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The Role of Livestock in the Tanzanian Economy: Policy Analysis Using a Dynamic Computable General Equilibrium Model for Tanzania

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Abstract

In agricultural economies of Africa, livestock sub-sector supports livelihoods of large proportion of households and has important role on value addition and on insuring national food security. However, its importance has often been ignored by policymakers as well as researchers. Researchers neglect livestock sector mainly for methodological reasons. This study tries to overcome this problem. We extend an existing DCGE model for Tanzania with a separately built herd dynamics module which enables us to specify stock-flow relationship, distinguishing between the capital role of livestock and the flow of livestock products.

The results from realistic TFP shocks on different agricultural sub-sectors clearly show that livestock sub-sector has better growth elasticity greater than the cereal and cash crop sub-sectors in contrast to previous literature. Factors reallocation among activities is observed which leads us to emphasize on livestock – cereal sub-sectors joint growth plan rather than cereal sub-sector growth alone.

Keywords: Livestock, livestock module, TFP, Tanzania

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1. Introduction

Livestock is a key agricultural sub-sector in Tanzania. About 36% of farm households are engaged in livestock-keeping, one percent as pure livestock farmers and 35% as crop-livestock mix farmers (GoT, 2007). The sub-sector contributes 5.9% of the country's Gross Domestic Product. This is low considering the large numbers of livestock kept. The low contribution has been associated with low livestock growth rates, high mortality rates, low production and reproductive rates, low off-take rates and poor quality of the final products from the industry (GoT, 2007). However, it is important to note that contribution of livestock is not limited to its share in GDP. Other contributions are through national food supply and food security, source of income to the smallholders (which may not be captured in the national accounts), and inflation-free store of value. Further, the sub-sector provides manure and animal draught power to the crop production sub-sector. This could imply that the contribution of livestock to the national economy has been greatly under-valued.

Consequently, it is important to model the livestock sub-sector in a manner that captures its direct contributions to the economy and the indirect contributions arising from linkages. This is possible through economy-wide models, capable of capturing both biological dynamic relationships between stocks and flows of livestock, and the economic linkages of the sub-sector and the rest of the economy. Thus, this study developed a model for livestock policy analysis for Tanzania which is the noble element of this work. This involved developing a separate livestock sub-sector module to be coupled with the existing dynamic computable general equilibrium (CGE) model previously developed by International Food Policy Research Institute (IFPRI) and verified to run well for Tanzania. The focus of the study is on meso and macro level policy analysis of the sub-sector. In most existing computable general equilibrium models, the complex biological dynamic processes are simply assumed away just like in other agricultural sub-sectors like arable farming where the production cycle is annual. However, modelling the livestock sector and revealing the intricate nature of the biological processes in livestock production and relationships between stocks (livestock numbers) and flows (livestock products) requires a dynamic modelling approach whereby the wealth accumulation role of livestock is adequately specified and economy-wide relationships are captured.

2. The livestock sector in Tanzania

Tanzania is one of the African countries known for livestock resources. It ranks third in Africa after Sudan and Ethiopia in livestock population (NBS, 2012). The main livestock types are cattle, goats, sheep, pigs, chickens, ducks, turkeys, rabbits, and donkeys. Based on the 2007/08 census, cattle are the first in population followed by goats. There are 21,280,875 heads of cattle and 15,154,121 heads of goats. Sheep are the third, with 5,715,549 heads while pigs are the fourth with 1,584,411 heads. Above these all Tanzania has very large number of chickens totalling to 43,745,505 which is almost equal to the total population of the major livestock types (cattle, goats, sheep and pigs).

Shinyanga, Mwanza and Tabora are the best three in order of their rank where most of the country's livestock including chicken are found¹. A total of 2,329,942 households are keeping livestock in Tanzania. 99.9% of the country's livestock is kept by small holder farmers leaving the contribution of large scale farms very insignificant.

Compared to the 2002/03 census, there has been an increase in the number of all major livestock species. The total number of livestock units (weighted with TLU) was 25,977,665 in 2007/08 representing 43.8 million livestock of different species. This shows a 30% increase from 20,353,866 livestock units in the 2002/03. Cattle showed an annual growth rate of 4% over the period 2002/03 to 2007/08. The annual growth rates of goats, sheep, pigs and chicken over the same period were 5.1%, 7.7%, 10.2% and 5.1%, respectively. However, there were virtually no growth in the number of layers and broilers. Most of the livestock species were of indigenous type.

