FAO COMMODITY AND TRADE POLICY
RESEARCH WORKING PAPER No. 37

STRUCTURAL CHANGES IN THE SUGAR MARKET AND IMPLICATIONS FOR SUGARCANE SMALLHOLDERS IN DEVELOPING COUNTRIES

COUNTRY CASE STUDIES FOR ETHIOPIA AND THE UNITED REPUBLIC OF TANZANIA

by

El Mamoun Amrouk, Manitra A. Rakotoarisoa, and Kaison Chang

Trade and Markets Division
Food and Agriculture Organization of the United Nations

Contents

List of Tables

ACKNOWLEDGEMENTS

This report is part of an initiative by the Trade and Markets Division of the Food and Agriculture Organisation (FAO) to analyse the determinants and impacts of smallholder participation in commodity markets. Thanks to Denis Issa and Debele Debela Enke, who carried out the field survey in Tanzania and Ethiopia, respectively. The authors are also grateful to the support received from the FAO representation office in Ethiopia and Tanzania. Special thanks for the support and assistance of the following FAO colleagues: Patrizia Mascianà, Barbara Ferraioli, Julia Delpapa, Jamie Morrison, Holger Matthey, Boubaker Ben-Belhassen, and David Hallam.

ABSTRACT

World sugar has experienced a number of trade and policy changes. Their impact on the sugar sector and stakeholders in developing countries has yet to be fully understood. For developing countries such as Ethiopia and the United Republic of Tanzania, which have the potential to expand sugar production and exports, understanding the impact of current and prospective trends in the world sugar market on the income and wages of smallholders and workers can provide useful insights into the contribution of the sugar sub-sector to development goals. This paper employs econometrics and simulation techniques on household survey data to analyze the effect of a set of policy and market scenarios on employment and income of stakeholders (smallholders, workers) in the sugar sub-sectors of Ethiopia and the United Republic of Tanzania. The study reviews the current state of the world sugar market, discusses the likely impacts of various market and trade policy scenarios, and identifies the linkages between the macro level changes and earnings of small stakeholders. The key findings are that changes in international markets have limited effects on smallholders' income, mainly because of the low supply response of smallholders in the face of relatively high elastic global supply. The increase in border price of sugar is beneficial to small farmers if the opportunity cost of land is low, or if domestic agricultural prices become more flexible.

Keywords: sugar market, trade, EU, Africa, liberalization

1. Introduction

The international sugar market has experienced a number of trade and policy changes. Their impact on the sugar sub-sector and stakeholders in developing countries has yet to be fully understood. Recent trends include the increasing role of biofuel crops in agricultural and industrial production, rising resource competition between food and industrial crops, increasing demand for commodities including food products, and domestic and trade policy reforms. For developing countries such as Ethiopia and the United Republic of Tanzania, which have the potential to expand sugar production and exports, the estimation of the impact of current and prospective trends in the sugar market on the income and wages of smallholder farmers and workers can provide useful insights into the contribution of the sugar sub-sector to development goals.

A significant body of literature already exists on the effect of policy measures and trade adjustments on the global sugar market. However, most of these studies were undertaken at the aggregate level both across and within countries. To better assess the effect of key factors such as changes in relative prices, changes in technology, and policy reforms, it is important that more empirical research be conducted at the household level. The objective of this study is to analyze the impacts of a set of policy and market scenarios on employment and income of stakeholders (smallholders, workers) in the sugar sub-sectors of Ethiopia and the United Republic of Tanzania. Specifically, this study sets out to (i) review the current state of the sugar market (ii) assess the impact of specific market and trade policy scenarios on the sugar sub-sector and (iii) identify the linkage between the macro level changes and earnings of small stakeholders. This study draws policy recommendations (investment, institutions, etc) on how to strengthen these linkages to reduce poverty.

Section 2 of the paper provides an overview of the world sugar market: supply and demand balance and its price implications. Sections 3 and 4 examine income determinants of smallholders derived from sugar and how farm productivity impacts poverty in both Ethiopia and Tanzania. The section also includes simulation results of the impact of a series of scenarios on smallholders. Finally, Section 5 draws some lessons and implications for policy intervention.

2. Sugar Market and Policies in Selected Countries

2.1 World Sugar Market, Prices and Production Costs

The world sugar market has been characterized by periods of short-lived price spikes followed by low and/or downward trending price patterns. This price behaviour emerges as a result of extensive use of protective policy measures by governments that isolate sugar producers from the world market. World sugar production, in raw equivalent, averaged 170 million tonnes between 2009/10 and 2012/13. Brazil was the world largest sugar producer and exporter accounting for 23 percent of world production and 48 percent of global trade during the same period. It is a common belief that the significant production growth that occurred in Brazil since the 1990s was linked to a massive investment in technology both at the farm level - in terms of the adoption of high performing sugarcane clones - and at the factory level, with the conversion of sugarcane into ethanol. India is the second largest producer accounting for 15 percent of global output followed by the EU (10 percent), China (7 percent), Thailand (6 percent), United States (4 percent) and Mexico (3 percent). Africa accounted for 6.1 percent of world sugar output between 2009/10 and 2012/13, down from 7 percent in 1990/91-1994/95.

World average sugar consumption between 2009/10 and 2012/13 was estimated at about 165 million tonnes, 26 percent larger than the previous decade. Growth in consumption has mostly taken place in the developing countries, driven by population and per capita GDP growth. Consumption in developed countries has been relatively stagnant because of already high levels per capita sugar consumption – 36 kg per caput in comparison to the world average of 24 Kg – and dietary shifts away from sweeteners have also contributed to slower sugar intake. Estimates for major sugar consuming countries reveal that industrial demand accounts for 68 percent in the EU, 48 percent in Brazil, while it is about 60 percent in India and the United States. Sugar usage by the manufacturing and food preparations sectors is

expected to expand the most in the developing countries in line with faster urbanisation rates and stronger gains in per capita income.

A prominent feature of the world sugar market in recent years has been the shift in EU trade position from a net exporter of predominantly white sugar to a net importer of mainly raw sugar reflecting the reforms of the sugar regime in 2006/07, when production support was removed. Imports to the EU are set to grow from an average of about 3.2 million tonnes in 2007/08-2009/10 to a projected level over 4 million tonnes in 2021. These imports are necessary in order to balance the internal market given the decline in production to about 16 million tonnes with consumption increasing to 18.5 million tonnes and export limited at 1.6 million tonnes (OECD, 2012). Initially, the bulk of the expected increase in import demand was to be sourced from countries that hold preferential market access to the EU. However, the level of these imports has remained relatively low, mostly because of the reduction in the EU reference price[1]. To address this, the EU introduced a series of measures, including duty-free quotas for imports to least developed countries, including those in the ACP group, an import quota tendering scheme, and reclassification of certain quantities of out-of-quota sugar production into quota sugar. In general, preferential suppliers that manage to produce and export sugar at a competitive price should benefit from greater market access to the EU, while high cost traditional suppliers may decide to reallocate exports to domestic or regional markets.

The influence of the energy market on the world sugar market has strengthened over the past 10 years, because sugarcane, which accounts for over 80 percent of world sugar output, is also a major input for the production of ethanol, a substitute for fossil fuels. This is notably the case in Brazil where more than half of sugarcane harvest is processed for the production of ethanol. When ethanol prices increase, sugar factories in Brazil choose to process relatively more sugarcane into ethanol at the expense of sugar, lowering the export availability of sugar and creating an upward pressure on world sugar prices, as Brazil is considered to be a global price setter accounting for more than 50 percent of world sugar exports.

1 As part of the reform of the sugar regime, EU sugar reference price was reduced by 36 percent over 4 years beginning in 2006/2007 season, while sugar beet price was cut by 40 percent.

While there is controversy surrounding the extent to which biofuels influenced the recent price upswing, there is broad consensus on the strengthening of the integration between energy and agricultural markets at both the supply and demand levels. An increase in oil prices translates into higher cost of production which tends to limit crop supply in the short-run. While at the same time, rising energy prices provide incentives for the production of ethanol, leading to an increase in derived demand for food crops by ethanol distillers. The net effect will depend on the final adjustments between food-based feedstock and biofuel/oil prices. A study by Balcombe and Rapsomanikis (2008) concluded that, on average, prices of oil, ethanol, and sugar tended to move together in the long-run but that the relationship was nonlinear. In other words, the relationship is activated only when oil prices move above a certain threshold, otherwise it is inactive and sugar prices are determined by their own market fundamentals. A study review carried out by Serra (2012) found that a majority of research showed that either crude oil or biofuel prices impact food price levels in the long-run. These studies, however, do not seem to find evidence that biofuel prices have a long-run impact on fossil fuel prices.

The prospect for expansion of biofuel consumption in the US and the EU (27), largely in response to institutional support in the form of mandated targets and tax incentives, means that in the years ahead, changes in the energy market will continue to be transmitted to food markets creating price volatility. Only with the development and commercialisation of second generation biofuels can the impact of this link be expected to lessen.

