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Kamel Louhichi, Aymeric Ricome, Sergio Gomez y Paloma

► **To cite this version:**

Kamel Louhichi, Aymeric Ricome, Sergio Gomez y Paloma. Impacts of agricultural taxation in Sub-Saharan Africa: Insights from agricultural produce cess in Tanzania. *Agricultural Economics*, In press, 10.1111/agec.12704 . hal-03595726

HAL Id: hal-03595726

<https://hal.science/hal-03595726>

Submitted on 11 Sep 2023

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IMPACTS OF AGRICULTURAL TAXATION IN SUB-SAHARAN AFRICA: INSIGHTS FROM AGRICULTURAL PRODUCE CESS IN TANZANIA

Abstract: This paper analyzes the economic impacts of agricultural produce cess in Tanzania and compares its effectiveness with alternative reform options relying on its removal or reduction. Produce cess is one of the common forms of agricultural taxation in Sub-Saharan Africa. This analysis is done using the farm household model FSSIM-Dev, which is applied to a country representative sample of 3,134 individual farm households taken from the 2012/13 Tanzania National Panel Survey. Simulations show that the current produce cess is too high and its removal or reduction would increase production intensity and boost farm income, ranging between +2% and +21% depending on options and regions. These positive impacts are driven by land productivity improvement rather than area reallocation. The largest impacts are experienced in Northern and Western highlands. Large farms and farms specialized in cash crops tend to gain more from the abolishment or reduction of produce cess. The increase in both production and income is, however, not sufficient to significantly reduce rural poverty and to improve nutrition security indicators. Finally, results show that a uniform cess rate of 1% for all crops seems to be the most efficient policy option. It gives the best trade-off between government revenue loss and farmers economic gain.

Keywords: Agricultural Taxation, Agricultural Produce Cess, Farm-household Model, Tanzania, Sub-Saharan Africa

1. Introduction

The agricultural sector has been, and continue to be, subject to high levels of taxation in many developing economies simply because it is among the largest economic sectors, both in terms of value added and employment. Its fiscal support to governments is vital to (i) finance public expenditure, (ii) transfer resources (agricultural surplus) to non-agricultural sectors, (iii) promote efficiency and diversification of agricultural production, and (v) redistribute incomes within the agricultural sector (Bird, 1974; Khan, 2001).

Although agricultural taxation has fallen significantly since the early 1990s¹, mainly in Africa and East Asia due to gradual economic liberalization and structural adjustment programs, it continues to be a fundamental and important source of revenues for many governments, particularly provincial and local governments.

Agricultural taxation comes in different forms depending upon the country. They can broadly be classified in two types, namely explicit and implicit taxes. Explicit taxes include both direct and indirect taxes. Direct taxes involve income, land, wealth and property (individual or household) taxes. Indirect taxes include taxes on domestic trade (e.g. VAT) and foreign trade, stamp duty and taxes levied in specific marketed products (excise tax and cess). Implicit taxes on the other hand are taxes on non-agricultural sectors which affect agricultural output prices such as non-tariff barriers, import tariffs, overvalued exchange rates, and procurement programs (for a review of agricultural taxation forms and experiences see Skinner, 1991a; Sarris, 1994; Khan, 2001; OECD, 2005).

In countries with inefficient bureaucracy and information system and where land ownership rights are not well formalized such as in Sub-Saharan African countries, local governments

¹ According to Anderson and Masters (2009), between the early 1980's and the early 2000's, agricultural taxation declined from about 30 percent to 10 percent in Sub-Saharan African countries and from about 15 percent to 5 percent in East and South Asia countries.

tend to prefer indirect taxes because they may generate significant government revenues and are relatively easy and inexpensive to administrator compared to direct taxes such as income or land taxes.

Agricultural produce cess is one of the indirect taxes used in several Sub-Saharan African and Asian countries (Tanzania, Kenya, Uganda, Zimbabwe, Ghana, Nigeria, Philippines, Malaysia, Sri Lanka, India, and Pakistan), primarily in rural areas, to finance government expenditures. It is an 'earmarked' levy charged by the state or provincial governments on specific marketed products. It can be imposed using flat, proportional or graduated tax² rates on either quantities (volume) or value of the traded commodities. Historically, produce cesses have mostly targeted (export) cash products such as tea, coffee, cocoa, and cotton and the generated revenues are reserved for improvement of the production and marketing of those products. More recently, both cash and staple crops are targeted by produce cess and the generated revenues are rather used to finance expenditures of local government authorities (LGAs). For instance, Kenya collects produce cess on several crops such as maize, sugar cane, tea, coffee, cotton and horticulture. Uganda imposes produce cess at least on maize and coffee. Zambia has collected up to 2009 local tax on maize, cotton, tobacco, rice, and livestock. Tanzania imposes cess on both cash and food crops with different rates.

Although agricultural produce cesses are relatively easy to implement, less costly to administer, and provide a significant source of revenue for many LGAs, they are being strongly criticized by agribusiness and stakeholders because they can adversely affect farmers' incentives to produce and trade, worsen food insecurity and poverty of households and cause market distortions, mainly when cess rates vary across country districts and products. This is for instance the case in Tanzania – object of this study – where the central government has given

² In this paper we use tax and cess interchangeably.

LGAs a lee-way to charge marketed agricultural product between 2% and 5% of its farm-gate price as levy (cess) (before the fiscal reform of 2003 the cess rate was going up to 20%). Even though traders are statutorily obliged to pay the cess, it has been shown that it is actually the farmers who pay most, if not all, of it through an equivalent reduction in the farm-gate price offered by traders (Nyange et al., 2014).

Due to farmers and stakeholders' pressures, the central government of Tanzania has decided in 2017 to amend the Local Government Finance Act (2017/18) and, thus, reduce the cap of the cess rate from 5% to 3%. However, this reduction seems insufficient according to stakeholders, and several reform options, aiming further reduction of cess rates and their harmonization among crops and LGAs, are currently under discussion by the Tanzanian government.

Accordingly, the main objective of this study is to contribute to the debate by providing evidence on the economic impacts of the agricultural produce cess currently implemented in Tanzania, from both farmers and government perspectives, and comparing its efficiency with three alternative reform options, namely, (i) full removal of produce cess for all crops and districts (*NoCess* scenario), (ii) removal of produce cess only for staple crops (*NoCess_Step* scenario), and (iii) reduction of produce cess rate from 3% to 1% on both staple and cash crops (*1%Cess* scenario). This is achieved using the micro-economic model FSSIM-Dev (Farming System Simulator for Developing Countries), applied to a representative sample of 3,134 farm-households spread out over all the country coming from the Tanzania National Panel Survey. The potential effects of the simulated options on crop acreage, production, input use, farm income, LGAs revenues, poverty level and some food security related indicators are presented and discussed.

The paper is organized as follows. Section 2 reviews the main strands of literature related to agricultural taxation, particularly on produce cess effects. Section 3 provides a description of

the economic model and the data. Section 4 presents and discusses the results. The final section summarizes the contributions of the analysis to the literature and discusses policy implications of the findings.

2. Literature reviews

Agricultural taxation and its roles in developing economies has been largely debated in the literature. While earlier literature claimed that agricultural taxation is necessary to support government expenditure, extract the agricultural surplus and ensure inter-sectoral equity, more recent one has questioned this view emphasizing that agricultural taxation reduces farmers' incentives to invest, affects resource allocation and curb economic growth and structural change (Dennis and Iscan, 2010; Valdé et Foster, 2010). Others have asserted that the acceptability of agricultural taxation depends on the level and means of taxation. For instance, Bird (1974) suggested, after having analyzed tax regimes in Northern America, Japan, Mexico and India, to levy taxes from agricultural sector but it should not be significant and preferably based on land instead of output values due to its small distorting impact on the economy. Similar results are found by Skinner (1991) using the specific experiences of Bangladesh, Argentina, and Uruguay. Khan (2001) argued, based on a deeper analysis of different tax regimes in selected developing countries, that tax on agricultural land and income should be a focus for raising government revenue and maintaining the conditions for efficiency and equity. While there is a growing literature on agricultural taxation, particularly on land taxation (Chatterji and Junankar, 1986; Strasma, 1987; Skinner, 1991a; Skinner, 1991b; Olowu and Smoke, 1992; Fjelstad and Semboja, 2000; Khan, 2001; Fjelstad, 2001; Andelson R.V., 2001; Bahiigwa et al., 2004; Tao et al., 2004; OECD, 2005; Kasara, 2007; Gordon and Li, 2009; OECD, 2010; Norregaard, 2013; Nyange et al., 2014; Booth, 2014; Kalkuhl et a., 2018), there are significantly less studies dealing with agricultural produce cess, despite its intensive use in

many Sub-Saharan and Asian countries. The few available studies are the ones developed by Ogada et al. (2018) who attempted to assess the impact of produce cess on the cost structure of major agricultural commodities in Kenya. They found that produce cess significantly increases production and distribution costs of target crops, reduce their competitiveness and create artificial barriers for their movement between different parts of the country. Nyange et al. (2014) found, using data on LGAs' revenues and expenditures in Tanzania, that (i) produce cess varies widely among crops and LGAs which may result into unfair competition, (ii) produce cess rates are too high for the agriculture sector which is characterized by low profitability margins, and (iii) produce cess collection system is inefficient and need to be improved in order to reduce tax evasion and avoidance. This finding has been supported by The Agricultural Council of Tanzania (ACT) report (2013) which found that produce cess rates are relatively heavy for the agriculture sector and need to be eliminated or reduced and replaced by grants from central government. In the opposite, a study performed by The Investment Climate Advisory Services of the World Bank Group (2009) has shown, based on a survey of 80 farmers, agricultural traders, and market participants covering 16 districts and 5 important crops grown in Tanzania (Coffee, Cashew, Cotton, Rice and Maize), that tax burden on agriculture sector was high for cashew but not for the other crops. Bahigwa et al., (2004) showed that local taxation in Uganda distorted relative prices of goods and services, accentuated income inequality and impacted negatively economic growth.

