

Working paper



International
Growth Centre

Expanding agricultural production in Tanzania

Scoping study for
IGC Tanzania on
the National Panel
Surveys



Vincent Leyaro
Oliver Morrissey

April 2013

When citing this paper, please
use the title and the following
reference number:
F-40022-TZA-1

DIRECTED BY



FUNDED BY



EXPANDING AGRICULTURAL PRODUCTION IN TANZANIA

Scoping study for IGC Tanzania on the National Panel Surveys

Dr Vincent Leyaro, University of Dar-es-Salaam
Professor Oliver Morrissey, University of Nottingham

April, 2013

CONTENTS

Purpose and Aims

1. Context: Agriculture in Tanzania
2. Overview of Agricultural Policy and Performance
3. Data Measures and Definitions
4. Descriptive Statistics from NPS 2007/08 and 2010/11
5. Phase II Proposal: Productivity and Supply Response

References

Appendix Tables

Purpose and Aims

As agriculture accounts for a large share of employment, export earnings and even GDP in Tanzania, the sector is seen as a main vehicle in any national economic strategy to combat poverty and enhanced agricultural productivity is crucial to realize this objective. Despite this, there are no comprehensive studies of agricultural production and productivity using farm-level data in Tanzania. The National Panel Surveys (NPS) of 2008/09 and 2010/11 provide extensive data on some 3,280 farm households sampled throughout Tanzania, including information on area planted, quantity and value of harvest and input use (purchased and household) for a wide a variety of crops. Analysis of these panels offers the potential to provide insight on the determinants of productivity and supply response, in particular to identify factors amenable to policy influence that can provide effective incentives for farmers to increase production and efficiency. The basic aim of the scoping study is to assess the potential of analysing this data by describing and summarising the information.

Principal aims:

1. Detail and describe the available farm-level data on production, value and input use classified by principal crops and regions.
2. Establish the current status of output, yield and return (value of output) per acre by crop and regions.
3. Identify crops with growth potential in terms of output and productivity.
4. Show that appropriate data are available to estimate supply response and determinants of yield and production.

1 Context: Agriculture in Tanzania

After 50 years of independence, despite apparent commitment to policies and strategies to transform the agriculture sector, performance in agricultural output and productivity has been disappointing. Policies and plans, such as ‘agriculture is the mainstay of the economy’ and *Kilimo Kwanza* (agriculture first), have remained slogans to the public as there is so little experience of reforms that have improved livelihoods and millions in the agriculture sector remain in poverty. Tanzania is endowed with considerable fertile agricultural land and inland fresh water resources that can be utilized for irrigation, but much of the land is underutilized and what is utilised often exhibits very low productivity. In this sense Tanzania has yet to achieve the traditional ‘structural transformation’ whereby increasing agricultural production provides a platform for manufacturing and economic growth. Balanced growth is achieved if agriculture becomes increasingly commercialized while the manufacturing sector grows. Initially manufacturing may be based on agriculture, through processing and agri-business, but ultimately manufacturing and the economy will become diversified. This has not happened in Tanzania, and the economy remains essentially agriculture-based, mostly a peasant economy with low productivity. Understanding the factors that can expand production and enhance agricultural productivity in Tanzania is critical for ensuring ‘structural transformation’ and economic growth, boosting development and reducing poverty (given that the majority of the poor are in rural areas).

Some 80 per cent of Tanzanians depend on agriculture for their livelihood; the sector accounts for about 50 per cent of GDP and 75 per cent of export earnings. Consequently, the National Development Vision 2025, the main national development strategy in Tanzania, places considerable emphasis on the sector and envisages that by 2025 the economy will have been transformed from a low productivity agricultural economy to a semi-industrialized one led by modernized and highly productive agricultural activities that are integrated with industrial and service activities in urban and rural areas. Against this background, in the last decade a number of policies and strategies have been formulated to support agriculture in a more systematic way. The Agricultural Sector Development Strategy (ASDS) was adopted in 2001, and gave rise to the Agricultural Sector Development Program (ASDP) of 2005; and the Cooperative Development Policy (CDP) of 2002, complemented by a variety of sector policies. The strategy and the ASDP are embedded in the National Strategy for Growth and Reduction of Poverty (NSGRP), which is a medium term plan to realize Vision 2025. *Kilimo*

Kwanza (agriculture first), developed in 2009, provides additional inputs for the implementation of ASDP and other programs favourable for the agricultural sector. It is an assertion of the commitment of the government and the private sector to agricultural development, and it invites all Tanzanians to become part of this commitment. Its ten pillars support the ASDS and the ASDP and strengthen them by adding additional initiatives, in particular in rural finance.

The agriculture sector is therefore seen as a main vehicle in any national economic strategy to combat poverty, enhanced agricultural productivity is crucial to realize the objectives, and the policy statements have at least identified the issues and proposed a strategy. The ASDS emphasized the need to improve the efficiency of input markets and product marketing, increase access to credit, enhance the provision of extension services and increase investment in rural areas (especially for irrigation and transport). The ASDP was in principle the strategy to implement these aims, but had limited impact – the strategies were not a success. Thus, the culmination of these initiatives was the formulation of a belief in the need to ‘reintroduce selective subsidies, particularly for agricultural inputs, machinery and livestock development inputs and services’ (ESRF, 2005: xii). The second phase of the research, by providing some quantitative assessment of the importance of different factors (such as prices, access to credit and other inputs, access to markets and marketing) to output levels for the major crops, will contribute to understanding why the strategy has failed and providing recommendations of factors to target for an effective strategy.

Despite the CDP, the cooperative sector has failed to respond to the challenge of liberalization. The sector suffers from weak managerial (and advocacy) skills, a lack of financial resources (in particular undercapitalization of cooperative banks, so credit constraints remain), and a weak institutional structure (especially in that they are not accountable to members). Thus, although the cooperative sector remains significant it is not viewed as successful, either in supporting development and growth or in representing the interests of members, giving added impetus to liberalization initiatives.

Agriculture is recognized as integral to the Poverty Reduction Strategy, and agricultural sector growth is essential if Tanzania is to achieve sustained economic development. While this may seem somewhat obvious, it marks a change in emphasis – the whole sector (not only export crops) has attained a higher status on the policy (and political) agenda, and a view is emerging that there is a need for positive support to the sector. In this context, it is timely to attempt to assess the determinants of production and productivity in

agriculture using crop and farm level data. This scoping study aims to assess the types of productivity and supply response analysis that can be undertaken with the NPS data.

2 Overview of Agricultural Performance

There was some growth in agriculture, especially food production, in the latter half of the 1980s that contributed to increasing the income and welfare of rural households, and hence in principle to poverty reduction (World Bank 1994). However, this growth was not sustained beyond 1994 when the removal of all subsidies for agriculture was associated with stagnation if not decline in production as the large increase in fertilizer prices reduced use and hence yields, especially for maize and wheat (Skarstein, 2005). Production of maize and paddy are very sensitive to drought, which can reduce paddy production by up to half (Isinika et al. 2005, pp. 199-200). Although levels of maize and rice production did increase during the 1990s, low real prices and limited marketing opportunities meant that much of this was for household own consumption. Tanzania had strong economic performance over 2000-04 and although agriculture had lower growth rates than industry or services it made a larger contribution to GDP growth (World Bank 2006, p. 4).

Although there have been many studies of agriculture in Tanzania, there are no recent nationwide studies of production and productivity covering all major crops. As part of the World Bank project on Distortions to Agriculture in Africa (Anderson and Masters, 2009), Morrissey and Leyaro (2009) provided an analysis and discussion of the bias in agriculture policy in Tanzania over the period 1976-2004. They found that reforms implemented since the late 1980s have reduced distortions in agriculture, but certain crops (especially cash crops) have become less competitive due to serious deficiencies in marketing and productivity. Morrissey and Leyaro (2009) analyzed 18 products, covering about 80 per cent of the sector (in terms of value of output), classified as:

Cash crops (8 exports): coffee, cotton, tea, sisal, tobacco, cashew nuts, pyrethrum and beans (a non-traditional export).

Import-competing food crops (4): maize, rice, wheat and sugar. While maize and sugar often had exports, sometimes even net exports, net imports are the norm and tend to be significant.

‘Non-traded’ crops (6): cassava, sorghum, millet, Irish potato, sweet potato, cooking (green) bananas.

Morrissey and Leyaro (2009) implemented the Anderson *et al.* (2006) methodology to measure the Nominal Rate of Assistance (NRA) for individual products and Direct Rate of Assistance (DRA) for processing sectors. The basic principle underlying these measures is that the price received by producers (farmers or processors), adjusted to allow for taxes (subsidies), margins (marketing and transport) and exchange rate distortions, is compared to a reference international price. In principle, the result is an estimate of the difference between the domestic and world price (for a product at a comparable point in the supply chain), a non-zero wedge implying distortions. For the non-traded goods there is no reference international price and given data limitations distortions could not be measured.

