The impact of taxes and subsidies on crop yields
Agricultural price distortions in Africa

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PBL

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Summary

It is well established that agricultural pricing policies (taxes, subsidies) have a substantial influence on farmer production decisions. However, little is known of how these policies influence agricultural intensification through their impact on crop yields. Understanding this relationship is important, as agricultural intensification is required to ensure food security for a growing population and avoid large-scale deforestation. In Africa in particular, a near doubling of crop yields will be needed over the next decade to feed the growing population. This report assesses whether the agricultural pricing policies currently in place in Africa support this objective.

The agricultural pricing policies considered include: i) taxes levied on key export commodities, such as coffee and cocoa, ii) subsidies on important national food items such as maize, and iii) price interventions on critical inputs such as inorganic fertilizer. The entirety of these interventions, often dubbed agricultural price distortions, is captured by the nominal rate of assistance (NRA). This measures the difference between the prices faced by farmers and the price without government intervention.

We quantitatively assessed the impact of agricultural pricing policies on crop yields by analysing the factors that explain changes in crop yields in various countries, over multiple time periods. Our analysis is based on data from 22 African countries covering the period from 1961 to 2010. The selection covers the largest economies in Africa, including more than 90% of agricultural value added, farm households, total population, and total gross domestic product (GDP). Crops were included based on their relative importance and data availability. The analysis covers three export crops (cocoa, coffee and cotton) and four import-competing crops (maize, rice, sugar and wheat).

Impact of subsidies and taxes on Africa's crop yields

Although it is generally expected that pricing policies have little influence on perennial export crops such as cocoa and coffee, as investments in plantations are either sunk or fixed costs, we found export taxes to have a strong, significant impact on cocoa and cotton yields. Hence, for these export crops, a decrease in taxation can be expected to lead to an increase in productivity. The potential gains could be substantial: for cocoa, a 10% increase in the NRA could raise cocoa yields in the order of 4% to 14%, suggesting that higher producer prices may induce productivity growth through producer adjustment of input use, agricultural investments and innovation.

On the other hand, where agricultural subsidies and higher prices are expected to motivate farmers to invest in crop productivity, we found no evidence of such a positive relationship between subsidies and crop yields. Although the effect is less robust than for cotton and cocoa, we found negative effects for maize, sugar and wheat. This suggests that subsidies may actually reduce crop yields, possibly because overinvestment in subsidised inputs leads to allocative inefficiency, and subsidisation can lead to inefficiency, lack of effort and limited competition.

The degree and speed by which agricultural pricing policies shape farmer production decisions differ between countries. For example, the effect of NRA on productivity is weaker in countries that witness more frequent changes in agricultural policies. However, although we expected there to be less impact of agricultural pricing policies in countries with less developed rural infrastructure, we found no such effect.

Why do African nations tax or subsidise agriculture?

Before jumping to conclusions about the environmental potential of changing agricultural pricing policies, it is important to understand why governments tax or subsidise agricultural crops. Many countries subsidise agricultural production with the objective to safeguard national food security. But, aggregated across all commodities, the agricultural sector in most African countries is taxed, although this trend has waned in recent years. This can partly be explained by public debt and inflation levels; our analysis indicated that increases in inflation and public debt (as a percentage of GDP) lead to increases in taxation (and reductions in subsidies). Also, we found that both the total population and the share of the rural population shape agricultural pricing policies, and that more democratic countries tax agriculture less.

Fostering sustainable agricultural intensification

While a strong case for reducing export taxes emerged from our analysis, such a conclusion would ignore the fact that many developing countries currently have only few alternative means to raise government revenue to fund the supply of public goods. Taxing export crops may often be the only means governments have to supply public goods such as rural infrastructure, healthcare and education. Often, a lack of alternative economic sectors and limited capacity at tax authorities inhibit the development of alternative taxation strategies.

Similarly, we found no evidence of staple crop subsidies (e.g. of wheat, maize or rice) spurring agricultural intensification. With declining arable land and the associated losses in natural ecosystems, the removal of subsidies thus appears an effective means to stimulate agricultural intensification. On the other hand, abolishing crop subsidies would have implications for rural incomes and, besides being politically untenable, may have unwarranted distributional effects.

Joint challenge for developing countries and donors

The global donor community has rightly committed itself to support African governments in the huge challenge to intensify agricultural production and double crop yields. With this aim, it supports a multitude of development programmes that attempt to improve agricultural productivity and farmer livelihoods through investments in enhanced production methods, reversal of market failures and infrastructure development.

Our analysis suggested that, in addition, enhanced cooperation in the strengthening of African fiscal capacity may be warranted, too. The need for enhanced capacity for domestic revenue mobilisation was recently reaffirmed by the Addis Ababa declaration of July 2015. However, this declaration did not consider agricultural intensification or fiscal greening strategies. Cooperation to enhance the fiscal capacity for domestic revenue mobilisation would complement ongoing private and public-private development interventions, such as projects linking smallholders to markets and value chain initiatives. Such interventions may well be much more effective, as less distorted prices provide better financial incentives for the smallholders concerned.

1 Introduction

Smallholder farmers dominate Africa's agricultural sector. About 80% of African farms each cover less than two hectares (Lowder et al., 2014). Despite this, nearly all smallholders engage in some form of trade through agricultural markets (Barrett, 2008). Local market prices shape production decisions by smallholders, be it the choices for cultivating specific crops or the intensity with which crops are cultivated; for example, concerning the amount of labour or fertilizer applied. However, the in- and output prices that smallholders are confronted with are not solely determined by forces of supply and demand. They are also shaped – and sometimes strongly so – by country-specific agricultural and trade policies.

These policies include taxes levied on key export commodities such as coffee and cocoa, subsidies on national staple foods, such as maize, or price interventions for critical inputs such as inorganic fertilizer. The entirety of these interventions, often dubbed agricultural price distortions, is captured by a specific index – the nominal rate of assistance (NRA[1]). This measures the percentage difference between the actual prices smallholder farmers are confronted with and an estimate of the price without government interventions (Figure 1).