2.2 Productivity gains and production costs

A closer look at world sugar prices, expressed in real terms, indicates the downward trend that characterised prices over the past 15 years seemed to have dissipated by the turn of this decade. Since 2000, real sugar prices have been trending upward at an average of 4.2 percent per year. The 2006 price hike accelerated the rate of growth, but even when we control for the influence of outliers, prices would still be increasing at a rate of 2.25 percent[2].

2 The 2006 price is smoothed out on the basis of a three year moving average.

This trend reversal in the long-term price development bears several possible implications for the sugar industry. Most importantly it illustrates the idea that productivity gains and new capacity in recent years may have not been large enough to keep up with the sustained expansion in global demand for sugar. It is likely that low and depressed prices recorded in the late 1990s did not provide sufficient incentives to boost investment in the sugar sector to a level that matched consumption growth. Relatively better biofuel returns have also contributed to the increase in real prices by diverting resources away from sugar, as most of the investments that have taken place recently in Brazil, have targeted the sugarcane-based ethanol sub-sector. Apart from shortfalls in investment levels, rising real prices may also reflect an upward shift of short-run and long-run average cost curves, as a result of higher factor input prices including energy, labour, pesticides, and freight.

This study assumes a baseline where productivity, measured in terms of sugarcane yield per hectare, will expand at an average rate of 0.77 percent over the next decade, which is down from a 0.98 percent growth in the 10 years. However, alongside expected expansion in cultivated area, projected growth in yields should be enough to force real prices to decline, but from a higher plateau. Productivity prospects for sugar are far from being certain and may change depending on a number of factors, chiefly the size of public investment in agriculture. This is relevant for developing countries where about 95 percent of research and development (R & D) is publicly funded and less than 0.5 percent of agricultural GDP is invested in R and D. Our assumptions on yield prospects and supply expansion remain contingent on the level of R & D funding and the speed of adoption of technologies, particularly by smallholder sugar producers.

3. Impact of Ethiopia sugar market changes on sugar farm household Income

3.1 Market Context and Challenges

Ethiopia produces 340 000 tonnes of sugar on 25 000 ha of land annually and about 20 000 tonnes a year is sold to the EU under the Everything but Arms (EBA) initiative. However, Ethiopia's domestic sugar consumption is considerably higher (1.26 times) than its production. Therefore, the country imports about 152 000 MT of sugar per year to satisfy domestic demand. Although foreign investors have expressed growing interest in sugar production, Ethiopia's sugar sector has remained mainly state-run under the Ethiopian Sugar Corporation (ESC and formerly known as Sugar Development Agency) which controls sugar production, processing, marketing and trade.

The sugar sub-sector in Ethiopia faces several challenges, the most important of which remains that of satisfying local demand at a stable and relatively low consumer price. Ethiopia exports some of its sugar to take advantage of the EBA but at the same time, its current production level still cannot keep up with the fast growing demand for both sugar and ethanol. The fast growing demand for both energy and sugar is due to the population and per capita income growth. Ethiopia is also facing challenges stemming from its complex sugar trade policies and trading arrangement at both regional and global levels. On the one hand, the sugar sub-sector struggles to satisfy rising domestic demand, while on the other hand it wants to take advantage of preferential market access such as the EBA.

Another big challenge the Ethiopian sugar sub-sector faces is the unpredictable changes in the world sugar market. Changes in the sugar market, specifically changes in international sugar prices, significantly affect the Ethiopian sugar industry. Consumers in the Eastern part of the country rely on cheaper imports coming through the Djibouti and Somali coasts, while those inland rely on the domestic industry. A hike in the international sugar price is likely to induce Eastern consumers to source their sugar supply

domestically, leading to a tight domestic market and subsequent higher sugar price, which would force Government to intervene to stabilize domestic prices.

3.2 Current measures, policies and additional Challenges

(i) Constraints linked to the expansion of production

Ethiopia has decided that one way to address these challenges is to expand production. Therefore, it is implementing an ambitious plan, through the ESC, to more than double production by expanding the cultivated land area and improving production infrastructure (dams, plant renovation). Ethiopia has currently three state-owned sugar production sites which are Metahara, Wonji and Finchaa. Ten new sugar projects are now being developed: one factory each at Tana Beles in the Amhara Regional State; Welkayt in Tigrai Regional State; Kesem; and Tendaho in Afar Regional State; and six factories in the South Omo Zone. The largest by far is however the project in Tendaho where the construction of a river dam has now been completed. When fully operational, the three expanded factories (Metahara, Wonji and Finchaa) will have a production capacity of 280 000 tonnes of sugar per year in total; and by the end of 2012 or early 2013, the Tendaho estate is expected to be operational with an annual output of 600 000 tonnes of sugar (crushing capacity of 26 000 tonnes of cane per day) from 64 000 ha. With all the expansion and new construction of sugar plants, Ethiopia's aim is to increase its total sugar production beyond 800 000 tonnes per year by the 2015.

Sugar production and especially the extension in cane area and processing have improved the livelihood of some neighbouring households through employment and income generation. However, they also present additional challenges which have implications on stakeholders both within and outside the sugar sub-sector. Land rights and relocation of farmers remain a big challenge. For instance, the expansion in production areas required households to be relocated, the majority of whom have been living in public lands for many years. These farmers would become landless facing the choice of either staying in the area as sugar workers or moving away, but in either case they will receive a certain amount of compensation

proportional to their purported losses. As the government is prepared to offer a compensation package for all the relocated households, i.e. both those who might move nearby and work for the sugar sector and those who would choose to move far outside the sugar areas, the amount and the basis of the allocation of the compensation remain unclear. Similarly, for those who stay, it is unclear how their entry into the sugar sector would really affect their income and wages. These uncertainties affecting both farmers and government's decision prompt in-depth studies of actual impacts of sugar policy on household's income in the area covered by the relocation. The present study intends to contribute to reducing such uncertainties.

(ii) Policies and Implications for the welfare of poor farmers and workers

Two of Ethiopia's main goals of its sugar policy instruments are the stabilization of the sugar supply and the control of consumer price. The instruments employed to achieve these goals may affect the livelihood of poor stakeholders and have an effect on the wages of sugar workers and farmers. Maintaining a low refined sugar price to consumers involves limiting prices and wages at the production level. In 2009, farm gate price for sugar cane was 160 birr (about 11 USD) per tonne while the price of refined sugar to consumers was at 8000-9000 birr (570-650 USD) per tonne. With a transformation ratio of 10 tonnes of cane per tonne of refined sugar, the ratio between farm and retail prices is about 1/5, highlighting the distortion imposed on farm price and on the size of the margin between the two[3]. How the extension of sugar production will affect acreage and income of smallholders is important in determining the effects of likely change in prices. Indeed, if the current control on domestic sugar prices is becoming unsustainable, any reform towards freer domestic market requires deeper analysis, as any new measure would weigh off the poor urban consumer's loss against poor farmer's gain.

As for exports, an increase in world price could imply a reallocation of sugar production between domestic consumption and export. The high level

3 These figures emanated from the surveys, not from official or institutional sources. Prices and transformation ratios may vary from one location to others. They are shown as an example of the distortions in the domestic market.

of segmentation of the sugar market in Ethiopia goes beyond the consumer classification groups and extends to geographical location; such market segmentation adds further complications on the estimation of impacts and implication at the country level.

3.3 Objectives

The expansion of sugar production and the changes in sugar market policies at the domestic and world markets pose particular challenges to the sugar sub-sector in Ethiopia. Yet the effects of these challenges on stakeholders, particularly on income of sugar farmers and workers at the household level are not well understood, despite the role sugar plays in consumption and livelihood of inhabitants in the production areas[4]. This study is designed to assess the impact of policy changes on the livelihood, specifically income of the population.

To estimate the likely impact of policy changes on income, household surveys were conducted in two different areas in rural Ethiopia: Wonji, in central Ethiopia, and Tendaho in the North-eastern part of the country. There were two steps in the analysis of the data collected. Firstly, the household data was used to estimate the model parameters, allowing the assessment of the effects of policy changes on farm income and workers' wages for both existing and new sugar locations. The second step involved the use of the parameters and information derived from the first step to examine the specific impact on farm income and workers' wages.

3.4 Model and Method

The model is drawn from a reduced form equation linking household income to output prices and input costs, along with some household

4 One recent study on the relocation of farmers following the creation of water dam in Tendaho by the ESC (former ESDA) gives important though insufficient insights on the difficulty to assess the impact of state-run development and investment projects on the local population.

characteristics. This model is adapted from the farm household model by Huffman (1991) extended by Fernandez-Cornejo (2005).

(1) *Net income = f(Output prices, Input prices and wage, consumer good prices, technology or production shifter, household characteristics, and other source of income (non-ag.))*

This model (1) is used as a basis to obtain parameter estimates in answering the question: How the extension of land use affects income for both existing and newly built sugar sites? Then, the parameter estimates are employed to determine the impacts of likely changes originating from world sugar and market policies and from the extension of sugar plantation on household income.