The results for **maize** provide evidence of sustained negative assistance to producers, usually corresponding to a subsidy to consumers: farm-gate and wholesale prices tended to move in line with the reference import price but retail prices tended to remain below the import price. To some extent this overstates the actual distortions, as prior to about 1990 and since about 2000 maize farmers have been able to avail of some fertilizer subsidies. As fertilizer (when used) accounts for 30 percent of production costs on average and the subsidy amounts to 50 percent of the fertilizer costs (on average for those who get the subsidy), production costs would be reduced by 15 per cent on average. As margins are fairly low, this could largely offset the distortion in the 2000s providing real incentives for some maize producers. The results for **rice** are similar and producers able to avail of fertilizer subsidies may receive a net subsidy (in 2000-04). This is consistent with the observation that the share of rice in total production increased slightly whereas that of maize declined in the first half of the 2000s. **Wheat** is a much less important crop and although the negative distortions faced by producers appear to have been eliminated since 1990, retail prices were consistently above the import price and local prices for wheat appear to have grown significantly faster than prices for other cereals, few farmers grew wheat. This may be because of inefficiency in transport and distribution so the high marketing margin reduced the effective farm-gate price. By the early 2000s there were no significant distortions against the major food crops, so one would expect to see a subsequent increase in output of maize and rice.

For cash crops, products with high estimated distortions appear to be those where there is limited competition and inefficient marketing or processing (cotton, tea and tobacco), whereas distortions are lower for those products where competition has been introduced and efficiency increased (coffee, cashewnuts and sisal). The level of distortion against agriculture remained reasonably high for all cash crops up to the early 2000s. Analysing time series data

over 1964-1990, McKay *et al* (1999) find that food crop production increased as prices relative to export crops increased, but aggregate export crop production was not responsive to prices. As producers seem to respond to the relative price and incentives for food crops compared to cash crops, with a high relative price elasticity for food crops (McKay *et al*, 1999), one expects increasing food production in the latter half of the 2000s.

Arndt *et al* (2012) use representative climate projections in calibrated crop models to estimate the impact of climate change on food security (represented by crop yield changes) for 110 districts in Tanzania. Treating domestic agricultural production as the channel of impact, climate change is likely to have an adverse effect on food security, albeit with a high degree of diversity of outcomes (including some favourable). Four different climate change scenarios are considered (the most favourable is 'wet' and the least favourable is 'dry') and the effects estimated for a projection to 2050 (Arndt *et al*, 2012, p 388). Under the 'wet scenario' agriculture output (in real GDP terms) could increase by 1percent, with gains for cereals, horticulture and export crops (only root crops decline). Under the other scenarios, however, agriculture output declines by 1.2percent to 12percent; the decline is about these ranges for cereals and export crops (lower in some scenarios, higher in others) and generally worse for horticulture (Arndt *et al*, 2012, p 388). Unless measures are undertaken now the most probable forecast of declines in agricultural output. The analysis points to the benefits of interventions that focus on irrigation and water collection/conservation measures and on crops that are less water intensive (Abrar *et al*, 2005).

Ahmed *et al* (2012) identify the potential for Tanzania to increase its maize exports as climate change scenarios suggest a decline in maize production in major exporting regions. Specifically, climate predictions suggest that some of Tanzania's trading partners will experience severe dry conditions in years when Tanzania is only mildly affected. Tanzanian maize production is far less variable than that of major global producers (no significant growth, but no large declines due to weather shocks), including compared to other SSA producers (Ahmed *et al*, 2012, p 403), so has scope to respond to the adversity other producers will face. However, as shown by Arndt *et al* (2012), Tanzania may itself suffer a decline in production. Addressing the reasons why production in Tanzania has not grown is crucial to create a production environment within which productivity can increase, and maize is a crop worthy of specific attention.

3 Data Measures and Definitions

The National Panel Surveys (NPS) are a series of nationally representative household panel surveys that assemble information on a wide range of topics including agricultural production, non-farm income generating activities, consumption expenditures and socio-economic characteristics. The 2008/09 NPS is the first in the series conducted over twelve months, from October 2008 to October 2009, and the 2010/11 NPS is the second and ran from October 2010 to September 2011 (the third round was scheduled to start in late 2012). Both the first and second rounds were implemented by the Tanzania National Bureau of Statistics (NBS) with a sample based on the National Master Sample frame, but are largely a sub-sample of households interviewed for the 2006/07 Household Budget Survey.

The 2008/09 NPS of 3,280 households from 410 Enumeration Areas (2,064 households in rural areas and 1,216 urban areas) was used to produce disaggregated poverty rates for 4 different strata: Dar es Salaam, other urban areas on mainland Tanzania, rural mainland Tanzania, and Zanzibar. The second round of the NPS revisits all the households interviewed in the first round of the panel, as well as tracking adult split-off household members to re-interview. For the 2010/2011 TZNPS sample design, a total sample size of 3,265 households were covered for 409 Enumeration Areas (2,063 households in rural areas and 1,202 urban areas).

The NPS data are collected and reported by plot (j) for household (i) and crop (c), recording inter-cropping and allowing for the long and short seasons. Most variables have to be calculated at the plot level as although over 40 percent of households have only one plot and fewer than 10 percent have more than three plots, most plots are used to grow more than one crop either by inter-cropping or sub-dividing the plot. Plot-level data are calculated and aggregated up to the farm (household) level. The descriptive statistics will mostly be presented at the farm-level (mean and median to capture the distribution of farm size) by crop and region.

The core variables for the descriptive statistics are:

Q_{Tic} = Total output quantity (typically in kgs) that can be broken down by sales (Q_S), post-harvest loss (Q_{PHL}), storage (Q_K) and own-consumption (Q_O , derived by deducting the previous three from Q_T).

- V_{Sic} = Value of sales (in '000s of TShs)
 P_{ic} = Unit value (farm-crop price, hereafter P) = V_{Sic} / Q_{Sic} (in TShs)
 V_{ic} = Value of output is reported in the NPS as estimates by the farmer at the plot level.
 The estimates can be checked by calculating $P_{ic} \cdot Q_{Tic}$ (in TShs)
 A_{ic} = Area planted with crop c (derived from information on how much of a plot is planted with the crop and summed over plots for i)
 A_{Hic} = Area harvested (in acres) summed over plots [note this can be less than total plot size, A]
 H_{ic} = Harvested area share of crop c [calculated as $A_{ic} / \sum_i A_{ic}$] for use as a weight
 X_{Pij} = purchased inputs (TShs), comprising fertilizer, pesticides, new seeds and hired labour, are reported at the plot level; $X_{Pi} = \sum_j X_{Pij}$
 w_{ijc} = share of crop in estimated value of output from plot = $V_{ijc} / \sum_j V_{ijc}$ (for use as weights)
 S_{ic} = Crop share (hereafter S) in farm output = $V_{ic} / \sum_i V_{ic}$ (for use as weights)

Derived measures are (where A_{Hic} weighted by H_{ic}):

- Y_{ic} = yield = Q_{Tic} / A_{Hic} (typically in kgs per acre)
 R_{ic} = return or income from crop = V_{ic} / A_{Hic} (in TShs per acre); from the data one can also calculate V_{Sic} / A_{Hic} (value of sales, marketed output, in TShs per acre)
 Π_{ic} = profit = $(V_{ic} - X_{Pic}) / A_{Hic}$ (in TShs per acre)

4 Descriptive Statistics from NPS 2007/08 and 2010/11

Agricultural sector still remains an important sector in Tanzania, as it contributes 24 percent of GDP and employs around 70 percent of Tanzanians (ES, 2010). Although the area under cultivation is continually increasing, the same is not the case when it comes to agricultural productivity. According to NSCA (2003/04), 9.1 million hectares were cultivated in 2002, which increased up to 10 million hectares in 2008 (about a 12percent increase, equivalent to 182,200 hectares per year). On average, annual agricultural output growth in 1970s was recorded at 2.9percent, in 1980s at 2.1percent, in 1990s at 3.6 percent and in 2000s at 4.7percent (ES, 2010). As area under cultivation grew at a lower rate, especially more recently, aggregate productivity appears to have increased (albeit not dramatically).

