Pulse consumption and demand by different population subgroups in Uganda and Tanzania

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Abstract

In recent years, the strategic importance of pulses in combating malnutrition and addressing health problems associated with overnutrition and obesity has been well acknowledged. However, previous research emphasized the production side and little is known about pulse consumption patterns by different groups of people. This study investigated pulse consumption patterns and demand by different socioeconomic groups in rural and urban localities of Uganda and Tanzania. Using the data compiled in the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) that are nationally representative of urban and rural households in Uganda and Tanzania, the study investigates the economic, temporal and spatial dimensions of pulse consumption and used econometric methods to evaluate the responsiveness of pulse demand to price and income changes. A two-stage censored food demand system was estimated to obtain consistent and unbiased unconditional expenditure and price elasticities for food and several food categories, including common bean in Uganda and pulses in Tanzania. Results indicate that consumption of pulses tend to increase with wealth and during harvesting periods as well as being higher in locations where production is also high. This emphasizes the important role that increased production of pulses could play in boosting consumption. Per capita consumption and contribution of pulses to protein in both countries is high. For example, in Uganda, bean contribute an average of 14.4 g of protein per person per day in rural areas, which is equivalent to 24% of the total daily per capita protein intake. In both countries, the poorer and wealthier households purchase a sizeable share of their consumed pulses. Pulse consumers are price sensitive and there is limited substitution for pulses, which suggests that price increase poses a risk for the nutritional security of the poor. Although projections in demand and supply growth rates indicate that supply might grow faster than demand, exports from both countries are growing faster than supply and this is likely to put pressure on domestic prices and further constrain demand among poorer households. Therefore, it is important to act now to avoid possible reduction in pulse consumption by poorer households that could lead to higher prevalence of malnutrition. Investment in agricultural research will be crucial such that farming households can adapt to a changing climate while increasing pulse productivity.

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1. Introduction

Pulses which include common bean, cowpea, chickpea, lentil, pigeonpea, faba bean, among others are an important source of macro and micronutrients, including proteins, iron and zinc. Pulses are rich in fiber and among foods with the highest micronutrient concentration to price ratio (Drewnowski, 2010). Therefore, frequent consumption of pulses can improve the diets of young children and women of reproductive age, who are the most vulnerable to micronutrient deficiencies (Ilse de Jager, 2013; Garden-Robinson 2013). They also play a key role in the diet of poor households who consume very limited quantity of animal source food (Sigh and Sigh 1992). According to the epidemiological and nutritional clinical studies, eating pulses several times a week may decrease the risk of coronary heart disease, diabetes, colorectal cancer, and helps with weight management (Heller, 2011). Considering their nutritional properties, pulses are considered strategic foods to combat malnutrition rampant in Sub-Saharan Africa (SSA) and public health concerns associated with over nutrition and obesity; also on the rise in developing countries. Pulses are also increasingly sold by rural producers to complement income (Gowda et al 2009) and are beneficial for sustainable cropping systems through symbiotic nitrogen fixation (Barton et al., 2014). Pulses, thus, offer a tremendous potential to contribute towards achieving the new sustainable development goals on food security, nutrition, health, and poverty reduction among small landholders in developing countries who consume and often grow them.

Although a great deal is known about the nutritional and health benefits of pulse, little has been published about pulse consumption patterns by different household categories such as poor vs. non-poor and rural vs. urban households. Moreover, recent studies analyzing price and income responsiveness of demand for pulse across countries and within countries are rather limited. In the context of growing interest in nutrition and health and agriculture linkages, policy makers need information on current consumption patterns for pulse and the sensitivity of demand for pulse to income and price changes. This information is required to make projections on the expected growth rate of demand for pulse in the context of income growth and rapid urbanization. In the event of a faster growth rate in the demand for pulse than in per capita pulse production, the price of pulse could increase, which could threaten the nutritional security of the poor who rely on pulse for nutrition adequacy. Therefore, knowledge on expected demand growth will allow policy makers to allocate resources to encourage increase in production and productivity for commodities whose demand is expected to grow rapidly.

The most consumed pulse worldwide is bean (Wortman *et al*., 1998; Broughton *et al*., 2003). Global per capita bean consumption is about 3 kg/year; which is slightly more than double that of chickpea that comes second with a per capita consumption of 1.3 kg/year (Akibode and Maredia, 2011). Bean consumption and production has been increasing globally, a trend driven by population growth and improvement in the economies of developing countries. However, there are wide variations among regions. Per capita bean consumption has been trending downwards in central and East Asia, Latin American, and Caribbean which have experienced rapid economic growth, and significantly reduced the number of people living in poverty (Nedumaran, 2015). This decline is consistent with the "Bennett's Law", which states that as countries develop and become wealthier, consumption shifts towards more diverse and nutritious foods, including greater consumption of animal source products (Nedumaran, 2015; Akibode and Maredia, 2011). On the other hand, the average per capita consumption of bean in SSA had a positive growth rate of 1.67% per year between 1994 and 2008; thanks to area expansion under bean as growth in productivity has been modest at about 0.7 percent per year (Akibode and Maredia, 2011). This increasing demand is driven by rapid population growth, projected to peak at 1.6 billon by 2030 from 1 billion in 2010 (AFDB, 2012). According to projections by Montpellier Panel (2013), 50% of this population will live in cities—thus providing income generating opportunities for farmers. If low productivity of bean persists, it will likely exacerbate the already increasing prices, making bean financially inaccessible for poorer households.

While informative, the information on bean consumption trends summarized above is based on the FAO food balance sheet that represent 'net availability' rather than actual bean consumption. In addition to being a proxy for consumption, estimates of production, seed usage, and wastage are difficult to estimate in developing countries as trade across national boundary might remain unrecorded, resulting in uncertainty about food supply in the country (FAO, 2001). Moreover, the measure of average per capita food availability masks the diverging trends in food consumption between households of different economic classes or regions of the country. The average national food availability can be adequate but malnutrition common in the country.

To have better understanding of pulse consumption and demand patterns by different population groups (i.e. poor vs rich, and rural and urban), we use the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) data for Uganda and Tanzania, which are nationally representative of rural and urban areas. Uganda and Tanzania are selected because they are top bean producers in SSA and major bean sellers in the East African regional markets (FAO statistics, 2013). These two countries also exhibit high levels of poverty and stunting among children under the age of five, which justifies the need to promote the production and consumption of pulse as a remedy for malnutrition in these countries. This study has the following specifics objectives:

1) Describe household level pulse consumption patterns for different population sub-groups;
2) Estimate disaggregated household food demand to understand how food demand and demand for pulse responds to price and income changes;
3) Estimate changes in pulse consumption due to an increase in its own-price;
4) Make projections about demand and production growth rate for pulse, and discuss their implications

While the target crop[1] for this study was bean, differences in questionnaire design between the two countries force us to conduct the analysis for pulse in the case of Tanzania, instead of bean like in Uganda.

The next section presents briefly the background information about the study area, Uganda and Tanzania. Section three introduces data source and measurement of key variables, followed by the descriptive statistics section, which depicts food and bean/pulse consumption trends. Section five discusses the econometric methods while results of the food demand system estimations are presented in section six. Projections about growth rate in demand for pulse and production of pulse are presented in section seven. Conclusions and recommendations are presented last.

2. The economic context, population and food supply

Uganda and Tanzania are both East African countries classified among the least developed countries in the world with a positive economic outlook. In this section, we provide an overview of each country, focusing on economic and population indicators, two key factors explaining food

[1] In both countries, beans are the main pulse consumed. Others include: peas, pigeon peas and cowpea.

demand. The section also sheds light on the status of food supply and diet quality in each country as measures of food security.

2.1 Uganda

Uganda's economy recorded an average annual GDP per capita growth of 2.0 % during 2011-2015 (World Bank 2016a). This is a good achievement considering that during the same time period, the country had a population growth rate of 3.3%, one of the highest in the world. The good economic growth of the last decade had allowed Uganda to make substantial progress fighting poverty, reducing it from 31.1% in 2005/6, to 19.7% in 2012/2013 (UBOS, 2014; World Bank 2016a). However, the average per capita GNI remains low, at about $440, and 6.7 million people live below the poverty line (AEO, 2016; World Bank 2016a). Moreover, the high levels of inequality (as indicated by a Gini coefficient of 0.395 in 2012/13), high population growth rate, and low agricultural productivity mean that many Ugandans are at high risk of sliding back into poverty (World Bank, 2016b). With a population of 37.6 million people and a high population density of about 156 people per km^2, Uganda is already confronted with land grabbing and conflict challenges. There is currently a rising number of landless poor in rural areas, even though the economy is heavily reliant on agriculture, employing 84% of the labor force (UBOS, 2014).

There is a strong connection between farm production diversity and household diets that explains nutritional outcomes, though access to markets can mediate these linkages (Jones et al. 2014; Sibhatu et al. 2015). The average food supply in Uganda was estimated at 2,272 kilocalories per day per capita in 2014 (FAO, 2015), above the FAO minimum kilocalorie requirement, (http://smallplanet.org/category/zingers-tags/fao) and is thus considered a food secure country. However, 69% of calories come from staples mainly maize, banana, cassava and sweet potato, while bean contributes 6% of the calories though it is the second frequently consumed food item after the staples (UBOs and WFP 2013, Haggblade and Dewina, 2010). About 34% of children aged 6-59 months were stunted and 5% under five of age wasted in 2013 (UBOS and WFP, 2013).

Common bean (*Phaseolus vulgaris)* is the most important legume crop grown and consumed in Uganda. It is planted to aproximately 669 000 hectares of land during March to June and September to December cropping seasons, leading to a production of about 869,610 tons of beans per year (FAOSTAT, 2016; UBOS and WFP, 2013). Per capita bean consumption is high in Uganda, meaning that bean makes a stronger contribution to household diets in Uganda relative to other countries in SSA on average (FAOSTAT, 2016; Kilimo Trust 2012). Traditionally grown for subsistence needs, bean in Uganda has shifted towards a tradeable commodity sold in domestic and regional markets (UBOS, 2010; PMA, 2008 in Kilimo Trust 2012). Bean exports from Uganda are growing due to favorable policies, such as regional integration, promotion of non-traditional export commodities, and demand deficit in the neighboring countries of Kenya, DRC and South Sudan (Dijkstra , T., 2001). However, bean exports from Uganda are both formal and informal but the latter is usually unrecorded, which underestimates the export volumes. Since bean imports into Uganda are very minimal, Uganda is a net exporter of bean.

2.2 Tanzania

Tanzania is the largest country in East Africa with an area of 945,000 km^2 and a population of 50 million people, 27.6% whom live in urban areas (African Economic Outlook, 2016). The country has experienced impressive economic growth, registering an average per capita GDP annual growth rate of 3.5% between 2011 and 2015 (World Bank, 2016a). In the last decades, Tanzania was ranked among the 20 fastest growing economies in the world (World Bank 2016a). Although per capita GNI, estimated at $570, remains low (AEO, 2016), the poverty headcount decreased from 34.4% in 2007 to 28.2% in 2012, which has been attributed to the surge in metal industries, agro-processing, retail trade and manufacturing that provide employment opportunities for the poor (World Bank, 2016b). Due to high population growth, a significant number of people (estimated at 4 million) still live below the poverty line –thus poverty alleviation continues to be an important objective of the national development programs as reflected in the country development plan of 2016-2021 (Ministry of Finance and Planning, 2016).

The food security situation in Tanzania in terms of dietary energy supply is estimated at 2207 kcal per capita per day in 2014 (FAO, 2015). However, the food basket is dominated by cereals and roots & tubers, which account for 67% and 19% respectively of the energy supply, while pulse accounts for 12% of calories intakes (FAO, 2014; Leliveld, et al., 2013). Therefore, the diet of most Tanzanian households lacks diversity, including low consumption of products from animal sources[2], which is correlated with poor nutrition outcomes. Besides, the agricultural sector which employs about 76.5% of the population has stagnated in terms of productivity growth

[2] Per capita livestock availability (TLU), declined from 0.62 million in 1961 to 0.38 million in 2011 and per capita fish availability grew by only 8% since 1961 (André Leliveld, et al., 2013). The authors calculated TLU as: cattle x 0.7; goats, sheep and pigs x 0.1; and chickens x 0.01.

due to drought and lack or poor agriculture technology[3]. As such, the consumption levels among the poor remain low despite a favorable economic growth (World Bank, 2016a); and the prevalence of stunting among children below five years remains high, estimated at 35% in 2011 (FAOSTAT, 2017).

Like Uganda, bean is the most widely grown grain legume in Tanzania, and the country ranks 7th in global bean production. The crop is the third in terms of area cultivated after maize and cassava, accounting for 7.5% of area under annual crops, equivalent to 1,134,394 hectares (FAO 2014). While bean is grown in most of the country, intensive cultivation occurs in the Northern zone (Kilimanjaro, Arusha, Manyara, and Tanga regions), Southern Highland zone (Mbeya, Ruvuma, Iringa, and Rukwa regions), and Lake zone (Kagera region). Households in the Northern and Lake zone grow bean twice a year (like in Uganda) while the Southern highlands, characterized by unimodal rainfall, has only one cropping season, which occurs between October and March. Like Uganda, Tanzania is also a net exporter of bean to its neighbor countries mainly, Rwanda, DRC and Kenya (ITC, 2016).

3. Data

3.1 Source of data

This study uses the LSMS-ISA data, which are collected by the national statistics institutes in collaboration with the World Bank. The LSMS-ISA data are nationally representative household panel data that include a strong agriculture component. For Uganda, we use the third wave of data, which was collected from November 2011 to November 2012. In addition to being nationally representative, the Uganda LSMS-ISA dataset is representative of urban and rural areas and of the main four regions of Uganda (North, West, and East, and Central) in rural areas. In Tanzania, we also use the third wave of data, which was collected about a year later than for Uganda, i.e. from October 2012 to November 2013. The Tanzania sample is representative of Dar es Salaam, other urban areas, and rural areas in the mainland, and Zanzibar.

[3] This is common across many Africa countries; the only region that did not achieve the millennium development goal of halving poverty between 1990 and 2015 and reducing malnutrition (UN, 2015).

For this study, we only use the household questionnaire, and mainly data from the sections on household consumption expenditures and household member characteristics. The Uganda consumption expenditures sections cover food expenditures over a 7-day recall period and non-food and services expenditures over a 30-day or 365-day recall period depending on the nature of the item. Ugandan households reported consumption of over 70 food items and expenditures on more than 80 non-food items. Similarly, in Tanzania, food consumption questions are based on a seven-day recall period and includes 59 items while the recall period for non-food expenditures varies (i.e. one week, one month, and one year). For both countries, food consumed at home includes food from purchases, own production, and gifts and in-kind payments (all values at market prices). The food consumption section for Tanzania is not as detailed as the one from Uganda. An item in the questionnaire might refer to a combination of foods. This is the case for dry pulses, which include beans, peas, lentils and other pulses, and the reason the analysis is conducted for pulse in the case of Tanzania.

3.2 Food groups aggregations

Having consumption data on a large number of food items requires aggregating food items into food groups for the analysis. To perform the grouping of food items, we follow approaches used in previous studies of household food demand in developing countries (Adbulai and Aubert, 2004; Boysen 2012; Ecker and Qaim, 2011). Food items grouped together should have similar nutritional value. Moreover, demand for food items within the same food group should behave in a similar way to changes in price and income. Following these two criteria, we created eight food groups for Uganda and Tanzania, with minor differences between countries due to difference in country questionnaire design. The eight food groups for Uganda (Tanzania) are: 1) Cereals and cereal products; 2) Starches; 3) Beans (Pulses); 4) Other pulses, nuts, and seeds (Nuts, and seeds); 5) fruits and vegetables; 6) Meat, egg, fish, and dairy products 7) Oils, fats, sweets, spices, and condiments; and 8) Beverages and food consumed away from home (Beverages).

3.3 Measure of household economic status

An indicator of household wealth is needed to analyze how consumption and demand for bean and pulse vary across households of different economic status within a country. In developing countries, consumption expenditures are considered a better proxy for household well-being than income because incomes are seasonal, difficult to measure for several reasons, and are more likely to be under-reported than expenditures in household surveys (Deaton, 1997). For these reasons, we use consumption expenditure as measure of household economic status. In the case of Uganda, we estimate household total annual consumption expenditure by summing the annual values of food consumed, non-durable and semi-durable goods, and the user cost of durable goods[4] following the methods outlined in Deaton and Zaidi (2002). To adjust for the differences in the cost of living across locations in Uganda, a Paasche index, using food prices, is computed and applied to household consumption expenditure. For Tanzania, the 2012-2013 LSMS-ISA dataset include a measure of household consumption aggregate that is the sum of annualized food expenditures and non-food expenditures[5] and is adjusted for cost-of-living differences (National Bureau of Statistics, 2014).