3.4.1 Impact of sugar production on household income and wage: Particular case where prices and yields are fixed

The difficulties in measuring the supply responses based on equation (1) are that sugar cane prices are officially fixed by the state-owned sugar manufacturer. Because the surveyed households are all living in the same area and around the sugar factory, they may have the same level of access to technology and share the same soil and microclimatic conditions. As a result, the yields and sugar content may not differ much among farmers, and therefore, little variation in unit values and revenue across farms. The only response to shocks (policy or price changes) that can provide variation for estimation is on acreage.

Moreover, given the resources and land constraints, the household's problem is on how to allocate their scarce land between sugar and other crops (cereals and vegetables). For these reasons, the basic and equivalent question to be asked becomes: how an increase in the sugar area relative to other crops will impact total or per capita income? In other words, the key variable is the share of sugar acreage rather than acreage per se. These remarks lead to the following model:

(2) $I = f(Pc, As, Ws, Z)$

I: is household income

Pc: is index price of crops other than sugar

As: is sugar acreage/total acreage

Ws: Wage

Z: host of household characteristics (age of households, level of education of the head of the household, livestock assets)

3.4.2 Impact of extension of sugar production on income and wage using the matching technique

Here the main question to be answered is how the participation in sugar production would affect the income of farmers and wages of workers who have not produced sugar in a large scale (or have never produced sugar cane). In other words, the questions are 'Do sugar farmers earn more than non-sugar farmers?' and 'Does the extension of sugar participation in the sugar sub-sector increase the household's wealth?'.

For this ex-ante evaluation, the approach chosen is the matching technique which is best summarized in Todd and Wolpin (2007). The detail of the matching technique is also presented in the Annex 1. This method matches untreated households (those who have not grown sugar cane on their land) with other households (those who have grown sugar) with similar characteristics, known as matching covariates. The key matching covariates for the estimation include household characteristics such as family size, level of education, age of the head of household, livestock assets, and landholding. For this estimation, the data from the surveyed households in Tendaho and Wonji were merged. The outcome variables, basis of comparisons, include household income, per capita income, and wage income.

3.5 The Data and Estimation Results

To have an insight into the impact of policy shocks on income and wages of smallholders and workers, surveys were conducted in Wonji and Tendaho located in the Central and North-eastern parts of the country (see Annex 2). 240 households were surveyed.

3.5.1 Description of the surveyed households

The key characteristics of the households are summarized in table 1 and are described below.

Table 1. Average statistics on the surveyed households (per household per year)

	Wonji	Tendaho
Total income (birr)	37 127	20 952
Sugar Income (birr)	11 134	6 219
Sugar farming income (birr)	5 812	0
Sugar labour income (birr)	5 322	6 219
Crop land return (birr/ha)	10 076	1 414
Sugar	4 310	0
Crops return other than sugar (birr/ha)	26 250	1 414
Income from livestock production (birr)	2 724	7 270
Land holding (hectare)	2.8	1.8
Allocated to sugar (hectare)	1.6	0
Total livestock unit equivalent	3.7	9.8
Family size	6.5	5.1
Age of the head of household	47.5	37.9
Number of years of education	2.1	1.1
Total number of households	120	120

Source: Authors

In 2008-2009, time of the survey, 1 dollar was about 14 birr (i.e. a1 birr is about 0.071 USD).

Wonji (120 households):

- Household income varies widely between 6 200 and 116 110 birr per year and is about 37 000 birr (about 2 643 USD) per household on average.
- Household derives 39 percent of their income from working for and farming in the sugar sector. Average income from sugar is about 11 000 birr (about 786 USD) per year per household
- Household income from the sugar sector is almost equally divided between income from sugar production and income from the wage earned within the sugar sector: income for sugar production is only slightly higher at 5 812 vs. 5 322 birr per year per household.
- The average land holding is 2.7 ha per household. While households devote on average a large land share (1.6ha per household, i.e. about 63% of total acreage) of for sugar production, sugar farming contributes about 19% of their income only. Besides the income coming from wage earned as sugar worker, the rest of household's income comes from livestock keeping and cereal, vegetable and other food crop growing.
- Sugar cropping provides on average an income of 4 310 birr (308 USD) per year per ha, while other crops (food grain and vegetables) contribute to about 26 250 birr (1 875 USD). This indicates that the opportunity cost of land is fairly high (and discouraging sugar production).
- Crop revenue per unit of land varies greatly between 600 to 25 882 birr but is on average about 10 076 birr (720 USD) per year and per hectare.

Tendaho (120 households):

- All households are currently sugar workers and at the time of the survey, none of them has planted sugar on its own land yet but some of them work in the sugar factory (as sugar workers).

- Household income varies greatly from 3 500 to 116 160 birr per year. Average household income is about 21 000 birr (1500 USD).

- 35 percent of the household income is derived from wage earned in the sugar sector (e.g. as a construction worker for the new sugar processor, or as a driver). The rest comes from livestock and food crops (cereals and vegetables).

- Land holding per household varies from 0 to 10 ha and is on average about 1.8 ha.

- Return per unit of land varies from 0 (landless) to 8 000 birr per ha per year and is on average about 1 413 birr (101 USD) per ha per year. Such return average is low compared to that of Wonji.

3.5.2 Estimation results and Implications

(a) **Results of the estimation of the impact of sugar production on household income and wage in Wonji**

An econometric model is obtained from model (2) by adding error terms and the variables are expressed in log form prior to the estimation. The model is run using household and per capita income as dependent variables. Heteroskedasticity problem arising from the high discrepancy in income has been corrected. The results of the estimation are summarized in Table 2 using the Wonji household data and showing that coefficients are statistically significant for many of the relevant variables, especially for the sugar share and price index of non-sugar crops. Specifically, the estimation results show that:

- The higher the share of land occupied by sugar plantation, the lower the total household and per capita income: one percent increase in sugar acreage share leads to a 0.3 percent reduction of the income.

- The higher the price of non-sugar crops, the higher the income: one percent increase in the index price of non-sugar crops leads to about 0.5 percent increase in the income per capita.

- But the higher the wage income from working in the sugar sector, the higher household income and per capita income.

Table 2. Household net income model for Wonji

	Dependent Variable (in log forms)	
	Income per household	Income per capita
Independent variables (in log forms)		
Price index of crops other than sugar	0.49 (6.89)	0.46 (6.08)
Sugar acreage share	-0.31 (-2.81)	-0.35 (-2.99)
Wage received in the sugar sector (per year per person)	0.04 (0.41)	0.55 (5.63)
Age of household head	0.32 (1.98)	0.12 (0.76)
Nb. of years of education	0.11 (1.78)	0.07 (1.07)
Total livestock unit equivalent	0.02 (0.41)	0.01 (0.23)
Constant	3.7 (3.17)	-0.30 (-0.25)
N=120 Adj R_sq	0.4	0.5

Note: All variables are in log form, except the 'total livestock unit equivalent'. Figures in parentheses directly below the coefficients are t-values.

These findings suggest that an expansion in area for sugar farming alone may not necessarily boost household income under the prevailing price. The negative correlation between area dedicated to sugar and income may signal a low production incentive and is perhaps due to the price fixing by sugar processors (which are also state owned). Households in Wonji may be better off allocating their land to produce other higher valued crops rather than sugar and for them to work as wage earners in the sugar sector (not cane growers). The expansion in sugar production may only increase household income, mainly because of the job opportunities it offers. To increase the incentives, sugar processors need to offer farmer prices that are as remunerative as other competing crops. As for the households, their strategy should build

on negotiating higher sugarcane prices, through farmer's association for example, and allocate resources where their revenues are maximized.

The reason Wonji households devote a large share of their land to sugar, despite it being less rewarding than other crops, remains unclear and is likely related to risk aversion. Fixed sugar prices somewhat guarantee income stability while revenue from other crops are more vulnerable to shocks and to the prices set by collectors. Similarly, planting sugar under the ESC may have eased access to inputs and credits.

(b) Results of the Estimation of the Expansion of Sugar production in Tendaho: ex-ante analysis and matching Tendaho-Wonji (see table 3)

The results of the estimation using the matching technique are summarized in Table 3 and interpreted as follows.

Table 3. Ex-ante assessment of effects of the expansion of sugar production in Tendaho using matching technique (birr)

	Average Treatment Effect of the whole sample(ATE)	Average Treatment Effect of the Treated (ATT)	Average Treatment Effect of the Control (ATC)
Effects on:			
Total income per household	11 659 (3.47)	18 561 (5.78)	4 757 (1.12)
Income per capita	3 429 (5.14)	3 262 (5.59)	3 596 (3.94)
Sugar labour income per capita	1 183 (2.63)	-186.50 (-0.64)	2 553 (4.17)
Share of sugar labour income	-0.14 (-3.53)	-0.24 (-5.27)	-0.06 (-1.20)
Crop land return per hectare	8 619 (11.78)	9 030 (10.68)	7 981 (9.9)
Nb. observation	240	120	120

Note: All units are in birr (about 0.071 USD) except for the variable *share of sugar labour income*. Figures in parentheses directly below the coefficients are *z*-values. As their names indicate, ATE is obtained by using the matching technique and taking the average estimates of the effects on all observations, whereas ATT and ATC are obtained by using the technique on only those households that participated in sugar farming and only those which did not participate, respectively.