The descriptive statistics reported in this section and the Appendix for NPS I (2008/09) and NPS II (2010/11) reveal considerable variability in yields (kg/acre) and income (TShs/acre) across crops and regions and, for given crops, in unit values (TShs/kg) across and even within regions. One difficulty in dealing with the NPS data is that most variables are measured at the plot or crop/plot level, some are measured at the farm (household) level, and more than one crop may be grown on a given plot or a given crop may be grown on more than one of a farm's plots. For this reason the descriptive statistics reported here should be considered preliminary: the data are indicative of patterns across crops and regions but also highlight discrepancies that require further investigation, such as unusual values for particular crops and regions or large changes in a crop/region measure across the two surveys. Furthermore, as can be observed in the tables, not all questions were answered for all plots (sample sizes vary) and/or some answers appear inconsistent. Some of the major anomalies will be highlighted in the discussion.

Table 1: Plot Usage in 2008/09 and 2010/11 NPS

Plot Number	2008/09 (%)	2010/11 (%)	Plots Usage	2008/09 (%)	2010/11(%)
M1	44.54	43.56	Cultivated	85.99	81.19
M2	30.55	30.19	Rented out	0.57	0.56
M3	14.79	15.14	Given out	0.76	1.36
M4	6.13	6.36	Fallow	10.22	14.31
M5	2.56	2.72	Forest	1.60	1.72
M6	0.92	1.14	Other	0.86	0.86
M7	0.29	0.43	Observation	5,126	6,038
M8	0.12	0.28	Cultivated	2008/09 (%)	2010/11 (%)
M9	0.08	0.15	YES	85.99	81.19
M10	0.04	0.03	NO	14.01	18.81
Observation	5,126	6,038	Observation	5,126	6,038

Note: Based on information reported by plot for the long season only.

Table 1 shows that just over 43 percent of farms had only one plot and over 90 percent of farms had three or fewer plots (in both surveys). Over 80 percent of plots were cultivated with 10-14 percent left fallow; the proportionally large increase in the share left fallow in 2010/11 deserves further investigation. There is no plots attrition between the 2008/09 and 2010/11, instead the plots increased by 912 (more than 17 percent of 2008/09 total). This is likely to be due to households' splits that lead to new entrants acquiring new plots. Table 2 provides the distribution of farm size: over half of farms are one acre or less, more than 10 percent are two acres and less than 15 percent are four or more acres.

Table 2: Household Farm Size by Acre in 2008/09 and 2010/11 NPS

Acreage	2008/09 percent	2010/11 percent
< 0.50	12.38	13.89
0.50	15.65	13.24
1.00	25.72	20.39
1.50	8.02	7.36
1.75	0.18	0.56
2.00	12.49	11.12
2.50	2.76	3.45
3.00	7.10	4.86
3.50	0.54	1.1
4.00	4.76	3.35
4.50	0.26	0.39
5.00	2.70	2.89
> 5.00	7.57	6.05

Note: As for Table 1; based on adding up all plots for each farm.

Table 3: Distribution of Crops by Plots in 2008/09 and 2010/11 NPS

No.	Crops	2008/09		2010/11	
		Freq.	%	Freq.	%
1	<i>Maize</i>	1,608	38.99	2,044	42.36
2	<i>Paddy</i>	489	11.86	610	12.64
3	<i>Sorghum</i>	155	3.76	172	3.56
4	<i>Millet</i>	75	1.82	69	1.43
5	<i>Wheat</i>	19	0.46	18	0.37
6	<i>Cassava</i>	670	16.25	720	14.92
7	<i>Irish Potatoes</i>	30	0.73	25	0.52
8	<i>Sweet Potatoes</i>	107	2.59	102	2.11
9	<i>Beans</i>	205	4.97	189	3.92
10	<i>Nuts, Seeds</i>	199	4.83	142	2.94
11	<i>Cotton</i>	61	1.48	56	1.16
12	<i>Tobacco</i>	22	0.53	27	0.56
13	<i>Pytherum</i>	-	-	7	0.15
14	<i>Sisal</i>	3	0.07	3	0.06
15	<i>Coffee</i>	35	0.85	45	0.93
16	<i>Tea</i>	5	0.12	6	0.12
17	<i>Cocoa</i>	8	0.19	14	0.29
18	<i>Cashew nuts</i>	141	3.42	112	2.32
19	<i>Sugarcane</i>	20	0.48	19	0.39
20	<i>Spices</i>	9	0.22	15	0.31
21	<i>Banana</i>	174	4.22	293	6.07
22	<i>Fruits</i>	27	0.65	50	1.04
23	<i>Vegetables</i>	41	0.99	50	1.04
24	<i>Others</i>	21	0.51	37	0.77
Observation /Total		4,124	100	4,825	100

Note: As for Table 1; based on reported main crop planted on plot in the long season. The difference in sample between Table 1 and 2 are attributed to different files with different focus plots/crops.

Table 3 reports the distribution of crops by plot for the long season; cash crop production is understated as the separate information on permanent (tree) crops has not yet been incorporated into the summary tables. The figures for cash crops such as tobacco or coffee can be interpreted as relating only to plots where they are inter-cropped (the share of plots with cashew nuts is probably accurate). The major food crops (maize, paddy and cassava) are grown on more than two-thirds of all plots; sorghum, banana, nuts and seeds, beans, and sweet potatoes are also grown on significant numbers of plots. These shares refer only to the major crops grown on the plot; almost 60 percent of plots are inter-cropped (Table 4), often with more than two crops (the plot may be partitioned for separate crops; tree crops may be mixed, such as coffee and bananas; or food crops may be planted under trees).

Table 4 reports important characteristics of the farms. Over 80 percent of plots are owned by the farmer and up to 95 percent are owned or used with free access; renting accounts for about 5 percent of plots. Very few plots are irrigated, 3 percent or fewer, demonstrating that farming is almost always rain-fed; in this context it is unfortunate that farmers were not asked questions about the reliability of rainfall, quantity and timing, as in the Ethiopian surveys analysed in Abrar and Morrissey (2006). About 10 percent purchase inorganic fertilizer or pesticides (these are likely to be same farms) or use organic fertilizer (which may be different farms). Inconsistencies between the two surveys are evident: although the sample was larger in 2010/11, fewer answered questions on fertilizer use. Almost a third use improved seeds and also about a third employ hired labour.

One reason for the low use of purchased inputs is the high cost for farmers with low incomes (although not reported here, the NPS reports that only one or two per cent of farmers are able to obtain inputs on credit). Table 5 reports that almost two-thirds have loam soil and most others are either sandy or clay; about half report the soil is of good quality and 45 percent that it is average; less than 15 percent of plots suffer from erosion and more than half are flat, with about another third gently sloped. In sum, the majority of farms are small, owned, rain-fed with good soil and orientation but do not use purchased inputs (except perhaps for seeds and hired labour). An important issue to address in future analysis is the differences between those farms that purchase inputs (especially fertilizer) and those that do not. One would expect that only larger and/or more commercial farms are able to purchase inputs, and this may be related to the crops grown (and the availability of irrigation). For example, vegetables, beans and perhaps fruits should be relatively profitable and responsive

to fertilizer. However, as noted in Section 2, some producers of maize or paddy may be able to obtain fertilizer subsidies.

Table 4: Farming Characteristics 2008/09 and 2010/11 NPS

	2008/09			2010/11		
<i>Ownership status</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Owned	4,268	83.26	83.26	5,088	84.27	84.27
Used free of charge	567	11.06	94.32	698	11.56	95.83
Rented in	256	4.99	99.32	201	3.33	99.16
<i>Kushirikiana</i>	6	0.12	99.43	3	0.05	99.21
Shared - own	29	0.57	100	48	0.79	100
<i>Total</i>	<i>5,126</i>	<i>100</i>		<i>6,038</i>	<i>100</i>	
<i>Plot Irrigated</i>	<i>Freq</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq</i>	<i>Percent</i>	<i>Cum.</i>
Yes	108	2.54	2.54	103	2.06	2.06
No	4,144	97.46	100.00	4,886	97.94	100
<i>Total</i>	<i>4,252</i>	<i>100</i>		<i>4,989</i>	<i>100</i>	
<i>Plot Intercropped</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	3,298	63.56	63.56	3,886	64.76	64.76
No	1,891	36.44	100	2,115	35.24	100
<i>Total</i>	<i>5,189</i>	<i>100</i>		<i>6,001</i>	<i>100</i>	
<i>Organic Fertilizer</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	446	10.66	10.66	513	10.68	10.68
No	3,738	89.34	100	4,292	89.32	100
<i>Total</i>	<i>4,184</i>	<i>100</i>		<i>4,805</i>	<i>100</i>	
<i>Inorganic Fertilizers</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	456	10.90	10.90	615	12.80	12.80
No	3,729	89.10	100	4,190	87.20	100
<i>Total</i>	<i>4,185</i>	<i>100</i>		<i>4,805</i>	<i>100</i>	
<i>Pesticides</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	450	10.75	10.75	433	9.01	9.01
No	3,735	89.25	100	4,372	90.99	100
<i>Total</i>	<i>4,185</i>	<i>100</i>		<i>4,805</i>	<i>100</i>	
<i>Improved Seeds</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	1,690	29.79	29.79	1,524	25.41	25.41
No	3,983	70.21	100	4,474	74.59	100
<i>Total</i>	<i>5,673</i>	<i>100</i>		<i>5,998</i>	<i>100</i>	
<i>Hired Labour</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	1,302	31.14	31.14	1,299	27.03	27.03
No	2,879	68.86	100	3,506	72.97	100
<i>Total</i>	<i>4,181</i>	<i>100</i>		<i>4,805</i>	<i>100</i>	

Note: As for Table 1; based on reported main crop planted on plot in the long season; table reports frequency (Freq), percentage and cumulative percentage (cum).

