Sectoral and Food Security Impacts of Agricultural Policy Adjustments in Colombia

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Abstract

We aim to assess the sectoral and food security impacts of changes in agricultural policy in Colombia. For this we use an agriculture specialized static CGE model, running on a 2007 SAM. Even though improving food security is not an stated objective of recent agricultural policy changes in Colombia, the perceived bias in resource allocation that implementation of the new policies have in terms of favoring non-food crops could potentially deteriorate food security, especially for low income households. Results from this research show that, at least in the short run, the reduced impacts that these policies have on the agricultural sector preclude the possibility that food security may deteriorate as a consequence of their implementation.

Keywords: Agricultural policy, Food security, Computable General Equilibrium, Colombia

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1. Introduction

During negotiation of a free trade agreement between Colombia and the United States, the government agreed, with representatives of agricultural producers, to out in place a program to compensate the losers of the agreement and to enhance sectoral competiveness. Such a program was launched in April of 2007, significantly reinforcing a policy trend in Colombia toward increased transfers to agricultural producers.

Given the level of resources deployed in the program and the way they have been assigned between crops, there is the possibility that the structure of agricultural production may be tilted against food security. This is so as resources from the program have been disproportionally assigned to perennial crops and for increasing capital use in the sector, characteristics that, in the case of Colombian agriculture, tend to be associated with production of goods that do not directly contribute to food consumption.

The goal of this article is to estimate the short run effects of this program at the sectoral level and their potential effects on food security. At the macro level, we want to evaluate the impact of this new agricultural policy on relative prices of goods and quantities produced. At the food security level we seek to appraise potential changes in food availability, especially in terms of the relationship between domestic production and import dependence, on one side, and accessibility, on the other.

We use an agriculture specialized static computable general equilibrium model for these purposes. The model runs on a 2007 SAM with relatively detailed agricultural sector and household disaggregation.

The structure of the paper is as follows. Section 2 provides the general policy context of the policy changes. Then, in section 3, a general description of the design and implementation of the policy package is provided. Section 4 presents the research objectives and methods, including a technical description of the main characteristics of the CGE model, as well as of the simulation that is carried out. In section 5 we present a general description of some relevant characteristics of food security in Colombia and of the size of the policy shocks to support our interpretation of the results. Section 6 presents and discusses the main results, and section 7 concludes the paper.

2. Policy background

According to the World Bank (2008), Colombia has made the shift from taxing to supporting agriculture. During the 1960s and up to the end of the 1970s, the nominal rate of assistance to agriculture was negative. It became positive during the 1980s, averaging 5% in the first half of the decade and 0.2% in the second half. The 1990s marked the beginning of a period of rising agricultural assistance: from 8.2% in the first half of the 1990s and 13.2% in the second half, to 25.9% in the first half of the 2000s. Most of this support was provided through border measures such as tariffs, quotas and administrative restrictions, while direct assistance on the domestic market was almost negligible. This stands in contrast with the behavior of the other Latin American countries included in the World Bank study. Although some countries (Brazil, Dominican Republic and Ecuador) have also shifted from overall taxation to protection in the agricultural sector, Colombia stands out in both the precocity and size of its supports.

Within this context, and given the recently negotiated free trade agreement (FTA) with the United States, the Colombian government agreed with farmers' organizations that a policy package would be designed and implemented to smooth out the impact of the FTA implementation period and to boost sectoral competitiveness. Announced in March 2006, the program, named Agriculture, Secure Income (AIS according to its Spanish language acronym), was put in place in April 2007 with the signing of a law that laid out its general principles and allocated a budget to it. The program was assigned a budget of around US$217 million in 2007, or about 35% of that year's total public sectoral budget (excluding debt service charges). Although the size of the program is modest in relative terms (around 2.3% of sectoral GDP) it is by far the largest sectoral policy instrument in Colombia.