- For two households having the same characteristics (family size, level of education, age of the head of household, livestock asset, landholding) a Wonji household member who is planting sugar and/ or working in sugar factory earns 3 000 birr (214 USD) per year more than a similar Tendaho household member earns.

- Similarly, sugar labour income per household and per year is about 1200 birr (86 USD) higher in Wonji than in Tendaho, as perhaps the extent of the sugar sector in Wonji allows allocation of more working hours on an individual basis. This could also suggest that extension of sugar activity in Tendaho would increase labour productivity.

- Also an expansion in the sugar plantation in Tendaho would lead to a jump in land return by 8 000-9 000 birr (between 571-643 USD) per ha. This big jump is not surprising because the return on crop cultivation (before sugar is planted) in Tendaho is currently low, in comparison with Wonji(cereal and food crops are not as high valued as in Wonji), and planting sugar on the land will then undoubtedly raise the value of land (as sugar appears more valued than the current crops cultivated in Tendaho).

- However, the share of income from labour working in the sugar industry compared to total household income would be significantly lower and reduced by about 14 percent if households in Tendaho started planting sugar cane as in Wonji. This seems puzzling at first but has a plausible explanation. While the share of the income from labour working in the sugar industry in Tendaho is currently higher than in Wonji, the revenue derived per unit area of land in Tendaho is far lower than in Wonji (see Table 1). This means that if growing sugar in their land proves optimal for some (not all) of the households in Tendaho there will be an adjustment in the structure of its income as a result of more resources (labour and land) going to be allocated to sugar plantation. As a result the share of income from sugar will decrease while the share and the return per unit area of land (because of the sugar cropping) will increase.

Therefore, households in Tendaho should not fear for the expansion in sugar area. The only caveat is that, assuming the situation in Wonji is a second best outcome, increasing area under sugar beyond the level reached in Tendaho may not prove beneficial because as the earlier finding show, additional increase in area (not acreage per se) is negatively correlated with the increase in income.

3.6 Conclusion and Implications from the Ethiopia study

The sugar policy in Ethiopia and the changes in the international sugar trade and markets affect income and wage of households that rely on sugar production and manufacturing. Using survey household data in an existing (Wonji) and a future (Tendaho) production area, this case study assesses the impact of these changes taking into account the flexibility in farm gate prices and the 'mobility' (i.e. flexibility of the supply) of farm land. The findings are as follows:

- The impact on household sugar production is difficult to measure and is somewhat hampered by the lack of flexibility in farm prices. Instead, the assessment is based on area allocated to sugar. In areas where the household land holding is fixed, the impact of an increase in sugar price translates to an increase in area allocated to sugar. If the opportunity cost of land is low, then an increase in area would benefit income. Otherwise, any measure that forces a farmer to increase area under sugar will fail to optimise income. Under any increase in sugar border price, income may only rise because of the increase in labour wage income, i.e. when the household member works as an employee in the sugar sector, instead of growing sugar cane.

- The increase in border price of sugar is most beneficial to small farmers if the opportunity cost of land (i.e. before sugar planting) is low (like in Tendaho), or if farm prices reflect the actual demand in the market. The ex-ante analysis of the effect of sugar production in Tendaho shows that expanding the sugar industry (plantation and factory) is beneficial to the Tendaho households for two reasons.

First it provides job opportunities and hence an increase in revenue from (though not the share of) labour income. Second, it also gives the opportunity for some households to grow sugar which will raise the return per unit area of land and further boost per capita and household income. Still, these gains could have been magnified when the farm prices were flexible.

The implication of these findings is that the benefit of an increase in sugar price should be better transmitted to growers by the removal of a fixed farm gate price and an expansion in land holdings. The lifting of the freeze on the farm gate price has not been considered for fear of a hike in consumer price leading to social turmoil. The Government of Ethiopia is addressing the land constraint by expanding acreage in new areas where production has never been taken place. However, expanding land area for farm households which are already producing sugar would prove beneficial also since these current sugar producers have already higher labour productivity than those in the new expansion area because of the skills already accumulated, but these gains to producers would be enhanced only if the farm gate price is allowed to reflect the market price more closely.

4. Impact of Tanzania's sugar market changes on sugar farm household Income

4.1 An overview of agricultural and sugar sector in Tanzania

Agriculture is the dominant sector in Tanzania. It accounts for about 45 percent of GDP and nearly 75 percent of merchandise exports. It is a major source of employment for about 68 percent of the employable adults with food cropping providing cash revenue for some 40 percent of households (Household budgetary Survey 2007). Recognizing the strategic importance of the agriculture sector for the achievement of national development goals, the Government of Tanzania devoted major efforts towards modernizing the sector and empowering agriculture producers. A seven-year program was

implemented in 2006/07 known as The Agriculture Sector Development Programme (ASDP) to address some of the bottlenecks hindering agriculture production and growth.

The 2007 Tanzania Household budgetary Survey showed that poverty levels were the highest amongst farmers. It showed that households were most likely to be poor if, among other contributing factors, they were dependent on the sale of food and cash crops. Given the determinant role of the agriculture sector as the main source of cash income for households and the body of evidence linking agriculture growth and poverty alleviation, the role of the sector becomes crucial in the fight against poverty and food insecurity. Within agriculture, the highest poverty incidence is found amongst households depending on livestock (59 percent), followed by households whose main activity is food cropping (41 percent), while the rate of poverty is about 39 percent and 33 percent for households who rely on cash crops and livestock products, respectively.

The major primary crop cultivated in Tanzania is maize, which occupies about 29 percent of area harvested, followed by sorghum (9 percent), rice (7 percent), beans (7 percent), and cassava (6.5 percent). The leading cash crop export is tobacco (unmanufactured) which represented nearly 21 percent of total agricultural export in 2006. Other major exports include coffee (14.5 percent), cotton (9 percent), cashew nuts (7 percent), and tea (6.6 percent). Sugarcane production in Tanzania accounts for less than 1 percent of harvested area and is currently used for the production of sugar. There are plans to use part of the sugarcane harvested for the production of ethanol but these remain at an initial stage. In 2010/11, sugar production reached 315 000 tonnes, a near 9 percent annual growth since 1998/99. The significant increase in sugar output is mainly attributed to large investments flowing into the sugar sub-sector in anticipation of improved access to the EU market as of October 2009, as part of the EBA.

About 16 percent of sugar production was exported in 2010/11, up from 3.5 percent in 1998/1999 as a result of expansion in production capacity and attractive export prices. Exports benefit from preferential market access to the EU under the Sugar Protocol, Special Preferential Sugar (SPS) – renamed as the Complementary Quota, following the EU reform of the sugar regime –, and the EBA initiative. Under SP, Tanzania holds a

quota of about 10 857 metric tonnes (raw sugar equivalent), while sugar delivered under SPS ranged between 1000 and 1700 metric tonnes (raw sugar equivalent). With the changes to the EU sugar regime in 2006, the gap between world and EU reference prices has narrowed considerably from levels where EU internal prices averaged three times higher than world prices. Tanzania is a relatively low cost sugar producer and is competitive even at the lower internal EU prices, and further gains can be expected provided targeted investments are put in place. Estimates showed that sugar costs of production in Tanzania are about 50 percent above the highest cost prevailing among the world's leading free market exporters[5] (FAO, 2005). In collaboration with the Government of Tanzania, the EU funded a programme to improve the efficiency and competitiveness of the sugar sub-sector. The programme's main objective was to improve infrastructure and institutional support and strengthen smallholders' participation in sugarcane production.

Prior to the liberalisation of the sugar sub-sector in the 1990s, marketing and trade of sugar was monopolised by the state-owned Sugar Development Corporation SUDECO. Since the reforms of the economy and the agricultural sector, purchases and merchandising of sugar was carried out by private agents who exercised arbitrage between surplus and deficit regions. Critics of the reform argued that the liberalisation process contributed to the surge in retail sugar prices as the commodity was subject to excessive speculative hoarding and smuggling to neighbouring countries. Measures were introduced to contain the price surge such as investment in storage capacity in the main producing and consuming centres. Improved infrastructure capacity and transportation services between producing surplus regions and net consuming regions should facilitate better price transmission within the sugar value chain and contribute to lower costs.