Table 5: Soil and Land Quality 2008/09 and 2010/11 NPS

2008/09				2010/11		
<i>Type of Soil</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Sandy	895	21.04	21.04	984	19.72	19.72
Loam	2,625	61.72	82.77	3,043	60.98	80.70
Clay	640	15.05	97.81	891	17.86	98.56
Other	93	2.19	100.00	72	1.44	100
Total	4,253	100		4,990	100	
<i>Quality of the Soil</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Good	2,143	50.39	50.39	2,315	46.40	46.40
Average	1,884	44.30	94.69	2,336	46.82	93.23
Bad	226	5.31	100	338	6.77	100
Total	4,253	100		4,989	100	
<i>Erosion Problem</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	555	13.05	13.05	644	12.91	12.91
No	3,697	86.95	100.00	4,345	87.09	100
Total	4,252	100		4,989	100	
<i>Measures taken</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Yes	659	15.50	15.50	511	10.24	10.24
No	3,593	84.50	100	4,477	89.74	100
Total	4,252	100		4,989	100.	
<i>Steep slope</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Flat bottom	2,176	51.19	51.19	2,941	58.95	58.95
Flat top	502	11.81	63.00	332	6.65	65.60
Slightly sloped	1,414	33.26	96.26	1,501	30.09	95.69
Very steep	159	3.74	100	215	4.31	100
Total	4,251	100		4,989	100	

Note: As for Table 4.

The remaining tables provide summary data on the 24 main crops (and on ‘others’ category) for 8 regions (some 7 aggregated from the 21 regions in Mainland Tanzania and 1 from the 5 regions in Zanzibar). For convenience we limit the discussion to median values for 2010/11 but where relevant will refer to mean values and statistics for 2008/09 (all in Appendix Tables). As there is considerable variability in farm and plot size, the median is a better indication of the ‘norm’ for the average farm (and is typically considerably lower than the mean). The simple pattern is one of significant variation across regions for every crop, although every region has at least one productive crop (and often a crop for which it is the most productive region).

Tanzania Regions with Two Agricultural Seasons (short and long rains)



Table 6 reports the median harvest in kg/farm. For the major crop, maize, Zanzibar, Mbeya and Dodoma have the highest median production (Arusha, Morogoro and Dodoma have highest mean production), whereas for paddy Mbeya, Arusha, Kigoma and Morogoro have the highest median values. Zanzibar, Dar and Mbeya have the highest values for cassava; Dar is also high for Irish potatoes (with Mwanza and Mbeya) and beans (with Mbeya and Zanzibar). Cashew nuts are mainly grown in Morogoro, Dar and Kigoma, sugarcane in Dodoma, Arusha, Morogoro, Dar, Mbeya and Kigoma, and banana is grown mostly in same regions including Mwanza. Fruits are mostly grown in Arusha, Morogoro, Dar and Zanzibar, and vegetables in every region except for Mwanza. Regions with the highest median quantity do not always have (among) the highest mean quantity, although in general the broad rankings are similar or consistent (Table A3).

Table 6: Median Quantity by Harvested Crop (Kg/farm) by Region 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	680	500	498	610	800	580	150	960
<i>Paddy</i>	255	1238	575	600	1420	800	200	600
<i>Sorghum</i>	460	1300	472	425	1392	700	150	600
<i>Millet</i>	460			1269	800	900	2670	
<i>Wheat</i>				1080	400	250		
<i>Cassava</i>	0	203	80	260	180	40	105	700
<i>Irish Potatoes</i>		540		2630	800		1680	
<i>Sweet Potatoes</i>	420	0	221	605	5826	600	170	
<i>Beans</i>	0	370	480	820	600	190	0	1140
<i>Nuts, Seeds</i>	1020	1225	150	650	810	2526	275	
<i>Cotton</i>	0			0	990	1216		
<i>Tobacco</i>				1912	550	2156		
<i>Pytherum</i>			790	785	303			
<i>Sisal</i>	1500							
<i>Coffee</i>		1011	0	1060	3690	80		
<i>Tea</i>		520			2880			
<i>Cocoa</i>					180			
<i>Cashew nuts</i>		0	200	240		1674		
<i>Sugarcane</i>	150	840	584	420	1100	8349		
<i>Spices</i>		65				240	175	
<i>Banana</i>	300	50	0	140	175	50	70	
<i>Fruits</i>	0	1058	0	230		0	0	700
<i>Vegetables</i>	120	2000	624	2025	980	136	485	
<i>Others</i>	100	1320	45	790	1105	50	0	

Note: Based on crop/farm data in 2010/11 NPS. The 21 regions identified in the NPS for Mainland Tanzania and 5 regions identified for Zanzibar are combined into regions as listed here (see Appendix Table A1).

Unit values vary across regions so the rankings in terms of value of output per plot (Table 7) are not always identical to those for quantity. For maize, Zanzibar, Dar, Mbeya and Dodoma have high value but Dodoma (not Dar) has the highest median value, whereas for paddy Arusha, Mbeya, Kigoma and Morogoro remain with the highest median values. Zanzibar, Dar and Mbeya again have the highest values for cassava; Dar is also the highest value for Irish potatoes (with Mwanza and Mbeya as before) and Zanzibar is again highest for beans (followed by Dar, Mbeya and Morogoro). Cashew nuts are mainly grown in Kigoma, Morogoro and Dar, sugarcane in Kigoma, Mbeya, Arusha and Morogoro, banana is grown mostly in same regions including Mwanza, fruits in Arusha, Zanzibar and Dar, and vegetables in all regions except Mwanza and Zanzibar; in all these cases the regions also have the highest median values. Regions with the highest median quantity do not always have (among) the highest mean quantity, although in general the broad rankings are similar or consistent (Table A3).

Table 7: Median Value Harvested Crop (000' TShs/farm) by Region 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	172	145	144	185	180	151	70	315
<i>Paddy</i>	175	598	203	255	420	320	110	246
<i>Sorghum</i>	112	158	169	133	321	314	81	246
<i>Millet</i>	135			1140	238	44	854	
<i>Wheat</i>				362	66	146		
<i>Cassava</i>	0	43	24	80	48	14	72	204
<i>Irish Potatoes</i>		130		444	210		210	
<i>Sweet Potatoes</i>	60	0	129	144	1152	101	90	
<i>Beans</i>	0	82	202	272	180	60	0	230
<i>Nuts, Seeds</i>	312	634	150	256	364	1120	256	
<i>Cotton</i>	0			0	480	503		
<i>Tobacco</i>				2759	1650	2431		
<i>Pytherum</i>			261	193	65			
<i>Sisal</i>	285							
<i>Coffee</i>		402	0	361	544	8		
<i>Tea</i>		210			468			
<i>Cocoa</i>					128			
<i>Cashew nuts</i>		0	90	80		502		
<i>Sugarcane</i>	75	345	166	108	334	1098		
<i>Spices</i>		19				120	96	
<i>Banana</i>	85	18	0	40	107	10	35	
<i>Fruits</i>	0	300	0	105		0	0	204
<i>Vegetables</i>	240	624	500	957	261	9	259	
<i>Others</i>	30	551	23	252	158	10	0	

Note: Based on crop/farm data in 2010/11 NPS.

As plot sizes may vary by region it is more informative to examine yields (kg/acre, in Table 8), income per acre (Table 9) and 'profit' (income minus purchased inputs) per acre (Table 10). As purchased inputs are report at the plot level and have to be allocated to crops, as most plots have more than one crop, the profit estimates may be unreliable (especially as answers for apportioning crops to plots are not always consistent). In general the 'ranking' of regions is unaltered. For maize (Zanzibar, Mwanza, Dodoma and Arusha) and for paddy (Arusha, Kigoma, Mbeya and Dodoma) the same regions have the highest yield, income and profit. Dodoma, Arusha, Morogoro and Mwanza have the highest yields and incomes for cassava; Mbeya and Dar have the highest yield and income for Irish potatoes (with Arusha, which appears to have far higher profit) and Mbeya, Mwanza and Dar have highest for beans (although a number of regions appear to have similar profits).