In both countries, real household consumption expenditures are divided by household size to give a measure of per capita economic well-being. We create quintiles to categorize per capita household consumption expenditures, which will serve as the basis for comparing food consumption patterns and how food demand responses to price and income changes across groups of different economic status. The first quintile represents the poorest 20% of the wealth distribution while the fifth quintile denotes the better-off 20%. Quintile are computed for urban and rural households separately.

3.4 Household profiles

In this section, we provide an overview of household profiles in Uganda and Tanzania, focusing on key household demographics and food expenditures. The descriptive statistics, disaggregated by wealth quintiles, are presented separately for rural and urban households.

3.4.1 Ugandan Households

A typical household in rural Uganda has about five members and an equal number of active members (15 years old and older) and children (0-14 years old) (table 1.a). However, poor households have more members compared to richer ones and more children relative to active members. About 68% of the rural households are male-headed, aged about 43 years. The spouse of the household head (or head for female-headed households) among the rural population has low educational achievement; 25% of them have no formal education, 60% have some level of primary

[4]The measure includes expenditures on beverages and tobacco, but excludes expenditures on medical care, as suggested in Deaton and Zaidi (2002). Due to the nature of questionnaire, flow of services derived from housing is not included in household total expenditures.

5 The consumption aggregate does not include flow of utility derived from ownership of durable goods and housing since the questionnaire was not designed to gather such information (National Bureau of Statistics, 2014).

education, and 15% have some secondary education or higher. Education of the main decision maker regarding food consumption choices and cooking can have strong implications for the nutritional status of the household members, and especially children.

The average rural household in Uganda spends 11,265 UGX per capita per week on food; those in the poorest quintile spend only about 4,000 UGX compared to 24,000 UGX for those in the fifth wealth quintile (table 1.a). At the same time, the poorest households devote 70% of their total expenditures to food compared to 57% for the best-off. This clearly indicates food deprivation among the poorest, which could be in the form of quantity and quality of the food consumed.

Table 1a: Summary statistics (mean) of per capita expenditures, food budget share, and household demographics, for rural households in Uganda

	Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*	*Average Rural*
PC total expenditure (UGX/week)	5,984	9,234	12,987	19,570	46,419	18,814
PC food expenditure (UGX/week)	4,182	6,408	8,929	12,556	24,309	11,265
Food budget share (%)	0.70	0.69	0.69	0.64	0.57	0.66
HH head present (1=yes)	0.92	0.91	0.91	0.90	0.96	0.92
HH head age	43.88	43.55	43.56	44.60	39.69	43.06
HH head sex (1=male)	0.66	0.69	0.66	0.68	0.70	0.68
Education of the spouse						
None	0.37	0.27	0.28	0.19	0.14	0.25
Primary	0.61	0.68	0.61	0.63	0.46	0.60
Secondary and higher	0.02	0.05	0.11	0.18	0.41	0.15
Household size	6.20	6.01	5.28	4.98	3.41	5.18
Nb of children (0-5)	1.48	1.38	1.23	0.88	0.56	1.11
Nb of children (6-14)	2.00	1.84	1.52	1.47	0.61	1.49
Nb of adult (15 & +)	2.72	2.79	2.52	2.63	2.24	2.58

Note: PC= Per capita, HH=Household, Nb=Number

While similar trends are found in urban areas, the average urban household appears better-off than the average rural household (table 1.b). The average household size in urban areas is 4.81 members with slightly more adults relative to children. The household head is a male for 62% of urban households and averages 43 years old, like rural households. About 10% of the spouse of the urban household heads (or head for female-headed households) have no formal education, 46% have some level of primary education, and 44% have some secondary education or higher.

Average food expenditure per capita per week in urban Uganda is 13,427 UGX and about 6,000 UGX amongst the poorest compared to 25,000 UGX for the best-off (table 1.b). Urban households at the bottom of the wealth distribution allocate 63% of their budget to food while those in the fifth quintile devote 42%. The average food budget share in urban areas is 52% compared to 66% in rural areas (tables 1.a & 1.b).

Table 1b: Summary statistics (mean) of per capita expenditures, food budget share, and household demographics, for urban households in Uganda

	Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*	*Average Urban*
PC total expenditure (UGX/week)	9,449	15,491	21,715	32,968	62,432	28,352
PC food expenditure (UGX/week)	5,977	8,284	12,268	15,367	25,382	13,427
Food budget share (%)	0.63	0.53	0.57	0.47	0.42	0.52
HH head present (1=yes)	0.88	0.94	0.94	0.89	0.93	0.92
HH head age	50.81	39.51	39.91	41.74	42.36	42.91
HH head sex (1=male)	0.51	0.64	0.68	0.63	0.65	0.62
Education of the spouse						
None	0.34	0.03	0.03	0.06	0.03	0.10
Primary	0.51	0.52	0.60	0.41	0.27	0.46
Secondary and higher	0.15	0.45	0.37	0.53	0.71	0.44
Household size	6.23	5.72	4.53	4.04	3.51	4.81
Nb of children (0-5)	1.30	0.98	0.94	0.57	0.49	0.86
Nb of children (6-14)	1.92	2.11	0.99	0.86	0.53	1.29
Nb of adult (15 & +)	3.00	2.63	2.61	2.62	2.50	2.67

Note: PC= Per capita, HH=Household, Nb=Number

3.4.2 Tanzanian Households

Household size in rural Tanzania averages 5.28 members and has about equal proportions of children (0-15 years old) and adults (16 years and older) (table 2.a). Differences in household size and share of children between households in the poorest versus best-off quintile are like those in rural Uganda. The average household head in rural Tanzania is 47 years old and more likely to be a man; 74% of households are male-headed. The spouse of the household head (or head for female-headed households) in rural Tanzania has even lower educational achievement than those in rural Uganda; 33% of spouses have no formal education, 61% have some level of primary education, and only 5% have some secondary education or higher. There are large differences in spouses' educational achievement between wealth quintiles in rural Tanzania. For example, 42% of the spouses in the bottom wealth quintile have no formal education compared to 21% for those in the top wealth quintile.

The average per capita weekly food expenditure among rural households in Tanzania is about 8,000 TZS while those in the poorest quintile spend about 3,500 TZS per capita on food compared to 15,000 TZS for those in the fifth wealth quintile (table 2.a). The gap in per capita food expenditure between households in the first and fifth quintile is not as large in rural Tanzania as in rural Uganda. However, there is a larger difference in the share of expenditure devoted to food between the poorest and best-off households in rural Tanzania compared to rural Uganda. In Tanzania, rural households in the first wealth quintile devote 73% of their budget to food compared to 56% for the best-off.

Table 2a: Summary statistics (mean) of per capita expenditures, food budget share, and household demographics, for rural households in Tanzania

	Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*	*Average Rural*
PC total expenditure (TZS/week)	4,489	7,363	10,066	14,568	29,829	13,253
PC food expenditure (TZS/week)	3,524	5,509	7,280	9,784	15,534	8,321
Food budget share (%)	0.78	0.77	0.72	0.68	0.56	0.70
HH head age	45.66	48.32	47.84	48.27	46.35	47.29
HH head sex (1=male)	0.73	0.72	0.78	0.77	0.71	0.74
Education of the spouse						
None	0.42	0.42	0.34	0.29	0.21	0.33
Primary	0.58	0.56	0.63	0.65	0.66	0.61
Secondary and higher	0.00	0.02	0.04	0.06	0.14	0.05
Household size	6.40	5.95	5.49	4.87	3.69	5.28
Nb of children (0-5)	1.56	1.19	1.07	0.87	0.44	1.03
Nb of children (6-15)	2.21	2.08	1.79	1.49	1.06	1.73
Nb of adult (16 & +)	2.63	2.68	2.64	2.50	2.18	2.53

Note: PC= per capita, HH=Household, Nb=Number.

In urban areas of Tanzania, the average household size is 4.35 members with more adults relative to children (table 2.b). The household head is more likely to be a man (70% of households are male-headed) and averages 43 years old, like in Uganda. The proportion of spouses (or female-headed households) that attended secondary school remains low in urban Tanzania but the lack of formal education is less common than in rural Tanzania. The educational gap between female decision makers between the poorest and richest quintile is even larger in urban than rural areas. Only 6% of the spouses in the bottom wealth quintile have some secondary education or higher compared to 48% for those in the best-off quintile.

The average per capita weekly food expenditure ranges from 6,410 TZS for households in the first wealth quintile to 20,022 TZS for those in the best-off quintile, indicating a larger food expenditure gap between rich and poor in urban areas compared to rural areas. Food expenditure represents about 50% of the budget for an average urban household in Tanzania. However, the poorest households allocate 68% of their budget to food compared to 32% for the richest. The gap between wealth quintiles for this metric of household well-being is larger in urban Tanzania than urban Uganda, which could indicate greater income inequality in urban areas of Tanzania.

Table 2b: Summary statistics (mean) of per capita expenditures, food budget share, and household demographics, for urban households in Tanzania

	Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*	*Average Rural*
PC total expenditure (TZS/week)	8,709	15,171	21,881	32,268	65,397	28,698
PC food expenditure (TZS/week)	6,410	8,708	10,503	13,807	20,022	11,894
Food budget share (%)	0.68	0.57	0.48	0.42	0.32	0.49
HH head age	46.66	45.69	43.15	40.38	37.92	42.76
HH head sex (1=male)	0.67	0.70	0.79	0.67	0.69	0.70
Education of the spouse						
None	0.24	0.16	0.07	0.05	0.02	0.11
Primary	0.70	0.71	0.73	0.69	0.50	0.67
Secondary and higher	0.06	0.13	0.19	0.26	0.48	0.22
Household size	5.41	4.97	4.60	3.91	2.85	4.35
Nb of children (0-5)	0.94	0.83	0.70	0.48	0.29	0.65
Nb of children (6-15)	1.92	1.43	1.08	0.80	0.39	1.13
Nb of adult (16 & +)	2.54	2.71	2.82	2.63	2.17	2.57

Note: PC= per capita, HH=Household, Nb=Number.

4. Descriptive analysis

In this section, descriptive statistics of food consumption patterns are presented first, allowed by descriptive analysis of bean consumption for Uganda and pulse for Tanzania. The section on food consumption patterns aims at informing the food demand analysis by describing the importance of the eight food groups in terms of their share in the household food budget. For the bean food group for Uganda, and pulse food group for Tanzania, the consumption analysis is pushed further. Using different measures of consumption, such as per capita bean/pulse expenditure, per capita quantity consumed and number of day bean/pulse were consumed over a week, we investigate how consumption varies over: 1) household economic status, 2) season, and 3) space. For rural households, we also investigate the source of bean and pulse consumed, i.e. whether they are from own production, purchased, or received as gift or in-kind payment.

4.1 Uganda

Food group expenditure shares, disaggregated by wealth quintiles and rural and urban location, are presented first. Then, an overview of how bean consumption varies over season and space and by household economic status is provided[6].

4.1.1 Food consumption patterns

In both rural and urban areas, starches represent the largest food expenditure share; households in rural areas spend, on average, 30% of their food budget on starches compared to 20% for urban households (table 3). Consistent with the Bennett's law, households in rural and urban areas in the wealthier quintiles spend a smaller proportion of their food budget on starches. The poorest households in rural areas devote 38% of their food budget on starches compared to 14% for urban households in the best-off quintile. This suggests a high reliance on starches (e.g. roots and tubers) as source of energy and nutrient intakes among rural households, and especially the poor ones. Cereal is the second most important food group in terms of expenditure share for rural households, followed by animal source foods. In urban areas, animal source foods rank second and cereal third. Like for starches, food expenditure share for animal source foods varies greatly by wealth quintiles. Poor households in rural (urban) areas spend 9% (11%) of their food budget on animal source foods compared to 21% (27%) for those in the best-off quintile. Given that these items are expensive, consumption of animal source foods among poor households is likely minimal. On the other hand, expenditure share on fruits and vegetables changes minimally by economic status, averaging about 9% of the food budget in rural and urban Uganda.

[6] Additional information on bean consumption patterns in Uganda can be found in Larochelle et al (2015a).

Table 3: Food group expenditure shares by wealth quintile, rural and urban Uganda, 2012

Food group	**Quintile 1**	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**	**Avg**
			Rural			
Cereals	16%	16%	17%	17%	13%	16%
Starches	38%	33%	32%	28%	20%	30%
Beans	11%	11%	10%	7%	5%	9%
Peas, nuts, and seeds	4%	4%	4%	5%	4%	4%
Vegetables and fruits	11%	10%	9%	9%	9%	10%
Meat, fish, and milk	9%	14%	15%	18%	21%	15%
Oil, fat, spice, and sugar	7%	6%	7%	8%	8%	7%
Beverages and FAFH	5%	5%	7%	9%	19%	9%
Urban						
Cereals	22%	19%	15%	15%	12%	17%
Starches	26%	23%	19%	20%	14%	20%
Beans	10%	7%	6%	7%	4%	7%
Peas, nuts, and seeds	10%	3%	4%	3%	4%	5%
Vegetables and fruits	9%	9%	10%	8%	9%	9%
Meat, fish, and milk	11%	16%	17%	21%	27%	18%
Oil, fat, spice, and sugar	6%	13%	10%	9%	9%	9%
Beverages and FAFH	6%	11%	20%	17%	21%	15%

Note: FAFH= Food away from home; Avg= Average.

Expenditures on bean account for about 9% of the food budget in rural areas compared to 6.7% in urban areas (table 3). In fact, bean ranks fifth in importance in terms of expenditures in rural areas and seventh in urban areas. Differences in food consumption patterns between rural and urban households are likely the result of several factors such as differences in income, life style, and preferences. The analysis of food consumption patterns by food group expenditure shares while informative, masks components of the household consumption decisions, such as the decision to consume a food item or not. Additional consumption indicators are considered in the next section to provide a more complete picture of bean consumption in Uganda.

4.1.2 Bean consumption by socio-economic groups

Over 80% of Ugandan households consume bean over a one week period in both rural and urban areas with noticeable differences between economic strata (table 4). In both rural and urban areas, the percentage of households consuming bean first increases with household wealth, and then decreases; it peak with households in the fourth wealth quintile in rural areas, and in the second wealth quintile in urban areas. For example, in rural areas, only 74% of the households in the poorest quintile consume bean compared to 88% for those in the fourth wealth quintile, and 78% for households in the best-off quintile. In urban areas, the second quintile has the highest share of households that consume bean while the proportion of households consuming bean is nearly the same in the remaining quintiles. This suggests that constraints as well as preferences play part in influencing bean consumption. Weekly per capita bean expenditure is the lowest among households belonging to the first wealth quintile in both rural and urban areas, and increases with wealth.

Table 4: Bean consumption indicators, by wealth quintile, rural and urban Uganda, 2012

	Share of HH consuming bean		Weekly per capita bean expenditure (UGX)		Per capita bean consumption (g/day)	
	Rural	Urban	Rural	Urban	Rural	Urban
Quintile 1	73.50%	78.60%	455	491	51.9	51.5
Quintile 2	82.85%	86.02%	704	617	65.0	65.9
Quintile 3	87.25%	79.68%	875	741	81.2	65.9
Quintile 4	87.62%	82.78%	862	930	77.7	86.0
Quintile 5	78.79%	78.07%	1,094	949	89.2	75.0
Average	82.01%	81.03%	798	744	73.0	68.8

Generally, per capita bean consumption increases for each additional wealth quintile[7] (table 4) while the share of the food budget devoted to bean decreases in wealth quintile (table 3). Bean expenditure represents 11% (10%) of the food budget for the poorest rural (urban) households, and goes down to 5% (4%) for the richest households (table 3). The quantity of bean consumed by rural individuals in the bottom quintile is about 55% of quantity consumed by rural individuals in the top quintile, an evidence that poor consumers in rural Uganda might be constrained in accessing sufficient quantities of bean for their consumption (table 4). In urban areas, most foods are purchased and one would expect low consumption of bean among the poorer urban households to be constrained by lack of purchasing power. What then, limits bean consumption by households at the bottom economic stratum in rural areas where bean production is concentrated? In the next section, we investigate the source of bean consumed in rural areas,

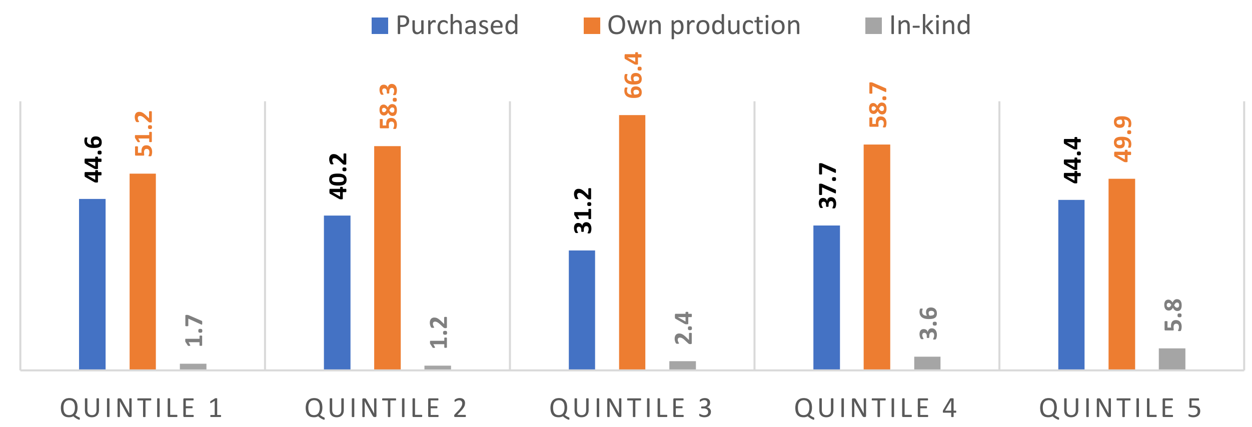
[7] At the exception of urban households in the fifth wealth quintile and rural households in the fourth wealth quintile.

i.e. whether bean was purchased, obtained from own production, or received as in-kind payment or gift, by wealth quintiles.