Whilst these few studies are promising and provide evidence on the negative impact of produce cess on agriculture competitiveness, more research is needed to better understand the effects of such tax policy on land use, farm performances, livelihoods, income distribution, rural poverty, as well as on LGAs budgets.

Accordingly, the overall objective of this study is to contribute to this debate by assessing the potential impacts of the agricultural produce cess in Tanzania and comparing its efficiency with

different alternative reform options. It notably seeks to (i) quantify the farm-level effects of the current produce cess system by comparing results with (i.e. baseline scenario) and without (*NoCess* scenario) produce cess, (ii) assess the effects of two alternative reform options (*NoCess_Step* and *1%Cess* scenarios), and (iii) identify the reform option that answers the classical taxation challenge of striking a balance between generating revenue while maintaining the incentive to produce and achieve equity (Fjeldstad and Semboja, 2000). In fact, the abolition (or reduction) of produce cess or the transition to a new tax system should consider the way for the compensation of the LGA revenue losses to avoid the Zambian's scenario. The government of Zambia abolished crop levies in September 2009, but re-introduced them in July 2012 after realizing that the central government transfers cannot cover for the lost revenues from the levies.

3. Empirical framework

3.1 Specification of the economic model

The farm household model FSSIM-Dev is used to quantify the potential impacts of the produce cess in Tanzania. FSSIM-Dev is a micro-simulation model designed to ex ante assess the impacts of agri-food policies and technological innovations on food security and rural poverty alleviation, in the specific context of low-income/developing countries. It aims to inform analysts and policymakers on how changes in prices, technology, food and agricultural policies might affect the viability, poverty and food security of heterogeneous sets of farm households that characterize the agricultural sector, which types of farm households will be most affected, and where they are located.

FSSIM-Dev is a constrained optimization model which attempts to reproduce farm household production and consumption decisions in a separable regime. The farm household's production decisions often depend on their resource endowment, attitude to risk, agro-ecological

conditions and socioeconomic contexts, while their consumption decisions are primarily driven by the income generated from both on-farm and off-farm activities and the preferences of the household's members. Both production and consumption decisions are affected by policies and prices, which in turn are affected by international markets, infrastructure and market efficiency (Figure 1). This dual character of farm households as producers and consumers has important implications for farmers' livelihood. Therefore, FSSIM-Dev aims to capture this dual nature of small farm households, as well as the other key features of developing countries' agriculture such as: (i) heterogeneity of farm households with respect to both their consumption baskets and resource endowments; (ii) inter-linkage between transaction costs and market participation decisions; and (iii) seasonality of farming activities and resource use.

[Insert Figure 1]

FSSIM-Dev is a comparative static and Positive Mathematical Programming (PMP) model. Positive means that the model aims to reproduce the real conditions under which the farmer operates as accurately as possible and to simulate 'what is likely' to happen to this situation when changing external conditions, i.e. exogenous shocks, occur (Howitt, 1995). For each single farm household, the model search for the optimal land and labor allocation that maximizes the household income taking into account resource endowments (land and labor) and consumption constraints. Farm household income (R) is defined as the income earned from all economic activities of family members of the same household. It is composed of three components: agricultural income, income from marketed factors of production (non-farm wages, rent of land and equipment) and off-farm incomes. Agricultural (farm) income is defined as the income earned by households from selling or consuming their own agricultural products. Off-farm incomes are defined exogenously and can originate from different sources such as non-farm wages, self-employed activities (petty trading, craftsmanship, etc.), pensions, transfers (including remittances) and donations. Agricultural (farm) income is computed as the

sum of agricultural gross margin minus a non-linear (quadratic) activity-specific function. Gross margin is the total revenue from agricultural activities, including sales and self-consumption, minus the accounting variable costs of production activities. The accounting costs include costs of seeds, fertilizers, crop protection, and other specific costs. The quadratic activity-specific function is a behavioral function introduced to calibrate the farm model to an observed base year situation, as is usually done in PMP models. The PMP methodology (Howitt, 1995), recently refined by Mérel et al. (2011) and Mérel and Howitt (2014), intends to reproduce households' decision in a precise way, allowing capture of the effects of factors that are not explicitly included in the model, such as price expectations, risk-averse behavior, capital constraints and other unobserved costs (Heckeley, 2002).

A crop-specific quadratic yield response function to nitrogen fertilizer, considered as the most important nutrient in sub-Saharan Africa, was econometrically estimated and then embedded in FSSIM-Dev, under the assumption that yields are independent of acreage planted. The other fertilizer elements (P and K) are assumed to be applied in fixed proportion to nitrogen fertilizer and the remaining intermediate inputs such as seeds, pesticides, labor use, etc. are assumed to be independent to fertilizer and employed in fixed rate by hectare of each specific crop.

Agricultural commodity prices (i.e. market prices) are exogenously fixed for households participating in markets. We assume that those farm households are price takers on commodity markets. However, the price at which the household values a commodity will be generated by the model, depending on household trading status (net buyer, net seller or self-sufficient), which in turn is related to transaction costs. In addition to resource endowment and household consumption constraints, FSSIM-Dev involves three blocks of equations for modelling market participation decisions: the first block for upper and lower bounds commodity prices; the second, known as complementary slackness conditions, to guarantee that a farm household uses its own internal shadow price if and only if it does not participate in the market for goods;

and the third one to ensure that, for each commodity, a farm household can be either a buyer or a seller but not both (households can also be self-sufficient, i.e. neither buying nor selling goods). It also includes a market clearing condition at household level to ensure commodity balance: the sum of production and market demand for each commodity must be equal to consumption plus market sales.

The general mathematical formulation of the model for each farm household h is as follows:

$$\begin{aligned} \text{Max } R_h = & \sum_i (s_{h,i} + cs_{h,i}) P_{h,i} + \sum_i sb_{h,i} x_{h,i} - \sum_i w_{h,i} N_{h,i} x_{h,i} - \sum_{i,k} a_{h,i,k} x_{h,i} \\ & - \sum_i (d_{h,i} + 0.5Q_{h,i,i'} x_{h,i}) x_{h,i} + \text{exinc}_h \end{aligned} \quad (1)$$

Subject to:

$$\sum_{tf} A_{h,i,tf} x_{h,i} \leq B_{h,tf} \quad [\rho_{h,tf}] \quad (2)$$

$$c_{h,j} P_{h,j} = \delta_{h,j} (R_h - \sum_{j'} v_{h,j'} P_{h,j'}) + v_{h,j} P_{h,j} \quad (3)$$

$$s_{h,j} b_{h,j} = 0 \quad (4)$$

$$p_j^m t_{h,j}^s \leq p_{h,j} \leq p_j^m t_{h,j}^b \quad (5)$$

$$s_{h,j} (p_{h,j} - p_j^m t_{h,j}^s) = 0 \quad (6.1)$$

$$b_{h,j} (p_{h,j} - p_j^m t_{h,j}^b) = 0 \quad (6.2)$$

$$q_{h,j} = y_{h,j} x_{h,j} \quad (7)$$

$$q_{h,j} = s_{h,j} + cs_{h,j}; c_{h,j} = cs_{h,j} + b_{h,j}; q_{h,j} + b_{h,j} = s_{h,j} + c_{h,j} \quad (8)$$

$$y_{h,j} = \alpha N_{h,j} + \beta N_{h,j}^2 + \mu_{h,j} \quad (9)$$

$$x_{h,j} \geq 0; y_{h,j} \geq 0; N_{h,j} \geq 0 \quad (10)$$

where indices $i = 1, 2, \dots, I$ and $j = 1, 2, \dots, J$ denote agricultural activities and products respectively, and $k = 1, 2, \dots, K$ are intermediate inputs (i.e. seeds, crop protection, etc.). R_h is the total income of the household h , \mathbf{s} is the $(n \times 1)$ vector of sold quantities of goods, \mathbf{cs} is the

($n \times 1$) vector of self-consumed quantities of goods, \mathbf{p} is the ($n \times 1$) vector of household prices of goods, \mathbf{sb} is the ($n \times 1$) vector of production subsidies (if it exists), \mathbf{x} is the ($n \times 1$) vector of non-negative levels of the agricultural activities, \mathbf{N} is the ($n \times 1$) vector of applied nitrogen fertilizer (kg per ha-1), \mathbf{w} is the ($n \times 1$) vector of fertilizer prices, \mathbf{a} is the ($n \times k$) matrix of accounting variable costs, \mathbf{d} is the ($n \times 1$) vector of the linear part of the activities' behavioral activity function, and \mathbf{Q} is the ($n \times n$) symmetric, (semi)positive matrix of the same function; $exinc$ is the off-farm household's income.