Table 8: Median Crop Yield (kg/acre) by Region 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	330	300	237	213	255	208	350	480
<i>Paddy</i>	330	909	275	300	360	400	235	150
<i>Sorghum</i>	164	650	216	180	192	136	269	150
<i>Millet</i>	182			333	182	100	763	
<i>Wheat</i>				390	541	46		
<i>Cassava</i>	355	350	226	187	200	199	210	140
<i>Irish Potatoes</i>		308		1533	3200		560	
<i>Sweet Potatoes</i>	667	1500	388	293	544	400	350	
<i>Beans</i>	135	211	199	229	275	150	270	253
<i>Nuts, Seeds</i>	160	411	194	168	300	151	141	
<i>Cotton</i>				125	176	132		
<i>Tobacco</i>				283	550	329		
<i>Pytherum</i>			790	209	223			
<i>Sisal</i>	710							
<i>Coffee</i>		407	200	397	688	296		
<i>Tea</i>		558			2880			
<i>Cocoa</i>					550			
<i>Cashew nuts</i>			384	160		431		
<i>Sugarcane</i>	150	420	389	280	437	1868		
<i>Spices</i>		325				480	175	
<i>Banana</i>	286	230	130	280	202	144	269	
<i>Fruits</i>		276	142	173			320	140
<i>Vegetables</i>	120	533	210	409	571	272	373	
<i>Others</i>	240	660	267	675	321	100	350	

Note: Based on crop/farm data in 2010/11 NPS.

Table 9: Median Crop Income (000' TShs/acre) by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	78	85	68	63	60	64	175	158
<i>Paddy</i>	130	484	113	115	119	140	132	62
<i>Sorghum</i>	51	144	67	67	21	52	126	62
<i>Millet</i>	34			127	64	5	244	
<i>Wheat</i>				97	89	27		
<i>Cassava</i>	156	142	73	56	65	58	137	41
<i>Irish Potatoes</i>		92		260	840		70	
<i>Sweet Potatoes</i>	175	250	86	87	120	83	200	
<i>Beans</i>	84	47	114	79	90	64	255	51
<i>Nuts, Seeds</i>	71	204	150	66	74	160	105	
<i>Cotton</i>				46	69	76		
<i>Tobacco</i>				368	1650	375		
<i>Pytherum</i>			261	51	73			
<i>Sisal</i>	143							
<i>Coffee</i>		97	51	87	222	35		
<i>Tea</i>		164			347			
<i>Cocoa</i>					180			
<i>Cashew nuts</i>			168	42		129		
<i>Sugarcane</i>	75	173	159	72	121	667		
<i>Spices</i>		93				240	96	
<i>Banana</i>	75	146	51	80	106	29	140	
<i>Fruits</i>		75	43	97			224	41
<i>Vegetables</i>	240	166	180	628	201	17	199	
<i>Others</i>	132	290	147	188	47	20	175	

Note: Based on crop/farm data in 2010/11 NPS.

Table 10: Median Profit (000' TShs/acre) by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	141	119	82	80	90	71	150	108
<i>Paddy</i>	153	354	135	129	144	183	167	37
<i>Sorghum</i>	54	115	74	74	48	63	145	43
<i>Millet</i>	51			88	66	5	224	
<i>Wheat</i>				93	89	21		
<i>Cassava</i>	132	128	85	72	82	68	152	41
<i>Irish Potatoes</i>		150		203	93		21	
<i>Sweet Potatoes</i>	223	159	136	117	103	117	288	
<i>Beans</i>	74	57	103	75	89	56	255	29
<i>Nuts, Seeds</i>	90	148	198	88	87	119	128	
<i>Cotton</i>				43	64	93		
<i>Tobacco</i>				373	960	248		
<i>Pytherum</i>			218	51	81			
<i>Sisal</i>	144							
<i>Coffee</i>		88	46	79	124	24		
<i>Tea</i>		151			18			
<i>Cocoa</i>					159			
<i>Cashew nuts</i>			135	77		89		
<i>Sugarcane</i>	75	116	121	92	106	562		
<i>Spices</i>		134					46	
<i>Banana</i>	135	127	59	64	115	44	212	
<i>Fruits</i>		73	52	72			216	41
<i>Vegetables</i>	305	209	175	556	169	63	167	
<i>Others</i>	130	271	170	122	34	20	175	

Note: Based on crop/farm data in 2010/11 NPS.

Cashew nuts are mainly grown in Morogoro and Dar, and sugarcane in Kigoma, Morogoro, Mbeya, Arusha, Dodoma and Dar. Although banana has highest production and in Dodoma, Mbeya and Dar and profit in Mwanza, Dodoma, Arusha and Mbeya, yield and income are highest in Dodoma, Dar and Mwanza. Fruits production and profit is highest in Mwanza, but yield and income is highest in Arusha and Mwanza. Vegetables production, yield and income is highest in Mbeya, Arusha, Dar and Mwanza, profit are higher in Dar, Arusha and Dodoma.

Three general conclusions can be drawn. First, we can be quite confident in identifying which crops are most important in which regions and vice versa, although it is not a one to one correspondence (many regions are important for a number of crops, and most crops are grown productively in a number of regions) and high production quantities and values do not necessarily imply high yield and income per acre. Second, the NPS data require further careful checking before proceeding to econometric analysis. The problem in deriving a measure of 'profit' has been shown, and apparent inconsistencies between farm and acre level measures have to be investigated. Furthermore, if results for 2008/09 (Appendix tables)

are compared to 2010/11 there are apparently inconsistent changes in magnitudes and rankings across crops and regions. Third, and following, careful checking of the data measured at the farm level will be required before embarking on econometric analysis. Although ‘adding up’ the plots in a farm is easy, the difficulty arises in determining the actual acreage devoted to each crop when more than one crop is grown on a plot (as is common) as the information reported is only approximate. This creates a particular problem in allocating purchased inputs (reported at the plot level) to crops. Furthermore, permanent and short season crops have to be included to accurately capture farm output and income. However, having undertaken this scoping investigation of the data it is evident that analysis of productivity and supply response is feasible.

5 Conclusion: Productivity and Supply Response

Although the NPS are small in sample size (3,280 households), they provide recent farm level household panel data with two waves (so lagged prices are available) and econometric analysis is feasible. The first preliminary analysis would be of the determinants of yields at the crop/farm level. This would employ variables subsequently used in analysing supply response as yield is posited to be a function of land size and quality, fertilizer and pesticide use, irrigation (unfortunately data on adequacy of rain was not collected) and farmer characteristics (age, education). We do not propose to estimate technical efficiency, but could as a final stage estimate supply response incorporating efficiency following the method employed by Abrar and Morrissey (2006).

The core analysis will be of supply response, the price and non-price factors determining production and how responsive farmers are to these factors. Two fundamental approaches are used in studying production decisions: the production function (primal approach) and the profit function (dual approach). Under appropriate regularity conditions, and with the assumption of profit maximization, both functions contain the same essential information on a production technology. The dual approach has several advantages: prices are specified as the exogenous variables as opposed to input quantities (prices are usually less collinear than input quantities); estimates of output supply, input demand, and the price (and cross-price) elasticities are more easily derived (as derivatives of the profit function); and it is more flexible for modelling multiple outputs and inputs systems (as is the case here).

Following Abrar *et al.* (2004) a profit, cost, or revenue function is estimated employing a variant specification of the profit function. Assume that farmers attempt to maximise restricted profit, defined as the return to the variable factors, so the profit maximisation problem can be expressed as:

$$\begin{aligned} \text{Max } \Pi(p, w; z) &= \text{Max } p'y - r'x \\ \text{s.t. } F(y, x; z) &\leq 0, \end{aligned} \quad (1)$$

where Π , p , w , respectively, represent restricted profit, and vectors of output and input prices. The variables y and x represent vector of output and input quantities respectively. $F(\cdot)$ is the production technology set of the producer, and Z is a set of control variables. The restricted profit function represents the maximum profit the farmer could obtain with available prices, fixed factors, and production technology. The profit-maximising output supply and input demand functions are derived as:

$$Y_m(p, w; z) = \frac{\partial \Pi(p, w; z)}{\partial p_m}, \quad \forall m = 1, \dots, M, \quad (2)$$

and

$$-X_n(p, w; z) = \frac{\partial \Pi(p, w; z)}{\partial w_n}, \quad \forall n = 1, \dots, N. \quad (3)$$

where m and n index the outputs and variable inputs respectively. There are usually four (translog, generalised Leontief, generalised Cobb-Douglas, and the quadratic forms) functional forms of the profit function that have been used in the literature. A choice of a particular specification, in part, depends on the nature of the data set available, and the translog profit function is generally preferred. These estimated parameters can be used to derive the elasticities for production relations of multiple-input, multiple-output farms.