4.1.3 Source of bean consumed for rural households

There is a U-shape relationship between wealth quintiles and share of bean purchased (Figure 1). For the poorest 20% of households, 45% of bean consumed were purchased. This proportion decreases to 40% for households in the second wealth quintile and reaches its lowest (31%) for households belonging to the third wealth quintile. Then, the share of bean consumed that was purchased increases for households in the fourth and fifth quintiles. In sum, a greater share of bean consumed by the poorest 20% is purchased compared to households in any other wealth quintile, making the poorest more vulnerable to bean price fluctuations and food insecurity.

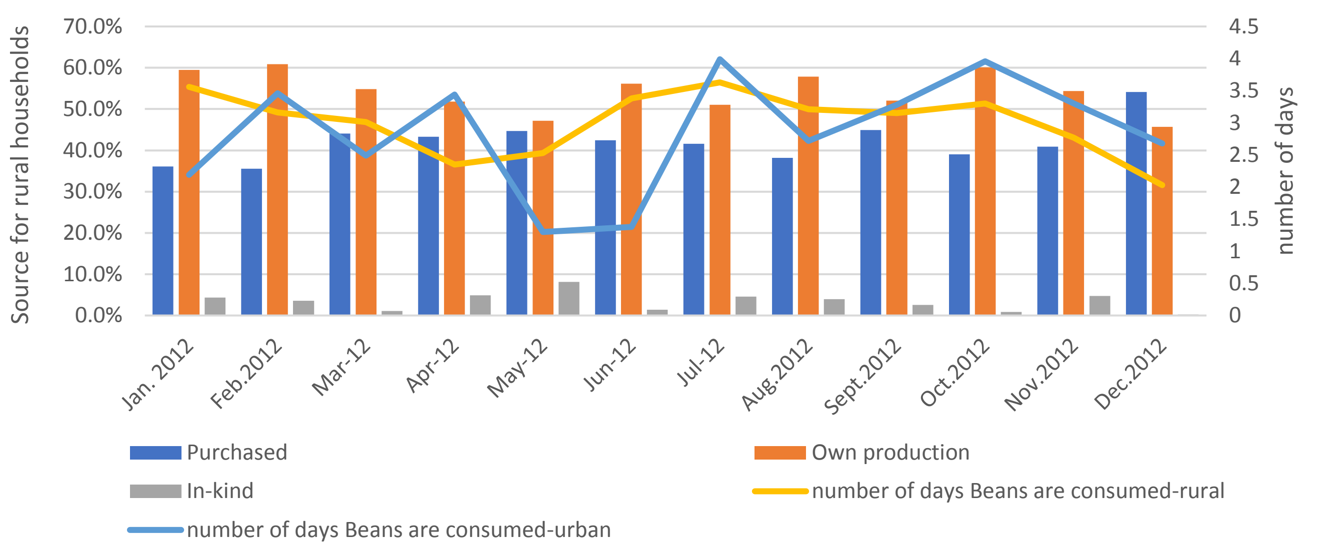
FIGURE 1: SOURCE OF BEAN CONSUMED BY WEALTH QUINTILE, RURAL UGANDA (%)



4.1.4 Seasonality trends of bean consumption

On average, a rural (urban) household consumes bean 3.1 (2.98) times per week, with significant fluctuations across months (figure 2). In rural areas, weekly bean consumption is at a minimum, consumed about twice per week, in the months of April and May which are the months of crop growth in the first cropping season, and reaches a maximum in the months when harvesting takes place. These are the months of January for the second season crop and June and July for the harvest of the first season crop. In urban areas, the frequency of bean consumption is at its highest (4.0/week) in the months of July and October (figure 2). The months of highest consumption frequency are also those for which bean share in food expenditure is highest, because during these periods other food crops have not yet matured.

Figure 2: Number of days beans were consumed in past 7 days in rural (urban) and source of beans per month for rural, Uganda



Seasonality also influences the source of bean consumed (i.e. from purchased, own production, or in-kind) in rural areas. The share of bean consumed from own production is highest in the months when bean is harvested, i.e. in January, and February (harvest for second season crop) and July (harvest of first season crop). The months for which own production accounts for a bigger share of bean consumed by the rural household are also the same months when bean consumption frequency is the highest. This is evidence that production and consumption are positively correlated, which suggests that increasing production among poorer households might enhance their bean consumption.

4.1.5 Spatial variability of bean consumption

Bean consumption in Uganda also varies over space. The number of days that bean is consumed over a week and bean expenditure share are generally higher in the southwestern parts of the country and lower in several districts of the north and eastern regions. While locations with high bean consumption also have high bean production, there is an imperfect correlation between production and consumption which suggests that trade might occur to adjust for differences in preferences and prices across geographical locations. Maps showing the spatial distribution of bean consumption frequency per week, per capita bean expenditure, and bean expenditure share across districts can be found in Larochelle et al (2015a).

4.2 Tanzania

In this section, we give an overview of food consumption patterns in Tanzania, and then describe pulse consumption as a whole due to the lack of disaggregated data about the different pulse types. Given that bean accounts for about 78% of the legume land area in Tanzania (Kweka et al., 2014), it is very likely that bean is also the most widely consumed pulse in the country. We provide more detailed information on pulse consumption than we did for bean consumption in Uganda since pulse consumption in Tanzania has not previously been documented (unlike bean consumption in Uganda). The descriptive analysis in this section is based on similar consumption indicators to those used in the descriptive report of bean consumption in Uganda (see Larochelle et al., 2015a).

4.2.1 Food consumption patterns

The most important food group in terms of expenditure in Tanzania is cereal, representing about 36% of the food budget in both rural and urban areas (table 5). Starches contribute a much smaller proportion of the energy and nutrient intakes in Tanzania than Uganda. About 13 and 6% of the food budget is spent on starches in rural and urban Tanzania respectively, and starch expenditure ranks third and sixth in the food budget of rural and urban households. The second largest food expenditure, after cereal, is for animal source foods. Rural households spend about 18% of their food budget on meat, fish, and dairy products and urban households, 21%. As in Uganda, the share of the food budget going towards animal and aquatic products increases drastically with wealth; it doubles in urban areas, and more than doubles in rural areas between households in the poorest and best-off quintile.

Table 5: Food group expenditure shares by wealth quintile, rural and urban Tanzania, 2013

Food group	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Average
Rural						
Cereals	39.5%	38.7%	37.7%	34.2%	30.1%	36.0%
Starches	16.3%	13.7%	13.2%	12.1%	10.9%	13.3%
Pulses	7.2%	7.2%	6.5%	6.4%	5.2%	6.5%
Nuts, and seeds	2.5%	2.6%	2.9%	3.2%	2.5%	2.7%
Vegetables and fruits	14.2%	13.1%	13.1%	12.5%	13.2%	13.2%
Meat, fish, and milk	11.5%	15.8%	17.1%	20.0%	26.3%	18.1%
Fat, spice, and sugar	7.2%	7.5%	7.9%	9.1%	8.7%	8.1%
Beverages	1.5%	1.3%	1.6%	2.3%	3.1%	2.0%
Urban						
Cereals	44.4%	39.1%	39.3%	31.8%	28.5%	36.6%
Starches	8.0%	6.9%	5.8%	6.7%	4.9%	6.4%
Pulses	5.8%	6.1%	4.6%	3.6%	2.7%	4.6%
Nuts, and seeds	2.8%	3.6%	3.1%	3.4%	2.6%	3.1%
Vegetables and fruits	13.2%	13.6%	14.0%	15.2%	15.0%	14.2%
Meat, fish, and milk	14.8%	18.2%	20.5%	24.2%	29.3%	21.4%
Fat, spice, and sugar	9.4%	10.4%	10.1%	10.4%	10.1%	10.1%
Beverages	1.5%	2.2%	2.5%	4.7%	7.0%	3.6%

Compared with Uganda, Tanzanian households spend a smaller share of their food expenditure on pulse (table 5). A typical household in rural Tanzania spends about 6.5% of its weekly food expenditure on pulse while an average urban household spends about 4.6% of its food budget on pulse. Like Uganda, pulse expenditures are relatively more important for the poor households than the better-off. Pulse consumption is more important for the nutritional adequacy of rural poorer households who have less diverse diets. Rural (urban) households in the first quintile allocate 7% (6%) of the budget food on pulse compared to 5% (3%) for those in the best-off quintile. While the relative importance of pulse consumption in household diets decreases with wealth, total consumption continues to rises as income increases, which is discussed further in the next paragraphs.

4.2.2 Pulse consumption patterns by socioeconomic groups

Pulse is consumed by most households in Tanzania. A respective 73 and 82% of rural and urban households reported having consumed pulse over a seven-day recall period (table 6). Like Uganda, the percentage of households consuming pulse among the rural and urban populations of Tanzania depicts a nonlinear relationship with household economic status, increasing across the economic strata and reaching a peak in the fourth wealth quintile in rural areas, at 84%, and in the second wealth quintile in urban areas, at 88%.

Table 6: Pulse consumption indicators, by wealth quintile, rural and urban Tanzania, 2013

	Share of HH consuming pulse (%)		Weekly per capita pulse expenditure (TZS)		Per capita pulse consumption (g/day)	
Wealth quintile	Rural	Urban	Rural	Urban	Rural	Urban
Quintile 1	57.5%	82.1%	240	344	27	33
Quintile 2	70.1%	88.3%	382	530	39	47
Quintile 3	74.4%	87.1%	461	480	46	41
Quintile 4	84.5%	84.4%	617	507	61	44
Quintile 5	80.3%	68.5%	738	591	69	49
Total average	73.3%	82.0%	487	490	48	43

While food expenditure share spent on pulse decreases with wealth, as shown in table 5, on average, weekly per capita expenditure on pulse increases as income increases (table 6). A rural household in the bottom economic stratum spends on average TZS 240 per capita on pulse per week; this is about one third of the per capita pulse expenditure for a household in the fifth quintile, which is TZS 738 per week. Per capita expenditure on pulse also increases by wealth quintile in urban areas, but not as sharply as in rural areas. Per capita pulse expenditure among urban households in the first quintile averages TZS 344 per week compared to TZS 530 for those in the second quintile and TZS 591 for those in the best-off quintile.

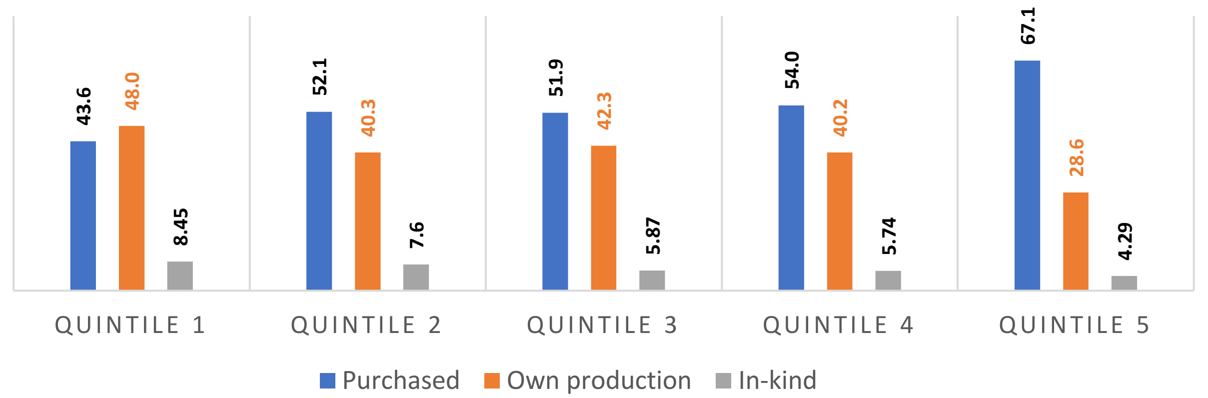
The average quantity of pulse consumed daily per capita is slightly higher in rural than urban areas (table 6). On average, an individual who resides in a rural area consumes 48 grams of pulse per day compared to 43 grams for one who lives in an urban area. In both rural and urban areas, per capita pulse consumption is the lowest among the bottom poor households and the highest among those in the top quintile.

4.2.3 Source of pulse consumed for rural households

The source of pulse consumed in rural Tanzania varies across socioeconomic strata. Unlike in Uganda, there is a linear relationship between household wealth quintile and the share of bean consumed that is purchased (Figure 3). The poorest households are the most likely to consume pulse from their own production and the least likely to purchase pulse for their own consumption.

But like in Uganda, households in the bottom 20% of the wealth distribution also purchase pulse to meet their consumption needs, purchasing 44% of pulse consumed. The proportion of pulse consumed that is purchased increases to 52% for households in the second wealth quintile and reaches its highest (67%) for households belonging to the fifth wealth quintile.

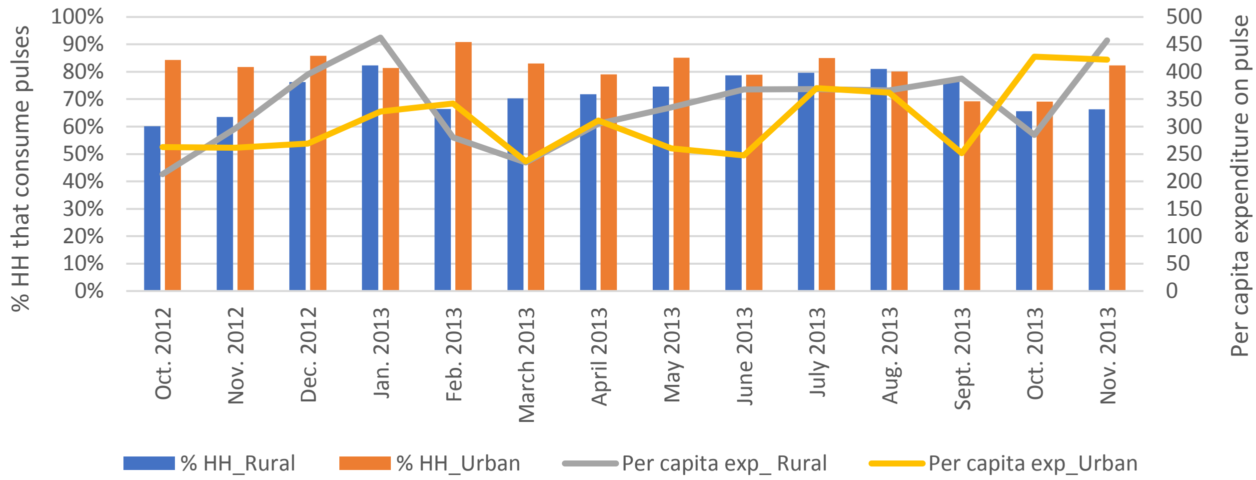
FIGURE 3: SOURCE OF PULSE CONSUMED BY WEALTH QUINTILE, RURAL TANZANIA (%)



4.2.4 Seasonality trend of pulse consumption

There are important monthly fluctuations in pulse consumption in both rural and urban areas. Consumption of pulse among rural households is most frequent in January, when pulse is consumed by 80% of households (Figure 4). Fewer than 60% of rural households consume pulse in November. Similar consumption trends, but less pronounced, are observed in urban areas. The proportion of urban households consuming pulse is highest in February, March, and July, and the lowest in September, October and November.

Figure 4: Percentage of households and weekly per capita expenditure on pulses (TZS), by month, rural and urban Tanzania



As expected, expenditure and share of food budget spent on pulse also fluctuate monthly in both rural and urban areas of Tanzania (Figure 4). Per capita weekly pulse expenditures peak in rural (urban) areas in January (July) at about TZS 450 (TZS 370). For most of the months considered (i.e. from October 2012 to October 2013), weekly per capita pulse expenditures[8] are either equal or higher in rural than urban areas, at the exception of the months of February and October 2013. The seasonal fluctuations in pulse per capita expenditure are more pronounced than those in the percentage of households that consume pulse, which reflects variations in crop availability (high after harvest, low before harvest) and the fact that pulse used to fill the hunger gap when other crops are not yet harvested.