Currently, there are 4 companies processing sugar, all located in three of the most suitable areas for sugarcane production. Kilombero Sugar Company and Mtibwa Sugar Estates in Morogoro (together producing over 80 000 tonnes of processed sugar annually); the Tanganyika Planting Company (TPC) (over 35 000 tonnes); and the Kagera Sugarcane Estates in Kagera, (over 2 000 tonnes). These companies have introduced major plans

5 Leading free market sugar exporters includes: Australia, Brazil, Colombia, Guatemala, South Africa, and Thailand.

for rehabilitation and investment with a target of cutting down production cost and raising cane quality delivered to the mill. Sugar estates dominate the structure of the industry. The participation of smallholders has strengthened over the years due to remunerative sugarcane prices, but considerable efforts must be deployed to provide farmers with technical and institutional support. There is considerable scope for smallholders to expand production driven by the expected increase in demand for sugarcane by the factories as a result of investment in new capacity. Direct employment in the sugar sub-sector is estimate at 80 000 people of whom one third are unskilled rural labour. Other indirect employment are associated with procurement and distribution of imported sugar, supplies in the input market, provision of transport and social services in the producing areas. In addition, about 14 500 small scale farmers produce sugar in 10 800 ha and supply sugarcane to sugar factories. Hence, total direct and indirect employment associated with sugar is estimated at 150 000 people.

Per capita sugar consumption in Tanzania is relatively low – 10.1 Kg - compared to an average of 21 Kg for the group of developing countries. However, per capita consumption has been rising at a sustained 2.6 percent per year since 1999/2000 supported by population and per capita income growth. As the economy expands, it is expected that the food and beverages industries will become a major source of demand for sugar.

4.2 Tanzania's sugar study

4.2.1 Household surveys

A total of 109 respondents participated in the survey which was conducted in both Mtibwa and Kilobero areas in rural Morogoro. These are the only two regions of Tanzania where a small scale sugarcane production scheme exists. Prior to the actual fieldwork to collect data, a participatory rural appraisal (PRA) was conducted in both Mtibwa and Kilombero to explain the objective of the fieldwork, time frame and request for the collaboration and participation of stakeholders. Participants to the PRA included smallholder farmers, agricultural extension officers, village leaders and other key informants. Farmers were asked to identify major livelihoods,

major food and cash crops in the community, and production constraints. A structured questionnaire was also administered to supplement information collected through PRA. Questionnaires developed contained both open and closed-ended questions divided into four groups; farmer's demographic and related characteristics, land access and utilization, production economics, general comments on sugarcane production. Secondary data were collected and used in the survey. Group discussions were also held with leaders of farmers associations, extension officers working in cane, sugar stockholders, and suppliers of inputs to smallholders.

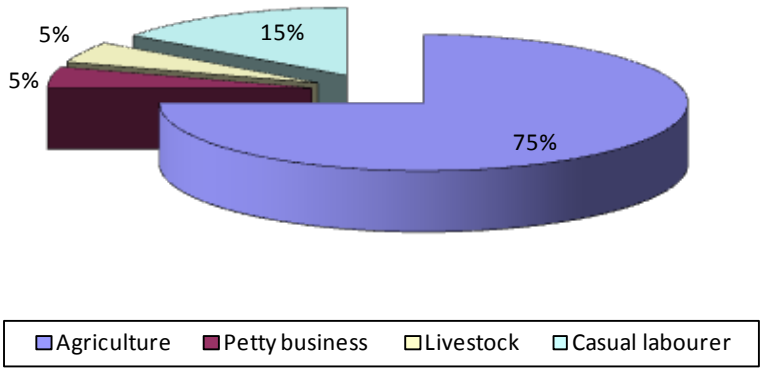
4.2.2 Survey key findings: Tanzania

Out of the 109 farmers who were interviewed, 50 were from Mtibwa and 59 from Kilombero. These were randomly selected from 25 villages located in cane growing areas. Major livelihoods categories in the community were found to be government and private sector employees (e.g. school teachers, social service, and transport providers), traders and sugarcane cutters. Sugarcane was ranked as the first major cash crop in both locations followed by rice, maize, and cassava. About 98 percent of farmers interviewed grew commercial sugarcane, with 50 percent of them spending between 20 and 40 percent of their time to attend sugarcane field. Over the recent past there has been a tendency to convert more land into sugarcane production at the expense of basic food crops, as these were associated with relatively high marketing and transaction costs. Sugarcane, on the other hand, was regarded as a fairly reliable cash crop, since prices were relatively stable and less susceptible to seasonal variation. In addition, access to credit was easier as some financial institutions were willing to provide funding using sugarcane as collateral. Returns from the survey indicated that in the 2007/08 season, 66 percent of the respondent allocated an area between 1 to 5 hectares to cane, while 17 percent cultivated an area between 5 to 10 hectares (Table 4). Major sources of income for the smallholders included agriculture (75 percent), casual labour (15 percent), small businesses (5 percent) and livestock keeping (5 percent) (Figure 4.1). Only about 4 percent of small-scale farmers had title deeds for their sugarcane fields. Most were unable to meet costs involved in processing and acquiring title deeds. This lack of security of tenure hampered access to credit from financial institutions.

Table 4. Total area allocated for sugarcane production (ha) in 2007/08

Area	Frequency	Percent
below 1 ha	7	6.6
1 - 5 ha	70	66.0
5 - 10 ha	18	17.0
10 – 15 ha	6	5.7
15 – 20 ha	1	0.9
20 – 25 ha	1	0.9
30 – 35 ha	1	0.9
40 – 45 ha	1	0.9
above 45 ha	1	0.9
Total	106	100

Figure 4.1: Source of income in cane growing areas



Source: FAO

Average household income for the sample was USD 2 170.5 and varied between USD 240 and USD 18 530. This corresponded to an income of about USD 6 per day. However, the average value masked large differences between households. About 40 percent of households earned less than USD 3 a day, while average income for 20 percent of them was less USD 2.2 a day (these were also identified as very poor by the PRA). Qualitative information obtained from the survey showed that this category of household usually did not earn and/or produce enough to meet the daily subsistence needs. Land ownership also demonstrated the disparity between households. Those who earned less than USD 3 a day owned less than 4 hectares of land, while the top quintile owned, on average, about 14 hectares. Despite disparities in land ownership, land utilisation was fairly similar between quintiles, as on average, household cultivated about 89 percent of the land, except for the top quintile who farmed 98 percent their land. Thus, poor households are relatively efficient in the use of the land, but constraints in accessing additional productive assets limit the possibility of higher income. On the other hand, sugarcane yields per hectare for the bottom quintile were 12 tonnes lower than the overall average (50 tonnes per ha), which underlined the large potential that exists in raising the income of the poorest through, for instance, better crop management and the adoption of higher yielding varieties. In fact, the top quintile allocated about USD 925 per hectare in farm expenses for the production of sugarcane, about USD 57 more that the bottom quintile.

Average value of assets held by households was estimated for the sample at USD 362, with only about 3 percent owning a tractor, and 1 percent use irrigation equipments on the farm. Food accounted for the largest share of household expenditure (45 percent), followed by expenditures on farm related activities (table 5). Consumption patterns were found to vary considerably among income quintile. Food expenditure accounted for the largest share of total income among the low-income quintile (86 percent), while it represented about 23 percent for the top quintile.

Table 5. Expenditures on selected household items by income quintile (%)

	Food	School	Medicine	Transport	Farming activities	Utilities
Quintiles						
First	39	7	6	7	24	18
Second	48	6	4	5	15	7
Third	54	8	5	7	19	9
Fourth	50	8	5	4	19	7
Fifth	34	16	6	8	39	6
Share (%)	45	9	5	6	23	9

Respondents were also asked to identify major constraints limiting the increase in production and income. A list of common constraint includes:

- Relatively high taxation rate imposed on sugarcane sales
- Inputs availability- not available in time and expensive
- Poor infrastructure – rural roads for transporting cane to the factory
- Lack of improved sugarcane varieties
- Low level of field management know how, including disease and pest management
- Credits – not available in time/lack of collaterals/high interest rate
- Weather – rainfall not reliable

4.2.3 Estimation results and Implications

The relationship between household income and sugar was assessed using model (2), as described in part 3. The estimation was carried out using returns from the sample surveys collected in Mtibwa and Kilobero. Results show that coefficients are statistically significant for many of the relevant

variables, particularly for the sugar share and price index of non-sugar crops (table 6). Specifically, the estimation output showed that:

- The higher the share of land occupied by sugar plantation, the higher total household income: 1 percent increase in sugar area leads to a 0.29 percent increase in household income. Land is a limiting factor in the extension of sugar production, partly because of a lack of resources to mobilize additional factor input but also existing administrative constraints in access to land. The allocative efficiency analysis showed that the marginal value product of land was larger than its optimal value as measured by the crop value added by hectare[6] - confirming that land expansion can increase income.