Milk production from cows during 2007/08 was 1.6 billion and 0.9 billion litres during wet and dry seasons, respectively. Average milk production per cow per day was 3 litres during the wet season and 2 litres during the dry season, a difference of about 33.3%. The leading regions in terms of milk production during the wet season were Shinyanga (13%), Arusha (12%), Tabora (9%) and Mbeya (10%). The number of eggs produced by smallholders during the 2007/08

¹ Detailed data on livestock population for the major types is available in the Appendix. It is disaggregated by administrative provinces.



period was 1,298,052,584 of which 1,173,652,417 (90.4%) were from indigenous chicken and layers, 106,969,876 (8.2%) were of ducks and 17,430,292 (1.3%) were of turkeys.

Production of meat, milk and eggs enables the sub-sector plays important role in the national food supply. Livestock also contributes to crop production through the provision of farm yard manure and draft power. For instance, there were 661,543 households using organic fertilizers in 488,696 hectares during the 2007/08 agricultural year which resulted in a 0.74 ha on average usage of organic fertilizers per household.

3. The dynamic CGE model

The model used in this study is the dynamic version of the standard computable general equilibrium (CGE) model originally developed by IFPRI. It is a multipurpose and flexible model that has been widely applied for macroeconomic and sectoral policy analysis in many developed countries (Lofgren, Harris and Robinson, 2002).

This model has dynamic extension which is of recursive type. This kind of dynamic model is based on the assumption that the behaviour of economic agents (private and public) is characterized by adaptive expectations: economic agents make their decisions on the basis of past experiences and current conditions, with no role for forward-looking expectations about the future (Lofgren, *et al.*, 2002). Recursive type of dynamic CGE models capture developing countries' reality better than inter-temporal dynamic models.

The model assumes that producers maximize profits subject to production functions. A multi-stage production function aggregates factor inputs into value-added, and then mixes value-added further with intermediate inputs. Aggregation follows constant elasticity of substitution (CES) or Leontief technologies. The domestically produced output of each commodity is either domestically used or exported. Profit maximization drives producers to sell their products in domestic or foreign markets based on the potential returns. Domestically produced output is an imperfect substitute for output that is internationally traded, by using constant elasticity of transformation (CET) functions. In an analogous way, the model incorporates imperfect substitutability between domestically produced and imported goods (i.e. Armington assumption).



In the model used here, representative household groups maximise their incomes by allocating mobile factors of production across activities. Households are differentiated along urban–rural and poor–non poor dimensions and their respective administrative provinces. On the demand side, a linear demand system is specified. The model assumes households maximize utility subject to budget constraints.

In a CGE model, the entire economy is assumed to be in general equilibrium. Equilibrium in the goods market is attained through the endogenous interaction of relative prices. In order to clear the factor market, capital and large land² are set to be fully employed and activity-specific, implying that sector-specific returns to these factors adjust to guarantee market clearing. Labour at any skill level: uneducated and those who completed any schooling level, small land³ and livestock are all assumed to be fully employed and mobile across sectors, economy wide wage rate being the market clearing variable for these factors.

The model includes three macroeconomic balances: the current account balance, the government balance, and the savings and investment balance. The current account balance is held constant by assuming flexible exchange rate at a fixed level of foreign savings (fixed in foreign currency). There is an implicit functional relationship between the real exchange rate and the trade balance. In the government account, the level of government expenditure, equal to consumption and transfers, is fixed in real terms while government revenue is determined by fixed direct and indirect tax rates. Government saving is determined residually as the gap between revenue and expenditure. This closure is chosen since it is assumed that changes in direct and indirect tax rates, as well as in government expenditure, are exogenously determined based on the economic policy. The macro closure applied for the saving–investment balance is the savings-driven investment closure in which the value of investment is determined by the value of savings. Fixed saving rates and flexible new capital formation are specified so that all savings are channelled into investment.

² Large land means big size land used for large scale cultivation like in the plantations.

³ Small land means a smaller size land cultivated by small holder farmers at a smaller scale.

In every period of the model run, the capital stock is updated with the total amount of new investment and depreciation. Total labour supply is updated by the population growth rate, i.e. as population grows, the total labour supply increases at the same rate.

Karl and Thurlow (2010) have modified the Dynamic CGE (DCGE) version of the standard IFPRI CGE model to better represent the Tanzanian economy. This model is used for their work, “Agriculture growth, poverty and Nutrition in Tanzania”. Further modifications are made to use this model in this livestock study. The primary novel modification made is the translation of the herd dynamics model presented in Figure 4.1 into algebraic equations for use in a computer programme in the GAMS (General Algebraic Modelling Systems) language.