\mathbf{y} is the ($n \times 1$) vector of crop yield (kg per ha-1), \mathbf{N} is the ($n \times 1$) vector of applied nitrogen fertilizer (kg per ha-1), and α , β and μ are, respectively, the linear terms, the quadratic terms and the intercepts of the crop yield response functions. The β coefficients have been estimated for the whole farms using the ordinary least squares (OLS) estimator (Riome et al., 2020). With this crop yield specification, the impact of nitrogen will vary according to the seed type used, whether the crop is rainfed or irrigated, and finally the agro-ecological zone. It allows for consideration of technological and soil/climatic heterogeneity. It also enables recommendations on fertilizer rates to be made under different policy options.

\mathbf{A} is the ($n \times m$) vector of resource requirements (e.g. land, labor), \mathbf{B} is the ($m \times 1$) vector of initial resource endowments and \mathbf{p} is the ($m \times 1$) vector of their corresponding shadow prices. \mathbf{c} is the ($n \times 1$) vector of consumed quantity of goods, \mathbf{v} is the ($n \times 1$) vector of incompressible consumption (interpreted as minimum subsistence or "committed" quantities below which consumption cannot fall), and δ is the ($n \times 1$) vector of marginal budget share $\left(\frac{\partial(c_{h,j}P_{h,j})}{\partial R_h}\right)$. \mathbf{P}^m is the ($n \times 1$) vector of market price of goods while \mathbf{t}^s and \mathbf{t}^b are ($n \times 1$) vectors of transaction costs related to the sales and the purchase respectively, of goods or tradable factors. Eventually, \mathbf{q} is the ($n \times 1$) vector of production level.

\mathbf{Q} and \mathbf{d} are estimated using a variant of the Positive Mathematical Programming approach (Louhichi et al., 2018, Louhichi et al., 2020). \mathbf{v} and $\boldsymbol{\delta}$ are estimated simultaneously in each region using the Highest Posterior Density (HPD) estimator and prior information on income elasticities and Frisch parameters (Louhichi et al., 2020).

Equation (1) represents the model's objective function, while equations (2) to (7) are the set of constraints faced by the farm households. Equation (2) is the resource endowment constraint; equation (3) is the household consumption constraints represented through the Linear Expenditure System (LES); equation (4) specifies that for a given product, the household can be either seller or buyer but not both; equation (5) is the upper and lower bounds of the household commodity prices; equations (6.1) and (6.2) represent the complementary slackness conditions; equation (9) computes the production level; equation (8) is the market clearing condition at the household level, assuming that for each product, the sum of production and purchase equals the consumption plus sales of this product; equation (9) is the crop yield response function to mineral fertilizer and equation (10) is the non-negativity conditions.

The model calibration was performed using an improved approach based on the HPD estimator, with prior information on land rental prices, supply and income elasticities (Louhichi et al., 2020). The aim of the calibration consumption module is to ensure that the consumption decisions of the farm households during the base year period are exactly reproduced by the optimal solution of the programming model. The calibration of the supply side of the FSSIM-Dev model aims to replicate the two key observable production decision variables: 'crop yield at plot level (i.e. by unit of area)' and 'land allocated at farm level' by taking into account the underlying profit optimization problem. This is performed in two successive steps: first we calibrate the crop yield, and then the land allocation. The aim is that the model exactly replicates the observed land allocation crops, as well as the exogenous set of supply elasticities. The calibration to the exogenous supply elasticities is performed in a non-myopic way, i.e. we

consider the effects of changing dual values on the simulation response (Mérel et al., 2011; Louhichi et al., 2018). The parameters of the behavioral function are estimated only for observed activities in each farm household, meaning that the well-known self-selection problem is not explicitly handled in this estimation. To cope with this problem, we adopted the following ad hoc modelling decisions in the simulation phase: (i) in each region, the gross margin of the non-observed activities is equal to the farm-type average gross margin; (ii) the activity's quadratic function parameter is equal to the activity's average quadratic function parameter within the farm type; and (iii) the linear term's quadratic function is derived from the difference between the gross margin and the dual values of constraints.

More details on FSSIM-Dev specification and its equations are supplied in Louhichi et al. (2020) and Louhichi and Gomez y Paloma (2014).

3.2 Data and descriptive statistics

The data used to parameterize the FSSIM-Dev model come from the 2012/13 Tanzanian National Panel Survey (TNPS), which is a nationally representative survey of all rural areas of Tanzania. TNPS is a joint project between the Tanzania National Bureau of Statistics (NBS) and the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) team. The World Bank has a tradition of collecting household survey data in many other developing and emerging economies. In the case of Tanzania, the survey is implemented every two years since October 2008. In this study, we only used the data of the third wave (2012-2013) which include 5,015 households among them 3,212 were farm households. The more recent 2014-15 wave is characterized by non-typical weather conditions in several zones of the country, which could bias the analysis if it is considered.

The TNPS survey gathered wide-ranging information on household characteristics, consumption, living conditions, and health, collected via a single visit to the households. The survey focused on agriculture to gather detailed and accurate agricultural data at the plot-level.

The survey is a two-stage cluster sample design. The primary sampling units are the enumeration areas (EAs), which correspond to a village in the rural area and have been stratified along two dimensions (rural and urban area) and four strata (rural areas, Dar es Salaam, other urban areas on the mainland, and Zanzibar). From this stratification, 410 EAs were randomly drawn from the 2002 Population and Housing Census. The second stage of sampling consisted of random selection of households to be interviewed in each EA, based on a household listing.

Before using the TNPS survey data, several steps were performed to screen the data and to convert them to a format that is compatible with the FSSIM-Dev modelling framework. Variables such as quantity of labor and input used, crop yields, consumption, and prices were treated for outliers and missing values, using Tukey's method based on Interquartile Range or winsorizing. After cleaning and dropping out the urban households, and the rural households having no commitment in any agricultural crop activities, the total sample used for the FSSIM-Dev model consists of 3,134 farm households spread throughout the country.

Table 1 presents some key sample characteristics, including for the main agricultural regions of Tanzania. The average farm size in our sample is 1.5 ha; however, there is considerable variability across households and regions. The smallest average farm size (0.87 ha) is observed in the Western highland and the largest (2.24 ha) in the Semi-arid and Arid zone. About 56% of households have a farm size of strictly less than 1 ha. 75% of the farms and 80% of the cultivated lands in the sample are concentrated in three main zones: Coastal plain, Plateau/South-western highland, and Semi-arid/Arid. The remaining three zones together represent less than 25% of the sample farms and less than 20% of the cultivated land. This indicates that some regions are more agriculture-oriented than others, so that the number of farm households from these zones – and their corresponding cultivated areas – dominate in the sampling frame.

[Insert Table 1]

A farm household cultivates, on average, 2.54 plots with an average plot size of 0.37 ha. The average fertilizer application rate remains very low rounding 32 kg/ha, and it is mainly used for maize and rice. Only 15% of the sampled farmers use fertilizer on at least one of their plots, however this percentage varies significantly across regions, ranging from 40% in the Southern highlands, to less than 5% in the Western highlands. Regional disparities on land use are well captured by the sample. The Coastal plain region which has low agricultural potential, particularly for cereals, is characterized by a higher presence of perennial crops (coconut, mango, orange in the north and cashew nut in the south) and cassava in comparison to other regions, to the detriment of maize. In the Semi-arid and Arid zone, sorghum, millet and legumes are quite common in comparison to other regions, while beans remain very low due to the high risk of failure caused by the scarcity of rainfall. Conversely, in the Northern highlands, which is a mountainous zone with abundant rainfall and fertile soils, maize and beans dominate with cash crops such as coffee and fruit trees (banana, avocado, etc.). In the Plateau and South-western highlands, maize, cassava and bean are the main crops, along with rice and cassava. The Southern highlands is considered one of the most productive area of Tanzania, due to the presence of fertile soils, good altitude and rains. Farmers grow mainly maize, beans and cash crops (rice, cocoa, coffee, horticulture, etc.). Finally, in the Western highlands, the farming system relies on the combination of banana-beans-coffee in the north, and root and tuber crops with beans and maize in the south. The average yield in our sample for the four main crops maize, rice, beans and cassava are 1091, 1591, 437, and 1095 kg per ha, respectively. Although the recent productivity improvement, these yields remains low compared to the world average of 4854, 4524, 836, and 10767 kg per ha, respectively for the same year (FAOSTAT data).