Figure 1: Average nominal rate of assistance for commodity groups in African countries
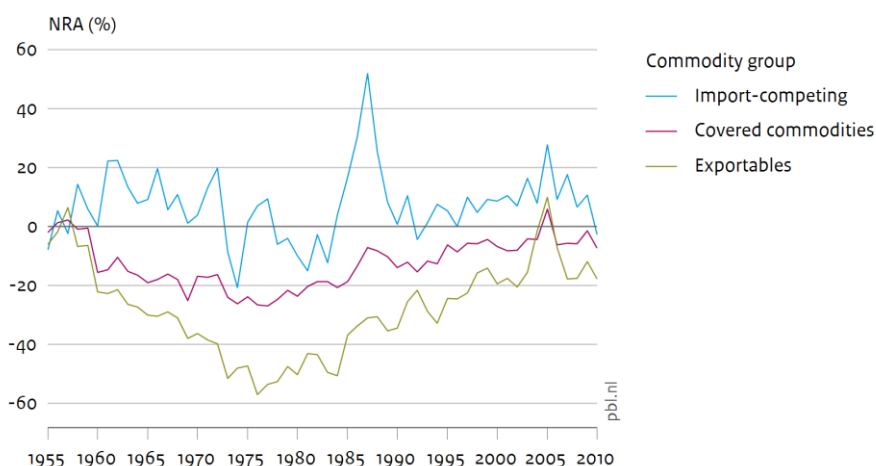
Source: Anderson & Nelgen, 2013

Figure 1 displays average historical trends of the nominal rate of assistance (NRA) in African countries for three groups of crops: export crops, import-competing crops and both groups combined. A positive value reflects a market price elevated above the fictive undistorted price, implying a net subsidy. Negative values indicate that actual market prices fall below their undistorted potential, with farmers effectively paying a tax.

Figure 1 illustrates that the market prices faced by farmers have been distorted, as the NRA is either above or below zero. For instance, in around 1980, government interventions across Africa lowered the prices that smallholder farmers received for export crops, such as coffee and cocoa, by around 50%. Indeed, export crops have commonly been taxed, under the presumption that long-term investments in plantations are relatively unaffected by taxes. On the other hand, domestic prices of import-competing commodities such as maize

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[1] Here, NRA refers to the *nominal rate of assistance* (not to be confused with other meanings of this abbreviation).

and rice are often subsidised to levels above going global prices. The conjecture is that such measures stimulate national production and domestic food security.

It is well established that policies included in the NRA have a substantial influence on farmer production decisions (Anderson et al., 2013). However, to date little is known about the relationship between NRA policies and agricultural intensification – something we explored in greater detail in this study. This report provides quantifications of the impact of NRA on crop yields as a measure of agricultural intensification, for important agricultural commodities across Africa.

Agricultural intensification is sought after by both international donors and national governments as a prime mechanism to enhance land-use efficiency, improve food security and alleviate poverty. Stimulating agricultural intensification across Africa remains imperative as the continent will bear the brunt of the projected global population growth (United Nations, 2012). Global food production needs to increase by 60% to meet increased demand and combat undernourishment (PBL, 2012). This goal is especially ambitious given the shrinking supply of readily available cropland (Lambin et al., 2013; Kastner et al., 2014), which is evidenced, for instance, by the fast conversion of remaining forest cover in Africa, with associated losses in biodiversity (Brink and Eva, 2009). Land-use allocations with the potential to both solve visible and hidden hunger *and* avoid large-scale deforestation are possible, but necessitate a near doubling of African crop yields (FAO, 2009; PBL, 2012).

The donor community has committed itself to supporting African governments in this huge challenge. It supports a multitude of development programmes that aim to improve agricultural productivity and farmer livelihoods through investments in enhanced production methods, the reversal of market failures and infrastructure development (Reardon et al., 1992; Fulginiti et al., 2004). Since agricultural pricing policies, as captured by the NRA, directly influence smallholder production decisions, they are equally likely to shape the effectiveness of these development programmes. This therefore begs our central question about the real strength of the relationship between NRA and crop yields, and whether common rationales for taxing export crops and subsidising food grains truly hold.

This research serves two closely related objectives. First, it allows policymakers to understand how existing country-level agricultural policies inflate or dampen the impact of various agricultural development interventions. Second, it serves to understand how prolonged and durable alterations in the NRA itself may spur or hinder agricultural intensification through more favourable prices. Both objectives help policymakers in the international donor community as well as in African governments to better understand the drivers of agricultural intensification and to design more effective interventions.

The next section quantifies and discusses this relationship in greater detail, using new estimates interspersed with insights from ongoing academic studies. Section 3 explores factors that cause countries to either tax or subsidise agriculture, and the fourth and final section discusses the implications and explores effective avenues for policymaking.