Average quantities of pulse consumed per person per day is also larger in rural areas than urban areas for all months, except during February, March, and April (figure 5). Per capita quantity of pulse consumed per day among rural households varies between 31 and 56 g/day); reaching its maximum in the months of July, August and September when harvesting and marketing occur.

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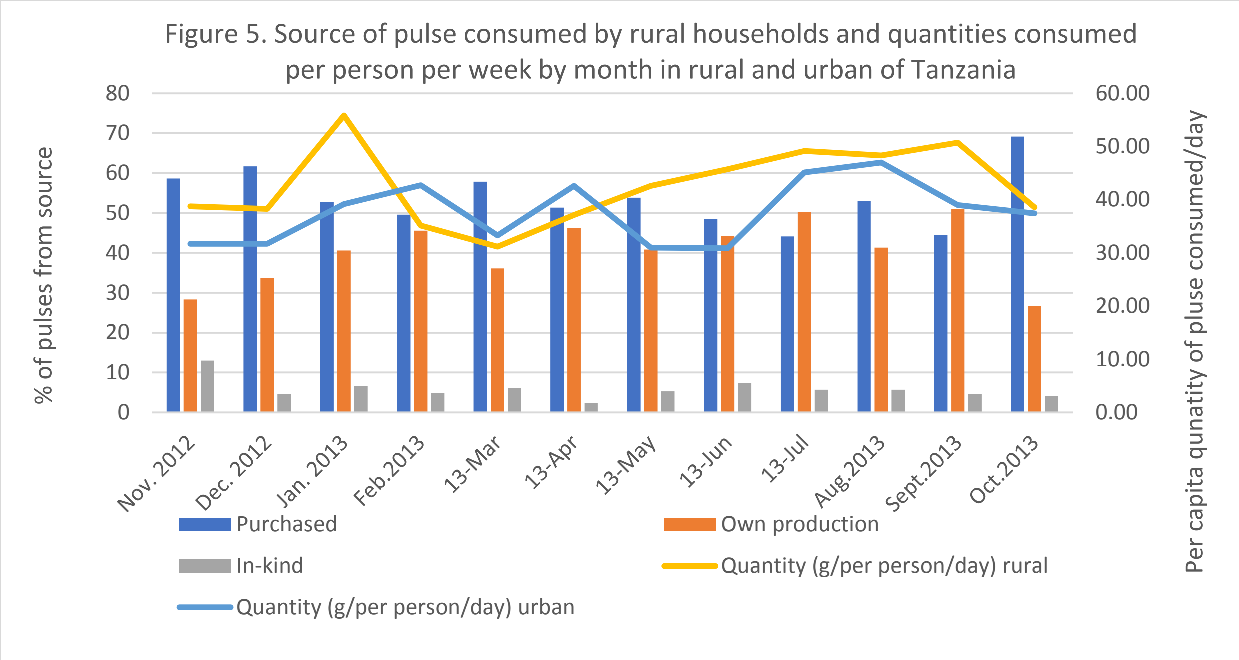
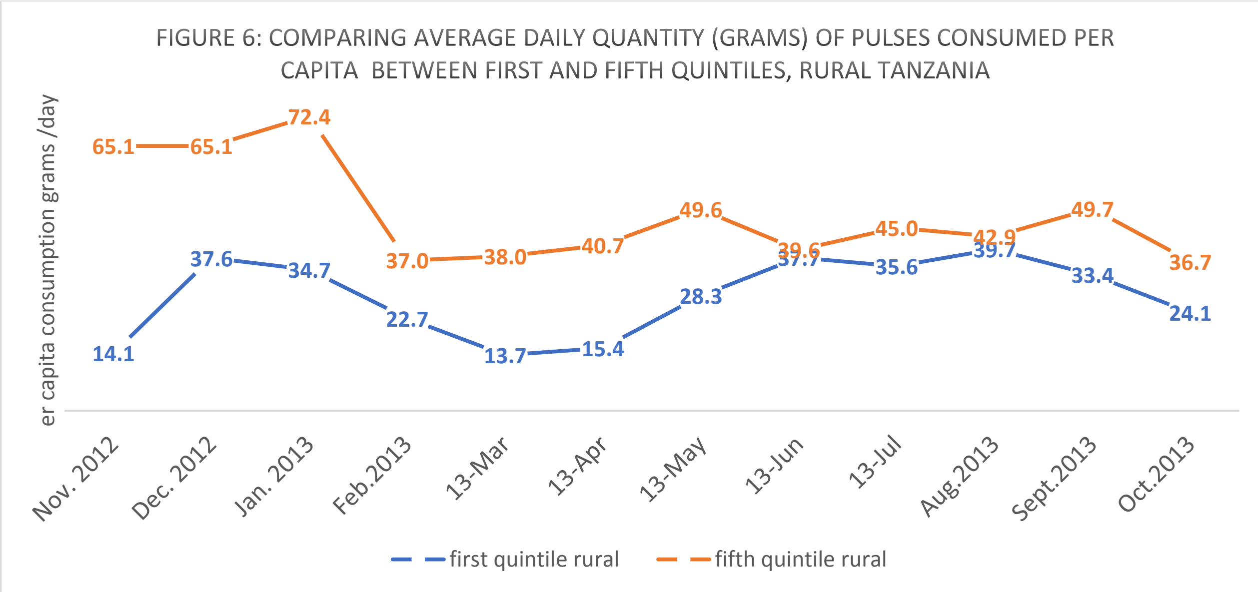
[8] Expenditures were normalized using a price index capturing differences in prices over time and space, such that expenditures can be directly compared between rural and urban areas as well as across months.



As figure 6 shows, per capita pulse consumption is always lower among rural households in the first quintile compared to those in fifth quintile. However, the gap in per capita consumption between the two socioeconomic groups gets narrower during the months of June, July and August when harvesting occurs across the entire country. Harvests in December and January in parts of the country with bimodal type of rainfall also increase pulse consumption for the poorer households, compared to months of crop growth (March and April & October November), although the pulse consumption gap between the poorest and best-off households is the largest in the harvest months of in December and January. This implies that the poorer households increase their pulse consumption during months of harvest when pulse is available in plenty but their demand may be constrained during several months in a year.



Pulse consumption from own production in rural Tanzania gains importance during the same months as consumption is the highest (Figure 5). The share of purchased pulse is particularly high during lean periods which occurs in the months of October, November and December. During these months, about 60-70% of pulse consumed is purchased, which means that market development for pulse is critical for supporting pulse consumption.

4.2.5 Spatial variability in pulse consumption in Tanzania

To understand the spatial dimensions of pulse consumption, the selected consumption indicators are averaged over Tanzania's 28 districts and depicted in figures 7a-d. From these maps, most households across Tanzania consume pulse but the percentage of households consuming pulse and the contribution of pulse to household diets in terms of weekly expenditures, quantity consumed, and expenditure share varies regionally. The likelihood that a household consumes pulse is highest (82-90%) in Kagera region, located in the North, Kigoma region, located in the North-Western, in Kilimanjaro and Manyara regions and districts of the central region (i.e. Morogoro, Iriga and Mbeya), and in the southern highlands. In these regions, bean is the most important pulse grown and consumed (Kweka et al., 2014). Households located in the regions east of Lake Victoria (i.e. Mara, Kaskazini Unguja, Kusini Unguja, Kaskazini Pemba, Mjini Magharibi and Mwanza) are the least likely to consume pulse. In these regions, only 38 to 56% of households consume pulse on a weekly basis (Figure 7a). The proportion of households that consume pulse in Tanzania does not depend on rainfall regime.

Figure 7a

Percent of households consuming pulses in the past 7 days, by region, Tanzania

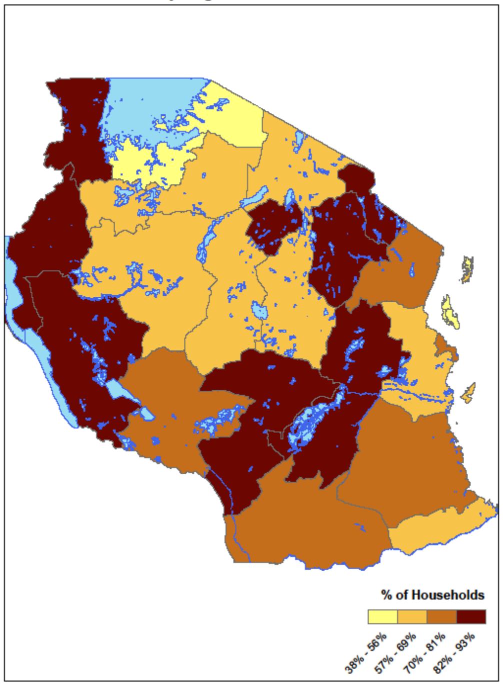


Figure 7b

Household weekly pulse consumption (kg), by region, Tanzania

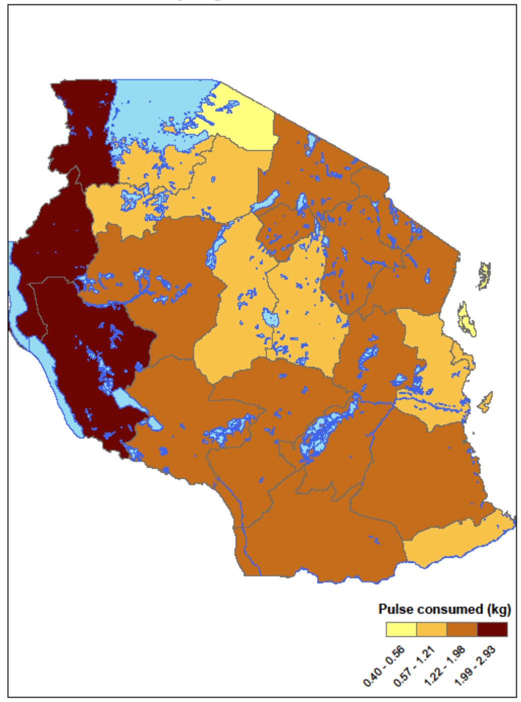


Figure 7c

Weekly household expenditures on pulses (TZS), by region, Tanzania

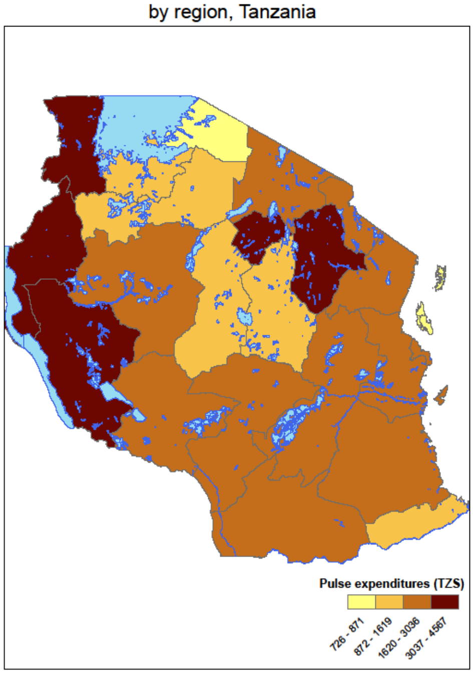
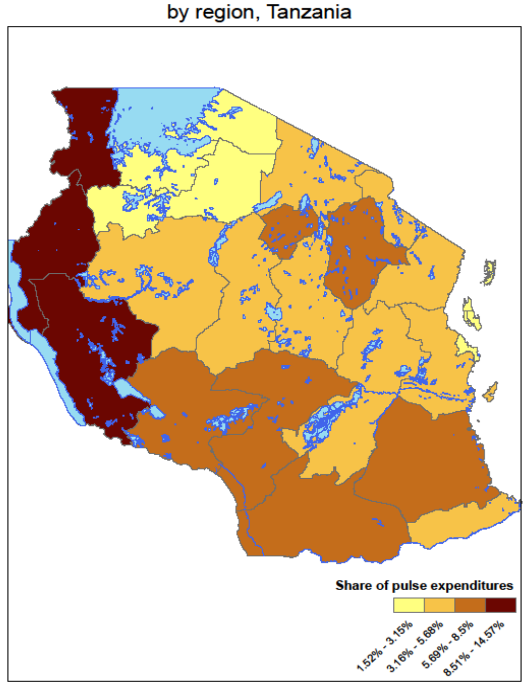


Figure 7d

Share of food expenditurs spent on pulses, by region, Tanzania



Similar spatial trends are found for pulse expenditure and pulse expenditure share (figures 7c and 7d). Pulse expenditure is the largest among households located in the Kagera, Kilimanjaro, and Manyara regions (Figure 7.c). Regions where expenditure share on pulse is the highest are the same as those where quantity consumed is the greatest. The imperfect correlation between average household expenditure on pulse and expenditure share on pulse per district might suggest that the price of pulse relative to other food items is not constant across regions and/or food preference differ across regions.

5. Econometric Analysis: Method

To achieve our second objective, i.e. to understand the responsiveness of bean and pulse demand to price and income changes, we estimate a household food demand system using a two-stage budgeting approach. In the first stage, households decide how to allocate expenditure between food and non-food commodities. In the second stage, households choose how to allocate their food budget across food groups. This two-stage budgeting approach has been previously used to study household food demand in developing countries (e.g. in Boysen, 2016). The approach is based on the assumptions that consumer preferences are weakly separable and food group price indices vary only slightly with household expenditure levels (Edgerton, 1997; Carpentier and Guyomard, 2001). Under these assumptions, elasticities from the first and second stage can be combined to obtain unconditional elasticities (Carpentier and Guyomard, 2001). In this study, a Working-Leser model is estimated in the first stage while a Quadratic Almost Ideal Demand System (QUAIDS) accounting for censoring is used in the second stage.

5.1 First stage: Working-Leser Model

The allocation of the budget between food and non-food expenditure is modeled according to Working-Leser model. The dependent variable is the share of the budget spent on food, which is a linear function of the natural logarithm of per capita household expenditure and a food price index (Deaton 1997). As in Boysen (2016), our model also includes household demographic variables, to reflect that the decision of how much to spend on food may depend on household characteristic, and per capita expenditure square to allow food expenditure share to be nonlinear in household income. As a result, the share of the total expenditures spent on food, w_f , is modeled as:

$$w_f = \alpha_F + \gamma_F ln p_f + \beta_F ln M + \lambda_F (ln M)^2 + \sum_{k \in K} \delta_k x_k \qquad (1)$$

where p_f is an aggregate food price index; M represents per capita household expenditures; and *x* is a vector of *k* household socio-demographic variables. The aggregate food price index is estimated using the Paasche index as specified in Equation (2):

$$p_f = \left[\sum_{k=1}^{n} w_{ik} * \left(\frac{p_{\mathrm{ck}}}{p_{0k}} \right)^{-1} \right]^{-1} \qquad (2)$$

where $\mathrm{w_{ik}}$ is household *i* food budget share for food item *k*; $\mathrm{p_{ck}}$ is the median price of food item *k* in cluster[9] *c* and p_{0k} is the national median price of food item *k*. Cluster level as opposed to household level prices are used to reduce potential issue related to price endogeneity, i.e. when for example wealthier (worst-off) households purchase foods of higher (lower) quality, resulting in higher (lower) unit prices (Deaton, 1997). Median prices are used as they are less sensitive to measurement errors than mean values (Deaton, 1997).

Based on equation (1), expenditure elasticity η_F and uncompensated Marshallian price elasticity ε_F of aggregate food demand are computed as follow

$$\eta_F = 1 + \frac{\beta_F}{w_F} + \frac{2\lambda_F \ln M}{w_F} \qquad (3)$$

$$\varepsilon_F = -1 + \frac{\gamma_F}{w_F} \qquad (4)$$

5.2 Second stage: Augmented Quadratic Almost Ideal Demand System

The second-stage consists of modeling household food demand, meaning that given household food expenditures in stage one, households must decide how much to spend on each of the eight food groups discussed above. Food items included in the same food group were close substitutes for the condition of weak separability to be met. Weak separability in this stage implies that a

[9] A cluster is an administrative unit. Administrative units in Uganda are: village, parish, sub-county, county, district, and sub-region. Administrative units in Tanzania are: village, district, region, and survey area. If the smallest administrative unit has five observations or more for which the price of item food k is reported, then the median price of this cluster is used. When there are fewer than five observations in the smallest administrative unit, price is obtained for the next administrative unit that has a minimum of 5 observations. Same foods but with different measurement units are considered as different items for the price index computation.

change in the price of an item included in food group one would result in the same change in the demand for all items included in food group two (Edgerton, 1997). We model household food demand using a QUAIDS specification, as proposed by Banks et al. (1997), which is an extension of the Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer, 1980). The quadratic specification allows the demand curves to be non-linear in the natural logarithm of total expenditures. This means that the same commodity can be considered a luxury or a necessity depending on household expenditure level (Boysen, 2016). The expenditure share equation of the QUAIDS model is specified by equation 5 (Poi, 2012).