Cereals, tuber, and root crops are the most consumed food items in Tanzania (50% of the total food expenditure), followed by the vegetable and fruit share (0.29%) and the legumes, meat,

and fish (0.21%).

3.3 Layout and implementation of baseline and scenarios

3.3.1 Baseline

The baseline is interpreted as a projection over time of the current situation, covering the most probable future development in terms of technological, structural and market changes. It serves as the starting point against which all scenarios are measured. In most cases, the baseline is a "no policy change" scenario, with a continuation of the current policy framework and the implementation of already decided policy changes. In this study, the main change, compared to the base year, in terms of policy assumption is the adoption of a uniform cess rate of 3% for all crops and farms. This rate corresponds to the maximum cess rate adopted by the government in 2017, assuming it will continue to be implemented up to 2020, taken as the time horizon for running simulations.

Regarding technological, structural and market changes, a status quo assumption is adopted, i.e. prices, yields, costs and total farm area are assumed to remain constant between the base year and the baseline (i.e. there is no interaction between farms, neither farm exit/entry nor substitution between different land types).

The other modelling assumptions are as follows:

- The burden of taxation is entirely supported by farmers (i.e. traders are assumed to fully transfer the cess to farmers through a reduction of farm-gate prices). This assumption comes from Nyange et al. (2014) who observed that “most if not all the cost is passed onto farmers, meaning that they end up paying at least the majority of the cess”. Inelastic supply in the short run and elastic demand tend to push the cost of the tax onto the farmers.”
- The mechanism of tax revenue collection is assumed to be efficient (i.e. there is no tax

evasion and/or avoidance). We are aware that this assumption is to a great extent unrealistic given all the issues raised by Nyange et al. (2014); however, our goal here is to estimate the potential and not the real LGAs cess revenue generated by each reform option (scenario).

- Market (price) effects of the simulated scenarios are not taken into account (i.e. market commodity prices are exogenously set).
- Livestock activities and large commercial farms are not considered due to missing data.
- Following Nyange et al. (2014), we assumed that, for the base year, the produce cess rate for staple crops and tea is equal to 3% and for cash crops (except tea) is equal to 4%. It is important to recall that information on these rates are not available neither in the Tanzania National Panel Survey nor in the statistical database.
- The following crops are considered as staple crops: cereals, roots, tubers, bananas and pulses. Cash crops are tea, oilseeds, vegetables, sugar cane, tobacco, and perennial crops. Note that the distinction between staple and cash crops is not always straightforward, because crops that are usually produced for subsistence purposes can, in some areas and during parts of year, be produced for marketing purposes and vice versa. Here, we classify the crops between these two categories according to how the government would make the distinction when setting the cess rate for each crop category.

3.3.2 Simulated scenarios

To build the scenarios, we engaged in extensive discussions with several stakeholders having an excellent knowledge of the produce cess reform options currently under discussion by the government. Those stakeholders were policymakers from the Ministry of Agriculture, researchers from the ASPIRES project, and academics from Sokoine University of Agriculture. From them, three reform options (scenarios) are simulated with the farm-level FSSIM-Dev model and compared to the baseline:

— **NoCess**: a total removal of the produce cess for all crops and districts. The difference between this scenario and the baseline provides an approximate of the effect of the currently implemented produce cess.

— **1%Cess**: a uniform reduction of the produce cess rate to 1% for all crops and districts.

— **NoCess_stap**: a total removal of the produce cess for only staple crops and tea. For cash crops (except tea), the produce cess remains unchanged compared to baseline.

[Insert Table 2]

Once the produce cess rates are defined for each scenario, we reset the farm-gate prices assuming a full transfer of the produce cess to farmers. To illustrate that, let us suppose that P_c^m is the farm-gate price for crop c before cess reduction, and r_c^s is the cess rate for the given crop c and scenario s . The farm-gate price after cess reduction for crop c under scenario s , P_c^s , can be calculated as follows:

$$P_c^{BY} = P_c^m * (1 - r_c^{BY}) \quad (11)$$

$$P_c^s = P_c^m * (1 - r_c^s) \quad (12)$$

Where P_c^{BY} and r_c^{BY} are the base year farm-gate prices and cess rate. From Eq. 11 we have:

$$P_c^m = P_c^{BY} / (1 - r_c^{BY}) \quad (13)$$

And substituting in Eq. 12 gives:

$$P_c^s = P_c^{BY} \frac{(1 - r_c^s)}{(1 - r_c^{BY})} \quad (14)$$

Given that the base year farm-gate prices (P_c^{BY}) are collected from the survey and the cess rates (r_c^{BY} and r_c^s) are based upon our assumptions (see Table), we can easily derive the farm-gate price P_c^s after cess reduction for each crop c under scenario s .

4. Results and Discussion

In this section, we examine whether and how the simulated options (scenarios) affect crop acreage, production, farmers' income, poverty level and local government budget at both regional and national levels, by farm specialization, farm economic size and for the full distribution across the farm population³. A comparative analysis of the costs and benefits of three options is also performed and discussed. To make results easily comparable across scenarios, all impacts were measured as percentage changes in comparison to the baseline. In addition, given the large number of individual crops included in the model, results are shown by crop type (staple and cash crops) rather than by individual crop.

Before presenting simulation results it is important to notice that farmers may respond in three ways to a reduction or elimination of produce cess: (i) extensive margin, that is, reallocation of acreage among crops (i.e. acreage effects), (ii) intensive margin, that is, increasing production intensity per hectare for a given crop (i.e. yield effects), and (iii) land extension/expansion, that is, bringing new land into cultivation (i.e. land extension effects).

With FSSIM-Dev we capture only the first two adjustments which represent the main opportunities for farmers to respond to shocks. Land extension/expansion is excluded because land endowment is assumed to be fix in our model. This may lead to an underestimation of the land effect of the simulated options.

4.4 Acreage and production effects

One obvious question when analyzing acreage effect is which crop category will gain more from produce cess reform (i.e. produce cess reduction or removal). For instance, cash crops are

³ Given the large diversity of farm households and farming systems in Tanzania, we decided to group farm households into homogenous groups, using two criteria: farm specialization and farm economic size. This typology allows analysing the differences among farm household groups and also to report and interpret model results according to these two criteria. For further information about this farm household typology see Ricome et al. (2020).

expected to gain more as they are produced for commercial purpose, but on the other hand, high production of staple crops may also be directly translated into marketable surplus and, thus, profit from the tax reduction. Moreover, a large increase in cash crop area, to the detriment of staple crops, may negatively impact household consumption. Another typical question is which crops to intensify and how much fertilizer to apply in response to tax reform (i.e. intensive margin decision). Indeed, one additional unit in fertilizer would impact differently crop yields. This means that it is not straightforward to anticipate the whole production (and consumption) effects of tax reduction or removal without a simulation model.

Table 3 reports the impacts of the three simulated scenarios on crop acreage, at both national and regional levels, by economic size and by farm specialization. Results show that at national level, the average change in staple and cash crop acreage is fairly limited, ranging from -0.86% to 0.32%. The change in staple crop acreage is mainly driven by maize, millet and cassava, while the change in cash crop area is attributed to groundnut, tobacco, and vegetables. The reallocation of land within each crop group (staple vs. cash) is much greater, ranging between -3.5% to 6%.

At the regional level, land changes are slightly larger, mostly when the tax reduction targets only staple crops (*NoCess_stap* scenario). This is the case in the Semi-arid/Arid region, where a tax cut only for staple crops leads to a 0.7% increase in staple crop area to the detriment of cash crop area. It is also interesting to note that an equal tax reduction for both staple and cash crops (*NoCess* and *1%Cess* scenarios) would favor staple crops in some regions (e.g. Southern highlands) and cash crops in other regions, depending on the dominance of the crop category in each region.

The acreage effect by economic size is much more significant, with a small advantage for large farms, particularly under the *NoCess_stap* scenario. This is because large farms are market-oriented and, thus, benefit more from the reduction or removal of produce cess, compared to

small/medium farms which are more oriented towards providing supplementary food for their families. Table 3 also shows that farms responding most to the reform options, in terms of land reallocation, are those specialized in annual cash crops which seem to have higher adaptation capacity compared to the other farm types. In fact, even under the *NoCess_stap* scenario where only staple crops are exempted from produce cess they were able to easily switch some part of their land from cash to staple crops in order to increase their incomes (i.e. land allocated to staple crops increases by 1.01%, to the detriment of cash crops which decrease by 1.57%). As expected, the response of farms specialized in permanent crops is the slightest due to the low land elasticities of permanent crops.

Overall, the acreage effect is fairly limited, especially at aggregated (national and regional) levels, and under the first two scenarios (*NoCess* and *1%Cess* scenarios). This is because, first, produce cess reduction is applied to all crops; second, the reduction rate of produce cess is not so significant as to lead to a large change in cropping pattern, as could happen for example with the adoption of a new technology. Finally, the produce cess reduction seems to stimulate intensification (i.e. an increase in land productivity) rather than land reallocation. It is important to note that our analysis assumes a fixed farm structure, implying that land extension/expansion in response to produce cess reduction is not considered.