2 Impact on crop yields

This section assesses the impact of taxes and subsidies, as measured by the NRA, on crop yields across African countries. Even though other studies have documented the effect of NRA on total factor productivity (Anderson and Masters, 2009), to our knowledge, no studies had yet assessed the impact on specific crop yields across Africa. The NRA contains a variety of policy measures (see Box 1) and has been computed for a range of major crops for various African economies.
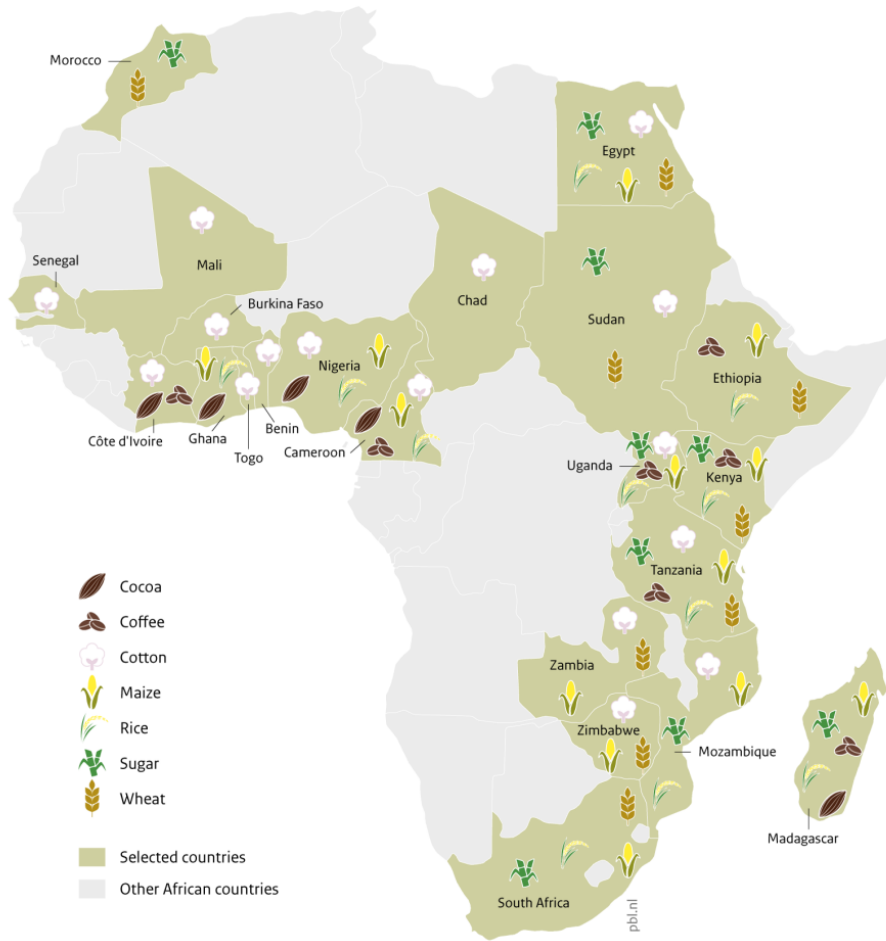

Box 1: Factors included in the nominal rate of assistance (NRA)

The nominal rate of assistance (NRA) is defined as the percentage change in gross return to farmers compared with the gross return to farmers without intervention (Anderson and Nelgen, 2013). The combination of policy measures that lead to such price differences constitute the NRA. Direct policy measures included are trade measures, such as export taxes or import tariffs, and domestic producer and consumer price-distorting measures, such as input subsidies or output taxes. Subsidies included relate to fertilizer, fuel and electricity, credit and pesticides. Subsidies on water, land or labour are not included. Finally, governments sometimes tax by setting currency exchange rates. On a global scale, trade distortions dominate in importance with about 60% of NRA attributable to export taxes and import tariffs (Anderson, 2009).

Our analysis is based on data from 22 African countries (Figure 2) covering the period from 1961 to 2010. Countries were selected according to the availability of NRA data, as reported in Anderson and Nelgen (2013). The selection covers the largest economies in Africa and includes more than 90% of agricultural value added, farm households, total population and total gross domestic product (GDP). Crops were included on the basis of their relative importance and data availability. The analysis covers three export crops: cocoa, coffee and cotton, and four import-competing crops: maize, rice, sugar and wheat. Data on NRA were available for individual crops, even though not all crops are cultivated in each country (Figure 2).

When assessing the impact of price distortions on crop yields, it is important to acknowledge the three types of factors that influence crop yields or NRA, as illustrated by Figure 3. The main factors that shape production include access to capital, land and fertilizer, as well as climatic variables such as temperature and rainfall, all shape production (Figure 3, *crop yield determinants*). Furthermore, policies that determine NRA are the result of a broader political debate in each country, a debate that itself is being shaped by macroeconomic conditions (Figure 3, *determinants of NRA*). This relationship is explored further in the next section. Finally, *mediating variables* may weaken or strengthen the effect of NRA on crop yields. For instance, a lack of infrastructure may lessen the speed with which world market prices are transmitted to local prices. Similarly, such variables could moderate the effect of NRA policies on farmers' crop production decisions.

Figure 2
Countries and crops included in the analysis, 1961 – 2010

Cocoa
Coffee
Cotton
Maize
Rice
Sugar
Wheat

Selected countries
Other African countries

Morocco
Egypt
Senegal
Mali
Burkina Faso
Chad
Sudan
Nigeria
Ethiopia
Côte d'Ivoire
Ghana
Benin
Togo
Cameroon
Uganda
Kenya
Tanzania
Zambia
Zimbabwe
Mozambique
Madagascar
South Africa

Source: Anderson and Nelgen, 2013

Figure 3
Factors affecting nominal rate of assistance (NRA) and crop yields

Determinants of NRA
Debt
Monopoly power
GDP (growth)
Rural population
Inflation
Self-sufficiency
Party orientation
Elections
Democracy

Mediating variables
Democracy
Policy variability
Infrastructure
Information

NRA

Crop yield

Crop yield determinants
Capital
Land
Temperature
Rainfall
Fertilizer
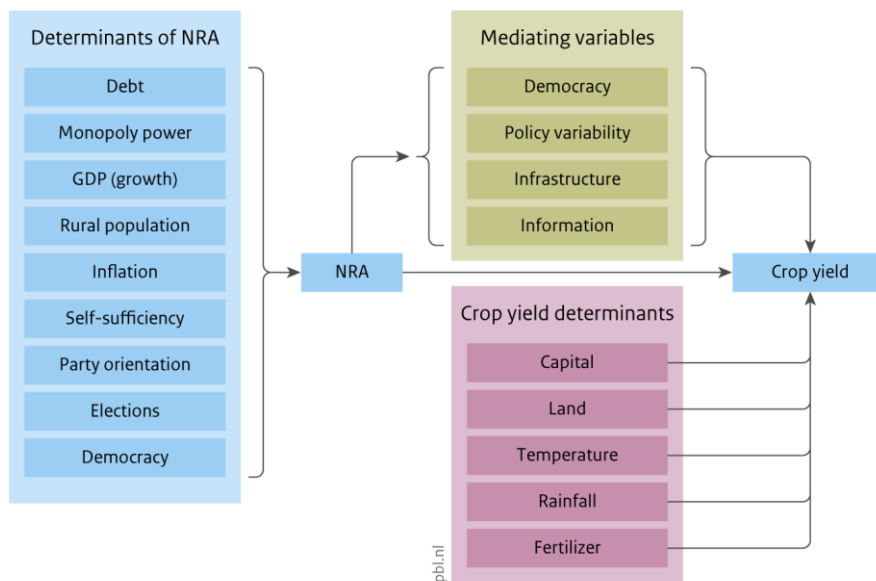
Bron: PBL