This study is based on the 2007 Tanzanian Social Accounting Matrix (SAM) which has 59 activities, of which 27 are agricultural activities (including 4 livestock based), 22 industrial and 10 services. All agricultural activities except fish and forestry are disaggregated based on the administrative provinces. There are 59 commodities, 67 factors of production, categorized under labour with different skill level, land, non-agricultural capital and livestock. And also there are 111 institutions made up of 110 household types, and the government. The households are disaggregated based on the administrative provinces, their location (i.e urban- rural) and income level. The SAM also has different tax, saving-investment, and ‘Rest of the World’ accounts to show the interaction of different economic agents.

4. Developments on the CGE model

4.1 The herd dynamics module, the conceptual framework and data organization

Building a herd dynamics module is a very necessary task in order to make a CGE model sufficient and comprehensive enough to present all the aspects in livestock sub-sector. In line with this, a herd dynamics module for Tanzania is built with all its unique features in this study. This herd dynamics module represents most of the livestock types. In Figure 4.1, this module is displayed in stock-flow diagram. One part of the figure shows the dynamics of the stocks. Naturally, mature females give birth to young ones, which are either male or female. Each sex category passes through different stages, from young to mature. The proportion that passes to the

next stage depends on survival rates. The dynamics of the stocks is generally addressed by adjustment to stocks, average annual changes in the number of livestock, as represented by the solid lines in the figure.

Figure 4.1: Schematic representation of herd dynamics and productivity

Figure 4.1 is a simple diagrammatic representation of stock-flow relationships that captures deeper economic logic too. For instance, a typical dairy cow continues to yield milk for over a decade until it is culled due to reduction in productivity at old age. And layer hens continue producing egg until they reach age of zero productivity. The sale of these livestock products is part of the economic flows in the sector. Moreover, during their life time, breeding stocks give birth to many off-springs that are sold year after year as finished stocks or can be slaughtered at different stages. These sold and/or slaughtered animals are represented by off-takes. In addition, livestock resources can also be used for their draft power as one factor of production in crop farming. The sum total of sales of live animals and livestock products, and returns from other economic uses of livestock gives total revenue from keeping livestock. This means livestock units are themselves assets that continue to survive year after year and produce products that can be sold or accumulated as wealth over the years. The figure also shows livestock costs at different stages of development. Like other sectors, livestock production requires labour, land, and capital stocks such as buildings, machinery, and equipment. The sum of these gives total costs of livestock production. The difference between total revenues and total costs yields gross margin of keeping livestock.

The herd dynamics built for Tanzania covered the four most important livestock types (cattle, sheep, goats, and chicken) and other less important ones under other livestock. Additional data sets on different aspects of five livestock types are used to track the stock–flow relationships in the herd dynamics model. A number of equations are developed in the herd dynamics module and also in the main standard CGE model in order to integrate the conceptual frameworks of the herd dynamics model presented in figure 4.1. This satisfies the need to establish a vital relationship between stocks (livestock numbers) and flows (livestock products). The data is

comprehensive in its coverage and consistent with the conceptual structure displayed in the herd dynamics model. The herd dynamics model built for Tanzania is disaggregated by sex, and administrative provinces.

Offtakes are calculated as a product of animal price and the offtake volume in each of the five livestock types. Because of lack of recent data, offtake volumes are calculated as a product of the 2007/08 animal stock (for each types) and offtake rates which are derived from the available recent 2002/03 livestock data (NBS, 2002/03). Besides, revenue collected from sale of milk is calculated as a product of number of lactating animal (cow or goat), average litres of milk production for each type per lactating animal per day, average number of days for lactating animal on milk in a year time and average milk price Tanzanian Shilling (Tsh) per litre⁴. The same technique is used to compute the revenue from sale of egg. It is calculated as product of number of layer hens, number of eggs per layer hen per year and national average egg price (in Tsh). The offtake value and revenue from sales of livestock products calculated in the module are finally used to modify the receipts by livestock commodities of the different livestock types in the SAM based on users' original payment proportion. Moreover, investment in the livestock sector is modified by value of stock changes calculated in the module using livestock price data and quantity of stock changes for each livestock type; calculated as year on year changes in the number of livestock at the national level average from 2002 to 2007. In addition, the CGE model is made to annually update this investment amount on each livestock type by the yearly rate of change in stock.

In general, the sizes and values of the breeding stocks change through time by restocking or destocking (just similar to the investment process in other capital stock categories) or appreciation in the value of breeding stocks due to investments in the maintenance of the health and body conditions of the livestock units or depreciation due to diseases and some other damages. The specification of this herd dynamics module couples the other source of dynamic changes in the livestock sector, i.e., the complex biological processes related to births, deaths, and survival rates are analysed jointly with the dynamic economic processes.