[Insert Table 3]

Table 3 also shows the percent changes in production and nitrogen use, under each simulated scenario, at national and regional levels. At national level, a total removal of the cess (*NoCess* scenario) leads to an increase in production, for both staple and cash crops, of around 5%; meanwhile, a reduction of cess from 3% to 1% (*1%Cess* scenario) raises production by only 3.5%, which is still not negligible. This finding indicates that the currently implemented produce cess rate reduces farmers' incentive to produce more and to sell their products. The other finding is that, for the majority of scenarios, the percentage change in production is larger

than the percentage changes in acreage. This means that production change is more driven by intensive margin (i.e. yield effects), rather than extensive margin (i.e. acreage effects).

Furthermore, we observe that the relative changes of production for cash crops are slightly bigger than those for staple crops. This is because the response of cash crops to nitrogen is slightly higher, leading to larger yield effects.

To better understand the yield changes provoked by the simulated scenarios, we show in Figure 2 how, at national level, the increase in average nitrogen application rate is translated into average yield enhancements for the *NoCess* scenario (only crops with the largest changes are reported). It appears that abolition of the produce cess leads to an increase in fertilizer application of up to 33% for onions, 30% for tomatoes, 26% for paddy and 22% for maize. These increases seem quite large in relative terms, but one should keep in mind that the observed fertilizer application rates in the baseline are fairly low for the majority of the crops. It translates into yield enhancement of 23% for onions, 8% for tomatoes, 3% for paddy and 5% for maize.

[Insert Figure 2]

At regional level, the effect of the simulated scenarios on production is quite heterogeneous, ranging from 1.2% in the Semi-Arid/Arid zone under the *1%Cess*, up to 11.2% in the Coastal plains under the *NoCess_stap* scenario. The increase in nitrogen application rate also varies across regions, ranging from 5% in the Southern highlands up to 136% in the Coastal plains in the case of the *NoCess_stap* scenario (the average nitrogen application rate in the baseline is around 2.71 kg/ha, which explains the large increase).

The production changes, gathered by economic size and specialization, are given in Table 3. This shows the extent to which large farms will benefit more from the reform options compared to small ones. This difference in impact is easily explained since the volumes sold on the market

are definitely not the same across farms, and thus that total savings allowed by the cess reforms are much higher for large farms than for small ones.

The direction and magnitude of changes are quite similar across crop specializations. This is because the cess reforms target all crops in the first two scenarios, and a large range of crops in the third one (*NoCess_stap*). The exception is under the *NoCess_stap* scenario, where farms specialized in annual cash crops seem to be much more negatively affected than the other ones. Also, it is interesting to note that, with a uniform reduction in cess rate for staple and cash crops, farms specialized in staple crops will mainly enhance staple crops (under the *NoCess* scenario, 5.05% increase in staple crops vs 3.03% increase in cash crops), while farms specialized in annual cash crops will mainly boost cash crops (under the *NoCess* scenario, 3.74% increase in staple crops vs 4.43% increase in cash crops).

Finally, the increase in production of targeted crops will positively impact market participation decisions, and shift some farm households' status from net buyer or self-sufficient to net seller.

4.5 Economic effects

One of the main goals of produce cess reform is the enhancement of farm income through an increase in marketed production. Therefore, in this section, we explore whether such a goal was achieved through the proposed reforms (scenarios), by assessing their impacts on farm income and its decomposition into staple and cash crop income.

Table 4 presents farm income changes under the three simulated scenarios at both national and regional levels, by economic size and by farm specialization. From this Table it is clearly seen that, first, the land use and production effects reported above largely explain the income changes, and second, the *NoCess* scenario engenders the biggest impact, with 8% increase in farm income at national level, followed successively by the *1%Cess* with +5.6% and the *NoCess_Stap* scenario with +4%. The large income increases provoked by the full removal of

produce cess (*NoCess* scenario) underscores the negative income impact of the current cess policy and confirms previous studies by Nyange et al. (2014) who found that agriculture sector in Tanzania, which is characterized by low profitability margins, is highly taxed. The other interesting finding is that the *NoCess_Step* scenario has less impact than the *1%Cess* scenario. This is because the share of marketed staple crops is much lower than the share of marketed cash crops. Thus, one unit increase in farm gate price has more income effect for cash crops than for staple crops, and, hence, a reduction or removal of produce cess provokes a larger increase in income for the former. The removal of cess only for staple crops (*NoCess_Step* scenario) leads as expected to an increase in production and income from staple crops, to the detriment of cash crops, which register a slight income reduction of -0.6%.

[Insert Table 4]

When looking at farm income changes by region, the impact appears significant and quite heterogeneous, mainly under the *NoCess* scenario. The biggest positive impact occurs in Northern highlands with +22%, followed by Coastal plains and Western highlands with +13% and +12%, respectively. For regions strongly relying on staple crops, such as the Southern_highlands and Northern_highlands regions, the *NoCess_Step* scenario generates larger impact than the *1%Cess* scenario. For the remaining regions, the ranking of simulated scenario impacts follows the same order observed at country level, with some differences in terms of magnitude.

The analysis of income effects of the simulated scenarios by farm economic size reveal that: (i) all farm economic sizes benefit from the simulated reform options, to different degrees; (ii) the *NoCess* scenario engenders the largest farm income increase, as expected, followed by the *1%Cess* scenario; and (iii) the larger the economic size, the higher the income increase. In other words, reduction or elimination of produce cess tends to favor large farms (in both absolute and relative terms) and likely to increase disparity among farms. For large farms, the increase

of farm income ranges from 5% to 9% depending on scenario, while for the small farms this increase amount to only between 1.5% and 3%. This is however not surprising, because large farms are market-oriented, while small farms are subsistence oriented.

It is also interesting to note that the *NoCess_Stap* scenario creates less variation among economic farm sizes in terms of income increase. However, it is also the scenario that causes the lowest income effect, whatever the farm economic size.

Regarding farm specialization, simulation results shows that all farm specializations improve their incomes under the simulated reform options, although at different levels. Farms specialized in cash crops and in permanent crops tend to gain more from removal or reduction of the produce cess. This is not unexpected, given that the majority of cash and permanent crops are grown for direct sale in the market, and therefore a rise in their prices will directly boost their production and income, contrary to staple crops which are mainly used for self-consumption. Moreover, given that most of the farms produce both staple and cash crops, their income increases even when cess reduction affects only staple crops (*NoCess_Stap*).

As projected, the *NoCess* scenario is the best scenario for all farm specializations, followed by the *1%Cess* scenario, except for farms specialized in staple crops. For the latter, income raises by 5.6%, 3.8%, and 4.6% under *NoCess*, *1%Cess* and *NoCess_Stap* scenarios, respectively. This result makes sense, since the *NoCess_Stap* scenario increases the competitiveness of staple crops. For the other farm specializations, an equal reduction in cess rate for staple and cash crops (*1%Cess* scenario) stimulates cash crops more, which generates higher incomes and thus engender a bigger income effect. Furthermore, a uniform cess rate of 1% leads to smoother relative income changes among farm specializations, ranging from +4% to +7%.

A key advantage of the FSSIM-Dev model is that it runs at individual farm household level. Hence, one can zoom in to see the effects of the simulated scenarios on every single sampled

farm household. Figure 3 shows the distribution of the income change relative to the baseline, across the total farm population. Only 5% of the farms experience a substantial increase in income (more than a 25%) with the reduction or abolition of produce cess. For the remaining 95% of farmers, income increase is less than 10%, due to low market participation for many farms. This figure also shows that total removal of produce cess (*NoCess* scenario) has the biggest positive effect on all farms (red line), in comparison to the other two scenarios which have pretty much the same distributional effects.

[Insert Figure 3]

Finally, the results for extreme poverty impacts are presented in Table 5. The extreme poverty gap indicator measures the difference between farm household income per household unit and the extreme poverty line of USD 1.90 equivalent per person per day (TZS 4,370). Overall, the impact on poverty is rather thin for the different farm types and for all regions. It ranges from -0.2% under the *NoCess_Step* scenario to -0.37% under the *NoCess* scenario. The largest impact is observed in Semi-arid/Arid region (with a change of -0.4%), in farms specialized in annual cash crops and in large farms (with a change of -0.7%). These results confirm that reducing or removing produce cess will not be sufficient for rural poverty alleviation.

[Insert Table 5]

The production and income effects shown above are expected to have a positive impact on farm household consumption, and thus on nutrition indicators⁴. However, looking to simulation results, one can observe that the overall impact on these indicators is quite moderated (Table 6), despite some variation by region, economic size and crop specialization. As for the poverty gap index, the largest – although still limited - impacts are experienced under the *NoCess*

⁴ To quantify the nutrition security impacts, we use the standard indicators of energy intake, protein intake and Healthy Food Diversity Index (HDFI), the details of which can be found in Louhichi et al. (2019). We decided not to report the results on HDFI because they are very small, i.e. less than 1% for all scenarios.

scenario, for the Coastal plain region (+2%), for large farms (+2.5%), and for farms specialized in permanent crops (+2%). This leads to the conclusion that reducing or removing produce cess will not be enough to improve poverty and nutrition security among Tanzanian farm households. However, one should recognize that these two objects were not listed among the cess reform's objectives.