We discerned the impact of agricultural market price distortions on crop yields through a detailed statistical analysis. As described above, the expected impact of policies on crop yields is compounded by several factors. To isolate this impact, the highlighted linkages in Figure 3 needed to be accounted for in the analysis. As tax and subsidy regimes differ substantially per crop type, as illustrated by Figure 1, the results for each crop type are discussed separately. Further details on the statistical approach are provided in Box 2 as well as in Malan (2015). Simultaneously, we determined which factors shape NRA itself; in other words, how the prevalence of and changes in taxes and subsidies can be explained by country-specific factors. This is discussed in Section 3.

Box 2: Estimating the impact of NRA on crop yields, econometrically

We isolated the impact of price distortions in three steps. In the first step, we estimated the relationship between NRA and crop yields, while controlling for other factors affecting crop yields (crop yield determinants – bottom of Figure 3). Also, a set of mediating variables was included (upper part of Figure 3) and their effects captured by including the cross-products of these mediating variables with the NRA. In the second step, the determinants of NRA were discerned, considering a set of macro-economic and political variables at country level, such as GDP and national debt (left-hand side of Figure 3). In the third step, potential endogeneity biases in the econometric estimations were addressed. These could occur, for instance, when (possibly structural) low crop yields induce governments to increase agricultural subsidies. In addition, unobserved variables, such as deeper institutional characteristics, could affect both agricultural productivity and NRA policies.

Different econometric techniques and model specifications were applied to assess the robustness of the results. In the first two steps, fixed effects regressions and multilevel modelling were used. In the third step, instrumental variable (IV) regression and simultaneous equation modelling were used to control for endogeneity bias. The population size of a country and the share of the population living in rural areas are valid and econometrically strong instruments and were found to correct the endogeneity bias, sufficiently.

The country and crop data on NRA were complemented with data on the variables as delineated in Figure 3. Overall, the database covered observations from 22 countries in the period from 1961 to 2010. Malan (2015) provide reference to the data sources, as well as detailed technical references and an extensive presentation of regression results.

2.1 The influence of export taxes on crop yields

First, we found price distortions (mostly taxes) to have a strong, significant impact on cocoa and cotton yields. As expected for these export crops, a decrease in taxation leads to an increase in productivity, and the expected gains were found to be substantial. The first column in Table 1 lists the estimated change in crop yield resulting from a unit (100%) increase in NRA. For cocoa, for instance, the increase is bounded by the estimated range of 40% to 143%. In other words, a 10% increase in NRA, narrowing the gap between taxed and undistorted prices from 30% to 20%, would raise cocoa yields in the order of 4% to 14%. When considering an increase in NRA by one standard deviation, based on recent historical variation, we observed that crop yields may expand by 10% to 48%. Box 3

provides more insights into the on-farm impact of such changes, through a detailed numerical example that calculates the potential impact on an average cocoa farmer in Ghana.

Table 1: Estimations of NRA impact on crop yields

Crop	Range in crop yield change due to NRA increase	
	NRA increase by 100%	NRA increase by historical standard deviation
Export commodities		
Cocoa	(40% ; 143%)	(11% ; 38%)
Coffee	0%	0%
Cotton	(30% ; 141%)	(10% ; 48%)
Import-competing crops		
Maize	(-57% ; 0%)	(-37% ; 0%)
Rice	0%	0%
Sugar	(-122% ; 0%)	(-67% ; 0%)
Wheat	(-104% ; 0%)	(-53% ; 0%)

The table provides estimates of the change in crop yields due to an increase in NRA, i.e. a reduction in taxes or increase in subsidies. The columns list the range of effects, either as a function of a unit increase in NRA or an increase by one standard deviation. The ranges are bound by the smallest and largest effect identified in different econometric estimations. A zero indicates that in some, or all, estimations no significant effects were observed.

Such a sizeable effect was not only found for cocoa, but also for cotton. However, we did not find a relationship between NRA and coffee yields. This strong negative effect of taxes on some crop yields in Africa has been documented before (Fulginiti and Perrin, 1993). In Tanzania, for instance, considerable producer responses for cotton and cashew resulting from taxation have been identified (Townsend, 1992, quoted in Kherallah et al., 2002).

The sizeable effect on cocoa and cotton yields is nonetheless remarkable. A long-standing notion exists that export crops, and plantation crops in particular, are less responsive to market price distortions (Anderson et al., 2013; De Gorter and Swinnen, 2002). The common argument is that investments in plantations are sunk or fixed costs and that price changes have little effect on short-term output.

Our results suggest otherwise, at least for cocoa and cotton. Short-term price changes are likely to induce farmers to adjust input use, such as fertilizer or labour. Indirectly, an increase in price, and thus in farm income, may reduce borrowing costs for farmers or reduce levels of risk aversion. In both cases, farmers may equally expand their short-term use of variable inputs (Rizov et al., 2013). Finally, a reduction in taxation and higher producer prices may induce productivity growth through innovation (Fulginiti and Perrin,

1993; Binswanger et al., 1978).

Box 3: The impact on a farming household

Consider the case of cocoa farmers in Ghana. Despite notable improvements over time, this sector remains relatively heavily taxed. The average NRA over the period from 2005 to 2010 for cocoa stood at -0.2941, implying that farmer prices were 29.41% less than the undistorted potential farm-gate revenue. To put this figure into perspective, we consider the full value of cocoa production. At undistorted farm-gate prices, this amounted to USD 1.55 billion (average 2005–2010) (FAO, 2016; ICCO, 2016). As Ghana has approximately 800,000 cocoa farmers, these figures suggest a single cocoa farmer, on average, produced a revenue of USD 1,942, conditional on the given NRA. Of this income, 29.41% (USD 571) is taxed away, yielding an income of USD 1,371 after tax.