- A 1 percent increase in the price of sugarcane leads to a 0.29 percent increase in income. The variance in the price received by farmers reflects differences in cane quality. Sugar factories set a price floor, with a sucrose content of 10 percent as basic – premiums are paid if the sugar content is higher than the basic requirement. A comparison of the value of sugar received by smallholders with the value of international raw sugar indicated that farmers in Mitbwa and Kilobero received, on average, about 7 percent of world raw sugar price in 2008. As a basis of comparison, sugarcane producers in Brazil, Thailand, and Sudan, received about 10 percent, 15 percent, and 7 percent of world raw sugar, respectively. The determination of the ''right'' price of cane for producers is a complex process which involves a whole host

6 Allocative efficiency analysis determines whether factor inputs are used up to their optimal level. An estimated production function was used to compute the marginal product of factor input as in Lerman and Grazhdaninova (2005) and Carter and Wiebe (1990). Marginal product for each input can be computed as: $MPX = \frac{\partial Q}{\partial X_i} = \beta_i \frac{Q}{X_i}$ where β_i is the estimated Cobb-Douglas regression coefficient for factor X_i, Q refers to quantity.
If the value of marginal product is larger than the marginal factor cost, then factor i is underused and household income can increase if the use of the factor is raised. In the case where the value of the marginal product is lower than the marginal factor cost, then factor i is overused and household income can increase by reducing the use of the factor. Allocative efficiency is reached when the value of marginal product is equal to the marginal factor cost. Because of a lack of data on rental cost, the value of land per hectare was proxied by computing the household value added from crop production. Value added from crop production is obtained by subtracting the value of all inputs, from the gross value of output.

of stakeholders, including sugar factory, sugar farmers, through their representative association, and governmental officials. In the case of smallholders in Mitbwa, the Mitbwa Out grower Association (MOA) carries out negotiations with the miller for remunerative prices. However, it was reported that farmers have consistently argued that prices were low and not large enough to cover production costs.

- A 1 percent rise in staple food prices, captured by the food price index variable, translates into a 0.16 percent increase in income. The lower effect of food staple prices on income reflects their reduced contribution to total household income, in comparison to sugar activities. Initially the trend was to allocate more land to food crops than cash crops, but over the recent years smallholders have shifted extensive areas to sugarcane. Farmers reported that sugarcane provided stable prices in comparison with food crops which were subjected to large seasonal variations.

- Technology has a positive effect on household income. Estimation results showed that adoption of production technologies such as irrigation systems, sprayers, tractors, etc, raises income by 47 percent in comparison to those who do not rely on these systems. The positive contribution of technology to income is the result of higher productivity in terms of higher cane yields but also higher sugar content, which translates into higher cane prices. Using the estimated equation from the allocative efficiency analysis, the marginal value product of capital was found larger than the cost of capital, implying that intermediate input were used below their optimal level in both Mitbwa and Kilobero.

- Estimation results also evidenced the positive contribution of farm expenses on income. A 1 percent increase in farm expenses, which include labour, equipment and fertiliser cost, results in 0.18 percent increase in income. Farm expenses are generally correlated with improved crop husbandry. Survey results showed that about 51 percent of the respondents applied fertilisers. In most cases the rate applied was below the recommended level. Also, weed control was mostly carried out by hand (about 61.2 percent of respondents), while only 1.7 percent used herbicides, and 37.1 percent using a

combination of hand weeding and herbicides. Estimation results also revealed a negative contribution of off-farm activities to income. However, it is possible that households maintain these activities as a source of income stability, in line with a risk aversion strategy.

These findings imply that increasing the share of land under sugarcane leads to increases in household. They also suggest that sugarcane cropping has the largest impact on smallholders' income, in comparison to other agricultural activities, given relative output prices faced by households. In particular, households earning less than USD 2.8 per day, could see their income improve if mechanisms were in place to facilitate access to additional land (they currently own less than 2.8 hectares of land), and capital to maximize the use of land, as evidenced by the marginal value product of both land and capital being higher than their respective unit cost.

Results also demonstrated the need to enforce the role of institutions such as the Sugar Cane Research Institute (SRI) and the National Sugar Institute (NSI), in support of smallholders' sugarcane producers. These institutions are critical in the dissemination of knowledge in sugarcane farming and the diffusion of technology. As the results illustrated, technology and crop management have positive effects on the income of smallholders. Other institutions, such as the Mtibwa Cane Outgrowers Association (MOA), which regroups smallholder sugarcane producers, can play a key role in assisting their members with input supplies, training, credit, and advisory services.

Table 6. Household model estimate for smallholders in Mtibwa and Kilobero

Dependent Variable:	Household income
Explanatory variables :	
Sugar acreage share	0.29* (2.23)
Price index of crops other than sugar	0.16* (2.27)
Assets	0.47* (2.93)
Price of cane	0.29* (2.30)
Age of household head	0.57** (1.65)
Off-farm work	-0.39* (-2.36)
Farm expenses	0.18* (3.88)

Note: All variables are in log forms, expect the dummy variable ''off-farm work''. Figures in parentheses below the estimates refer to t-values.

*significant at 5 percent

**significant at 10 percent

Source: Computed by authors

4.3 Conclusion and implications from the Tanzania study

The descriptive and empirical results discussed in the previous sections illustrate the relationship between sugar production and the income of smallholders in Mtibwa and Kilobero areas in rural Morogoro, Tanzania. The analysis provided several key findings. First, the level of technology used by smallholders in sugarcane production is low and is essentially labour intensive, with limited use of intermediate factor input and agricultural productive assets. Agricultural productive assets accounted for only a small share of total household assets, while at the same time they were found to be employed below their optimal use. One direct implication is that raising the use of capital can increase income because the cost of an extra unit of

capital is offset by the incremental revenue. The challenge is to address the factors that hamper capital accumulation at household level, mainly access to credit for input purchases, as reported in the survey. Options range from increasing the size of the land cultivated by smallholders, strengthening market integration of smallholders with sugar processors and input suppliers, to setting up/supporting saving institutions to enable producers to use their own savings for input purchases and capital accumulation. Similarly, the average size of the land cultivated by smallholders was found to be small, as evidenced by the value of the marginal product being below its optimal level. Results from the survey indicated that only about 4 percent of smallholders had title deeds for their sugarcane field. Regulations and government incentives need to be strengthened to facilitate access the title deeds, which then can be used as collateral to acquire credit from financial institutions and expand farm size.

Simulations carried out indicated that the largest benefits to smallholders' sugar producers derive from access to preferential markets, namely the EU sugar market – but these benefits can increase further if gains in efficiency were achieved, as illustrated in the previous section. Similarly, the use of sugarcane for the production of fuel ethanol offer an attractive source of income for producers, provided import tariffs on sugar are eased to mitigate price surges in times of supply shortages. Changes in international markets were found to have limited effects on smallholders' income, mainly because of the low supply response of smallholders in the face of relatively elastic global supply. International markets can become a viable market opportunity and a source of income growth for smallholders only if measures are implemented to improve the competitiveness of the sugar sub-sector. Measures include construction and maintenance of rural roads that are essential for linking farmers and processors with export points, ensuring affordable access to energy, fuel, and communication services, providing technical assistance to producers and processors, investing in research, and creating a macroeconomic environment conducive to investment, including a fairly-valued exchange rate. These issues are explored in the next section.

5. Results of the effect of policy changes: Simulation and sensitivity analysis on policy scenarios for Tanzania and Ethiopia

Four scenarios (see table 7) were carried out to evaluate their effects on smallholder sugar producers in both Tanzania and Ethiopia. For the latter, it was assumed that millers translate price changes to sugar growers. The first scenario evaluated the impact of the EBA initiative of the EU on the income of smallholders by looking at the change in sugarcane domestic prices and their likely impact on the income of smallholders. The second scenario assessed the impact of a sustained increase in the demand for sugar in Asia, particularly in China, India, Indonesia, and Malaysia on international sugar market and their possible effects on domestic sugar prices. The third and fourth scenario looked at the effect of biofuel demand on domestic sugar market and the impact of higher crude oil prices on sugarcane supply, respectively.