AIS has a relatively complex structure. The two main components of this program target different objectives. One of them is the direct provision of income support to protect farmers during the implementation period of the FTA with the US (Sectoral Direct Support Component, SDSC). The other aims to make the agricultural sector more competitive through increased productivity and help to launch restructuring processes (Competitiveness Enhancement Component, CEC). Direct support is unconditionally provided to farmers and is meant to be selective and temporary. Measures to enhance competitiveness are also an important part of the program and should thus be allocated no less than 40% of the program's total budget.

Although each of these components is set up differently, both share a set of subprograms through which they are implemented. Of these, the most important for our purposes are: the Special Credit Line (SCL), the Incentive for Rural Capitalization (IRC), and the Call for Irrigation and Drainage Projects (CID).[1] The SCL is a subsidized credit scheme that supports productivity improvements and restructuring (shifts between agricultural subsectors) through the financial system. Credit through the SCL has been offered under various conditions over the years, but has tended to be at a significantly lower interest rate than on private markets (generally between 5 to 12 percentage points lower, depending on the type of farmer and the year). Small farmers tend to use this credit to carry out activities related to planting and maintaining crops, while large-scale farmers use it to acquire machinery to engage in primary transformation of products. Medium size farmers tend to be the main beneficiaries of this scheme (as indicated by their share of total program disbursements) and devote their resources to planting and maintenance of crops and to land adequation.

The IRC is intended to facilitate agricultural investment by offering a line of credit that operates at market interest rates but that includes some financing (credit and interest) forgiveness. The IRC existed before the AIS was established, but the AIS now uses the IRC to distribute some of its resources. It has also expanded the set of activities that are eligible beyond those targeted by the original IRC. The provisions state that small producers are forgiven 40% of credit devoted to activities on an eligibility list. Medium size and large farmers are forgiven 20% subject to some exceptions (depending on the activities carried out). In the case of construction, enlargement or rehabilitation of large irrigation projects, forgiveness is 40% for all farm sizes, and there are no limits to the size of the incentive.[2] The list of eligible activities includes land adequation and water management; productive infrastructure; biotechnology development and application; machinery and equipment for agricultural production; livestock and aquaculture equipment; low technology fishing; primary transformation of agricultural goods; planting, maintenance, and renewal of perennial crops; acquisition of pure breed bovine livestock; implementation of integrated livestock and forestry projects; and investment in generic agricultural inputs.

The CID is a subprogram which co-finances irrigation and drainage projects for existing or prospective production. The size of the subsidy granted by the government varies by project type (individual, cooperative or regional) and may reach up to 80% of direct costs. The remainder of the costs must either be covered by regional institutions, directly by the farmers or by both. Funds for this program are allocated on a competitive basis. Beneficiaries must have prepared a proposal, including an economic evaluation, and entered a competitive process to determine who

[1] The other subprograms are the: Incentive for Technical Assistance, Livestock, Sanitation, Coffee Extension Service, Forestry Incentive Certificate, Science and Technology, and a fertilizer program (Fertifuturo).
[2] Some of these conditions change from time to time.

gains access to the funds.[3]

The SDSC operates through some of the same subprograms used by the CEC, notably the SCL and the IRC. A difference here is that funds from this component target specific sectors according to a government valuation. The other difference is that the level of the subsidy is higher in this case. Credit forgiveness for medium- and large- scale farmers benefiting from IRC are higher than under the previous arrangement, for instance (30% compared to 20% under the CEC). In 2007, all resources from this component were directed to cereals and rice and were disbursed in similar proportions to the SCL and IRC (44% and 56% on average). In 2009, this component of the program prioritized the cut flowers sector (for social and environmental purposes), planting of corn for feedstock purposes and the planting of beans in coffee growing areas.

Despite the fact that negotiations for the FTA with the US ended in November 2006, and that the treaty was only approved by the US Congress in October 2011 (which means that implementation could only begin in 2012 at earliest), the AIS came into force in 2007 and has been in place since then. To accommodate the fact that the trade pact was not in place and that there was therefore only a weak basis for implementation of the SDSC, the government determined that 72% of the budget should be allocated to the CEC, 26% to the SDSC, and the other 2% went to program administration. This prioritization of the CEC has continued in recent years.