⁴ All of this information is administrative province specific.



In such framework, exogenous shocks to the livestock production systems can be traced to the economic flows. Economic shocks that affect equilibrium relationships in the system of national accounts can also be traced back to the bio-physical level. Specifying stock–flow linkages in economy wide CGE models like this has rarely been implemented.

4.2 Developments in the SAM

For livestock model to be reliable it should be comprehensive enough. Every single contribution of the livestock sub-sector to the wider economy should be captured. Besides its direct contribution, the livestock sub-sector has indirect contributions to the economic growth through its linkages (forward and backward) with other sub-sectors in the agriculture and manufacturing sectors. In this regard there are two major modifications made to the SAM used in this study. In the original SAM, livestock's contribution to the dairy industry and crop cultivation through provision of drought power were completely missing. Now this forward linkage is clearly developed into the SAM by compiling necessary data from different sources. In the modified SAM, milk produced from cattle is also supplied to the dairy industries which are adding value on raw milk and producing processed food.

The other very important modification to the SAM is the identification of livestock capital as a factor of production in crop cultivation activities. In many economy-wide models, livestock capital is found merged together with other capital stock categories like land or capital in general. The original SAM for Tanzania also lacks this feature. The modified SAM has now detailed presentation of the value addition of all factors of production including livestock and their contribution to household income. Livestock as a factor is now adding value also to the crop sub-sector as it is doing in the livestock sub-sector. These inclusions make the role of livestock sub-sector in the economy complete.

Livestock receipt and payment figures in the SAM are also modified with more relevant numbers to make it more suitable for the study and compatible with the separately developed livestock bio-economic module.

5. Simulation specification

The external intervention into the model economy in this study is shocking the Total Factor Productivity (TFP) of the different activities in the model. TFP shocks are applied on the three major sub-sectors (cereal, livestock and cash crops) of the agriculture sector with the objective of comparing their growth potential. In the cereal category, sub-sectors like cereal, root crops and pulses and oilseeds are included. In the cash crops, major export crop items like coffee, cashews, cotton, sisal, sugarcane, tea, tobacco and other crops are included. The livestock sub-sector is composed of all livestock activities in the model, cattle, sheep, goats, poultry and other livestock. The TFP growth rates used in this study are directly adopted from Karl and Thurlow (2010).

There are five simulation scenarios in this study; BASE, CEREAL, LIV, CASH and AGRIC. All of them run from 2008 – 2015. CEREAL, LIV and CASH are sub-sector specific scenarios which means accelerated TFP shocks are applied on their respective sub-sectors (cereal, livestock and cash crops, respectively), leaving all the other activities to grow at the base rate. The base rate is the historical trend. In all simulation scenarios, TFPs grow with the base rate for the first two years, 2008 and 2009. But afterwards accelerated TFP growth rates are applied up to 2015 for all simulation scenarios except BASE.

Figure 5.1: Sub-sectors initial size (billions of Tsh)

The three major sub-sectors of agriculture (cereals, livestock and cash crops) initially had the following shares in total agricultural GDP: 42.3 %, 35%, and 7.9 % respectively (Figure 5.1). These shares are important for comparing the sectors' growth elasticity after the TFP shocks.

BASE – (business as usual or baseline scenario). This simulation scenario targets on replicating the historical production growth trends for all sectors in the economy (including cereal, livestock and cash crop sub-sectors). In the BASE run, continuation of the 1998- 2007 growth trends of the Tanzanian economy is assumed to take place during the simulation period 2008 –2015 too. These growth rates, in weighted averages, are: cereals (2.06); livestock (1.20), and cash crops

(2.40). The weighted average of annual TFP growth across all agricultural activities is 1.50 %⁵ (Table 5.1).

CEREAL – Only the cereal + root crops + pulses and oilseeds sub-sectors receive accelerated TFP growth. All the other sub-sectors follow their baseline trend. Annual TFP growth rate in the cereal sub-sector is 6.75 on average. The weighted average of annual TFP growth across all agricultural activities is 3.49 % (Table 5.1).

LIV – Only the livestock sub-sector receives accelerated TFP growth. All the other sub-sectors follow their baseline trend. Annual TFP growth in the livestock sub-sector rises to be 3.10, on average, during the accelerated simulation period. The weighted average of annual TFP growth across all agricultural activities is 2.17 % (Table 5.1).

CASH - Annual TFP growth in the cash crops sub-sector averages 5.57 % during the accelerated simulation period. All other sub-sectors follow their baseline trend. The weighted average of annual TFP growth for all agricultural activities is 1.75 % (Table 5.1).