Table 7. Simulation results and impact of domestic sugarcane prices, comparing Tanzania with Ethiopia

		Simulation	Baseline	Average change %
Simulation 1 (EBA)	Ethiopia	458.46	396.45	13.53
	Tanzania	107320.11	74919.79	30.19
Simulation 2 (Increase in demand in Asia)	Ethiopia	464.15	458.46	1.24
	Tanzania	108914.06	107320.11	1.49
Simulation 3 (use of sugar cane as ethanol)	Ethiopia	458.67	458.46	0.04
	Tanzania	128291.35	107320.11	19.54
Simulation 4 (increase in energy price)	Ethiopia	496.76	458.46	8.35
	Tanzania	112829.81	107320.11	5.13

Source: Computed by authors

(i) Results of scenario 1

Results are illustrated in table 7. Using the Aglink/Cosimo model[7], changes in domestic sugarcane prices were estimated to increase by 30 percent in Tanzania and by 13.5 percent in Ethiopia as a result of the implementation of the duty and quota free access to the EU. It was assumed that the simulated domestic price changes are fully transmitted to farmers, as sugar mills adjust payment schemes to reflect movements in cane prices. Also, it was assumed that existing border measures, including import tariffs on sugar, remained in place. The relatively large increase in cane prices was due to rising sugar export to the EU market, given the relatively higher EU reference price (EUR 335 per MT), limited domestic supply response, and existing measures to limit sugar imports. The estimated model (2), as described in the previous section, was then simulated to measure the impact of higher domestic prices on smallholders' income. Results of the simulation showed that a 30 percent rise in sugarcane prices translates into an average 8.7 percent increase in the income of smallholders in Tanzania. The large increase in domestic sugarcane prices underlines, to a large extent, the low elasticity of supply in Tanzania. One reason is the high cost of production that characterises the sub-sector. Estimated total cost of production of 1 Mt of sugar amounts to EUR 350 (fob). Adding freight cost from Tanzania to the EU, which can range between USD 30 and USD 80 per Mt, total cost of production (CIF) could reach EUR 432 per tonne of sugar. At these cost levels, only sugar producers with competitive cost structure are able to export profitably to the EU, while domestic market, and to some extent regional market, offer attractive options for the bulk of the producers. However, the potential to increase productivity at both farm and factory level exists

7 The Aglink/COSIMO is a partial equilibrium dynamic model for the world's main agricultural commodities developed by the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organisation of the United Nations (FAO). The model is a multi-region, multi-commodity system for medium term projections and forward looking analysis. The sugar component of the model includes 1457 equations and covers about 55 countries/regions, including Ethiopia and Tanzania. It accounts for two traded sugar; white (or refined) and raw, two sugar inputs; cane and beet, molasses, high fructose corn syrup (HFCS), and additional crop sweeteners for specific countries. Links between various commodities - through the principles of substitution and complementarity - are explicitly represented in the demand and supply systems. Links also exist between the biofuel component and relevant agricultural feedstock such as sugarcane and sugarbeet.

and can be fully exploited with effective measures. Further, the markets for by-products are currently limited. If these are developed, mills can further reduce cost through returns on ethanol, molasses, and surplus electricity derived from cogeneration.

In Ethiopia, applying the COSIMO simulation to the households of the two surveyed areas requires two sub-scenarios depending on land availability. The result is illustrated in table 8.

Table 8. Results of the simulation of sugar price changes on a representative household in Wonji, Ethiopia

	Scenario 1 (EBA)		Scenario 2 (increase in demand in Asia)		Scenario 3 (use of sugar cane as ethanol)		Scenario 4 (increase in energy price)	
Sugar Price increase	**13.5%**		**1.2%**		**19.5%**		**8.3%**	
Land endowment	Fix	Flexible	Fix	Flexible	Fix	Flexible	Fix	Flexible
Change in:								
Total income per household (in birr)	-310	186	-28	17	-448	269	-191	115
Total income per household (%)	-0.80	0.50	-0.07	0.05	-1.20	0.70	-0.51	0.30
Sugar Acreage (%)	2.70	2.70	0.24	0.24	3.90	3.90	1.70	1.70

- Under fixed supply of farmland

When households have fixed amount of land (no hope for land extension), their decision is on how to allocate fixed acreage of land between sugar and other crops. This implies that there is an opportunity cost of allocating more land to sugar plantation. Results show that the 13.5 percent price increase due to the increased access to EBA in Scenario 1 would increase sugar acreage by 2.7 percent but this would reduce Wonji household income by about 0.8 percent (310 birr income reduction).

- Under flexible (elastic supply of) amount farmland

However, when households have the possibility to acquire new land (i.e. extension as in Tendaho), the.13.5 percent increases in sugar price under

the EBA simulation would slightly increase Wonji's household income by only about 0.5 percent (just 186 birr). In either case the impact of the EBA on the household income is small.

(ii) **Results of scenario 2**

According to the results of scenario 2, a sustained increase in demand for sugar in Asia, namely, China, India, Indonesia, and Malaysia[8] is likely to raise international sugar prices by 2 percent over the medium-term, in comparison with the baseline. Most of the increase in prices occurred in the first two years of the shock. The relatively reduced price impact was due to the high supply response of Brazil, which absorbed most of the increase in world demand. The dominant role of Brazil in world sugar market is illustrated by its share in sugar trade. Brazil accounted for 52 percent of world sugar trade and for about 65 percent of all raw sugar traded globally in 2010/11. If the quantities of raw sugar exported to the EU and US under trade agreements were subtracted, as they do not enter the world market, then Brazil was responsible for about 75 percent of all raw sugar trade. For relatively small sugar exporters, with limited supply response, such as Ethiopia and Tanzania, there is limited scope in supplying international markets; however opportunities exist in nearby countries due to freight cost advantage with respect to Brazil. For example, in 2007/08, India and Thailand managed to displace Brazil in some markets in Asia and the Middle East, as historical high freight costs prevented Brazil from being competitive. Simulation results of scenario two also showed that a 2 percent increase in world sugar prices over the medium-term raises sugarcane prices in Tanzania by 1.5 percent and by 1.2 percent in Ethiopia. As in the first scenario, it was assumed that the simulated domestic price changes are fully transmitted to farmers, as sugar mills correct payment schemes to reflect movements in cane prices. In addition, it was assumed that existing border measures, including import tariffs on sugar, remained in place. Based on model (2), a 1.5 percent increase in sugarcane prices led to an average 0.45 percent rise in the income of smallholders in Tanzania and by only 0.05 percent if farmland extension is available for the household sample (or decrease by -0.07 percent if acreage is fixed) in Ethiopia. Results showed that, at current

8 In 2009/10, China, India, Indonesia, and Malaysia represented about 22 percent of world sugar trade.

technology and cost structure, the potential to enhance the income of sugarcane smallholders through international market is rather narrow. The potential exits, however, with preferential and regional markets, that offer better returns and/or freight cost advantage.

(iii) **Results of scenario 3**

Sugarcane prices could also increase as a result of the use of sugarcane as a feedstock for the production of ethanol. A third scenario was run by which it was assumed that 10 percent of sugarcane production was diverted away from sugar to ethanol production. Simulation results obtained from Aglink/COSIMO model showed that sugarcane prices could rise by as much as 19.5 percent in Tanzania and almost no change in Ethiopia. The smaller increase in Ethiopia reflects a much larger trade elasticity, which enables the counties to quickly offset the reduction in sugar production through imports. Model (2) showed that a 19.5 percent increase in cane prices translates into a 4.5 percent increase in the income of household in Tanzania and by only 0.7 percent under flexible acreage for Ethiopia. The main assumption of the scenario is that ethanol competes with sugar over sugarcane availability. In the case where new land is set aside for the exclusive use of cane as feedstock for biofuel use, then the impact on sugarcane prices would be relatively limited. In fact, recently, the government of Tanzania identified about 314 000 hectares, not currently utilised, that can be allocated for biofuel feedstock without negative feedbacks on food prices.

(iv) **Results of scenario 4**

The last scenario looked at the impact of higher world oil prices on smallholders' sugar producers. The channels through which high energy prices affect producers are on both the demand and supply sides. Higher oil prices cause the demand for biofuel to increase because of substitution effect, which leads to higher biofuel prices. As a result, demand for feedstock, such as sugarcane, rises and creates an upward pressure on the feedstock prices, leading to increased supply. However, higher energy prices reduce the incentive for supply response as crop production cost increase. The final equilibrium feedstock prices will depend on the extent to which rising feedstock prices compensate for larger production costs, the resulting supply response, and the response of total demand. In the case of Tanzania, the increase in energy prices led to a 5 percent rise in sugarcane prices, while

in Ethiopia they increased by 8.3 percent. Simulating model (2) with these sugarcane price changes showed that the income of smallholders increase by 1.5 percent in Tanzania. However, the net effect on smallholders' net income rests upon the share of energy in total production cost and the extent to which energy prices increase with respect to sugarcane prices. For Ethiopia, these 8.3 percent increase in sugar price would increase a representative household income by only 0.3 percent if households have the chance increase the size of their farmland.

6. Summary and conclusions

World sugar markets have experienced over the last decade a number of fundamental changes which translated into both challenges and opportunities for sugar producing developing countries. Using household-level data collected from smallholder sugar producers in Ethiopia and Tanzania, this study analysed the contribution of sugar production to the livelihood and more precisely the income of smallholders and assessed the potential impact of changes in international and national sugar policies. Results from both case studies showed that the extent of the contribution depends on initial endowment (e.g. household characteristics, land size, capital, labour, etc) of the smallholder, relative prices between sugarcane and food crops, prevailing domestic sugar prices and policies, and the wage rate in the labour market.