[Insert Table 6]

4.6 Policy efficiency

Tax reduction often implies a trade-off between public revenue loss and economic boost. However up to this point, we have only discussed the potential farmers' gain from eliminating or reducing produce cess, without considering the potential loss of revenues for the LGAs. Yet, this is an important aspect to consider for policymaking, because whatever the selected reform option, LGAs need to know the amount of revenue they will lose and how to cover it. Hence, it is important to calculate the total 'cost' of each simulated reform option and compare it with the total 'benefit'. From a cost-benefit perspective, the most efficient policy option is the one that best achieves the targeted benefit at lowest cost. Accordingly, we measure policy efficiency (PE) as the ratio of farmers' income gain (i.e. total farm income increase) to LGAs revenue loss (i.e. total costs supported by LGAs). This ratio could be understood as how much unit of income can be gained by reducing produce cess by one unit (1 TZS).

Obviously, the reform option that provides the highest gain is also the costliest. Indeed, the implementation of the *NoCess* scenario came at a total cost of TZS 86 billion and a total benefit of TZS 214 billion, which means a PE ratio of 2.49. The application of the *1%Cess* option leads to a total cost of TZS 55 billion and a gain of TZS 144 billion, that is a PE ratio of 2.61. Whereas, the application of *NoCess_Step* scenario leads to a total cost of TZS 53 billion and a total gain of TZS 107 billion, namely a PE ratio of 2.

The main conclusion coming out from this comparison is that a uniform cess rate of 1% (*1%Cess* scenario) for all crops seems to be the most efficient policy option (TE of 2.61). It gives the best trade-off between LGAs revenue loss and farm-households economic gain. Similar results are obtained when we use *NoCess* scenario as counterfactual: *1%Cess* policy option is more efficient than both the currently implemented (i.e. baseline) and *NoCess_Step* policies. This finding implies that the current produce rate is too high and a uniform tax higher than 1% or a tax targeting only cash crops are not desirable reform options. However, these results need to be interpreted with caution because all the administrative costs related to the implementation of the policy are not considered and also the tax collection system is assumed to be efficient which is not the case according to Nyange et al. (2014). Moreover, reducing the produce cess from 3% (*baseline*) to 1% (*1%Cess*) rises the issue of how to cover the loss of revenues for LGAs. Some solutions are being discussed in the country such as enhancement of central government transfers, improvement of cess collection mechanism, transition to non-distortionary tax system, etc. (ACT, 2013).

5. Conclusions and policy implications

This paper attempts to assess the potential impacts of the reduction and removal of the agricultural produce cess (tax) in Tanzania, using the farm household model FSSIM-Dev and microdata from the 2012/13 Tanzania National Panel Survey. The produce cess is a levy charged by local government authorities (LGAs) as a percentage of the value of marketed agricultural production. Although it constitutes a major source of revenue for many LGAs, the produce cess has been strongly criticized by farmers, agribusiness and stakeholders for hindering the competitiveness of Tanzanian agriculture and reducing farmers' incentive to produce and to invest. Based on discussions with relevant stakeholders, three potential reform options are simulated and analyzed: (i) full removal of produce cess for all crops and districts

(*NoCess*); (ii) removal of produce cess only for staple crops (*NoCess_Step*); and (iii) reduction of produce cess rate from 3% to 1% for both staple and cash crops (*1%Cess*).

From a methodological perspective, the novelty of this paper lies in the use of a comprehensive and detailed modelling approach which allows to (i) simulate the effects of tax reforms on both farm-household production and consumption decisions, (ii) reflect the full heterogeneity among farm households and regions, (iii) capture both the intensive and extensive margins of tax reform options thanks to the economic production functions that explicitly allow for an adjustment of crop yield and area, and (vi) estimate the distributional impacts of policies across the farm population.

Findings from this study reveal several exciting patterns. First, consistent with previous literature, the currently implemented produce rate seems to be too high and its reduction or removal would boost crop production for both staple and cash crops, increase market participation (a shift in farm-household status from net buyer or self-sufficient to net seller) and enhance farmer's income with different degrees ranging between +2% and +21% depending on farm types and regions. These results are in line with Nyange et al. (2014), who also found that agriculture sector is highly taxed in Tanzania. Second, our results show that, given that the produce cess is levied on marketed products, its reform would yield greater benefit for large farms, which are market-oriented, rather than small farms. While some small farms may also gain from the reform, by increasing their market participation and their surplus, their gain remains low compared to large farms. Thus, a removal of cess may increase disparities among farms, particularly if a part of the tax collected by the LGAs was used to directly or indirectly support smallholders. Third, the substantial production growth resulted from the simulated options is mainly driven by the rise in land productivity (i.e. yield effect) rather than the reallocation of land (i.e. acreage effect). The acreage effect remains low owing to the fact that most crops are targeted by the reform options and also because of risk and

consumption constraints. Fourth, the impact of produce cess reduction or removal on rural poverty alleviation and nutrition security is quite limited. This means that such reform cannot be considered an appropriate solution for significantly reducing rural poverty and improving nutrition security. Nevertheless, one should recognize that these two targets are not among cess reform objectives. Finally, a uniform cess rate of 1% for all crops seems to be the most efficient policy option. It gives the best trade-off between government revenue loss and farmers economic gain. The loss of revenues for LGAs by reducing the produce cess from 3% (*baseline*) to 1% (*1%Cess*) could be covered, as suggested by several previous studies, through grants from central government transfers or improvement of cess collection mechanism (ACT, 2013).

These findings must however be considered with some caution, on account of the model's assumptions. First, the heterogeneity among LGAs in terms of implementation of produce cess is not fully considered. Second, given that FSSIM-Dev is a price-exogenous model, the market (price) effects of the simulated reform options are not taken into account, which could lead to overestimate the simulated impacts. A third potential caveat to our analysis is that we assume a fixed farm structure, implying that expansion of agricultural land in response to the reduction in produce cess is not considered. This may lead to underestimation of the simulated impacts, mainly for farms faced with binding land constraints. Fourth, the 2012/13 Tanzania National Panel Survey includes only small to medium farms; large commercial farms, which would gain most from the cess reform, are underrepresented in the database. A careful analysis of each of these limitations is therefore needed when examining simulation results.

Despite these limitations, this study provides insights into the potential effects of the cess reform options at different levels, from farm to region and up to country level. The simulation results presented here could be useful to policymakers as they confirm previous findings that produce cess lead to unfavorable effects and its removal or abolition may yield significant

benefits for farmers. Perhaps policymakers may gain from being cognizant of negative effects of the current produce cess system and replace it with a non or less-distortionary tax such as land tax (if applicable), considering that there have been voices advocating for this (e.g. ACT, 2013). Other alternative options could be to harmonize and reduce cess at acceptable and affordable rate as we suggested in this study, or to charge it on profit instead of production value, as suggested by some Tanzanian farmers. Local governments could also improve the collection mechanism to be more transparent and efficient.

Beyond analyzing the effects of selected policy options, this paper highlights the potential of this kind of modelling approach for making fine policy analyses and for providing policymakers with useful insights into how and where policy options may be expected to be most effective.

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Table 1. Sample characteristics