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i ln\left\{\frac{m}{a(p)}\right\} + \left\{\frac{\lambda_i}{b(p)}\right\} + \left[ln\left\{\frac{m}{a(p)}\right\}\right]^2, \qquad i = 1, \dots, k \qquad (5)$$

w_i represents expenditure share for food group *i*, p_j the price index for food group *j*, *m* is household food expenditure, *ln(a(p))* is a transcendental logarithm price index corresponding to:

$$\ln(a(p)) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{k}\sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_k \qquad (6)$$

b(p) is the Cobb-Douglas price aggregator:

$$b(p) = \prod_{i=1}^{k} p_i^{\beta_i} \qquad (7)$$

and

$$\lambda(p) = \sum_{i=1}^{k} \lambda_i \ln p_i \qquad (8)$$

The food group price indices are computed following the same approach as for the aggregate food price index. The price index for food group *j* can be expressed by:

$$p_j = \left[\sum_{t=1}^{n} w_{ijt} * \left(\frac{p_{cjt}}{p_{0jt}}\right)^{-1}\right]^{-1} \qquad (9)$$

Where w_{ijt} is the budget share of food commodity *t* in food group *j* for household *i*; *n* is the number of food items in food group *j*; p_{cjt} is the median price of food item *t* in food group *j* in cluster *c*; and p_{0jt} is the corresponding food item national median price.

To satisfy demand theory, adding up (10), homogeneity (11), and symmetry (12) should be opposed:

$$\sum_{i=1}^{k}\alpha_i = 1, \sum_{i=1}^{k}\beta_i = 0, \sum_{j=1}^{k}\gamma_{ij} = 0, \sum_{i=1}^{k}\lambda_i = 0 \tag{10}$$

$$\sum_{j=1}^{k}\gamma_{ij} = 0 \tag{11}$$

$$\gamma_{ij} = \gamma_{ji} \tag{12}$$

The standard AIDS model is nested in the QUAIDS model and is recovered when all the, $\lambda_i = 0$. This gives an opportunity to test whether the QUAIDS provides a better fit than the original AIDS.

In addition to depending on prices and expenditure levels, food demand is also expected to vary with household demographics. These variables are represented by the vector, x, and includes the same household demographic variables as in the first-stage model. Demographics are introduced into the food demand system following Ray (1983), which leads to the following expenditure share equations (Poi, 2012):

$$w_i = \alpha_i + \sum_{j=1}^{k}\gamma_{\mathrm{ij}}\ln p_j + (\beta_{\mathrm{i}} + \eta_i' x)\left\{\frac{m}{\bar{\boldsymbol{m}}_{\boldsymbol{0}}(x)a(p)}\right\} + \left\{\frac{\lambda_i}{b(p)c(p,x)}\right\} + \left[ln\left\{\frac{m}{\bar{\boldsymbol{m}}_{\boldsymbol{0}}(x)a(p)}\right\}\right]^2 \tag{13}$$

Where $\bar{\boldsymbol{m}}_{\boldsymbol{0}}(x) = 1 + \rho'\mathrm{x}$ (14)

And $c(p,x) = \prod_{j=1}^{K} p_j^{\eta_j' x}$ (15)

Since zero expenditure for certain food groups is common for reasons such as preferences, unavailability, and unaffordability, estimating food group expenditure shares as specified in equation 13 would result in biased estimates. To address this issue, known as censoring, and obtain consistent estimates for the second stage of the food demand system, we follow the approach proposed by Shonkwiler and Yen (1999). This approach stipulates that households make their food consumption decisions in a two-step manner. In the first step, households decide on whether to consume a food group, and conditional on a positive consumption decision, they decide on the food expenditure share to allocate to this food group. This two-step process can be represented as follow:

$$d_{ih}^{*} = \theta_i z_{ih} + \nu_{ih} \tag{16}$$

$$w_{ih}^{*} = f(x_{ih}, \beta_i) + \varepsilon_{ih} \tag{17}$$

$$d_{ih} = \begin{cases} 1 & if\ d_{ih}^{*} > 0 \\ 0 & if\ d_{ih}^{*} \leq 0 \end{cases} \tag{18}$$

$$w_{ih} = d_{ih} w_{ih}^{*} \tag{19}$$

where d_{ih} and w_{ih} represent household *h* observed dependent variables for the binary consumption decision for food group *i* and its budget share respectively, and d_{ih}^{*} and w_{ih}^{*} are their unobserved latent counterparts; *x* and *z* are vectors of exogenous variables. The first-step entails modeling the binary food group consumption decision (yes/no) in Equation (16) using a Probit model. Then, the predicted values of the Probit model are used to compute the cumulative distribution $\widehat{\Phi}_i$ and probability density functions $\widehat{\phi}_i$, which both enter the second stage of the food demand system to correct for censoring. More specifically, in the second stage, the w_i specified in equation (13) is replaced by the following expression:

$$w_i = \widehat{\Phi} w_i^{*} + \delta_i \hat{\phi} \tag{20}$$

This model accounting for censoring is referred to as the augmented QUAIDS. The expenditure elasticity of food group *i* for the augmented QUAIDS model with demographics are computed as follow:

$$\eta_i = 1 + \frac{\overline{\Phi}_i}{w_i}\left[\beta_i + \boldsymbol{\eta}_i'\boldsymbol{x} + \frac{2\lambda_i}{b(p)c(p,x)} ln\left\{\frac{m}{\overline{m}_0 a(p)}\right\}\right] \tag{21}$$

and the uncompensated price elasticity of food group *i* with respect to changes in the price of food group *j* is given by equation 22.

$$\varepsilon_{ij} = \frac{\overline{\Phi}_i}{w_i}\left\{\gamma_{ij}\left[\beta_i + \boldsymbol{\eta}_i'\boldsymbol{x} + \frac{2\lambda_i}{b(p)c(p,x)} ln\left\{\frac{m}{\overline{m}_0 a(p)}\right\}\right] * (\alpha_j + \sum_l \gamma_{ij} lnp_i) - \frac{(\beta_j + \boldsymbol{\eta}_j'\boldsymbol{x})\lambda_i}{b(p)c(p,x))}\left[ln\left\{\frac{m}{\overline{m}_0 a(p)}\right\}\right]^2\right\} - \Delta_{ij} \tag{22}$$

5.3 Elasticities

Elasticities represented in equations 21 and 22 are conditional elasticities (conditional on the first stage budgeting). Having a two-stage budgeting demand system, we are interested in the unconditional expenditures and price elasticities of the different food groups, which we derive following the procedure developed by Carpentier and Guyomard (2001). The unconditional food group expenditure elasticities are obtained by multiplying the conditional food group expenditure elasticity (obtained in the second stage) by the aggregate food expenditure elasticity (obtained in the first stage). The unconditional uncompensated price elasticities are obtained as follow:

$$\varepsilon_{ij}^U = \varepsilon_{ij} + w_j\left(\frac{1}{\eta_j} + \varepsilon_F\right)\eta_i\eta_j + w_F w_j \eta_F \eta_i(\eta_j - 1) \tag{23}$$

i and *j* are indices that represent commodities in the second stage (here food groups) and *F*, commodity in the first stage (here food only). Consequently, $\varepsilon_{ij}^U$and ε_{ij} represent the unconditional and conditional price elasticities for food group *i*; w_j and w_F are the food group expenditure share and aggregate food expenditure share; ε_F is the price elasticity of food; $\eta_i\eta_j$ are the conditional food group expenditure elasticity while η_F is the food expenditure elasticity. We focus on the uncompensated (or Marshallian) price elasticity as opposed to the compensated (Hicksian) price elasticity given that most households are income constrained. Hicksian price elasticities are derived keeping the level of utility constant while Marshallian price elasticity assume constant income level. For example, an increase in the price of bean would reduce consumer real income, which is captured by the Marshallian price elasticities. On the other hand, Hicksian price elasticities are derived assuming consumer income is augmented to compensate for the higher price.

The unconditional expenditure elasticities, which indicate the percentage change in demand associated with a one percent change in household expenditure, are expected to be positive, indicating that the food commodities are normal goods. An unconditional expenditure elasticity greater than one indicates that the food item is a luxury, meaning that the increase in the quantity demanded is proportionally greater than the increase in expenditures. Food commodities with unconditional expenditure elasticities between zero and one are considered necessities. Quantity demanded increases as expenditure rises but in a smaller proportion than the increase in expenditure. Expenditures on these necessity goods augment in absolute terms as total expenditures increase, but decrease in relative terms. For an inferior good, the unconditional expenditure elasticity is negative, indicating that demand for this food decreases when total expenditures rise. The unconditional uncompensated own price elasticity measures the percentage change in quantity demanded associated with a one percent change in the price of that good. Own price elasticities are normally negative, indicating that the quantity demanded decreases as price increases. A good is considered to have an elastic demand if its own price elasticity, in absolute value, is greater than one and an inelastic demand when its own price elasticity, in absolute value, is between zero and one. Cross-price elasticities indicate the percent change in the quantity demanded for food item *x* due to a one percent change in the price of food item y. Two commodities are substitutes when their cross-price elasticity is positive, and complements for negative cross-price elasticity. Cross-price elasticities are generally small, and often insignificant.

5.4 Estimation

In both countries, models are estimated separately for rural and urban areas as food availability and preferences are expected to differ between the two locations. Probit models to explain the household non-consumption of certain food groups are estimated first. Then, the Working-Lesser model and augmented QUAIDS are estimating jointly, facilitating computation of elasticities and corresponding standard errors. Since the food group share equations are augmented by the cumulative distributions and probability density functions of the Probit model predicted errors to account for censoring, the additivity constraint of budget shares (Eq.10) can no longer be satisfied.

Therefore, the censored demand system is estimated using the full set of food group budget share equations with no additivity constraint (Shonkwiler and Yen, 1999)[10].

In both Uganda and Tanzania, food consumption is expected to vary with household demographic and location; the variables are included in vector *x* in the equations above. The variables included in this *x* vector in the case of Uganda are age and sex of the household head, education of the spouse[11], whether the household head is a present member, the number of children between 0-5 years old, the number of children between 6 and 14 years old, and the number of adults (15 years old and older). Ten regional dummy variables are also included. In Tanzania, the *x* vector includes: age and sex of the household head, education of the spouse, household size, the share of children between 0-5 years old, the share of children between 6 and 14 years old, and regional 26 dummy variables.

When modeling the household decision on whether to consume a food group, it is recommended to have at least one additional variable that is not included in the *x* vector to facilitate identification, other than through non-linearity. Therefore, the *z* vector in equation 16 includes, in addition to the exogenous covariates included in the *x* vector, dummy variables indicating the month the interview was conducted. The rational for including these monthly dummies is that the availability and affordability of certain food items is expected to vary with the time of the year affecting household decision to consume a food item or not.

Elasticities are computed at sample variable means. First-stage elasticities are incorporated into second stage elasticities, such that food group expenditure and price elasticities presented are the unconditional ones. Having estimated a QUAIDS model, which allows elasticity estimates to differ in household expenditures, unconditional expenditure and uncompensated price elasticities are re-estimated at each wealth quintile mean expenditure level[12]. This allows us to obtain the responsiveness of food demand to changes in price and income for households of different wealth

[10] The models are estimated in Stata using the NLSUR commands. Startup values for alpha are set to a value just below the minimum value of ln m (Banks et al., 1997).
[11] Based on the assumption that women more frequently make the food purchases for the household.
[12] Variables other than household expenditures and food expenditures are computed at sample mean for each quintile to ensure that difference in elasticities are only attributed to change in household wealth status. For example, demographics, like household size, is expected vary by quintile, but quintile elasticities are computed at the sample mean of household size. This ensures that changes in demand between quintiles is only driving by changes in income and not by changes in income and changes in household characteristic that comes with different economic status.

status. These elasticities take into consideration how the first stage estimated parameters also vary by wealth quintiles.

5.5 Projecting demand growth

Using our estimates of unconditional expenditure elasticities and assumptions about population growth rate and per capita income growth rate, we estimate the growth rate of demand for bean in Uganda, and pulse in Tanzania in 2015, 2020, and 2025. Rural and urban population growth rate and their projections are obtained from the World Bank (these estimates are based on the UN Population Division's World Urbanization Prospects). Projected per capita GDP annual growth rates (proxy for per capita income growth rate) are obtained from the ERS International Macroeconomic Data sets. Growth rate in the demand for food item *i* for year *t* is computed using formula:

$$D_{it} = \eta_{it} y_t + p_t \tag{24}$$

where η_{it} represents the unconditional expenditure elasticity for food item *i*, i.e. either bean or pulse, in year *t*. For t=2015, we use the average expenditure elasticity we estimated. Since expenditure elasticity of demand for food normally decreases as income rises, we follow an approach like the one in Zhou and Staatz's (2016) to reflect the changing expenditure elasticity for food over time as income grows. The authors[13] used the food expenditure elasticities for the top quintile as average expenditure elasticities that would prevail in the country in 2040. Limiting our projections to 2025, we use the average expenditure elasticities for households in the fourth quintile as proxy for average expenditure elasticities in 2025. The expenditure elasticity of demand for food item *i* in 2020 is simply the average value between 2015 and 2025. y_t represents the expected growth rate in per capita income in year *t*. Since projected per capita GDP annual growth rates are not disaggregated by rural and urban areas, we make the simplistic assumption that economic growth is evenly distributed across population subgroups. Last, p_t is the projected population growth rate in year *t*. Growth rates in the demand for food are computed separately for

[13] Zhou and Staatz's (2016) also worked with the LSMS-ISA that were published in similar years to the data used in this study.

rural and urban areas, and then weighted by their respective population shares to obtain national estimates.

6. Econometric Analysis: Results

In this section, aggregate food and food groups demand elasticities are presented and discussed. All elasticities are computed at sample variable means and food group elasticities are unconditional, meaning that first-stage elasticities have been incorporated. Findings are presented for Uganda first. For each country, we start with a brief discussion on model specification and tests, then present expenditure and price elasticities, and finish with a discussion on variations in bean/pulse demand responsiveness by household sub-groups.

6.1 Uganda

Each budgeting stage and Probit models are estimated separately for rural and urban areas. For both rural and urban specification, the lambda coefficients of the QUAIDS are jointly significant supporting a quadratic specification over a linear one. Also, all demographic coefficients are jointly and individually significant in the QUAIDS models, meaning that food demand varies with household characteristics and over location[14].

6.1.1 Expenditure elasticities

Expenditure elasticity for food in Uganda is high; 0.96 in rural areas and 0.83 in urban areas (tables 7a-b). This means that a large share of additional income will be spent on food, reflecting a demand for improved diet, either in terms of quantity or quality, and likely greater convenience at higher income level. While large, these food expenditure elasticities are in line with previous studies in similar context (Ecker and Qaim, 2011; Boysen, 2016). Boysen (2016), who estimated a two-stage food demand system in Uganda using the 2012/2013 Uganda National Household Survey reported expenditure elasticities with respect to food of 0.94 and 0.81 in rural and urban areas.

[14] The joint significance of the lambda coefficients and demographic variable coefficients was tested using a Wald test. In all cases, the variables are jointly significant with a p-value of zero.