AGRIC– Both the cereal and the livestock sub-sectors receive accelerated TFP growth simultaneously. The mean annual TFP growth rates in the cereal and livestock sub-sectors are 6.75 % and 3.10 %, respectively during the accelerated simulation period. All other sub-sectors follow their baseline trend. In this simulation, the weighted average of annual TFP growth across all agricultural activities is 4.15 % (Table 5.1).

Table 5.1: Weighted average accelerated TFP growth rates from 2010-2015

The weighted average TFP growth rates of all the other agricultural activities, manufacturing and service sectors of the economy are similar across simulations. Activities in other-agriculture sector receive average TFP growth rate of 0.35. Manufacturing and service activities enjoy a 6.27 and 4.29 average TFP growth rates respectively (see Table 5.1).

⁵Individual activities' shares of total agricultural value added in 2007 are used as weights here.

6. Results

Simulation results show that the livestock sub-sector in Tanzania has significant importance in increasing various macro measures and alleviating poverty. Agricultural GDP and overall GDP growth levels achieved in the livestock TFP shock scenario are significantly important which clearly show that the sub-sector has strong growth potential.

Factors of production are dynamically re-allocating between agricultural activities whenever there is wage difference between the activities following the changes in demand and supply for that particular factor. Based on this mechanism, strategies focusing on cereal sector development alone can be better efficient if equal policy priority emphasis is given to the livestock sector as well. Livestock – cereal sub-sectors joint growth plan is highlighted instead of cereal sub-sector growth alone.

Table 6.1: Average annual percentage changes in value-added for own sub-sector, agriculture sector, and overall economy together with sub-sectors' growth elasticity.

Table 6.1 shows that all the simulations have positive and significant growth effect on their own sub-sector in particular and the agriculture sector and the entire economy in general. Own effect of LIV as well as its effect on agriculture GDP (AGDP) and overall GDP are positive and significant, though weak as compared to the other simulations. This is the result of the magnitude of the TFP growth rate injected into the livestock sub-sector in this simulation (see Table 5.1). However, the sub-sector's growth potential is clearly seen in the growth elasticity calculated. A one percent growth in the livestock sub-sector impacts AGDP and overall GDP higher than similar growth rate in the cereal and cash crop sub-sectors. This shows that the livestock sub-sector has higher growth potential. This is attributable to its strong backward and forward linkages with activities in the agriculture and industry sectors.

Accelerated productivity growth in the livestock sector also has a strong positive effect on factor income, particularly land income (see Figure 6.1). In LIV simulation, factor land enjoys higher payments as a result of the increasing demand for it compared to the CEREAL simulation. Factor

land is used only in crop production activities and these activities receive accelerated factor productivity in CEREAL simulation which makes it highly efficient. Thus the demand for that land either stagnates or decreases, leading to lower returns to land. However, in LIV simulation, as a result of strong linkages, the fast growing livestock activities prompt the cereal sub-sector for faster growth which leads to greater demand for factor land. Thus, its return increases faster. Besides, both simulations come up with almost similar growth effect on returns to labour. Hence large income gains are realized under the LIV simulation as land and labour are the predominant assets of poor households.

Livestock factor has got the largest income gain from CEREAL run and the lowest from LIV simulation. Accelerated growth in the cereal sector in turn triggers livestock activities to start growing at a faster rate which leads to increased demand for factor livestock. As a result returns to factor livestock increases the most during the CEREAL simulation. However increased efficiency of factor livestock in the LIV simulation reduces its demand such that its value diminishes. Capital owners enjoy higher returns in both simulations, especially CEREAL simulation.

Figure 6.1: Simulation effects on returns to factors of production (Average annual percentage change)

Consistent with the discussion above, increased factor returns leads to increased household income. All the simulations show strong and significant growth in household income (see Table 6.2). Rural households are better off than their urban counter parts when livestock activities are growing at an accelerated rate. However accelerated growth in the cereal sub-sector makes urban households better off.

Table 6.2: Simulation effects on household income (Average annual percentage change)

Simulation effects on household consumption are replica of the effects on household income. All the simulations show that the accelerated economic growth, as a result of the TFP shocks, enables households to have better consumption (see Table 6.3). Faster growth in the livestock



sub-sector has a strong positive effect on improving household consumption. LIV simulation has strong positive effect on the country's external trade as well. Exports grow, on average, at rate of 10.3% annually while imports grow at 7.7%.