	Tanzania	Coastal plain	Northern highland	Plateau/Southwest highland	Semi-arid/Arid	Southern highland	Western highland
Nbre of households (hh) surveyed	3,134	943	167	785	638	346	255
Farm size (ha)	1.47 (2.14)	1.12 (1.40)	1.07 (2.47)	1.7 (2.00)	2.24 (3.28)	1.09 (1.07)	0.87 (1.21)
Plot size (ha)	0.37 (0.77)	0.30 (0.53)	0.23 (0.77)	0.44 (0.60)	0.66 (1.44)	0.26 (0.37)	0.18 (0.34)
Nbre of plots per household	2.54 (1.46)	2.50 (1.37)	2.14 (1.44)	2.52 (1.51)	2.51 (1.30)	2.92 (1.61)	2.58 (1.55)
Fertilizer application (Kg/ha)	32.80 (117.01)	13.95 (82.08)	72.61 (84.86)	42.10 (127.11)	10.83 (61.40)	103.22 (192.69)	7.21 (58.66)
Nbre of farmers using fertilizer (%)	15.1	7.3	25.1	21.2	6.7	40.7	3.5
Total production value (1000 TZS/ha)	39856 (238846)	46896 (309100)	69682 (207489)	23708 (173720)	7373 (35344)	30761 (208444)	107619 (359814)
Male equivalent adult per hh	3.98	3.7	4.06	4.21	4.4	3.4	3.87
Food budget share	0.75 (0.18)	0.76 (0.18)	0.71 (0.19)	0.75 (0.18)	0.75 (0.20)	0.70 (0.21)	0.75 (0.17)
Non-food budget share	0.25 (0.18)	0.24 (0.18)	0.29 (0.19)	0.25 (0.18)	0.25 (0.20)	0.30 (0.21)	0.25 (0.17)
Cereal, tuber and root crops share ¹	0.50 (0.16)	0.47 (0.14)	0.44 (0.12)	0.52 (0.15)	0.49 (0.17)	0.50 (0.15)	0.53 (0.14)
Legumes, meat and fish share ¹	0.21 (0.14)	0.20 (0.12)	0.21 (0.12)	0.24 (0.15)	0.20 (0.16)	0.20 (0.12)	0.26 (0.13)
Vegetable & fruit share ¹	0.29 (0.14)	0.33 (0.13)	0.35 (0.13)	0.24 (0.15)	0.31 (0.16)	0.30 (0.14)	0.21 (0.13)
Share of self-consumed goods	0.36 (0.24)	0.25 (0.21)	0.39 (0.23)	0.41 (0.25)	0.38 (0.25)	0.41 (0.22)	0.39 (0.23)
Share of cultivated land	100	22	4	29	31	8	5
Land use in the long rainy season (% total cultivated land in each region)							
Annual crop	85	67	93	90	91	88	87
Perennial crop	15	33	7	10	9	12	13
Staple crop	0.73	0.55	0.86	0.80	0.68	0.81	0.82
Cash crop	0.27	0.45	0.14	0.20	0.32	0.19	0.18
Maize	34.6	22.9	61.6	36.9	34.9	49.6	28.6
Rice	8.5	10.5	1.8	10.2	8.1	6.2	3.7
Sorghum/millet	4.3	2.6	2.2	2.5	8.9	0.6	1.9
Cassava	6.6	13.2	0.2	8.0	1.3	1.7	13.8
Other roots	3.3	1.9	1.4	4.7	2.1	3.4	8.1
Banana	3.5	4.6	3.7	4.6	0.7	6.0	6.0
Beans	6.9	1.1	16.4	10.0	1.5	14.1	23.2
Other legumes	11	10.5	3.8	10.1	15.5	6.8	6.2
Cashew nut	5.8	18.8	0.0	1.0	4.8	0.0	0.0
Cotton	4.7	0.0	0.0	2.9	12.2	0.0	0.2
Other annual crops	5.3	4.2	5.9	4.6	6.8	5.8	0.8
Other perennial crops	5.5	9.8	3.0	4.4	3.3	5.8	7.5

Source: TNPS 2012/13; Standard deviation in parentheses. ¹ The share is over the total food expenditure.

Table 2. Produce cess rate assumed in each simulated scenario

	Base year	Baseline	NoCess	1%Cess	NoCess_stap
Staple crops + Tea	3%	3%	0%	1%	0%
Cash crops (except tea)	4%	3%	0%	1%	3%

Source: authors

Table 3. Production, acreage and nitrogen use changes under simulated reform options (% change relative to the baseline)

		Staple crops			Cash crops		
		No Cess	1% Cess	No Cess	No Cess	1% Cess	No Cess
		Cess_stap			Cess_stap		
Tanzania	Production	5.00	3.54	5.38	4.97	3.27	-1.23
	Area	0.04	0.04	0.32	-0.10	-0.12	-0.86
	Nitrogen use	24.10	15.50	24.50	18.50	12.00	-0.69
<i>Region:</i>							
Coastal plain	Production	10.09	7.64	11.25	7.32	5.27	-0.05
	Area	-0.17	-0.13	0.11	0.21	0.15	-0.13
	Nitrogen use	135.38	85.97	136.98	127.38	90.84	0.06
Northern highland	Production	9.36	6.13	9.46	1.02	0.72	-0.27
	Area	0.04	0.02	0.12	-0.22	-0.11	-0.73
	Nitrogen use	51.74	33.51	52.23	4.33	3.57	-9.56
Plateau/Southwest highland	Production	4.09	2.92	4.36	8.83	5.45	-1.08
	Area	-0.11	-0.04	0.19	0.43	0.16	-0.79
	Nitrogen use	28.44	17.95	28.69	20.84	13.16	-0.50
Semi-arid/Arid	Production	1.76	1.22	2.08	-0.13	-0.23	-2.73
	Area	0.33	0.26	0.70	-0.70	-0.54	-1.47
	Nitrogen use	34.65	22.74	34.60	12.12	8.30	-0.14
Southern highland	Production	5.35	3.64	5.47	3.41	2.27	-0.34
	Area	0.16	0.12	0.28	-0.69	-0.52	-1.18
	Nitrogen use	5.08	3.41	5.47	0.92	0.21	-1.28
Western highland	Production	6.09	4.25	6.60	13.56	9.31	-0.83
	Area	-0.18	-0.14	0.14	0.79	0.57	-0.61
	Nitrogen use	39.39	27.22	39.50	338.53	230.21	-0.70
<i>Economic farm size:</i>							
Small	Production	1.30	0.85	1.39	2.26	1.34	-0.19
	Area	-0.08	-0.05	0.01	0.38	0.22	-0.05
	Nitrogen use	11.22	7.33	11.35	21.81	14.28	-0.46
Medium	Production	4.06	2.73	4.21	4.44	3.09	-0.13
	Area	-0.08	-0.05	0.02	0.28	0.18	-0.08
	Nitrogen use	15.98	10.33	16.00	24.13	15.85	-0.40
Large	Production	6.10	4.38	6.63	5.29	3.44	-1.62
	Area	0.10	0.09	0.48	-0.23	-0.21	-1.12
	Nitrogen use	31.99	20.50	32.65	17.70	11.52	-0.74
<i>Farm specialization:</i>							
Staple crops	Production	5.05	3.62	5.36	3.03	1.81	-0.68
	Area	-0.01	0.01	0.11	0.01	-0.07	-1.18
	Nitrogen use	26.42	17.52	26.90	33.78	16.59	-7.20
Annual cash crops	Production	3.74	2.55	4.36	4.43	2.48	-2.74
	Area	0.32	0.33	1.01	-0.50	-0.51	-1.57
	Nitrogen use	26.79	16.74	28.37	17.56	11.55	-0.39
Permanent crops	Production	6.71	4.77	7.27	3.64	2.62	-0.23
	Area	-0.14	-0.11	0.18	0.09	0.06	-0.11
	Nitrogen use	14.08	8.96	13.99	20.15	13.60	-0.08
Mixed crops	Production	5.19	3.62	5.54	7.02	4.90	-0.87
	Area	0.03	0.01	0.40	-0.06	-0.03	-0.91
	Nitrogen use	20.69	12.57	20.54	17.45	12.26	-0.20

Source: model results

Table 4. Farm income changes under simulated reform options (% change relative to the baseline)

	NoCess	1%Cess	NoCess_stap
Tanzania	8.29	5.59	4.15
<i>Region:</i>			
Coastal plain	12.4	3.2	8.7
Northern highland	21.3	16.6	13.4
Plateau/Southwest highland	8.3	4.6	5.4
Semi- arid/Arid	4.7	2.9	3.2
Southern highland	7.0	5.5	4.6
Western highland	12.0	5.3	8.1
<i>Economic fam size:</i>			
Small	3.0	1.7	1.9
Medium	6.7	2.9	4.5
Large	9.8	5.1	6.6
<i>Farm specialization:</i>			
Staple crops	5.7	4.7	3.8
Annual cash crops	11.1	5.5	7.2
Permanent crops	8.9	2.1	6.3
Mixed crops	10.0	3.7	6.7

Source: model results

Table 5: Change in extreme poverty level under simulated reform options (% change relative to the baseline)

	NoCess	1%Cess	NoCess_stap
Tanzania	-0.36	-0.25	-0.24
<i>Region:</i>			
Coastal plain	-0.22	-0.15	-0.12
Northern highland	-0.10	-0.06	-0.09
Plateau/Southwest highland	-0.39	-0.25	-0.30
Semi- arid/Arid	-0.45	-0.30	-0.26
Southern highland	-0.36	-0.23	-0.30
Western highland	-0.21	-0.13	-0.18
<i>Economic fam size:</i>			
Small	-0.08	-0.05	-0.07
Medium	-0.28	-0.18	-0.22
Large	-0.83	-0.54	-0.53
<i>Farm specialization:</i>			
Staple crops	-0.31	-0.20	-0.29
Annual cash crops	-0.60	-0.40	-0.15
Permanent crops	-0.72	-0.49	-0.14
Mixed crops	-0.34	-0.22	-0.20

Source: model results

Table 6: Food intake changes under simulated reform options (% change relative to the baseline)