Table 7a: Rural households, Uganda: Expenditure and selected unconditional price elasticities for food and food groups

	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
1st Stage						
expenditure elas.	0.960***	1.029***	0.990***	0.961***	0.921***	0.836***
	(0.012)	(0.018)	(0.013)	(0.011)	(0.013)	(0.025)
Uncompensated price elas.	-0.978***	-0.980***	-0.979***	-0.979***	-0.978***	-0.975***
	(0.041)	(0.039)	(0.039)	(0.039)	(0.042)	(0.047)
2nd Stage						
Unconditional expenditure elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	0.927***	1.070***	0.978***	0.930***	0.865***	0.750***
	(0.050)	(0.060)	(0.051)	(0.047)	(0.046)	(0.061)
Group 2	0.818***	0.943***	0.865***	0.825***	0.757***	0.625***
	(0.032)	(0.033)	(0.032)	(0.031)	(0.033)	(0.041)
Group 3	1.071***	1.118***	1.083***	1.062***	1.061***	0.995***
	(0.056)	(0.060)	(0.051)	(0.051)	(0.065)	(0.073)
Group 4	0.813***	0.958***	0.872***	0.801***	0.769***	0.639***
	(0.074)	(0.087)	(0.071)	(0.080)	(0.064)	(0.078)
Group 5	0.677***	0.702***	0.690***	0.659***	0.654***	0.618***
	(0.053)	(0.058)	(0.054)	(0.056)	(0.054)	(0.051)
Group 6	1.177***	1.499***	1.228***	1.173***	1.085***	0.971***
	(0.038)	(0.065)	(0.038)	(0.037)	(0.036)	(0.043)
Group 7	0.982***	1.127***	1.040***	0.983***	0.919***	0.824***
	(0.072)	(0.090)	(0.089)	(0.071)	(0.062)	(0.061)
Group 8	1.285***	0.928***	1.339***	1.386***	1.440***	1.110***
	(0.088)	(0.135)	(0.135)	(0.114)	(0.105)	(0.061)
Unconditional own-price elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.801***	-0.833***	-0.813***	-0.816***	-0.804***	-0.728***
	(0.043)	(0.040)	(0.041)	(0.040)	(0.041)	(0.056)
Group 2	-0.896***	-0.929***	-0.908***	-0.901***	-0.881***	-0.842***
	(0.029)	(0.025)	(0.027)	(0.028)	(0.031)	(0.041)
Group 3	-0.780***	-0.823***	-0.817***	-0.800***	-0.720***	-0.654***
	(0.064)	(0.051)	(0.053)	(0.058)	(0.082)	(0.102)
Group 4	-0.850***	-0.858***	-0.864***	-0.838***	-0.864***	-0.821***
	(0.047)	(0.047)	(0.043)	(0.051)	(0.042)	(0.055)
Group 5	-0.699***	-0.735***	-0.709***	-0.680***	-0.673***	-0.687***
	(0.048)	(0.041)	(0.046)	(0.051)	(0.053)	(0.050)
Group 6	-0.978***	-0.989***	-0.982***	-0.978***	-0.974***	-0.975***
	(0.037)	(0.053)	(0.036)	(0.036)	(0.035)	(0.037)
Group 7	-0.666***	-0.662***	-0.610***	-0.672***	-0.693***	-0.684***
	(0.081)	(0.085)	(0.096)	(0.080)	(0.073)	(0.075)
Group 8	-0.794***	-0.724***	-0.674***	-0.730***	-0.778***	-0.911***
	(0.048)	(0.071)	(0.073)	(0.061)	(0.054)	(0.032)

Cross-price elasticities w.r.t. Group 3						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.031	-0.028	-0.029	-0.028	-0.029	-0.039
	(0.031)	(0.029)	(0.030)	(0.028)	(0.029)	(0.039)
Group 2	-0.008	-0.006	-0.007	-0.007	-0.009	-0.012
	(0.015)	(0.012)	(0.014)	(0.015)	(0.016)	(0.022)
Group 4	-0.123***	-0.122***	-0.112***	-0.132***	-0.109***	-0.142***
	(0.047)	(0.047)	(0.043)	(0.051)	(0.042)	(0.055)
Group 5	-0.030	-0.024	-0.028	-0.032	-0.034	-0.034
	(0.038)	(0.033)	(0.037)	(0.041)	(0.042)	(0.040)
Group 6	0.041*	0.060*	0.039*	0.040*	0.037*	0.036*
	(0.022)	(0.032)	(0.021)	(0.022)	(0.020)	(0.020)
Group 7	-0.128**	-0.135**	-0.151**	-0.126**	-0.116**	-0.120**
	(0.064)	(0.068)	(0.076)	(0.063)	(0.058)	(0.059)
Group 8	-0.044	-0.051	-0.063	-0.056	-0.056	-0.032
	(0.034)	(0.049)	(0.052)	(0.043)	(0.038)	(0.020)

Note: Group numbers denote 1) Cereals, 2) Starches, 3) Beans, 4) Other pulses, seeds, and nuts, 5) Fruits and vegetables, 6) Meat, fish, and dairy products, 7) Oil, fat, spice, and sugar, 8) Beverages and FAFH

Table 7b: Urban households, Uganda: Expenditure and selected unconditional price elasticities for food and food groups

1st Stage						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
expenditure elas.	0.828***	0.899***	0.850***	0.842***	0.782***	0.715***
	(0.035)	(0.048)	(0.040)	(0.032)	(0.042)	(0.068)
Uncompensated price elas.	-0.912***	-0.927***	-0.913***	-0.919***	-0.901***	-0.889***
	(0.129)	(0.107)	(0.127)	(0.119)	(0.145)	(0.162)
2nd Stage						
Unconditional expenditure elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	1.078***	1.104***	1.080***	1.126***	1.038***	1.024***
	(0.087)	(0.084)	(0.084)	(0.094)	(0.095)	(0.137)
Group 2	0.895***	0.933***	0.899***	0.913***	0.850***	0.822***
	(0.084)	(0.084)	(0.078)	(0.088)	(0.086)	(0.122)
Group 3	0.689***	0.787***	0.711***	0.696***	0.651***	0.503***
	(0.082)	(0.075)	(0.083)	(0.085)	(0.080)	(0.128)
Group 4	0.445***	0.634***	0.159	0.399***	0.300**	0.321***
	(0.109)	(0.083)	(0.191)	(0.125)	(0.136)	(0.120)
Group 5	0.866***	0.900***	0.876***	0.876***	0.822***	0.767***
	(0.100)	(0.108)	(0.108)	(0.091)	(0.105)	(0.108)
Group 6	0.946***	1.165***	1.018***	0.974***	0.889***	0.765***
	(0.079)	(0.116)	(0.092)	(0.084)	(0.079)	(0.088)

Group 7	0.957***	1.124***	0.945***	0.965***	0.913***	0.828***
	(0.107)	(0.186)	(0.085)	(0.102)	(0.111)	(0.117)
Group 8	0.425**	-0.067	0.237	0.524***	0.436***	0.466***
	(0.190)	(0.410)	(0.276)	(0.151)	(0.165)	(0.134)
Unconditional own-price elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-1.212***	-1.150***	-1.187***	-1.236***	-1.232***	-1.314***
	(0.139)	(0.105)	(0.126)	(0.151)	(0.151)	(0.198)
Group 2	-1.061***	-1.036***	-1.044***	-1.066***	-1.065***	-1.109***
	(0.124)	(0.097)	(0.106)	(0.129)	(0.134)	(0.187)
Group 3	-0.646***	-0.741***	-0.659***	-0.636***	-0.646***	-0.377
	(0.146)	(0.106)	(0.141)	(0.151)	(0.146)	(0.260)
Group 4	-0.878***	-0.925***	-0.808***	-0.866***	-0.843***	-0.844***
	(0.137)	(0.072)	(0.226)	(0.155)	(0.184)	(0.183)
Group 5	-0.773***	-0.790***	-0.766***	-0.795***	-0.750***	-0.761***
	(0.086)	(0.081)	(0.089)	(0.078)	(0.095)	(0.089)
Group 6	-0.979***	-1.007***	-0.990***	-0.980***	-0.977***	-0.957***
	(0.108)	(0.125)	(0.117)	(0.115)	(0.109)	(0.101)
Group 7	-0.801***	-0.687***	-0.854***	-0.814***	-0.788***	-0.797***
	(0.151)	(0.242)	(0.107)	(0.141)	(0.162)	(0.155)
Group 8	-0.979***	-0.979***	-0.985***	-0.972***	-0.972***	-0.964***
	(0.163)	(0.325)	(0.231)	(0.127)	(0.148)	(0.125)
Cross-price elasticities w.r.t. Group 3						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.130**	-0.092**	-0.114**	-0.148**	-0.139**	-0.195**
	(0.053)	(0.039)	(0.047)	(0.059)	(0.058)	(0.076)
Group 2	0.019	0.018	0.018	0.018	0.021	0.020
	(0.041)	(0.033)	(0.035)	(0.043)	(0.044)	(0.061)
Group 4	0.082	0.051	0.130	0.091	0.107	0.103
	(0.099)	(0.053)	(0.162)	(0.112)	(0.132)	(0.131)
Group 5	-0.037	-0.032	-0.038	-0.033	-0.040	-0.041
	(0.071)	(0.068)	(0.074)	(0.064)	(0.079)	(0.074)
Group 6	-0.109**	-0.137**	-0.122**	-0.120**	-0.104**	-0.089**
	(0.051)	(0.060)	(0.056)	(0.055)	(0.050)	(0.042)
Group 7	0.147*	0.228*	0.108*	0.137*	0.159*	0.149*
	(0.079)	(0.126)	(0.056)	(0.074)	(0.085)	(0.081)
Group 8	0.076**	0.144**	0.105**	0.061**	0.071**	0.059**
	(0.033)	(0.065)	(0.047)	(0.026)	(0.030)	(0.025)

Note: Group numbers denote 1) Cereals, 2) Starches, 3) Beans, 4) Other pulses, seeds, and nuts, 5) Fruits and vegetables, 6) Meat, fish, and dairy products, 7) Oil, fat, spice, and sugar, 8) Beverages and FAFH

Food group expenditure elasticities in rural areas is the lowest for fruits & vegetables (0.68) and the largest for beverages & FAFH (1.29). In urban areas, expenditure elasticities of the eight food groups range from 0.45 for Peas, nuts, & seeds to 1.08 for Cereals. This indicates that all food groups are normal goods. Items considered luxuries among rural households are bean, meat, fish & dairy products, and beverages & food away from home. The proportional increase in quantity demanded for luxury items will be greater than the increase in income. In rural areas, a 10% increase in household expenditures (our proxy for income) will increase quantity demanded for meat products, fish & dairy products by 11.8%. The magnitude of these estimates is consistent with the current low consumption level of animal source of food in Uganda, and in particular among rural poor households. Only cereal is considered a luxury food item in urban areas. Comparing consumption patterns of the different cereal products between the poorest and best-off urban households suggests that as income grows, demand for rice and bread will increase quickly in urban Uganda. Only 6% and 9% of the poorest urban households consume rice and bread on a weekly basis compared to 63% and 53% of households in the best-off wealth quintile.

6.1.2 Price elasticities

The unconditional uncompensated own-price elasticities of food and food groups reveal that demand for food in Uganda is highly responsive to price changes (tables 7a-b). The uncompensated own-price elasticity of food (first stage) is, in absolute value, 0.98 in rural areas and 0.91 in urban areas.

In rural areas, demand for meat, fish & dairy products is the most price-responsive, with absolute own-price elasticity of 0.98. This high value is not surprising given that animal and fish source products are considered luxuries among rural households. Own-price elasticity for bean in rural Uganda, in absolute values, is 0.78. Only demand for vegetables & fruits, and demand for condiments are less price responsive than demand for bean, indicating that rural households have strong preferences for bean and also because they have limited options.

In urban areas, demand for cereal products is the most responsive to change in its own-price. In fact, demand for cereal products is elastic in urban areas, meaning that quantity demanded will decrease proportionally more than the increase in its own price. The dominantly consumed cereal products in urban areas are maize flour, rice, and bread, consumed by 70%, 40%, and 31% of households respectively over a seven-day period. While maize flour is also frequently consumed in rural areas, only 23% and 16% of rural households consume rice and break, respectively, on a weekly basis. Compared to other food groups, demand for bean among urban households is the least sensitive to price changes. Own-price elasticity for bean, in absolute values, is 0 0.646 in urban areas.

6.1.3 Bean demand by household economic status

The remaining discussion focuses on bean demand and how it varies depending on household location and wealth. Since the unconditional elasticities take into consideration how the first stage elasticities vary within wealth quintile, we first present aggregate food expenditure and own price elasticities by income groups. Aggregate food expenditure elasticity differs significantly according to household economic status, averaging 1.029 (0.899) for rural (urban) households in the poorest wealth quintile compared with 0.836 (0.715) for the better-off 20 percent in rural (urban) areas (tables 7a and 7b). This is consistent with the Engel's law that states that as income increases, the share of income spent on food decreases. Like the case for expenditure elasticity, the own price elasticity of aggregate food demand is higher, in absolute value, in rural than urban areas and among the poorest households. However, the deference in the point estimates between households in the first and fifth quintile is much smaller for own price elasticity than expenditure elasticity, reflecting the low substitutability between food and non-food commodities.

Demand for bean is expected to grow considerably as income raises in rural areas. Bean is considered a luxury good for rural households in the first, second, third, and fourth wealth quintiles. More precisely, the expenditure elasticity for bean ranges from a high of 1.12 for rural households in the poorest wealth quintile to 0.99 from those in the wealthiest quintile (tables 7a and 7b). A 10% increase in household expenditures among the poorest 20% of the income distribution would increase demand for bean by 11.2%. Anticipated increase in demand for bean because of income growth is more modest in urban areas; bean expenditure elasticity ranges from 0.79 among the poorest urban households to 0.50 for those in the fifth quintile. This means that demand for bean among urban households will increase in absolute value as income grows but its relative importance will decrease. Boysen (2016) estimated the unconditional expenditure elasticities for legume[15] to be 0.70 (0.80) for urban (rural) households in the poorest quintile compared to 0.26 (0.61) for those in the fifth quintile. Compared to Boysen (2016), our estimates

[15] The food expenditure questionnaire includes two legumes: bean and pea, and according to the 2012 data, bean represents about 90% of the legume expenditure.

are higher among rural households and the poorest in urban areas which could be due to differences in methodology[16] and as well as the reference period.

Comparing bean expenditure elasticities by place of residence (urban/rural) and economic status suggest that urbanization has induced changes in food preferences. The expenditure elasticity for bean among urban households in the poorest wealth quintile is smaller than rural households in any wealth quintile. However, urban households in the first quintile are poorer than rural households in the third, fourth and fifth quintiles, as indicated by per capita household expenditure (tables 1a and 1b). In fact, urban households in the first quintile have on average similar per capita expenditure level to rural households in the second wealth quintile. However, an increase in income will generate a smaller demand response for bean among urban households compared with rural households of similar wealth status. Yet, poor urban households have on average a high number of children under five years of age, who are most vulnerable to malnutrition and would benefit from greater consumption of nutrient dense foods such as bean.

Demand for bean is more responsive to changes in its own price in rural than urban areas, and this is true for all wealth quintiles. In addition, in urban areas, there is a greater difference in the responsiveness of demand to price change between households in the worst-off and better-off quintiles than in rural areas (tables 7a-7b). A one percent increase in the price of bean would decrease the quantity demanded by 0.74% among the poorest urban households while the coefficient is insignificant among those at the top of the wealth distribution. In rural areas, bean own-price elasticity, in absolute value, ranges from 0.823 for the poorest households to 0.654 for those in the wealthiest quintiles. Boysen (2016) reported own-price elasticities for legumes by wealth quintiles that range between -0.80 and -0.70 for rural households and between -0.86 and -0.73 for urban households. Our results are consistent with Boysen (2016) in rural areas but we find greater variations in own-price elasticities across households of different economic status in urban areas than did Boysen.

Poor households in Uganda rely heavily on bean to meet their nutritional needs, as indicated by the large share of their food budget devoted to bean (table 3). Therefore, food security among poor households could be threaten because of higher bean prices. While higher prices for

[16] In Boysen (2016), the demographic variables only shift the intercept in the QUAIDS. He also uses a different approach to address price endogeneity.

bean will result in smaller quantity consumed among households of all economic status, in both rural and urban areas, the net nutritional effect of an increase in the price of bean will depend on the substitutability and complementarity between bean and the other food groups. Cross-price elasticities provide the answer by indicating the changes in the quantity demanded for other food groups due to a one percent increase in the price of bean. In rural areas, peas, nuts & seeds and condiments are considered complements to bean while meat products are substitutes. In urban areas, cereals and meat products are complements to bean while condiments and beverages & FAFH are considered substitutes to bean. The other cross-price elasticities with respect to the price of bean are insignificant.

6.2 Tanzania

As for Uganda, all the models are estimated separately for rural and urban households. The Wald test for the joint significance of the lambda coefficients has a p-value of zero in both rural and urban models indicating that the quadratic specification is superior to the linear one. Also, all demographic coefficients are jointly significant in explaining food expenditure patterns in rural and urban areas, and all demographic variables are individually significant at the exception of the share of children between 6 and 15 years old in the food group demand system for rural areas. These findings indicate that household characteristics and location play a significant role in explaining responsiveness of food demand to prices and incomes.

6.2.1 Expenditure elasticities

Aggregate food expenditure elasticity is also high in Tanzania, but not as high has in Uganda. Like in Uganda, the aggregate food expenditure elasticity is higher in rural areas (0.82) than urban areas (0.70) (tables 8a-b). At the exception of vegetables and fruits, food group expenditure elasticities are also larger in rural areas than urban areas. Pulse and meat products are luxury goods for rural households in Tanzania. This result is interpreted to mean that a 10% increase in income among rural households will increase quantity demanded for pulse by 11.24% and meat products, fish & dairy products by 10.13%. Expenditure elasticity for other food groups among rural households ranges between 0.477 for fruits and vegetables and 0.93 for nuts and seeds. In urban areas, expenditure elasticity is the smallest for pulse (0.539) and the largest for meat products (0.888), indicating that all food groups are necessities.