The Translog profit function can be specified as:

$$\begin{aligned} \ln \pi^*(p, w, z; \beta) &= \beta_0 + \sum_i \beta_i \ln(P_i^*) + \sum_v \beta_v \ln W_v^* + \sum_m \beta_m \ln Z_m + \\ &\quad \sum_i \sum_v \beta_{iv} \ln(P_i^*) \ln W_v^* + \sum_i \sum_m \beta_{im} \ln(P_i^*) \ln Z_m + \sum_v \sum_m \beta_{vm} \ln W_v^* \ln Z_m \end{aligned} \quad \left. \begin{array}{l} (4) \\ 21 \end{array} \right\}$$

$$+ \frac{1}{2} [(\sum_i \sum_j \beta_{ij} \ln(P_i^*) \ln(P_j^*) + \sum_v \sum_r \beta_{vr} \ln W_v^* \ln W_r^* + \sum_m \sum_k \beta_{mk} \ln Z_m \ln Z_k)] + e$$

where

π^* = restricted variable profit, normalized by the price of labour

P_i^*, P_j^* = Price of outputs, respectively, normalized by the price of labour

W_v^*, W_r^* = Price inputs, respectively, normalized by the price of labour

Z = quantity of fixed and quasi-fixed inputs (land size, family labour, animal capital) and other farmer social-demographic and human capital factors (age, education and farming experience).

The β s are parameters to be estimated and ε is an error term with the usual properties. All prices are normalized by the price of labour. The core variables to be derived from the NPS are summarized in Table 11.

Table 11: Summary of variables to be used (measured farm-level by crop)

Variable Category	Variable Name/Symbol	Description/Measurement
Profit	Restricted farmer profit (π^*)	Total revenue less cost of variable inputs (purchased inputs plus hired labour)
Prices of Outputs	Output price (P_i^*, P_j^*)	Unit price of crop sales
Prices of Inputs	Input Price (W_v^*, W_r^*)	Prices of variable inputs
Fixed/quasi fixed (Z)	Land Size	Total area cultivated in acres
	Family Labour	Total own labour available to the household, between the ages 15 and 65 inclusive
	Animal Capital	Total number of hooved animals available to a farming household
	Age	Farmer age in years *
	Education	Farmer formal education in years
Control Variables	Irrigation	Binary variable (yes = 1)
	Soil quality	Index combining indicators
	Market access	Distance to nearest market/village

Notes: Age is used (*) on assumption that farmer has always been in farming. If there is information on those only recently in farming or who took a break, years of experience in farming may be included as a separate variable. Information on land and soil quality for plots will be used to construct binary variables [Good = 1, Poor =0] (at farm level) combining soil erosion [Yes = 0, No =1], are there control measures [Yes = 1, No =0], soil type and land slope categories converted to [1, 0].

References

- Abrar, S., O. Morrissey and A. Rayner (2004), 'Crop-level Supply Response by Agro-climatic Regions in Ethiopia' *Journal of Agricultural Economics*, 55:2, 289-312
- Abrar, S., and O. Morrissey (2006), 'Supply Response in Ethiopia: Accounting for Technical Inefficiency' *Agricultural Economics*, 35 (3), 303-317
- Ahmed, S., Diffenbaugh, N., Hertel, T. and Martin, J. (2012), Agriculture and Trade Opportunities for Tanzania: Past Volatility and Future Climate Change, *Review of Development Economics*, 16 (3), 429-447
- Anderson, K., W. Martin, D. Sandri and E. Valenzuela (2006), Methodology for Measuring Distortions to Agricultural Incentives, *Agricultural Distortions Research Project Working Paper 02*, World Bank, Washington DC, August.
- Anderson, K. and W. Masters (eds, 2009), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank
- Arndt, C., Farmer, W., Strzepek, K. and Thurlow, J. (2012), Climate Change, Agriculture and Food Security in Tanzania, *Review of Development Economics*, 16 (3), 378-393
- Fan, S., Nyange, D. and Rao, N. (2012), Public Investment and Poverty Reduction in Tanzania: Evidence from Household Survey Data, Chapter 6 in T. Mogues and S. Benin (eds), *Public Expenditures for Agriculture and Rural Development in Africa*, London: Routledge, pp 154-177
- Isinika, A., G. Ashimogo and J. Mlangwa (2005), From Ujamaa to Structural Adjustment – Agricultural Intensification in Tanzania, in G. Djurfeldt, H. Holmén, M. Jirström and R. Larsson (eds), *The African Food Crisis: Lessons from the Asian Green Revolution*, Wallingford: CABI Publications.
- McKay, A., O. Morrissey and C. Vaillant (1999), 'Aggregate Agricultural Supply Response in Tanzania', *J. International Trade and Economic Development*, 8:1, 107-123
- Morrissey, O. and V. Leyaro (2009), 'Distortions to Agricultural Incentives in Tanzania', in K. Anderson and W. Masters (eds.), chapter 11, pp. 307-328
- Skarstein, R. (2005), Economic Liberalisation and Smallholder Productivity in Tanzania: From Promised Success to Real failure, 1985-1998, *Journal of Agrarian Change*, 5 (3), 334-362.
- World Bank (1994), *Tanzania Agriculture: A Joint Study by the Government of Tanzania and the World Bank*, Washington DC: The World Bank
- World Bank (2006), *Tanzania: Sustaining and Sharing Economic Growth*, Country Economic Memorandum and Poverty Assessment, Volume 1 (draft, 28 April).

Appendix A: Supplementary Tables

Table A1: Correspondence of the 10 to the 21 regions in Tanzania

No.	Region name	Comprises	Ecological zone
1	Dodoma	Dodoma, Singida, Tabora, Shinyanga	
2	Arusha	Arusha, Kilimanjaro, Manyara	
3	Morogoro	Morogoro, Tanga, Coast, Lindi, Mtwara	
4	Dar es Salaam	Dar es Salaam,	
5	Mbeya	Mbeya, Ruvuma, Iringa	
6	Kigoma	Kigoma, Rukwa	
7	Mwanza	Mwanza, Mara, Kagera	
		North Unguja, South Unguja, West	
8	Zanzibar	Unguja, North Pemba, South Pemba	

Source: Authors own compilation

Table A2: Weather Condition at GPS Measurement: 2010/11 NPS

Climatic Zones	Freq.	Percent	Cum.
Clear/Sunny	3,953	34.07	34.07
Mostly Clear/Mostly Sunny	1,422	12.26	46.33
Partly Cloudy/Partly Sunny	5,038	43.42	89.75
Mostly Cloudy/Considerable Cloudiness	592	5.10	94.85
Completely Cloudy	398	3.43	98.28
Rainy	199	1.72	100.00
Total	11,602	100	

Source: Authors own compilation

Table A3: Mean Quantity of Harvested Crops by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	1480	29502	1399	1077	1475	1086	342	1227
<i>Paddy</i>	1566	1854	986	1187	2129	1631	216	816
<i>Sorghum</i>	768	6451	795	519	1789	1011	110	600
<i>Millet</i>	920			1622	4220	900	2670	
<i>Wheat</i>				1354	377	250		
<i>Cassava</i>	169	972	436	490	1099	453	127	700
<i>Irish Potatoes</i>		657572		3336	1714		1680	
<i>Sweet Potatoes</i>	620	177	1146	1360	4195	1700	168	
<i>Beans</i>	887	652	624	1443	1173	450	15	1140
<i>Nuts, Seeds</i>	1606	1076	583	800	2029	2096	323	
<i>Cotton</i>	0			1928	1609	1520		
<i>Tobacco</i>				1779	1056	2082		
<i>Pytherum</i>			730	785	388			
<i>Sisal</i>	1293							
<i>Coffee</i>		1011	150	1292	3415	66		
<i>Tea</i>		1260			2210			
<i>Cocoa</i>					416			
<i>Cashew nuts</i>		0	587	547		1674		
<i>Sugarcane</i>	150	708	584	775	840	6154		
<i>Spices</i>		1486				240	277	
<i>Banana</i>	552	653	78	752	406	364	139	
<i>Fruits</i>	0	936	855	428		0	40	700
<i>Vegetables</i>	453	7816	1648	9160	1367	811	653	
<i>Others</i>	91	876503	95	839	1105	50	47	

Note: Mean in kg per farm based on 2010/11 NPS.