Table 6.3: Simulation effects on major macro variables (Average annual percentage change)

Agricultural commodities constitute large exports in the economy. Accelerated agricultural TFP expansion thus results in significant export growth. The significant growth in domestic consumption observed in the economy may eventually lead to faster growth in demand for imports. This may also be linked with the positive and significant growth in domestic investment registered from the simulations.

7. Summary and Conclusion

In small developing economies like Tanzania where agriculture is the main stay of the economy, livestock sub-sector directly or indirectly supports livelihoods of large proportion of households. In Tanzania about 36% of farm households are engaged in livestock-keeping. On top of that the sub-sector contributes significant share of total value-addition in the Tanzanian economy. It is also used as a source of national food supply which has substantial impact on insuring national food security. Furthermore, it is strongly linked to other activities in the economy, especially with other agricultural activities, through provision of manure and animal draught power.

However, the importance of the livestock sector has often been ignored by policymakers as well as researchers. Researchers neglect livestock sector mainly for methodological reasons. In livestock production systems, biological and economic interactions and stock dynamics are a great deal more complex than in crop production. This bias seems to have been compounded by the perception of policymakers that food security concerns can be addressed by focusing only on production of staple crops.

Previous literature emphasized cereal-led growth as the optimal strategy while livestock sector was considered as an auxiliary sector which has weaker potential for growth. However, very recent research works on role of livestock on economies like Ethiopia and Kenya clearly showed that livestock sub-sector has great potential to economic growth contrary to the ages long thinking (Ayele et. al 2012 and Engida et al 2013). This study further confirms the potential of the livestock sub-sector.

The study is intended to inform policymakers regarding the economy wide direct and indirect outcomes of enhancing productivity growth for the livestock sector. This study set out to overcome the shortcomings in existing economy wide modelling for Tanzania as well. The study extends the existing dynamic CGE model for Tanzanian economy developed for examining policy priorities in the agricultural sector. The intricate nature of the biological processes in

livestock production and relationships between stocks (livestock numbers) and flows (livestock products) are dynamically modelled which is the noble element of this research work.

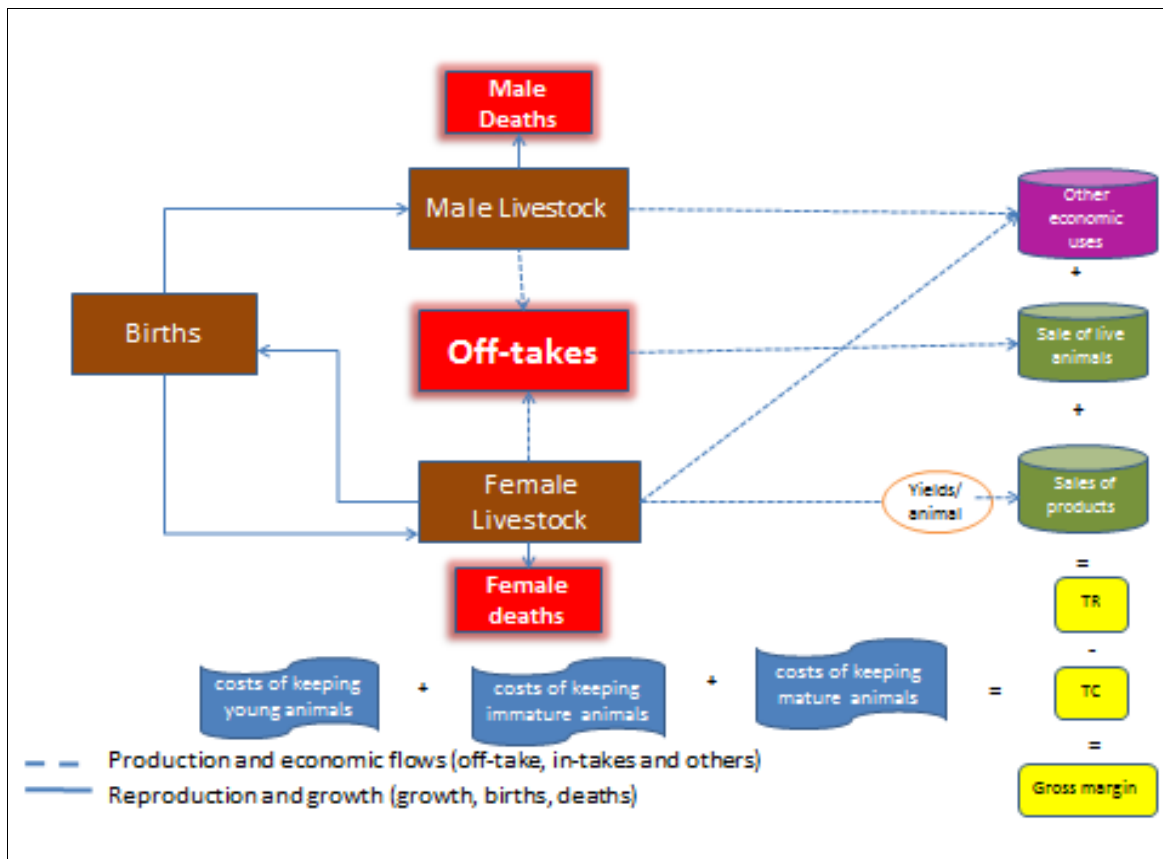
The study simulates a number of agricultural growth scenarios where productivity in different sub-sectors grows at an accelerated, yet realistic rate. Generally, results show that the livestock sector in Tanzania has the potential for economic growth and poverty alleviation. Agricultural GDP and overall GDP growth levels achieved in the livestock TFP shock scenario are positively significant which clearly show that the sector has strong growth potential. Moreover it is clearly seen that livestock sector has better growth elasticity. For instance, a percentage point growth in the livestock sub-sector impacts AGDP and overall GDP better than similar growth rate in the cereal and cash crop sub-sectors. This is the result of its strong back ward and forward linkages with the other agricultural activities and activities in the industry sector.