How much do producers stand to gain if this tax would be removed? Obviously, farmers would save having to pay USD 571 in taxes, but the estimates in Table 3 also indicate that farmers are likely to expand production in response to an increase in NRA. Table 3 suggests a specific crop yield increase in the range of 40% to 143%, depending on the econometric estimation, due to a unit increase in NRA. Taking the midpoint of this range (91.5), an increase in NRA of -29.41% to 0% would lead farmers to expand their cocoa crop yield by 0.915*29.41% = 26.47%. If world market prices would not be influenced by such changes in Ghana's production, then the increase in crop yields translates directly into the same amount in increased gross revenue for farmers. Hence, gross revenue would increase by 26.47% from USD 1,942 to 2,457. The overall gain for such a farmer would then not only be the saved amount in tax payment (of USD 571), but also that of an increase in output of USD 514. In other words, this would result in a near doubling of the net income from cocoa production, from USD 1,371 to 2,457.

These figures can be used to compute a benefit-to-cost ratio from eliminating this form of taxation. The costs of abolishing this tax for the government would be USD 571per farmer, while farmers would gain a net amount of USD 1,085 each. Together, this implies a decent public benefit-to-cost ratio of 1.90 (1,085/571). However, despite this large potential to raise rural incomes, opportunities for governments to raise public revenue elsewhere may be limited (see Section 3).

2.2　The impact of subsidies on food grain production

Market price distortions equally affect farmer production and input choices for 'import-competing' crops. Such crops are mostly staple grains produced by subsistence farmers or for domestic consumption and include non-perennial crops, such as maize, wheat, rice and sugar. Many African countries have resorted to subsidisation of such crops (Figure 1), often with the aim to safeguard national food security. The most commonly used mechanisms are to levy import tariffs (hence *import-competing*), in effect elevating the domestic price above the world market price. In addition, inputs such as inorganic fertilizer are frequently subsidised.

Decisions related to the planting and production of grain crops are taken annually. Investment decisions by smallholders are therefore expected to be more responsive to price changes. Agricultural subsidies and higher prices supposedly motivate farmers to invest in crop productivity, while higher expected output prices further incentivise farmers to

innovate (Binswanger et al., 1978). Input subsidies have indeed sometimes been found to enhance crop yields, more recently in Malawi (Denning et al., 2009).

However, we found no evidence of such a positive relationship between subsidies and crop yields. The lower half of Table 1 provides estimates of the expected change in crop yields of specific crops in response to a change in NRA. Some of the estimates are conspicuous, with strongly negative values. This suggests a large negative response of crop yields, sometimes more than proportionally so, when subsidies increase. We found the largest of such responses for sugar yields, where a roughly standard deviation increase in NRA could lead to a reduction in crop yields of up to 67%. Rice production and crop yields appear invariant to pricing policies, as we found no relationship between NRA and rice yields, contrary to findings elsewhere (Rakotoarisoa, 2011).

However, the relationship between NRA and import-competing crop yields is less robust than for cotton and cocoa. We pursued different estimation approaches and, for all four import-competing crops, at least one estimation approach revealed no significant relationship for crop yields. Nevertheless, whenever we did find a significant effect it was consistently negative, which digresses from common expectations that subsidies positively affect crop yields. Indeed, our estimates reveal an overall lack of agricultural intensification in response to agricultural subsidies.

Agricultural output could still increase if subsidies would incentivise farmers to expand cropped areas rather than crop yields. Even though this would raise production and income at the farm level, it would be undesirable from the viewpoint of agricultural intensification. Fertilizer subsidies have indeed been shown to lead to a relatively greater increase in area than crop yields (Mason et al., 2013). As on-farm responses to fertilizer are often low – considerably lower than at research farms – it could be more economical for farmers to increase cropped area rather than to intensify, with additional fertilizer at hand.

Even though our findings countered our initial expectations, they were not entirely surprising, as subsidies have been found to decrease productivity. For instance, overinvestment in subsidised inputs can lead to allocative inefficiency and subsidisation may also lead to inefficiency, lack of effort and limited competition (Kornai, 1986; Rizov et al., 2013) and decreased productivity. Furthermore, increased subsidies elevate the prices received by farmers, thereby acting as a form of income support. With a higher base income guaranteed, producers may reduce agricultural labour supply altogether (Singh et al., 1986) or reallocate labour to the production of more remunerative export commodities. In addition, these import-competing crops are what economists call inferior goods, the demand for which falls when incomes rise. Finally, a higher NRA implies a higher domestic price for a given product, in response to which urban and rural consumers may decide to reduce their consumption of that product or find a substitute.

The negative impact of increased subsidies on crop yields in our estimates may well be a combination of all these factors. Hence, further subsidy does not intensify the production of maize, sugar or wheat. Rather, intensification could be achieved through a reduction in subsidies.

2.3 Impacts influenced by country characteristics

While taxes and subsidies affect the prices faced smallholder producers are confronted with , the degree and pace at which such policies shape prices in local, sometimes isolated, markets may differ. We investigated whether three country-specific factors – democracy, policy variability and infrastructure – shape the intensity with which NRA impacts crop yields. We labelled these as mediating factors, as depicted in Figure 3.

First, in more democratic countries, the effect of NRA on productivity was found to be weaker, albeit for some crops only. This finding is puzzling and counters an initial hypothesis, whereby democratic governments – associated with better quality institutions – are postulated to influence the degree of policy implementation positively throughout the country. It is possible that more secure property rights in democratic countries affect crop choice and production and, therefore, would explain this finding, but this requires further investigation.

Second, in countries that had experienced more frequent changes in agricultural policies as measured by an index of policy variability, the influence of NRA was found to be weaker for cocoa, cotton and wheat. This appears to be in line with other studies that report a negative effect of high policy variability (Hopenhayn and Muniagurria, 1996). Specifically for cocoa, a unit increase in policy variability was found to reduce the effect of NRA on cocoa yield by 7.4%. In such cases, smallholders appeared to opt for production strategies that are relatively invariant to the (too) frequently changing policy environment.