Table A3: Mean Value of Harvested Crop (000' TShs/plot) by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	918	304	313	354	509	378	147	399
<i>Paddy</i>	732	971	330	457	797	612	123	240
<i>Sorghum</i>	190	263	248	177	387	474	60	246
<i>Millet</i>	284			650	1257	44	854	
<i>Wheat</i>				405	188	146		
<i>Cassava</i>	60	102	135	165	174	162	75	204
<i>Irish Potatoes</i>		288		726	284		210	
<i>Sweet Potatoes</i>	195	46	249	250	919	488	95	
<i>Beans</i>	236	180	286	440	316	170	14	230
<i>Nuts, Seeds</i>	765	565	380	350	650	1306	249	
<i>Cotton</i>	0			711	694	721		
<i>Tobacco</i>				2471	1945	2599		
<i>Pytherum</i>			268	193	131			
<i>Sisal</i>	257							
<i>Coffee</i>		274	38	383	889	14		
<i>Tea</i>		382			372			
<i>Cocoa</i>					145			
<i>Cashew nuts</i>		0	229	267		502		
<i>Sugarcane</i>	75	277	166	330	233	1578		
<i>Spices</i>		404				120	165	
<i>Banana</i>	206	85	27	225	145	119	85	
<i>Fruits</i>	0	250	248	165		0	28	204
<i>Vegetables</i>	296	789	909	3760	436	270	274	
<i>Others</i>	47	383	52	253	158	10	23	

Note: Mean in thousand (000') TShs per farm based on 2010/11 NPS.

Table A4: Mean Crop Yield (Kg/Acre) by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	487	4384	315	301	358	251	322	398
<i>Paddy</i>	372	864	426	371	421	521	327	191
<i>Sorghum</i>	225	1697	224	213	222	172	208	150
<i>Millet</i>	214			275	232	100	763	
<i>Wheat</i>				360	387	46		
<i>Cassava</i>	417	676	322	266	280	277	292	140
<i>Irish Potatoes</i>		100705		1301	2585		560	
<i>Sweet Potatoes</i>	832	955	633	812	564	795	564	
<i>Beans</i>	264	201	198	259	319	154	270	253
<i>Nuts, Seeds</i>	275	370	227	212	338	198	177	
<i>Cotton</i>				125	169	210		
<i>Tobacco</i>				309	466	288		
<i>Pytherum</i>			638	209	259			
<i>Sisal</i>	710							
<i>Coffee</i>		407	200	373	1109	229		
<i>Tea</i>		546			2283			
<i>Cocoa</i>					435			
<i>Cashew nuts</i>			357	227		431		
<i>Sugarcane</i>	150	348	454	251	437	1531		
<i>Spices</i>		485				480	209	
<i>Banana</i>	391	1505	215	322	279	325	324	
<i>Fruits</i>		303	251	259			320	140
<i>Vegetables</i>	259	128190	340	1808	625	370	414	
<i>Others</i>	272	117465	323	591	321	100	350	

Note: Yield in Kg per acre based on 2010/11 NPS.

Table A5: Mean Crop Income (000' TSHs/acre) by Regions 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	157	142	88	91	106	81	156	126
<i>Paddy</i>	177	446	157	141	161	197	186	57
<i>Sorghum</i>	58	123	73	81	46	71	116	62
<i>Millet</i>	54			89	72	5	244	
<i>Wheat</i>				125	107	27		
<i>Cassava</i>	164	136	106	83	82	77	180	41
<i>Irish Potatoes</i>		218		253	578		70	
<i>Sweet Potatoes</i>	253	177	155	107	108	116	346	
<i>Beans</i>	88	58	114	98	123	73	255	51
<i>Nuts, Seeds</i>	96	194	168	97	97	140	143	
<i>Cotton</i>				46	75	101		
<i>Tobacco</i>				427	1125	347		
<i>Pytherum</i>			220	51	97			
<i>Sisal</i>	143							
<i>Coffee</i>		97	51	96	284	28		
<i>Tea</i>		163			347			
<i>Cocoa</i>					181			
<i>Cashew nuts</i>			155	83		129		
<i>Sugarcane</i>	75	135	159	85	121	632		
<i>Spices</i>		134				240	124	
<i>Banana</i>	149	146	61	79	146	51	214	
<i>Fruits</i>		78	67	95			224	41
<i>Vegetables</i>	322	241	201	604	184	79	184	
<i>Others</i>	130	381	170	190	47	20	175	

Note: Mean in thousand (000') TSHs per acre based on 2010/11 NPS.

Table 6: Mean Profit in '000'TSHs by Regions: 2010/11 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma	Mwanza	Zanzibar
<i>Maize</i>	141	119	82	80	90	71	150	108
<i>Paddy</i>	153	354	135	129	144	183	167	37
<i>Sorghum</i>	54	115	74	74	48	63	145	43
<i>Millet</i>	51			88	66	5	224	
<i>Wheat</i>				93	89	21		
<i>Cassava</i>	132	128	85	72	82	68	152	41
<i>Irish Potatoes</i>		150		203	93		21	
<i>Sweet Potatoes</i>	223	159	136	117	103	117	288	
<i>Beans</i>	74	57	103	75	89	56	255	29
<i>Nuts, Seeds</i>	90	148	198	88	87	119	128	
<i>Cotton</i>				43	64	93		
<i>Tobacco</i>				373	960	248		
<i>Pytherum</i>			218	51	81			
<i>Sisal</i>	144							
<i>Coffee</i>		88	46	79	124	24		
<i>Tea</i>		151			18			
<i>Cocoa</i>					159			
<i>Cashew nuts</i>			135	77		89		
<i>Sugarcane</i>	75	116	121	92	106	562		
<i>Spices</i>		134					46	
<i>Banana</i>	135	127	59	64	115	44	212	
<i>Fruits</i>		73	52	72			216	41
<i>Vegetables</i>	305	209	175	556	169	63	167	
<i>Others</i>	130	271	170	122	34	20	175	

Note: Mean in thousand (000') TSHs per acre based on 2010/11 NPS.

Table A7: Mean Quantity of Harvested Crop (Kg/farm) by Regions 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	1042	960	978	1090	2399	705
<i>Paddy</i>	1018	793	957	1006	1897	1105
<i>Sorghum</i>	1117	81	862	920	1949	507
<i>Millet</i>	961	102		1133	814	351
<i>Wheat</i>				1435		
<i>Cassava</i>	0		1993	680	1274	427
<i>Irish Potatoes</i>		1591		1043	1482	260
<i>Sweet Potatoes</i>	500	766	743	717	1108	983
<i>Beans</i>	1355	565	889	1430	1754	723
<i>Nuts, Seeds</i>	1307	557	439	1221	1777	478
<i>Cotton</i>					2126	338
<i>Tobacco</i>				1319	1421	
<i>Sisal</i>				1136		
<i>Coffee</i>				380		
<i>Cashew nuts</i>			3886	161	3160	
<i>Sugarcane</i>			525			
<i>Banana</i>		754	454			522
<i>Fruits</i>		300	492	184	4050	
<i>Vegetables</i>	470	852	3218	1350	2221	1171
<i>Others</i>		286	7674	444		

Note: Mean in kg per farm based on 2008/09 NPS.

Table A8: Median Quantity of Harvested Crop (Kg/farm) by Region 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	708	400	310	468	980	300
<i>Paddy</i>	232	209	432	552	1080	300
<i>Sorghum</i>	720	70	400	440	1630	245
<i>Millet</i>	750	64		629	387	345
<i>Wheat</i>				1480		
<i>Cassava</i>	0		235	218	1274	220
<i>Irish Potatoes</i>		960		810	320	240
<i>Sweet Potatoes</i>	500	500	210	579	425	336
<i>Beans</i>	1029	254	449	780	936	320
<i>Nuts, Seeds</i>	995	260	400	450	1070	320
<i>Cotton</i>					1242	200
<i>Tobacco</i>				1150	888	
<i>Sisal</i>				1380		
<i>Coffee</i>				380		
<i>Cashew nuts</i>			375	161	3160	
<i>Sugarcane</i>			525			
<i>Banana</i>		80	500			120
<i>Fruits</i>		300	550	184	4050	
<i>Vegetables</i>	470	400	520	300	776	240
<i>Others</i>		360	60	255		

Note: Median in kg per farm based on 2008/09 NPS.

Table A9: Mean Value of Harvested Crop (000' TShs/farm) by Regions 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	206	303	203	242	389	230
<i>Paddy</i>	336	275	228	238	495	197
<i>Sorghum</i>	250	52	384	244	527	162
<i>Millet</i>	178	46		282	197	84
<i>Wheat</i>				409		
<i>Cassava</i>	0		296	175	188	138
<i>Irish Potatoes</i>		264		304	308	50
<i>Sweet Potatoes</i>	48	183	174	210	262	382
<i>Beans</i>	285	198	232	420	414	236
<i>Nuts, Seeds</i>	273	140	184	237	432	216
<i>Cotton</i>					570	80
<i>Tobacco</i>				277	298	
<i>Sisal</i>				171		
<i>Coffee</i>				77		
<i>Cashew nuts</i>			253	33	447	
<i>Sugarcane</i>			1500			
<i>Banana</i>		109	189			106
<i>Fruits</i>		54	215	44	1404	
<i>Vegetables</i>	90	265	281	209	596	484
<i>Others</i>		71	209	407		

Note: Mean in kg per farm based on 2008/09 NPS.