Data from the household surveys indicated that smallholders' productive technology is essentially labour intensive, with limited use of factor input and improved technology. Indeed, agricultural productive assets accounted for a small share of household total assets while factor input were found to be employed below their optimal use. The limited take up of technology and intermediate factor input implies that a significant expansion of the sugar sub-sector in both Ethiopia and Tanzania, as well as in other similar sugar producing least developed countries, will not take place unless constraining factors are identified and addressed. These constraining factors often relate to distortionary domestic policies. As the case study in Ethiopia demonstrates, fixing wages and domestic sugar prices limit the expansion of sugar production, as it cannot compete with relatively more remunerative competing crops, such as food grains and vegetables. Constraining factors,

which limit access to private productive assets, reinforce the initial conditions and do not enable smallholders to reap the benefit of productivity gains. The appropriate policy intervention in this case would be to improve smallholders' access to financial services such as credit and insurance, as well as development of asset building programmes. Also, strengthening and developing institutions such as sugar producers cooperatives and associations often contribute positively to the success of policy interventions. Institutions such as sugar cooperatives enable smallholders to negotiate better contractual terms with sugar mills, as was demonstrated in the case of the Mitbwa Outgrower Association (MOA) in Tanzania.

The flexibility of land and prices supports the development of smallholder sugar production. When sugarcane prices are allowed to fluctuate, smallholders can value sugarcane production at the true opportunity cost and decide on how much resources to allocate to it. As the case of Ethiopia illustrated, the fixity of prices did not allow sugarcane to compete with food crops, which limited its development amongst smallholders. Fixity of land also hampers extension of sugar acreage. In Tanzania, the flexibility of sugarcane prices was a strong incentive for sugar development but the gains were limited because smallholders could not expand acreage due to constraints, mostly administrative, affecting access to land. However, it should also be noted, that household income could rise because of the opportunities offered through increases in labour wage income, i.e. when the household member works as an employee in the sugar sector, instead of growing sugarcane.

Simulations carried out showed that access to preferential markets, namely the EU sugar market, leads to slightly higher sugarcane prices for farmers in both Ethiopia and Tanzania. These benefits can increase if gains in efficiency were to be achieved. The simulations also showed that changes in world sugar prices have very limited effects on smallholders' income, due to low supply response of smallholders in Tanzania and Ethiopia in the face of relatively elastic global supply. The relatively low supply response reflects a combination of factors, including distortionary domestic policies, weak private productive assets, and high natural trade costs. Improving the competitiveness of the sugar sub-sector calls for addressing these impediments, but also requires investment in physical infrastructure such as rural roads (and railroads, in many cases), which are important for linking

farmers and sugar mills with export points, communication structures and services, and energy plants. Also, investment in institutional infrastructure, such as markets, as well as farmers' cooperatives and associations, is essential to the sustainability of sugar production. Finally, sound, transparent, and predictable government sugar policies, including macroeconomic policies, support the development of an enabling environment for private sector investment in the sugar industry.

References

Abadie, A., Drukker, D., Herr, J.L., and Imbens, G.W. (2001). Implementing Matching Estimators for Average Treatment Effects in Stata. *The Stata Journal* 1:1-18

Abadie, A., and Imbens, G.W. (2002). Simple and Bias-Corrected Matching Estimators. *Tech. rep. Department of Economics*, UC Berkeley. http;//emlab.berkeley.edu/users/imbens/.

Balcombe, K., Rapsomanikis, G. (2008) "Bayesian Estimation and Selection of Non-Linear Vector Error Correction Models: The Case of the Sugar-Ethanol-Oil Nexus in Brazil.'' *American Journal of Agricultural Economics*, 90 (2) 658-668.

Carter, M.R., Wiebe, K.D. (1990) ''Access to Capital and its impact on agrarian structure and productivity in Kenya''. *American Journal of Agricultural Economics* 72(6): 1146-50.

Dehejia, R. H., and Wahba, S. (1999) " Causal Effects in Nonexperimental Studies: Reevaluating the Evaluation of Training Programs". *Journal of the American Statistical Association,* 94: 1053-1062.

Fernandez-Cornejo, J., Hendricks, C., and Mishra, A. (2005) "Technology Adoption and Off-farm Household Income: The Case of Herbicide-Tolerant Soybeans". *Journal of Agricultural and Applied Economics* 37(3): 549-563

Food and Agriculture Organization (FAO) (2005) "Sugar: the impact of reforms to sugar sector policies a guide to contemporary analyses''. FAO trade policy technical note.

Lerman, Z. and Grazhdaninova, M. (2005) "Allocative and technical efficiency of corporate farms in Russia'' *Comparative Economic Studies*, 47, 200-213.

Huffman, W.E. (1991) "Agricultural Household Models: Survey and Critique," In *Multiple Job Holding Among Farm Families*, M.C. Hallberg, J.L Findeis, and D.A. Lass (eds.). Iowa State University Press, Ames, IA.

Imbens, G. (2003) "Semiparametric Estimation of Average Treatment Effects under Exogeneity: A Review. Tech. Rep". Department of Economics, UC Berkeley. http://emlab.berkeley.edu/users/imbens/.

Mitchell, D. (2008) "A note on rising food prices" *World Bank Policy Research Working Paper No. 4682*.

OECD (2012). *OECD-FAO Agricultural Outlook 2012-2021*. OECD Paris.

Serra, T. (2012) "Biofuel-related price transmission literature: a review". CREDA working paper.

Todd, P.E., and Wolpin, K.I. (2007). Ex-Ante Evaluation of Social Programs. *Annals of Economics and Statistics* (or Working Paper 06-22. Penn Institute for Economic Research. Department of Economics, University of Pennsylvania.)

Trostle, R. (2008) "Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices". United States Department of Agriculture. A Report from the Economic Research Service. May 2008.

ANNEX 1
The matching technique

The aim of the application of the matching technique is to compare the outcome variable (here agricultural income or wage) of households that are engaged in planting sugar (mainly in Wonji) and the outcome variable of those who are not yet engaged (mainly in Tendaho). The advantage of the matching technique (Dehejia and Wahba, 1999; Abadie et al., 2001; Imbens 2003; Todd and Wolpin, 2007) here is that it directly elicits how the participation in sugar plantation affects income and wage, rather than to determine why household participate in sugar plantation. In the absence of historical data on participation to sugar farming, and in the absence of information on the 'before' and 'after' the participation for each household, the matching technique is likely more useful than other methods.

For each household, the matching technique compares the observed outcome to an estimated outcome. The technique computes an estimate of the outcome variable for a non-participating (or participating) household had it (or had it not) participated in any regular off-farm activity. It does so by averaging over the values of the outcome variable of the participating (or non-participating) households which have the similar or the closest attributes to each of the non-participating (or participating) households. The average of the difference between the observed and the estimated outcome variable should reflect how much the participation in sugar plantation affects the outcome variable.

Following standard notations, we assign a dummy variable W_i =1, 0 to indicate whether a household *i* participates or not in sugar farming and Y_i (W_i) as the outcome for individual household *i*. The outcomes $Y_i(1)$ and $Y_i(0)$ represents, respectively, the outcomes when *i* participates and when *i* does not participate in any sugar farming. Ideally, an estimate of the average effect would be just $E= (1/N)\Sigma_i(Y_i(1) - Y_i(0))$. But in this paper the nature of the data is that each observation *i* has only one observed outcome (i.e., the household either participates or it does not), we need to use an estimate of the missing outcome to make the comparison. Such an estimate is constructed in the matching technique as the simple average of the outcomes of households that share similar (or closest) characteristics of the household *i* (Abadie et al.).

Formally the matching estimator for the average treatment effect (ATE) is

$$\tau = \frac{1}{N}\sum_{i=1}^{N}(\hat{Y}_i(1) - \hat{Y}_i(0)$$

where the matching estimates $\hat{Y}_i(0)$ and $\hat{Y}_i(1)$ are defined as follows:

$$\hat{Y}_i(0) = \begin{cases} Y_i(0) & \text{if } W_i = 0 \\ (1/M_i)\sum_{i \in M_i} Y_i & \text{if } W_i = 1 \end{cases}$$

$$\hat{Y}_i(1) = \begin{cases} (1/M_i)\sum_{i \in M_i} Y_i & \text{if } W_i = 0 \\ Y_i(1) & \text{if } W_i = 1 \end{cases}$$

where Y_is are the outcome, $W_{i=}$1,0 indicates participation or non-participation, and M_i is the number of the households that have the same or the closest characteristics to household i[9].

Basic assumptions: unconfoundedness and identifiability.

Two basic assumptions permit the use of the matching technique[10]. The first is the so-called 'unconfoundedness' assumption which ensures that for households having the same characteristics, the decision to allocate acreage to sugar cropping is random and independent of the knowledge of whether or not the allocation is the most efficient way to maximize household income and profit. This assumption appears somewhat non-realistic since in many case and by experience, farmers do use their best knowledge and information to decide on how to allocate their land, especially that they know already

9 See details in Abadie et al. (2001).

10 See Imbens (2003) for ample explanations.

how much the ton of sugar cane will be paid since it is fixed. However, the uncertainty of agricultural activities (weather, pest and disease) makes total incomes uncertain. Moreover, even if the sugar price is known, the prices of the other crops are flexible which complicate the decision on acreage allocation. The second assumption, which is easier for the present survey to comply with, is the 'identifiability' assumption which ensures that there is at least one household that is not involved in sugar farming in order to perform the matching with those which are involved.