Finally, we hypothesised that, in countries with less developed rural infrastructure, the pace and magnitude by which national price changes permeate rural markets are weak. Poor market access and lack of information due to weak infrastructure are particularly pervasive in Africa (Minot, 2010). The effect of NRA changes in such countries could then also be weaker, but we did not find evidence of such an effect in the data.

3 Understanding policies

Most African countries tax the agricultural sector (Figure 1), although this trend has waned in recent years (Kherallah et al., 2002). African countries, together, raised USD 10 billion in agricultural taxes in the late 1970s; however, by the early 2000s, this figure had dropped to USD 6 billion. The decline was even more pronounced per agricultural worker: from USD 134 to 41, per year (Anderson and Masters, 2009). However, such averages mask considerable diversity between countries. In Ethiopia, for instance, agricultural taxes constitute 68% of the total tax revenue (IMF, 2012), whereas in Ghana, the NRA tax burden amounts to only 3% (Anderson and Masters, 2009).

We investigated the diversity in NRA across African countries in more detail, to understand how country-specific institutional and macroeconomic characteristics may explain differences in agricultural taxation or subsidisation. In line with previous studies, we found that the prevalence of taxes and subsidies were indeed being shaped by a range of economic and political variables (Table 2).

Table 2: Factors associated with the level of agricultural taxes and subsidies

	Effect on NRA	
	NRA decrease (lower subsidies & higher taxes)	No discernible relationship
Macroeconomic factors		
Increase in:		
- Inflation	X	
- Debt (% of GDP)	X	
- Monopoly power in commodity markets	X	
- GDP per capita		X
- GDP growth		X
Population factors		
Increase in:		
- Population size	X	
- Rural population (% of total)	X	
Institutional and political factors		
Change:		
- Less democracy	X	
- Stronger left-wing orientation of ruling party	X	
- Elections held		X
- Higher food self-sufficiency (% of total consumption)		X

The table lists factors influencing the NRA across African countries. Specifically, it lists whether factors in the left column significantly affect levels of NRA, or whether no significant effect could be discerned. The precise magnitude of estimated effects are reported in Malan (2015).

3.1 Debt, inflation and political institutions

Considering macroeconomic characteristics, a significant relationship could be observed between inflation and public debt on the one hand, and the level at which farmers were taxed on the other. Specifically, increases in inflation and public debt (as a percentage of GDP) lead to a decrease in NRA, therefore, by definition, to an increase in taxation. These relationships are plausible, as a high public debt presses governments to increase tax revenues for debt servicing (Tanzi, 1992). Inflation is a key indicator of overall macroeconomic stability shaping policy decisions and NRA.

We further investigated the effect of monopoly power in commodity markets. Specifically, in our sample, Côte d'Ivoire was found to wield substantial producer influence in the global cocoa market. We hypothesised that Ivorian producers are relatively unaffected by local tax regimes as taxes raised by (near) monopolists are predominantly born by global importers and consumers (Johnson and Antle, 1996). We did not, however, find evidence of Côte d'Ivoire setting levels of NRA that were distinctively different from those set in other African countries. Finally, measures relating to the size of the economy, GDP per capita and GDP growth appeared invariant to NRA, despite hypotheses that these may increase protection levels in the agricultural sector (Anderson et al., 2013; De Gorter and Swinnen, 2002).

Taking into account the structure of the population, we found that total population and the share of the rural population both shaped the levels of NRA, in line with findings in other studies (Anderson et al., 2013; De Gorter and Swinnen, 2002). This relationship is often dubbed the development paradox, whereby a larger rural population triggers greater taxation of the agricultural sector. A common explanation for this paradox rests in political factors. When the share of the rural population in the overall population is small and the share of consumer income spent on food is relatively low, the agricultural sector tends to be more protected (i.e. receives more subsidies) as there is less opposition to agricultural protection. This effect holds in developed countries, but our data also suggest evidence for such an effect in African countries.

Finally, a number of institutional and political variables were found to influence NRA. More democratic countries tax agriculture less, so that more democratic governments appear to redistribute income from the rich to the poor. Also, in more democratic countries with more accountable governments, the – non-rural – elite has fewer means to dictate policies (Anderson et al., 2013). There is further evidence (e.g. Olper, 2001) that governments oriented to the right of the political spectrum tax agriculture less than left-oriented governments, which was also apparent from our data.

It is commonly assumed that ruling parties alter agricultural policies in election years, as a way to secure more votes (Anderson et al., 2013; De Gorter and Swinnen, 2002; Henning and Struve, 2007). Such an effect was, however, not apparent from our analysis. Furthermore, and surprisingly, we did not find a relationship between higher agricultural subsidies and increased domestic food self-sufficiency. In fact, the objective of greater self-sufficiency in food grains was one of the most commonly aired motivations for greater subsidisation of the agricultural sector (Anderson et al., 2013). However, our analysis did not bear out a relationship between the two.

4 Fostering intensification

The results presented in this report have wide-ranging implications for policymakers seeking effective and sustainable mechanisms to accomplish agricultural intensification. Some of the main findings defy common assumptions. Crop yields of export crops could be considerably more responsive to taxation than assumed, while subsidies for food grains and sugar were found to be an ineffective mechanism to stimulate intensified agricultural production.

At first glance, these results appear to call for reduction and elimination of both agricultural taxes and subsidies as an effective avenue to stimulate agricultural intensification. Our analysis also illustrates that reductions in export crop taxes, as pursued by many countries in recent decades, have had a noticeable upward impact on crop yields. Room for further reductions for specific crops and countries remains and should be the aim in the long term. However, this is unlikely to be tenable in the short term, where policymakers face some difficult trade-offs. This section discusses these trade-offs below, with a separate focus on export taxes and subsidies, and concludes with two main avenues for effective policy development.