Regarding returns to factors, faster growth in the livestock sub-sector come up with faster growth on returns to different factors especially land. Households enjoy strong and positive income growth. Rural households are better off than their urban counter parts. Faster growth in the livestock sub-sector also shows that it has a strong favorable effect on improving household consumption and the country's external trade as well.

Factors reallocation among activities is observed as a strong play maker in the model economy. So based on this fact, livestock – cereal sub-sectors joint growth plan is emphasized instead of cereal sub-sector growth alone. Because strategies focusing on cereal sector development alone can be better efficient if equal policy priority emphasis is given to the livestock sector as well.

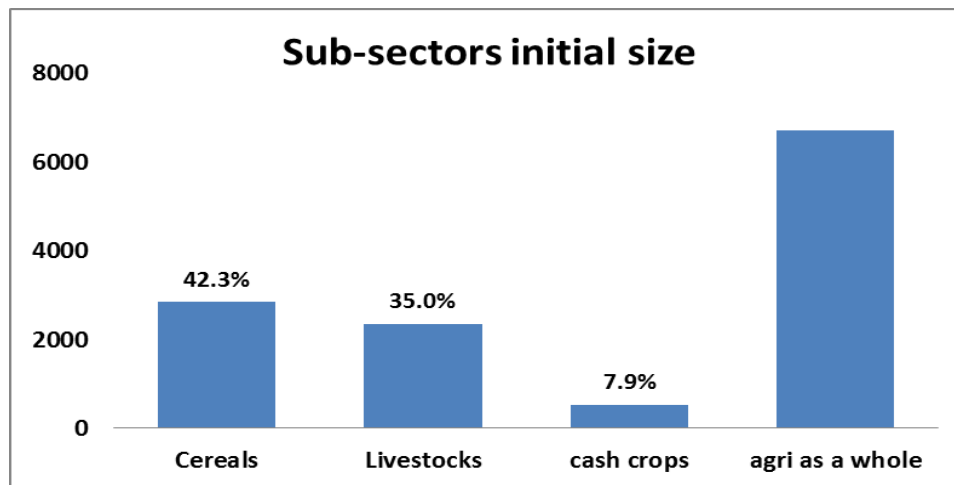
Tables and Figures

Figure 4.1



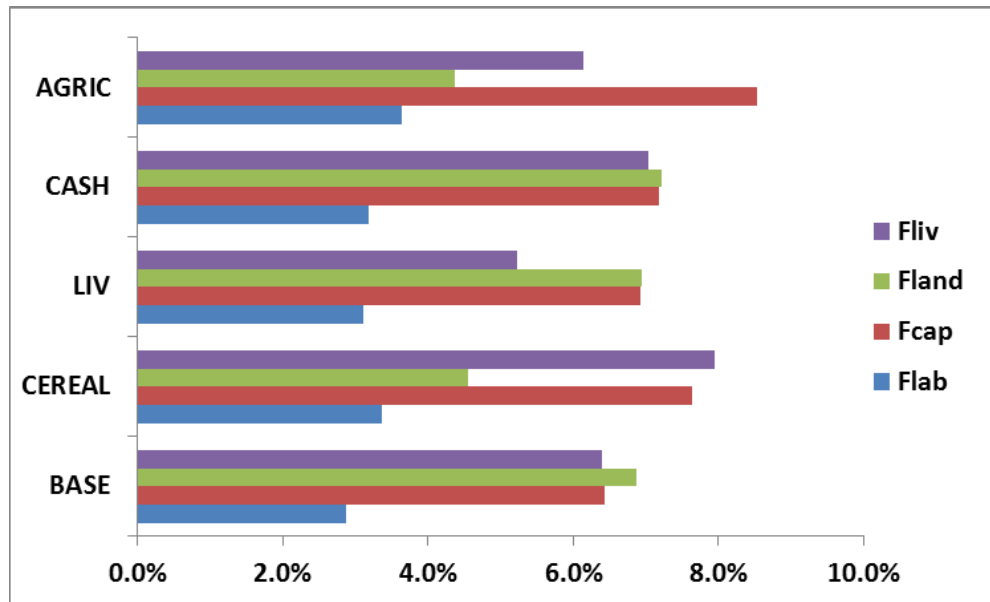
Source: Authors computation

Figure 5.1



Source: Compiled from the 2007 Tanzania SAM.

Figure 6.1



Source: Authors' calculation

Table 5.1

	BASE	CEREAL	LIV	CASH	AGRIC
Cereals	2.06	6.75	2.06	2.06	6.75
Livestock	1.20	1.20	3.10	1.20	3.10
Cash crops	2.40	2.40	2.40	5.57	2.40
Other Agri	0.35	0.35	0.35	0.35	0.35
Agri as a whole	1.50	3.49	2.17	1.75	4.15
Industry	6.27	6.27	6.27	6.27	6.27
Service	4.29	4.29	4.29	4.29	4.29

Source: Authors computation

Table 6.1

	Own sub-sector	Agriculture sector	GDP	Growth elasticity	
				AGDP	GDP
BASE		4.22%	7.25%		
CEREAL	9.16%	6.18%	8.00%	0.67	0.87
LIV	5.45%	4.78%	7.46%	0.88	1.37
CASH	12.56%	4.51%	7.31%	0.36	0.58
AGRIC		6.72%	8.18%		

Source: Authors' calculation

Table 6.2

	BASE	CEREAL	LIV	CASH	AGRIC
Urban	4.54%	5.38%	4.91%	4.85%	5.95%
Rural	4.94%	5.28%	5.01%	5.53%	5.33%