Table 8a: Rural households, Tanzania: Expenditure and selected unconditional price elasticities for food and food groups

1st Stage						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
expenditure elas.	0.816***	0.937***	0.870***	0.821***	0.760***	0.597***
	(0.010)	(0.013)	(0.009)	(0.009)	(0.012)	(0.024)
Uncompensated price elas.	-0.965***	-0.968***	-0.968***	-0.966***	-0.964***	-0.956***
	(0.034)	(0.030)	(0.031)	(0.033)	(0.035)	(0.042)
2nd Stage						
Unconditional expenditure elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	0.782***	0.897***	0.835***	0.788***	0.728***	0.568***
	(0.016)	(0.020)	(0.016)	(0.016)	(0.017)	(0.026)
Group 2	0.843***	0.973***	0.901***	0.846***	0.782***	0.616***
	(0.024)	(0.025)	(0.025)	(0.024)	(0.025)	(0.031)
Group 3	1.124***	1.249***	1.163***	1.128***	1.057***	0.896***
	(0.038)	(0.040)	(0.036)	(0.038)	(0.039)	(0.051)
Group 4	0.930***	1.041***	0.986***	0.934***	0.863***	0.707***
	(0.035)	(0.039)	(0.037)	(0.034)	(0.031)	(0.041)
Group 5	0.477***	0.505***	0.489***	0.482***	0.447***	0.367***
	(0.052)	(0.064)	(0.058)	(0.052)	(0.049)	(0.040)
Group 6	1.013***	1.292***	1.112***	1.031***	0.925***	0.700***
	(0.033)	(0.058)	(0.040)	(0.035)	(0.031)	(0.034)
Group 7	0.785***	0.879***	0.831***	0.790***	0.738***	0.580***
	(0.035)	(0.055)	(0.042)	(0.035)	(0.027)	(0.028)
Group 8	0.621***	0.742***	0.612***	0.583***	0.586***	0.476***
	(0.126)	(0.124)	(0.166)	(0.153)	(0.113)	(0.082)
Unconditional own-price elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.976***	-0.977***	-0.978***	-0.977***	-0.976***	-0.972***
	(0.028)	(0.025)	(0.026)	(0.028)	(0.030)	(0.035)
Group 2	-0.923***	-0.951***	-0.930***	-0.922***	-0.908***	-0.890***
	(0.035)	(0.024)	(0.033)	(0.035)	(0.041)	(0.048)
Group 3	-1.176***	-1.140***	-1.152***	-1.175***	-1.190***	-1.250***
	(0.078)	(0.060)	(0.067)	(0.078)	(0.085)	(0.109)
Group 4	-0.880***	-0.901***	-0.884***	-0.882***	-0.885***	-0.845***
	(0.052)	(0.042)	(0.049)	(0.051)	(0.049)	(0.067)
Group 5	-0.489***	-0.553***	-0.494***	-0.483***	-0.450***	-0.469***
	(0.060)	(0.058)	(0.061)	(0.061)	(0.063)	(0.060)
Group 6	-1.089***	-1.142***	-1.100***	-1.093***	-1.080***	-1.071***
	(0.047)	(0.065)	(0.052)	(0.050)	(0.044)	(0.038)
Group 7	-0.500***	-0.436***	-0.464***	-0.491***	-0.556***	-0.535***
	(0.103)	(0.116)	(0.111)	(0.105)	(0.092)	(0.096)

Group 8	-1.023***	-1.019***	-1.029***	-1.029***	-1.022***	-1.018***
	(0.185)	(0.135)	(0.220)	(0.227)	(0.189)	(0.170)

Cross-price elasticities w.r.t. Group 3

	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.019	-0.012	-0.015	-0.018	-0.022	-0.028
	(0.014)	(0.012)	(0.013)	(0.014)	(0.015)	(0.017)
Group 2	0.017	0.010	0.016	0.017	0.021	0.022
	(0.023)	(0.016)	(0.021)	(0.023)	(0.027)	(0.032)
Group 4	0.068	0.059	0.068	0.068	0.063	0.083
	(0.044)	(0.036)	(0.042)	(0.043)	(0.042)	(0.057)
Group 5	-0.030	-0.012	-0.026	-0.031	-0.038	-0.040
	(0.034)	(0.033)	(0.035)	(0.035)	(0.036)	(0.034)
Group 6	0.029	0.036	0.034	0.033	0.028	0.015
	(0.024)	(0.032)	(0.027)	(0.026)	(0.023)	(0.019)
Group 7	-0.048	-0.046	-0.048	-0.049	-0.046	-0.053
	(0.055)	(0.062)	(0.059)	(0.056)	(0.049)	(0.051)
Group 8	0.210*	0.160*	0.254*	0.259*	0.211	0.184
	(0.127)	(0.094)	(0.151)	(0.156)	(0.129)	(0.116)

Note: Group numbers denote 1) Cereals, 2) Starches, 3) Pulses, 4) Seeds, and nuts, 5) Fruits and vegetables, 6) Meat, fish, and dairy products, 7) Oil, fat, spice, and sugar, 8) Beverages

Table 8b: Urban households, Tanzania: Expenditure and selected unconditional price elasticities for food and food groups

1st Stage

	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
expenditure elas.	0.701***	0.794***	0.745***	0.690***	0.642***	0.513***
	(0.020)	(0.027)	(0.022)	(0.020)	(0.022)	(0.043)
Uncompensated price elas.	-0.614***	-0.720***	-0.665***	-0.602***	-0.549***	-0.406
	(0.160)	(0.116)	(0.139)	(0.165)	(0.187)	(0.247)

2nd Stage

Unconditional expenditure elasticity

	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	0.632***	0.737***	0.679***	0.627***	0.570***	0.451***
	(0.026)	(0.031)	(0.027)	(0.025)	(0.028)	(0.042)
Group 2	0.714***	0.825***	0.764***	0.703***	0.653***	0.532***
	(0.031)	(0.035)	(0.032)	(0.033)	(0.030)	(0.049)
Group 3	0.539***	0.655***	0.614***	0.526***	0.460***	0.329***
	(0.040)	(0.038)	(0.034)	(0.041)	(0.045)	(0.050)
Group 4	0.605***	0.672***	0.655***	0.595***	0.558***	0.421***
	(0.043)	(0.052)	(0.040)	(0.043)	(0.040)	(0.051)
Group 5	0.689***	0.818***	0.742***	0.677***	0.631***	0.512***
	(0.038)	(0.048)	(0.041)	(0.038)	(0.036)	(0.050)

Group 6	0.888***	1.059***	0.973***	0.888***	0.798***	0.616***
	(0.037)	(0.051)	(0.042)	(0.038)	(0.036)	(0.055)
Group 7	0.704***	0.777***	0.742***	0.695***	0.646***	0.511***
	(0.033)	(0.046)	(0.036)	(0.032)	(0.030)	(0.044)
Group 8	0.580***	0.283	0.487**	0.524***	0.559***	0.453***
	(0.115)	(0.304)	(0.204)	(0.168)	(0.084)	(0.058)
Unconditional own-price elasticity						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	-0.798***	-0.828***	-0.812***	-0.787***	-0.788***	-0.761***
	(0.082)	(0.071)	(0.077)	(0.082)	(0.090)	(0.101)
Group 2	-0.890***	-0.912***	-0.897***	-0.882***	-0.888***	-0.857***
	(0.085)	(0.067)	(0.080)	(0.094)	(0.082)	(0.114)
Group 3	-0.646***	-0.712***	-0.720***	-0.637***	-0.572***	-0.452*
	(0.165)	(0.134)	(0.128)	(0.169)	(0.202)	(0.262)
Group 4	-0.929***	-0.934***	-0.938***	-0.927***	-0.928***	-0.912***
	(0.100)	(0.098)	(0.084)	(0.102)	(0.097)	(0.125)
Group 5	-0.422***	-0.423***	-0.415***	-0.414***	-0.442***	-0.422***
	(0.125)	(0.133)	(0.130)	(0.127)	(0.119)	(0.122)
Group 6	-0.919***	-0.959***	-0.942***	-0.920***	-0.889***	-0.811***
	(0.079)	(0.080)	(0.079)	(0.082)	(0.087)	(0.113)
Group 7	-0.632***	-0.626***	-0.646***	-0.632***	-0.634***	-0.612***
	(0.222)	(0.236)	(0.216)	(0.221)	(0.216)	(0.224)
Group 8	-2.285***	-3.650***	-3.087***	-2.920***	-2.013***	-1.668***
	(0.262)	(0.537)	(0.423)	(0.389)	(0.209)	(0.144)
Cross-price elasticities w.r.t. Group 3						
	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Group 1	0.019	0.017	0.022	0.020	0.018	0.017
	(0.022)	(0.018)	(0.021)	(0.020)	(0.025)	(0.027)
Group 2	-0.004	-0.002	0.000	-0.005	-0.004	-0.015
	(0.068)	(0.054)	(0.064)	(0.075)	(0.065)	(0.091)
Group 4	-0.031	-0.031	-0.020	-0.031	-0.030	-0.045
	(0.099)	(0.097)	(0.083)	(0.101)	(0.096)	(0.123)
Group 5	-0.047	-0.056	-0.048	-0.047	-0.043	-0.046
	(0.059)	(0.063)	(0.062)	(0.060)	(0.055)	(0.056)
Group 6	-0.021	-0.036	-0.024	-0.022	-0.018	-0.014
	(0.028)	(0.036)	(0.033)	(0.029)	(0.025)	(0.021)
Group 7	0.194***	0.205***	0.192***	0.194***	0.188***	0.192***
	(0.068)	(0.072)	(0.066)	(0.067)	(0.066)	(0.068)
Group 8	-0.270	-0.566	-0.444	-0.410	-0.212	-0.139
	(0.175)	(0.358)	(0.283)	(0.260)	(0.139)	(0.095)

Note: Group numbers denote 1) Cereals, 2) Starches, 3) Pulses, 4) Seeds, and nuts, 5) Fruits and vegetables, 6) Meat, fish, and dairy products, 7) Oil, fat, spice, and sugar, 8) Beverages

6.2.2 Price elasticities

Own-price elasticities for aggregate food and food groups indicate that demand for food responds more strongly to price changes in rural than urban Tanzania, which is consistent with the lower wealth status among rural households. The own-price elasticity for aggregate food (first stage), in absolute value, is 0.965 in rural areas compared to 0.614 in urban areas (tables 8a-b). In rural Tanzania, demand for pulse, meat, fish & dairy products, and beverages is elastic, meaning that a change in price will result in a proportionally greater change in quantity demanded. Own-price elasticity is the smallest for vegetables and fruits (0.489), followed by condiments (0.500) in rural areas. In urban areas, demand for beverages is extremely elastic with an own-price elasticity of 2.285; all other food groups have inelastic demand, with own-price elasticities ranging from 0.422 for vegetables and fruits to 0.929 for nuts and seeds. As for pulse, own-price elasticity, in absolute values, is 1.176 in rural Tanzania and 0.646 in urban areas.

6.2.3 Pulse demand by household economic status

As for Uganda, the remaining discussion focuses on how pulse demand varies with household economic-status and between rural and urban areas. Before discussing the responsiveness of pulse demand to price and income changes, it is worth mentioning the price and expenditure elasticities of demand for aggregate food by wealth quintiles since these first-stage estimates influence second-stage estimates. Aggregate food expenditure elasticity varies greatly between wealth quintiles in both rural and urban areas; it is 0.937 (0.794) for rural (urban) households in the poorest wealth quintile compared with 0.597 (0.513) for the better-off 20 percent in rural (urban) areas (tables 8a-b). These findings are strongly consistent with the Engel's law; as income increases, the proportion of income spent on food decreases. The wealthiest rural households will spend about 60% of additional income on food compared to about 90% among the poorest rural households. Own-price elasticity of food also decreases in household wealth, but to a much smaller extend than expenditure elasticity. Own-price elasticity of demand for aggregate food ranges from 0.968 to 0.956 (0.720 to 0.406) between the first and fifth wealth quintile in rural (urban) areas.

Income growth among rural households in Tanzania is expected to have a strong impact of pulse demand. Pulse is considered a luxury good for rural households in the first, second, third, and fourth wealth quintiles (table 8a). More precisely, the expenditure elasticity for pulse goes from 1.249 for rural households in the poorest wealth quintile to 0.896 from those in the wealthiest quintile. A 10% increase in the income of the poorest households, i.e. those at the bottom 20% of the income distribution, would increase the quantity demanded for pulse by 12.5%. Demand for pulse is expected to growth more modestly in urban areas as households get wealthier; the expenditure elasticity for pulse ranges from 0.329 among urban households in the fifth quintile to 0.655 for those in the worst-off quintile (table 8b).

Demand for pulse in rural Tanzania is much more responsive to change in its own price than in urban Tanzania. Own-price elasticity for pulse averages 1.176, in absolute value, in rural areas and increases slightly from the first to the fifth wealth quintiles (tables 8a). While the elasticity estimates are not statistically different between quintiles, the trend is contrarily to expectation which could reflect that poorer households consume a greater share o pulse that is from own production (about 48% compared to 29% for the best-off 20%), making them less sensitive to price changes. This is because it takes longer to adjust to price changes when the food is produced compared to when it is purchased. In urban areas, the pulse demand is more responsiveness to price change among poor households. The own-price elasticity for pulse in urban Tanzania is 0.712 for households in the poorest wealth quintile compared to 0.452 for those in the wealthiest quintile (tables 8b).

In rural Tanzania, pulse and beverages are considered substitutes; however, the cross-price elasticity between these groups is only significant at the 10 percent for the rural sample and households in the first, second, and third wealth quintile (tables 8a). In urban areas, and for all wealth quintiles, pulse and condiments are considered substitutes (table 8b). All other cross-price elasticities with respect to the price of pulse are insignificant.

6.3 Price volatility and pulse consumption

Pulse consumption plays an essential role in the food and nutrition security of poor households as indicated by the magnitude the food budget share devoted to pulses. In rural Uganda, the poorest devotes about 11% of the food budget to beans while rural households at the bottom of the wealth distribution in Tanzania spend on average 7% of the food budget on pulses. Therefore, food security among poor households could be threaten by pulse price volatility. To investigate the impact of higher pulse price, for example due to production shocks or greater demand in neighboring countries, on household pulse consumption, we consider the implication of a 20% increase in the price of bean on actual quantity consumed and then corresponding calorie and protein intakes in Uganda. For Tanzania, we can also estimate the change in pulse quantity consumed as a result of a 20% increase in the price of pulse. The resulting changes in calorie and protein intakes depend on the types of pulse consumed, and do not have this information. The predicted change in quantity demanded is obtained using consumption data[17] and own price elasticities of demand for rural and urban of the different wealth quintiles. Calories and protein compositions are derived from the conversion factors of the World Food Dietary Assessment System (FAO, 2010).

6.3.1 Uganda

Among rural (urban) households in the poorest wealth quintile, current bean consumption is estimated to 52 (51) grams per day per capita (table 9). For these rural (urban) households, bean provides 11.9% (10.3%) and 26.2% (24.6%) of the daily calorie and protein intakes respectively. While per bean capita consumption tends to increase with household wealth, the relative contribution of bean to calorie and protein intakes decreases. For rural (urban) households in the fifth wealth quintile, bean consumption represents 8.2% (7.1%) and 18.4% (15.6%) of the daily calorie and protein intakes.

Table 9: Bean consumption in terms of quantity and share of calories and protein intakes, per capita, per day, by wealth quintiles, Rural and Urban Uganda

	Quantity g/day/per capita	Calories/day/ per capita	Calories share in diet	Protein g/day/per capita	Protein share in diet
Quintile 1	51.9	157.3	11.9%	10.41	26.2%
Quintile 2	65.0	200.0	11.6%	13.23	25.4%
Quintile 3	81.2	240.2	11.2%	15.89	25.9%
Quintile 4	77.7	232.6	8.7%	15.39	21.3%
Quintile 5	89.2	261.4	8.2%	17.28	18.4%
Total Rural	73.0	218.3	10.3%	14.44	23.5%
Quintile 1	51.5	164.1	11.2%	10.87	24.6%
Quintile 2	65.9	208.3	11.2%	13.79	26.2%
Quintile 3	65.9	205.7	9.6%	13.61	22.4%
Quintile 4	86.0	268.9	11.5%	17.80	25.0%
Quintile 5	75.0	238.1	7.1%	15.76	15.6%
Total Urban	68.8	216.7	10.1%	14.35	22.8%

[17] All local units used to indicate quantity consumed were transformed into kg. Fresh food items were also converted into dry equivalent and adjusted for edible portion.

Assuming a 20% increase the price of bean, the quantity of bean consumed would decrease by 16.5% among the poorest households in rural areas (table 10). This corresponds to an average reduction in the quantity of bean consumed of 8.5 grams per capita per day, resulting in a reduction of 26 calories and 1.7 grams of proteins intakes per capita per day. Given that rural households in the poorest quintile consume on average 35.2 grams of proteins per capita per day, this represents a protein intakes loss of about 5%, which could have negative repercussion on health and productivity.