4.1   Agricultural intensification or increased tax revenue?

The previous sections highlight how a considerable part of low productivity of export crops stems from high taxes and low farm-gate prices. Farmers were found to respond well to price changes and may reap significant income gains from a reduction in taxation. This appears to defy common expectations of policymakers, who tax export crops based on the assumption that farmer responses are inelastic. The assumption about inelasticity is critical, because otherwise governments would forego revenue as the increase in tax revenue would be overturned by a proportionally greater reduction in taxable output.

It is difficult to tell whether current taxes for coffee and cotton have been set too high. This could be uncovered through micro-analysis in the respective countries. Table 3 lists a range of estimated crop yield responses, covering both elastic and inelastic values. Inelastic responses would show up as estimates smaller than 100; elastic responses as those greater than 100. For both cocoa and cotton, the upper bound falls in the elastic range (with a respective 143% and 141%, at most). In the elastic range, a short-term reduction in the tax rate would not only translate into an increase in farmer income but also into an increase in taxes collected.

While a strong case for reducing export taxation emerges, at least in the long term and possibly in the short term, such a conclusion ignores the fact that many developing countries currently have only few alternative means to increase government revenue to supply public goods. Often, a lack of alternative economic sectors and limited capacity in tax authorities inhibit the development of alternative taxing strategies. Government budgets in developing countries typically amount to 10% to 15% of GDP, of which trade taxation – the dominating

component in our NRA measures – constitutes a third (5% of GDP). In high-income countries, trade tax constitutes only 1%, on average (Baunsgaard and Keen, 2010), even with overall taxation being much higher at 40% of GDP.

Even though the size and importance of export taxes has been reduced in recent years (Figure 1), crops such as coffee and cocoa are still being taxed. Taxing export crops may be the only means for governments to supply public goods such as rural infrastructure, healthcare and education. This trade-off presents a formidable challenge for finding the socially most optimal strategy.

4.2   Agricultural intensification or rural income support?

We did not find evidence of subsidisation of staple crops, such as of wheat, maize or rice, spurring agricultural intensification or, in other words, higher crop yields. Rather, an increase in subsidisation (or a reduction in taxation) was found to have a negative or zero effect on maize, rice, sugar and wheat yields. Subsidies, therefore, fail to bring agricultural intensification closer. With declining arable land and the associated losses in natural ecosystems, a removal of subsidies thus appears an effective means of stimulating agricultural intensification. However, a rapid removal may be untenable in the short term, as argued, due to the directly resulting losses in rural income.

Even though the negative response in crop yields may appear counter-intuitive at a first glance, we found that a combination of producer and consumer responses make this a plausible finding. It must be noted that overall production of the crops under consideration could still increase, if smallholders, in response to subsidies, choose to expand the cropping areas for these crops. Furthermore, subsidies entail a substantial transfer of income to rural populations. Subsidy policies may thus still contribute to a policy goal of greater domestic food security and less poverty.

Altogether, our results further call into question the effectiveness of subsidies, similar to arguments aired in ongoing debate, with a particular emphasis on input subsidies and based on recent detailed insights from Malawi and Zambia (Dorward and Chirwa, 2011; Jayne et al., 2015). Moreover, large-scale subsidy programmes drain limited national resources; resources that can thus not be spent on the supply of alternative public goods. In addition, our findings signal a fundamental underlying question, namely that of whether development programmes focusing on these crops provide the best entry points for supporting agricultural and rural development, at all. The negative response to subsidies suggests that smallholders may well choose to divert production resources to more promising crops or activities when subsidies on wheat or maize increase.

Unfortunately, there appears to be no simple solutions, and most effective strategies are bound to be country- and even locality-specific. The best strategies for promoting land-sparing agricultural intensification thus point to identifying the right mix of incentives for the right crops and the right regulations. Additional research should uncover the most effective combination in individual countries.

4.3 The joint challenge for developing countries and donors

Current tax and subsidy regimes are unlikely to deliver the right foundation for a transition towards agricultural intensification. The need to augment African crop yields remains undisputed, with a growing population and increasing pressure on the remaining natural areas. However, this may involve a trade-off with the quest for greater domestic revenue generation in developing countries, the need for which was most recently re-affirmed by the Addis Ababa declaration (July 2015). Donors and developing partners should join hands to identify the most effective changes in fiscal systems, with the aim to increase domestic revenues as well as stimulate land-use intensification. Such cooperation would complement ongoing private and public-private development interventions, such as ubiquitous projects that link smallholders to markets and value chain initiatives. The latter type of intervention may well be much more effective in raising crop yields and agricultural production when less-distorted prices provide a better financial incentive to smallholders. Below, two avenues are discussed which may encourage a transition towards more intensive agriculture.

First, this report presents data on African aggregates. The actual impacts on crop yields may differ from one country to another. Detailed knowledge on precise producer responses to changes in taxes and subsidies across various economic sectors should be the cornerstone of any policy formulation or reformulation. Such knowledge would better equip African countries to integrate insights into domestic policy discourses. This is particularly relevant for the possibly elastic responses of export crop yields. In some of these cases, short-term adjustments to taxes may already provide gains to farmers, the government and the environment. Additional exercises should identify the precise price elasticities for specific crops, in specific countries. In some instances, raised crop yields have been known to spur cropland expansion (Byerlee et al., 2014). When and where this may occur needs to be uncovered, in order to design additional policies to limit such negative effects.

Such knowledge would also benefit donors. For instance, general donor-funded agricultural development programmes, targeting productivity enhancements in export crops, contribute directly to increased tax collection in supported countries. The question is whether such programmes represent the most efficient way of spending the scarce public funds of donor countries. In fact, in some cases, direct budget support for developing countries, coupled with a negotiated reduction in NRA, may prove to be as effective in stimulating farmer income and agricultural intensification.