Total	4.80%	5.32%	4.98%	5.31%	5.53%

Source: Authors' calculation

Table 6.3

	BASE	CREAL	LIV	CASH	AGRIC
HH Consumption	5.09%	6.32%	5.46%	5.39%	6.75%
Investment	9.65%	9.15%	9.43%	9.20%	8.75%
Export	10.20%	10.57%	10.26%	10.92%	10.60%
Import	7.63%	7.82%	7.66%	8.00%	7.83%
Real GDP	7.25%	8.00%	7.46%	7.31%	8.18%

Source: Authors' calculation

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Appendix

Total number of livestock by type and administrative province for 2007/8

	Cattle	Goat	Sheep	Chicken	Pig	Total
Dodoma	1185501	915356	270299	1947024	116854	4435034
Arusha	1813637	1818450	1402236	955966	27475	6017764
Kilimanjaro	494135	644334	355961	1657479	123696	3275605
Tanga	732130	718625	216983	2099582	17155	3784475
Morogoro	639764	377572	118792	2766861	88462	3991451
Pwani	255258	172769	43141	1875732	14458	2361358
Dar es Salaam	32398	53688	20888	1211340	35479	1353793
Lindi	30784	159322	4908	1574475	7063	1776552
Mtwara	18115	234564	16794	1496854	10998	1777325
Ruvuma	75366	344738	20535	1701242	183276	2325157
Iringa	475031	298887	56448	2343579	241829	3415774
Mbeya	870218	544473	98222	3574172	346466	5433551
Singida	1588837	839169	477772	1615779	48935	4570492
Tabora	2133090	942926	352543	2939481	25668	6393708
Rukwa	804411	428247	43577	1590761	80608	2947604
Kigoma	157581	500019	116534	871134	18286	1663554
Shinyanga	3651251	1963056	739829	4890370	14753	11259259
Kagera	837204	816260	76713	1346650	64432	3141259
Mwanza	1976971	919753	224403	3329364	17277	6467768
Mara	1691118	913524	418077	1802523	1741	4826983
Manyara	1662452	1479417	640319	1076179	96485	4954852
Mainland	21125251	15085150	5714975	42666543	1581396	86173315
Zanzibar	155624	68972	574	1078962	3015	1307147

Source: The 2007/8 census, National Bureau of Statistics (2012)