Table 10: Change in bean quantity consumed and calories and protein intakes for an 20% increase in bean price, Rural and Urban Uganda

	% Δ in quantity consumed	Δ quantity g/day/per capita	Δ calories/day/per capita	Δ protein g/day/per capita
Quintile 1	-16.5%	-8.54	-25.90	-1.71
Quintile 2	-16.3%	-10.62	-32.67	-2.16
Quintile 3	-16.0%	-12.99	-38.44	-2.54
Quintile 4	-14.4%	-11.19	-33.50	-2.22
Quintile 5	-12.9%	-11.67	-34.19	-2.26
Total Rural	-15.6%	-11.01	-32.98	-2.18
Quintile 1	-14.8%	-7.63	-24.32	-1.61
Quintile 2	-13.2%	-8.68	-27.45	-1.82
Quintile 3	-12.7%	-8.39	-26.16	-1.73
Quintile 4	-12.9%	-11.11	-34.74	-2.30
Quintile 5	-7.5%	-5.65	-17.95	-1.19
Total Urban	-12.9%	-8.31	-26.17	-1.73

However, to get the net nutritional effect of an increase in the price of bean, one would have to consider how households substitute away from beans. Cross-price elasticities suggest limited substitution effects between beans and other food groups in Uganda (meat products at the 10% in rural areas, and beverage and FAFH at the 5% in urban areas).

6.3.2 Tanzania

In Tanzania, pulse consumption is estimated at about 27 and 69 grams per day per capita among rural households in the first and fifth wealth quintiles (table 11). In urban Tanzania, the consumption gap between the poorest and richest is smaller; pulse consumption averages 34 grams per day per capita for the poorest compared to 49 grams for the best-off.

While quantity of pulses consumed is smaller in Tanzania than Uganda, the own-price elasticity for pulse is larger in rural Tanzania than rural Uganda. Consequently, a 20% increase in the price of pulse would result in larger relative adjustments in quantity consumed. Pulse consumption would decrease by more than 20% as a result of a 20% increase in pulse price among rural households of all wealth quintiles in Tanzania (table 11). This corresponds to a reduction in the quantity of pulse consumed of about 6 grams per day per capita for households in the poorest quintile compared to 17 grams for those in the fifth quintile. These high own-price elasticities mean that the absolute reductions in the quantity consumed as a result of an increase in the price of pulse would be larger among rural households in the fourth and fifth quintiles compared to the same of groups of households in Uganda, despite that Tanzanian households have lower level of pulse consumption.

Table 11: Current and change in pulse quantity consumed for an 20% increase in pulse price, Rural and Urban Tanzania

	Current pulse consumption g/day/per capita	Δ % quantity consumed	Δ quantity g/day/per capita
Quintile 1	26.8	-22.8%	-6.10
Quintile 2	39.0	-23.0%	-8.99
Quintile 3	46.4	-23.5%	-10.90
Quintile 4	60.6	-23.8%	-14.41
Quintile 5	68.7	-25.0%	-17.19
Total Rural	48.3	-23.5%	-11.35
Quintile 1	33.5	-14.2%	-4.77
Quintile 2	47.4	-14.4%	-6.82
Quintile 3	41.0	-12.7%	-5.22
Quintile 4	43.7	-11.4%	-5.00
Quintile 5	48.9	-9.0%	-4.42
Total Urban	42.9	-12.9%	-5.54

The own-price elasticity for pulse in urban Tanzania is lower, in absolute value, than in rural areas, decreases with wealth, and is of similar magnitude to the own-price elasticity for bean in urban Uganda. Therefore, the percentage change in quantity consumed for pulse due to a 20% increase in its price is similar between urban Tanzania and urban Uganda. Quantity consumed would decrease by about 14% among the poorest urban households if the price of pulse were to increase by 20% compared to 9% for the best-off. This corresponds to a reduction in the quantity of pulse consumed varying between 4 to 7 grams per day per capita, depending on wealth quintile of the household.

7. Demand growth for bean in Uganda and pulse in Tanzania

7.1. Projected growth rates

While the expenditure elasticity of bean is higher in rural than urban Uganda, the growth rate in future demand for bean is expected to be higher in urban areas, due to high urban population growth rate, which is projected to be above 5% until 2025 (table 12). Therefore, demand for bean in urban areas is expected to grow at 6.8% in 2015 and slowly going down to 6.5% in 2025. In rural areas, the demand for bean is projected to grow at a rate of about 4.6% in 2020 and 4.5% in 2025. These figures are based on the assumption of an evenly distributed economic growth; however, if there were to be an "urban bias" in the future economic growth of Uganda, as it is often the case, the rate of growth in the demand for bean in urban Uganda could be higher. Combined, the national demand for bean in Uganda is projected to grow at 5% in 2020 (table 9).

Table 12: Projected demand growth rate for bean (Pulse) in Uganda (Tanzania), given assumptions on expenditure elasticity, and population and economic growth, 2015-2025

	Expenditure elasticity		Per capita income growth rate	Population growth rate		Share of the population		Demand growth rate		
Year	Rural	Urban	National	Rural	Urban	Rural	Urban	Rural	Urban	National
					Uganda					
2015	1.07	0.69	1.85	2.88	5.51	83.90	16.10	4.86	6.79	5.17
2020	1.07	0.67	1.80	2.72	5.39	82.11	17.89	4.64	6.60	4.99
2025	1.06	0.65	1.92	2.50	5.20	80.14	19.86	4.54	6.45	4.92
					Tanzania					
2015	1.12	0.54	4.05	2.08	5.46	68.39	31.61	6.62	7.65	6.94
2020	1.09	0.50	2.19	1.89	5.06	64.86	35.14	4.28	6.16	4.94
2025	1.06	0.46	1.54	1.76	4.70	61.40	38.60	3.39	5.41	4.17

The growth rate in the demand for pulse is stronger in Tanzania; estimated at 6.6% in rural areas and 7.7% in urban areas for 2015 (table 9). Like in Uganda, high urban population growth rate explains the stronger demand growth in urban areas compared with rural areas. Contrary to Uganda, projections suggest a clear downward trend in pulse demand in Tanzania between 2015 and 2025 which is mainly driven by a slowdown of the economic growth. Projected per capita GDP growth rates are 4.1%, 2.2%, and 1.8% in 2015, 2020, and 2025 respectively. Consequently, in 2025 the demand growth rates in rural and urban Tanzania are estimated to be 3.4% and 5.4%, which is more than one percentage point lower than the projected demand growth rates for bean in Uganda in the same period.

Tanzania is more urbanized than Uganda, with almost 40% of the population projected to live in cities in 2025. This means high national growth rate in the demand for pulse in Tanzania, being about 7% in 2015, and decreasing to 5% in 2020 and then 4.2% in 2025. In the next section, the growth rate in the demand for bean/pulse are compared with growth rates in supply of bean in Uganda and pulse in Tanzania.

7.2 Comparing demand with domestic supply outlook

We assume that the supply growth rates for bean and pulse observed during 2006-2015 will be maintained until 2025. This is based on the assumption of sustained investments to adapt pulse production to climate change and counter possible decline in yield growth predictions for several parts of East Africa (Ramirez-Villegas and Thornton, 2015). The growth rates indicated in table 13 for bean (pulse) production and exports were computed based on data from the FAO crop production/commodity balance sheet for 2005-2014 using a semi-log trend function. This is also the method used by the World Bank to project growth in indicator of economic growth (http://data.worldbank.org/about/data/methodologies)[18].

[18] $\ln Z_t = \beta_0 + \beta_t t$ Where Z_t is the dependent variable in time t, and represents harvested output, area, or yield for bean (pulse); t is a time trend from 1995 to 2015; β_t is the coefficient of the trend to be estimated in time t and $\ln$ is the natural logarithm. Then the average annual growth rate in each specified period t, was computed by taking the antilog of the coefficient of β_1; subtracting 1 from the answer and multiply by 100 to convert it into percentages

Table 13: Ten-year average annual growth rate (%) of bean (pulse) production and their respect exports in Uganda and Tanzania for 2005-2014

Country	Average annual growth rate(%) for bean and pulse in Uganda and Tanzania		
	Bean/pulse production	bean/pulse exports	Self-sufficiency factor (SSR)[19]
Uganda	10.1	19.6	102.8
Tanzania	8.4	11.7	103.8

In the last decade, both Uganda and Tanzania enjoyed positive growth trends in bean and pulse production respectively. The average annual supply growth rate for bean in Uganda was 10.1% from 2005 to 2014 while it was 8.4% for pulse in Tanzania during the same period (table 13). The self-sufficiency factors for bean in Uganda and pulse in Tanzania are slightly above 100, meaning that the two countries are self-sufficient in these commodities and are net exporters. Given that the annual growth rates for bean and pulse production exceed their respective projected growth rate in demand, the two countries have a potential to increase exports. However, there is reason to worry about the nutrition of the poor in these countries, who depend on pulse for their nutrition security. The growth rate in exports of bean and pulse from both countries has been higher than their annual growth rates in production in the last decade. If these export growth rates are sustained in the future, it could put pressure on domestic prices, negatively affecting poorer households. This is because an increase in domestic prices of bean or pulse will result in lower quantity consumed, and possibly lower macro and micronutrient intakes among poorer households which could make them more vulnerable to malnutrition. It is therefore important to invest in productivity enhancing technologies for bean (pulse) in these countries in order to prevent further price increases while making the crops more competitive at farm level.

8. Conclusions and recommendations

Uganda and Tanzania are both in transition economies, with significant reduction in poverty levels in the last decade. At the same time, malnutrition especially among children under five years old

[19] Self-sufficiency factor (SSR) was computed as a percentage of the domestic supply (i.e. domestic production+ import -exports) based on the FAO available data series 2002-2013

is still rampant and obesity a growing concern in both countries. This underlines that household nutrition security does not automatically improve with decreasing poverty but requires additional, specific and targeted interventions. Pulses have been depicted as a strategic remedy for hidden hunger and health problems associated with over nutrition. However, there is limited information on pulse consumption trends and demand by different socioeconomic groups and how each group adjusts its demand when faced with price and income changes. This study contributes to understanding of the problem and possible interventions to improve nutrition security through promotion of pulses by assessing the consumption patterns and estimating demand by different population groups for common bean in Uganda and pulses in Tanzania.

This study employed nationally representative data of urban and rural households in both countries. We used descriptive analysis to investigate the economic, temporal and spatial dimensions of pulse consumption and econometric methods to evaluate the responsiveness of pulse demand to price and income changes. A two-stage censored food demand system was estimated to obtain consistent and unbiased unconditional expenditure and price elasticities for food and several food categories, including common bean in Uganda and pulse in Tanzania. The first stage, represented by a Working-Leser model, explained household budget allocation between food and non-food items. The second stage utilized a censored QUAIDS to examine how households make consumption decisions between food groups. Models are estimated separately for urban and rural areas. Statistical tests support the quadratic specification and inclusion of socio-demographic variables, thus implying the importance of incorporating these terms to obtain unbiased elasticities of demand for food.

In Uganda, over a 7-day period, poorer households, i.e. those at the bottom 20% of the wealth distribution, and wealthier households, those at the top 20% of the wealth distribution, in both rural and urban are less likely to consume bean compared with households in other wealth segments. Moreover, there are large differences in per capita bean consumption between the poorer and wealthier households. The average quantity of bean consumed per person per day is significantly lower for households in the bottom two strata of the wealth distribution compared with households in the third, fourth and top economic strata. This is despite that poorer households have less diversified diets and beans (pulses) account for a larger share of their food expenditure. A slight different consumption pattern is observed for pulses in Tanzania. On a weekly basis, the poorest households in rural areas and best-off households in urban areas are less likely to consume pulses compared with households in other wealth quintiles. These results suggest a non-linear relation between income and pulse consumption in both countries due to access constraints among poorer households especially in rural areas while urbanized wealthier households are diversifying away from pulses into other foods.

The percentage of households consuming bean in Uganda and pulse in Tanzania over one-week period is relatively stable between months, but the quantity consumed by rural and urban dwellers fluctuates monthly reaching its peak during harvesting period and its low, during planting time. For example, per capita pulse consumption in Tanzania declines between harvesting and planting months by about 40%, but the decline is relatively higher among the rural poorest households, falling from an average of 39.7 grams to 13.7 grams per person per day (equivalent of 65% decline). Increased consumption during harvesting time reflects availability as well as the fact that bean is fast maturing and usually used to fill in the hunger gap when other crops have not yet matured. However, during the lean period, lack of sound storage facilities and trade means that supply of pulses on the market is low and prices increase, explaining the low quantity consumed. Since the bottom rural poor households in Tanzania (Uganda) access over 40 percent of their pulses (beans) consumed from the market, decline in consumption during the lean season might also reflect cash constraints as prices rise with scarcity of supply.

The estimated food demand systems included bean for Uganda and pulse for Tanzania as one of eight food groups. For both countries, the expenditure elasticity of demand for bean/pulse is higher in rural than urban areas. This holds true even between households of the same economic status, an indication that urbanization has induced changes in food consumption patterns. A one percent increase in income leads to more than one percent increase in the quantity demanded for bean/pulse in rural areas of Uganda and Tanzania. In urban areas, the expenditure elasticity of demand for bean/pulse is low relative to other food groups. Quantity demanded for bean is expected to increase by about 0.78% in urban Uganda and 0.54% in urban Tanzania for a one percent increase in income. Own-price elasticity of demand for bean, in absolute value, is above 0.6 and less than one for all Ugandan households except for urban households in the top 20% of the economic stratum. Of the eight food groups, demand for bean in urban Uganda is the least responsive to price changes. In rural areas, only fruits & vegetables and condiments have a lower own-price elasticity of demand, in absolute value, than bean. Thus, we conclude that demand for bean is price inelastic and results suggest a strong preference for bean among Ugandan households.

In Tanzania, the own-price elasticity of demand for pulses is greater than one among rural households of all wealth quintiles, indicating a very strong responsiveness to price changes. However, in urban Tanzanian, the own-price elasticity for pulse is 0.65, in absolute value, one of the lowest after fruits & vegetables and condiments, which is similar to Uganda's findings.

There are weak substitution and complement effects between bean/pulse and other food groups. Other legume foods (groundnut, peas), animal products (such as meat, fish and dairy products) are expected to be substitutes for bean. However, the study found that in rural areas of Uganda, an increase in the price of bean reduces the quantity demanded for pea, seed, & nut as well as condiments, indicating these food groups are complements; rather than substitutes. Since pea expenditure represented only a very small share of this food group compared to groundnuts, this result makes sense because beans can be cooked with groundnut paste; meaning that the two food items are complements. In urban Uganda, beverage & food away from home and bean are weak substitutes. The lack or weak substitution effects between bean and other food groups and the low own-price elasticity for bean relative to other food groups in rural and urban Uganda imply that the Ugandan households will attempt to preserve some quantity of bean consumed in the event of an increase in price. In urban Tanzania, pulse and condiments are substitutes for each other. The remaining cross-price elasticities between pulse and other food groups are insignificant, which is surprising given the high own-price elasticity for pulse in rural Tanzania.

Projections about demand and supply growth rate for bean in Uganda, and pulse in Tanzania indicated a positive outlook on the demand and supply sides, supply growing faster than demand. This means that both Uganda and Tanzania have the potential to expand quantity of beans/pulses exported in the regional market. Pulse exports are also growing quickly, which is attributed to the production deficit in the neighboring countries. If future economic and population growth in the region is strong, the volume of pulse exports from Uganda and Tanzania could growth at an even higher rate. Larger pulse exports could lead to higher domestic prices and thus lower quantity consumed. Because poorer households depend on pulse for their nutrition security and have limited options when prices increase, it is important to act now to avoid possible reduction in pulse consumption by poorer households that could lead to higher prevalence of malnutrition. Investment in agricultural research will be crucial such that farming households can adapt to a changing climate while increasing pulse productivity. Efforts in the development and dissemination of new technologies to reduce post-harvest losses could also improve food availability. Interventions and programs that increase the incentives of producers while benefiting consumers will be particularly successful in achieving increased pulse consumption, as lower prices and higher incomes would greatly stimulate demand.

High projected demand growth rates for pulse in urban areas indicate that pulse trade will grow in importance such that the rapidly growing demand can be met. This is likely to require increase in marketing infrastructure such as warehouses near farming communities, and efficient and well-coordinated wholesale and retail marketing systems that can supply pulse to consumer at lower prices while increasing the share of the consumer market price that goes to producers. The latter will provide farmers the incentives needed to adopt better technologies required for improving productivity.

Finally, the high consumption of pulse during harvesting among poorer households emphasizes the important role improved production among this group could play in their consumption demand for pulses. This calls for further research to better understand the status of pulse production among the poorer households and challenges they face in order to develop and disseminate production technologies that target their needs.

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