Table A10: Median Value of Harvested Crop (000' TShs/farm) by Regions 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	119	106	84	120	177	103
<i>Paddy</i>	106	38	107	138	239	80
<i>Sorghum</i>	216	49	136	135	244	72
<i>Millet</i>	146	28		135	83	90
<i>Wheat</i>				250		
<i>Cassava</i>	0		84	75	188	74
<i>Irish Potatoes</i>		72		269	96	30
<i>Sweet Potatoes</i>	48	144	60	110	75	85
<i>Beans</i>	163	80	117	154	244	96
<i>Nuts, Seeds</i>	174	82	140	120	200	85
<i>Cotton</i>					327	55
<i>Tobacco</i>				217	171	
<i>Sisal</i>				201		
<i>Coffee</i>				77		
<i>Cashew nuts</i>			260	33	447	
<i>Sugarcane</i>			1500			
<i>Banana</i>		20	200			85
<i>Fruits</i>		54	69	44	1404	
<i>Vegetables</i>	90	132	192	85	180	84
<i>Others</i>		90	18	236		

Note: Median in thousand (000') TShs per plot based on 2008/09 NPS.

Table A11: Mean Crop Yield (Kg/acre) by Region 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	275	476	380	450	3312	380
<i>Paddy</i>	437	593	881	300	431	1129
<i>Sorghum</i>	286	144	318	320	508	392
<i>Millet</i>	226	78		456	303	483
<i>Wheat</i>				301		
<i>Cassava</i>			405	355	203	571
<i>Irish Potatoes</i>		713		262	240	824
<i>Sweet Potatoes</i>	100	874	390	250	438	313
<i>Beans</i>	222	315	301	464	395	441
<i>Nuts, Seeds</i>	254	400	373	443	419	487
<i>Cotton</i>					434	246
<i>Tobacco</i>				699	287	
<i>Sisal</i>				327		
<i>Coffee</i>				253		
<i>Cashew nuts</i>			1421	161	181	
<i>Sugarcane</i>			105			
<i>Banana</i>		355	198			567
<i>Fruits</i>		300	98	92	900	
<i>Vegetables</i>	121	537	719	474	413	394
<i>Others</i>		291	691	90		

Note: Yield in Kg per acre based on 2008/09 NPS

Table A11: Median Crop Yield (Kg/acre) by Region 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	214	300	187	251	313	235
<i>Paddy</i>	312	400	230	192	358	350
<i>Sorghum</i>	217	175	156	132	318	245
<i>Millet</i>	217	64		267	254	493
<i>Wheat</i>				291		
<i>Cassava</i>			122	231	203	347
<i>Irish Potatoes</i>		1056		233	128	960
<i>Sweet Potatoes</i>	100	200	400	205	391	217
<i>Beans</i>	155	200	150	314	288	264
<i>Nuts, Seeds</i>	217	288	190	275	273	296
<i>Cotton</i>					385	200
<i>Tobacco</i>				221	205	
<i>Sisal</i>				325		
<i>Coffee</i>				253		
<i>Cashew nuts</i>			162	161	181	
<i>Sugarcane</i>			105			
<i>Banana</i>		160	200			480
<i>Fruits</i>		300	107	92	900	
<i>Vegetables</i>	121	400	157	133	270	200
<i>Others</i>		360	80	68		

Note: Based on crop/acre data in 2010/11 NPS.

Table A12: Mean Crop Income (000 TShs/acre) by Region 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	54	141	98	114	101	122
<i>Paddy</i>	148	214	237	74	115	117
<i>Sorghum</i>	66	98	111	68	170	108
<i>Millet</i>	40	35		100	74	119
<i>Wheat</i>				85		
<i>Cassava</i>			68	86	26	187
<i>Irish Potatoes</i>		112		78	61	110
<i>Sweet Potatoes</i>	10	151	111	74	83	160
<i>Beans</i>	44	112	71	109	105	142
<i>Nuts, Seeds</i>	53	103	134	97	85	148
<i>Cotton</i>					113	58
<i>Tobacco</i>				156	88	
<i>Sisal</i>				52		
<i>Coffee</i>				51		
<i>Cashew nuts</i>			101	33	26	
<i>Sugarcane</i>			300			
<i>Banana</i>		61	83			189
<i>Fruits</i>		54	38	22	312	
<i>Vegetables</i>	23	178	110	101	261	179
<i>Others</i>		71	69	84		

Note: Based on crop/acre data in 2010/11 NPS.

Table A12: Median Crop Income (000 TShs/acre) by Region 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	36	91	60	57	63	69
<i>Paddy</i>	134	150	62	50	108	95
<i>Sorghum</i>	43	123	53	37	64	69
<i>Millet</i>	38	28		64	53	129
<i>Wheat</i>				70		
<i>Cassava</i>			46	43	26	100
<i>Irish Potatoes</i>		119		65	38	120
<i>Sweet Potatoes</i>	10	60	100	47	63	56
<i>Beans</i>	32	73	49	71	68	70
<i>Nuts, Seeds</i>	47	81	63	60	60	96
<i>Cotton</i>					92	50
<i>Tobacco</i>				46	52	
<i>Sisal</i>				47		
<i>Coffee</i>				51		
<i>Cashew nuts</i>			74	33	26	
<i>Sugarcane</i>			300			
<i>Banana</i>		40	80			136
<i>Fruits</i>		54	32	22	312	
<i>Vegetables</i>	23	132	60	67	66	96
<i>Others</i>		90	24	63		

Note: Median in thousand (000') TShs per acre based on 2008/09 NPS.

Table A13: Mean Profit (000'TShs/acre) by Regions 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	46	117	95	112	94	123
<i>Paddy</i>	116	207	223	70	118	112
<i>Sorghum</i>	47	75	113	57	158	97
<i>Millet</i>	40	34		96	67	114
<i>Wheat</i>				79		
<i>Cassava</i>			78	53	22	179
<i>Irish Potatoes</i>		116		66	55	104
<i>Sweet Potatoes</i>	8	118	95	63	79	153
<i>Beans</i>	42	96	68	105	89	130
<i>Nuts, Seeds</i>	50	63	130	95	76	138
<i>Cotton</i>					102	57
<i>Tobacco</i>				87	85	
<i>Sisal</i>				50		
<i>Coffee</i>				51		
<i>Cashew nuts</i>			110	28	26	
<i>Sugarcane</i>			296			
<i>Banana</i>		61	43			158
<i>Fruits</i>			42	15	299	
<i>Vegetables</i>	22	131	118	102	269	139
<i>Others</i>		71	67	83		

Note: Median in thousand (000') TShs per acre based on 2008/09 NPS.

Table A13: Median Profit (000'TShs/acre) by Regions 2008/09 NPS

Crops	Dodoma	Arusha	Morogoro	Dar	Mbeya	Kigoma
<i>Maize</i>	34	80	57	53	53	71
<i>Paddy</i>	108	71	59	45	133	89
<i>Sorghum</i>	36	94	50	28	53	51
<i>Millet</i>	38	28		62	39	126
<i>Wheat</i>				62		
<i>Cassava</i>			53	43	22	83
<i>Irish Potatoes</i>		192		38	34	120
<i>Sweet Potatoes</i>	8	30	24	46	60	48
<i>Beans</i>	46	63	46	67	57	52
<i>Nuts, Seeds</i>	40	23	56	58	49	81
<i>Cotton</i>					82	45
<i>Tobacco</i>				25	45	
<i>Sisal</i>				46		
<i>Coffee</i>				51		
<i>Cashew nuts</i>			74	28	26	
<i>Sugarcane</i>			296			
<i>Banana</i>		40	27			126
<i>Fruits</i>			32	15	299	
<i>Vegetables</i>	22	96	64	57	55	84
<i>Others</i>		90	12	56		

Note: Median in thousand (000') TShs per acre based on 2008/09 NPS.

The International Growth Centre (IGC) aims to promote sustainable growth in developing countries by providing demand-led policy advice based on frontier research.

Find out more about
our work on our website
www.theigc.org

For media or communications
enquiries, please contact
mail@theigc.org

Subscribe to our newsletter
and topic updates
www.theigc.org/newsletter

Follow us on Twitter
[@the_igc](https://twitter.com/the_igc)

Contact us
International Growth Centre,
London School of Economic
and Political Science,
Houghton Street,
London WC2A 2AE

IGC
International
Growth Centre

DIRECTED BY



FUNDED BY



Designed by soapbox.co.uk