	-109.02
Crops	-34.93	-2.20	-110.09
Export crops	-42.30	-0.78	-120.68
Food staples	4.25	-2.37	10.59
Livestock	17.29	-7.58	1.07
Food	13.32	-0.44	9.33
Non-food	2.57	-1.30	98.68

Source: Model results

Annex 5. Online resources

Most of the results presented in this report and the 2014 Social Accounting Matrix of Kenya are available on the public website “JRC agro-economic portal DataM". Links can be also accessed with the below QR codes.

Figure A31. QR code – DataM URL

https://datam.jrc.ec.europa.eu

Source: JRC, 2018.

Using DataM users can access and analyse main results of the report through an interactive dashboard

Figure A32. QR code – ASGTS Report

https://datam.jrc.ec.europa.eu/datam/mashup/ASGTS_KENYA

Source: JRC, 2018.

Using DataM, users can make a bulk download of the SAM in a ZIP file (Dataset_JRC_-_Social_accounting_matrix_-_Kenya_-_2014.zip) containing a homonymous CSV file. The hyperlink for the direct bulk download is in Figure A3

Figure A33. QR Code – direct bulk data download

https://datam.jrc.ec.europa.eu/datam/perm/od/2f0d7a66-93fd-4ecb-9b45-879a83ab3cba/download/dataset.zip

Source: JRC, 2018.

—

— Finally, users may explore and analyse the data through an interactive dashboard placed in the “Model inputs, baselines and social accounting matrices (SAMs)” visualisation section of the website (Figure A4).

Figure A34. QR Code – direct link to the interactive dashboard

https://datam.jrc.ec.europa.eu/datam/mashup/SAM_KE_2014

Source: JRC, 2018.

KJ-NA-29231-EN-C

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub

Publications Office

doi:10.2760/091326

ISBN 978-92-79-85949-6