Second, strategies for reforming tax codes need to be developed. Such an exercise would need to be rooted in continued support for laying prudent macroeconomic foundations. Given the strong relationship between NRA and debt, a key role for donors remains with the financial support of African countries through processes of debt restructuring or servicing. However, for many countries, we also signalled a heavy reliance on cross-border taxes of agricultural commodities. A complementary task thus calls for donor support in redesigning the tax code. In the long term, shifting the tax base to also include other sectors. In doing so, the impact on agricultural intensification and land-use efficiency would need to be taken into account, explicitly. This would provide an opportunity for donor countries to partner

with developing countries in providing technical and, where needed, financial support.

References

Anderson K. (2009). Distortions to agricultural incentives: A global perspective, 1955–2007, World Bank Publications.

Anderson K and Masters WA. (2009). Distortions to agricultural incentives in Africa. Washington, D.C., World Bank Publications.

Anderson K and Nelgen S. (2013). Updated national and global estimates of distortions to agricultural incentives, 1955 to 2011. World Bank, Washington D.C.

Anderson K, Rausser G et al. (2013). Political economy of public policies: insights from distortions to agricultural and food markets. Journal of Economic Literature 51: 423–477.

Barrett CB. (2008). Smallholder market participation: concepts and evidence from eastern and southern Africa. Food Policy 33: 299–317.

Baunsgaard T and Keen M. (2010). Tax revenue and (or?) trade liberalization. Journal of Public Economics 94: 563–577.

Binswanger HP, Ruttan VW et al. (1978). Induced innovation: technology, institutions, and development, Johns Hopkins University Press, Baltimore.

Brink AB and Eva HD. (2009). Monitoring 25 years of land cover change dynamics in Africa: A sample based remote sensing approach. Applied Geography 29: 501–512.

Byerlee D, Stevenson J et al. (2014). Does intensification slow crop land expansion or encourage deforestation? Global Food Security 3: 92–98.

De Gorter H and Swinnen J. (2002). Political economy of agricultural policy. Handbook of agricultural economics 2: 1893–1943.

Denning G, Kabambe P et al. (2009). Input subsidies to improve smallholder maize productivity in Malawi: Toward an African Green Revolution. PLoS Biol 7: e1000023.

Dorward A and Chirwa E. (2011). The Malawi agricultural input subsidy programme: 2005/06 to 2008/09. International Journal of Agricultural Sustainability 9: 232–247.

FAO (2009). How to feed the world in 2050. FAO, Rome (IT).

FAO (2016). FAOSTAT database collections. Retrieved 7 October 2016.

Fulginiti LE and Perrin RK. (1993). Prices and productivity in agriculture. The Review of Economics and Statistics: 471–482.

Fulginiti LE, Perrin RK et al. (2004). Institutions and agricultural productivity in Sub-Saharan Africa. Agricultural Economics 31: 169–180.

Henning C and Struve C. (2007). Electoral systems, postelection bargaining and special interest politics in parliamentary systems: The case of agricultural protection. Topics in Analytical Political Economy. International Symposia in Economic Theory and Econometrics.

Hopenhayn HA and Muniagurria ME. (1996). Policy variability and economic growth. The Review of Economic Studies 63: 611–625.

ICCO (2016). Monthly averages of daily prices (cocoa). Retrieved 7 October 2016, from http://www.icco.org/statistics/cocoa-prices/monthly-averages.html.

IMF (2012). Regional Economic Outlook. Sub-Saharan Africa. Washington D.C., International Monetary Fund.

Jayne TS, Mather D et al. (2015). Rejoinder to the comment by Andrew Dorward and Ephraim Chirwa on Jayne, T. S., D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. How do fertilizer subsidy program affect total fertilizer use in sub-Saharan Africa? Crowding out, diversion, and benefit/cost assessments. Agricultural Economics, 44 (6), 687–703. Agricultural Economics 46: 745–755.

Johnson DG and Antle JM. (1996). The Economics of Agriculture, Volume 2: Papers in Honor of D. Gale Johnson, University of Chicago Press.

Kastner T, Erb K-H et al. (2014). Rapid growth in agricultural trade: effects on global area efficiency and the role of management. Environmental Research Letters 9: 034015.

Kherallah M, Delgado CL et al. (2002). Reforming agricultural markets in Africa: Achievements and challenges, Intl Food Policy Res Inst.

Kornai J. (1986). The soft budget constraint. Kyklos 39: 3–30.

Lambin E, Gibbs H et al. (2013). Estimating the world's potentially available cropland using a bottom-up approach. Global Environmental Change 23: 892–901.

Lowder SK, Skoet J et al. (2014). What do we really know about the number and distribution of farms and family farms in the world? ESA Working paper no 14–02.

Malan M. (2015). Agricultural price distortions in Africa: Insights into the determinants of price distortions and their effect on land use efficiency. MSc thesis. Development Economics Group, Wageningen University, Wageningen.

Mason NM, Jayne T et al. (2013). Zambia's input subsidy programs. Agricultural Economics 44: 613–628.

Minot N. (2010). Transmission of world food price changes to markets in Sub-Saharan Africa, International Food Policy Research Institute Washington.

Olper A. (2001). Determinants of Agricultural Protection: The Role of Democracy and Institutional Setting Alessandro Olper. Journal of Agricultural Economics 52: 75–92.

PBL (2012). Roads from Rio+20. Pathways to achieve global sustainability goals by 2050. PBL Netherlands Environmental Assessment Agency, The Hague.

Rakotoarisoa MA. (2011). The impact of agricultural policy distortions on the productivity gap: Evidence from rice production. Food Policy 36: 147–157.

Reardon T, Delgado C et al. (1992). Determinants and effects of income diversification amongst farm households in Burkina Faso. The Journal of Development Studies 28: 264–296.

Rizov M, Pokrivcak J et al. (2013). CAP subsidies and productivity of the EU farms. Journal of Agricultural Economics 64: 537–557.

Singh I, Squire L et al. (1986). Agricultural household models : extensions, applications, and policy. Johns Hopkins University Press, Baltimore.

Tanzi V. (1992). 12 Structural factors and tax revenue in developing countries: a decade of evidence. Open Economies: Structural Adjustment and Agriculture: 267.

UN (2012). World Population Prospects, the 2012 revision. Department of Economic and Social Affairs, United Nations, New York.