	NoCess		1%Cess		NoCess_stap	
	Energy intake	Protein intake	Energy intake	Protein intake	Energy intake	Protein intake
Tanzania	1.19	1.16	0.6	0.6	0.9	0.8
<i>Region:</i>						
Coastal plain	2.09	1.92	1.49	1.37	0.63	0.56
Northern highlands	0.19	0.20	0.11	0.12	0.12	0.13
Plateau/South-west highlands	1.35	1.40	0.90	0.97	0.77	0.85
Semi-arid/Arid	0.64	0.62	0.43	0.41	0.39	0.38
Southern highlands	0.88	0.84	0.59	0.56	0.69	0.66
Western highlands	1.73	1.87	1.17	1.26	0.70	0.78
<i>Economic farm size:</i>						
Small	0.17	0.17	0.11	0.11	0.09	0.09
Medium	0.91	0.85	0.61	0.57	0.36	0.35
Large	2.51	2.48	1.74	1.74	1.31	1.34
<i>Farm specialization:</i>						
Staple crops specialist	0.67	0.62	0.46	0.43	0.57	0.53
Annual cash crops specialist	1.44	1.39	0.93	0.90	0.60	0.59
Permanent crops specialist	2.03	1.93	1.42	1.35	0.49	0.57
Mixed crops specialist	1.73	1.73	1.19	1.21	0.62	0.70

Source: model results

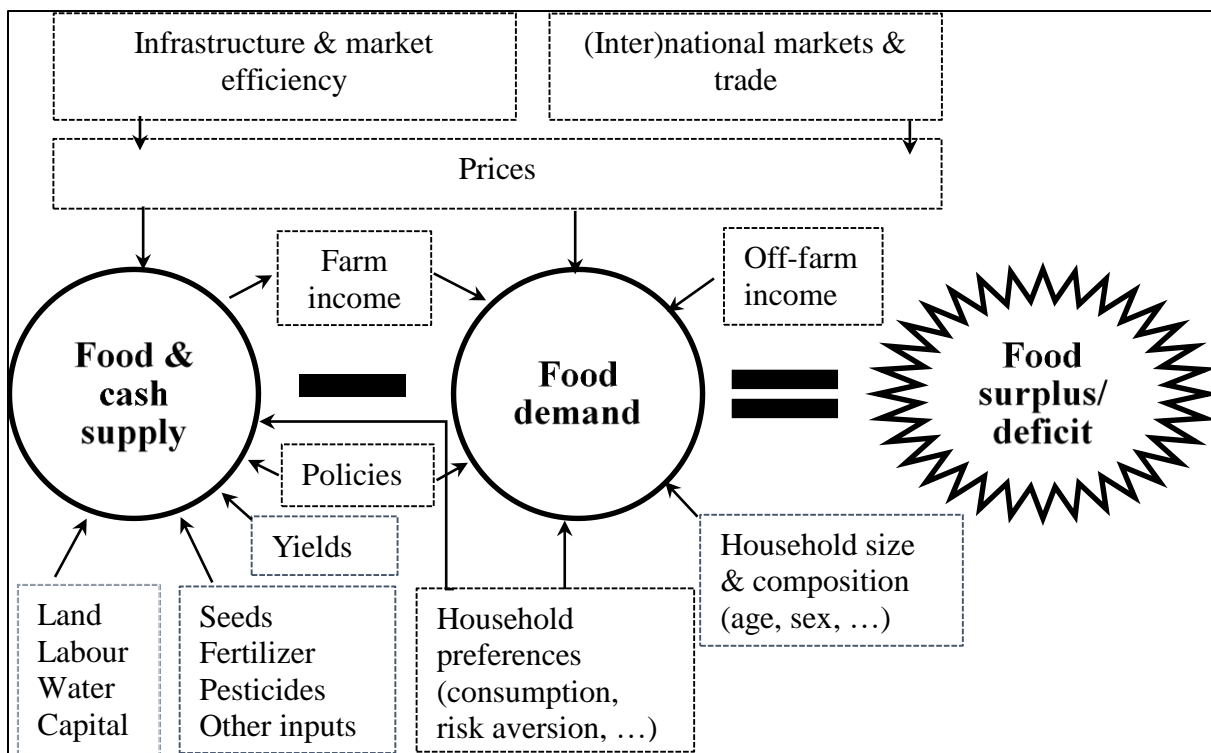


Figure 1. Simplified diagram of the FSSIM-Dev model

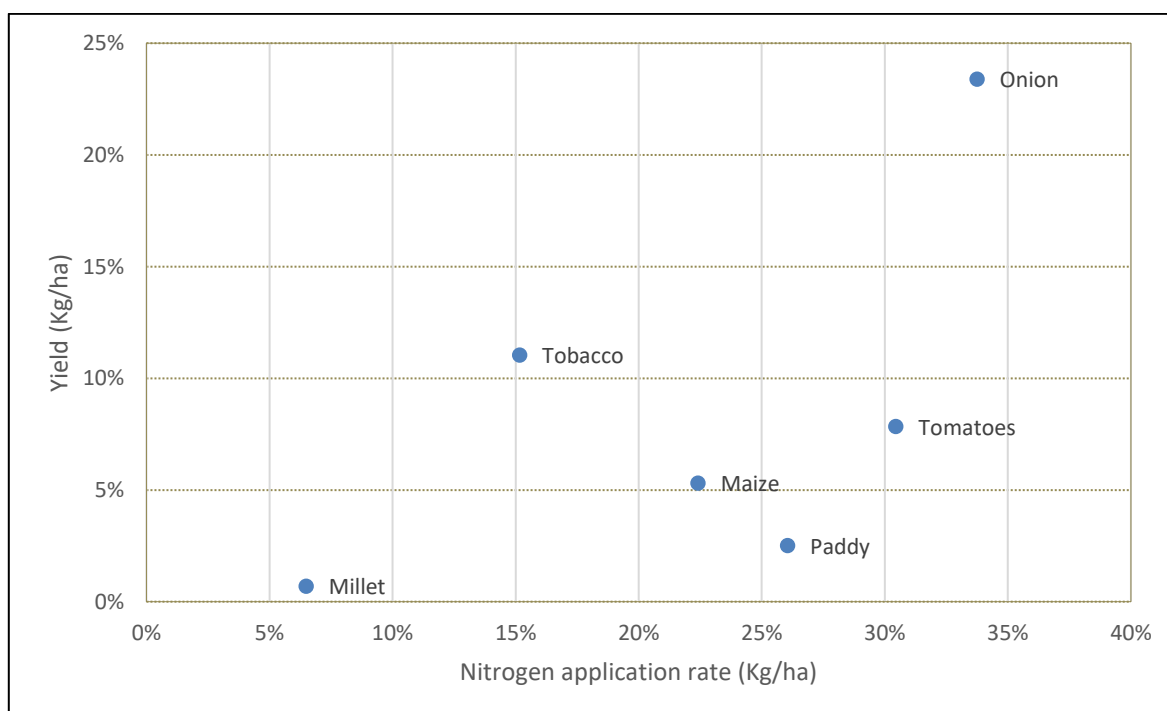


Figure 2. Changes in nitrogen application rate and yield for selected crops under *NoCess* scenario (percentage change relative to the baseline)

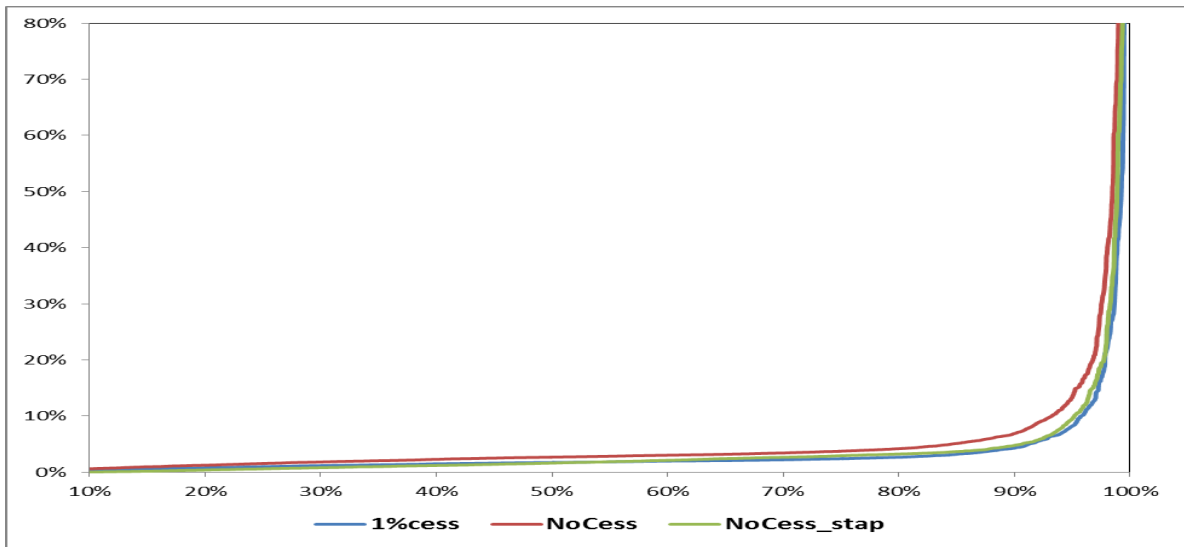


Figure 3. Distribution of income change caused by the simulated scenarios, across the whole farm sample (% change relative to the baseline)