In 2009, the program came under fire when a misallocation of resources was made public by the press. With a new government in power, the program was rebranded as Equitable Rural Development (DRE for its acronym in Spanish) in 2011. Large-scale farmers were denied access to the DRE and small operational changes were introduced. Its basic structure, organization and use of policy instruments continue to be the same.[4]

3. Implementation of AIS/DRE

Between 2007 and 2009, the program disbursed a total of around US$704 million, 91% of which was devoted to the CEC. As mentioned in the program evaluation that was contracted by the Ministry of Agriculture (Econometria, 2011), the majority of resources were used by four sub-

[3] This program is the main reason that the AIS was criticized, since large farmers have been better positioned to present good proposals than small farmers. Furthermore, large farmers fragment their projects, effectively violating the ceilings imposed on subsidy amounts, allowing them to illegally access a major share of resources dedicated to this component of the program.

[4] Currently, there is discussion in policy circles about major changes in agricultural policy, including a potentially large reduction in direct support measures in favor of public goods provision. However, no formal changes have been introduced to agricultural policy yet.

programs: the Special Credit Line (SCL), the Incentive for Rural Capitalization (IRC), the Incentive for Technical Assistance (ITA) and the Call for Irrigation and Drainage Projects (CID). The baseline and the Econometria evaluation itself were limited to these four subprograms.[5]

We use the CGE model to estimate the expected impacts of the three subprograms mentioned: the SCL, the IRC, and the CID. Despite the institutional complexity of the program (two components, eleven subprograms, different access rules and subsidy levels for each potential subprogram-component-beneficiary combination), the situation is actually fairly straightforward when looking at the economic incentives it creates for farmers. A set of policy instruments lower the unit cost of production, while others lower the cost of capital or the cost of land, and the remainder tend to boost productivity.[6]

Since the model we use does not distinguish between farmers types, subsidies through the program are only considered at the aggregate level. For the purpose of this modeling, the size of the subsidy to small farmers (40%) benefitting from the IRC and the subsidy to large farmers (20%) does not necessarily matter. Rather, it is the total amount granted to each agricultural subsector in the model that matters. The total amounts of subsidies disbursed by the program in 2008 and the implicit subsidy rates are both reported in table 1 for each type of incentive.[7] We can see there that slightly more than half of the resources considered here were granted as subsidies to productive capital (US$74.7 million, or 51.9% of the total), followed by irrigation subsidies (US$64.5 million, or 44.8% of the total) and by working capital subsidies (US$4.7 million, or 3.3% of the total). Therefore, the program actually devoted the majority of resources to uses that may bring some form of technological change, assuming that capital investments reflect a particular technology choice.[8] While working capital subsidies are expected to be neutral in terms of factor proportions, productive capital subsidies clearly support capital intensification and its effect on labor use depends on whether capital and labor are complements or substitutes.

We can also see in the table that the subsector receiving the largest amount of resources is

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[5] The methodology used in this evaluation follows the general procedures of an econometric program evaluation.

[6] Instruments lowering unit costs include: credit for working capital, planting and crop maintenance, and agricultural production. Those lowering the cost of capital and land include: credit for productive infrastructure, primary processing and marketing, machinery and equipment, land adaptation, irrigation and drainage projects, and planting of late yield perennials. The only one that boosts productivity among those that we consider here is irrigation and drainage projects.

[7] Subsidy rates are calculated as the government's share of total project costs. Therefore they do not represent the subsidy level across an entire agricultural subsector, but rather correspond to the average project in the program.

[8] This is clearly not always the case, as capital investment may also be directed to replace old capital.

agricultural investment, a subsector that includes newly planted areas of perennial crops. US$55.9 million (38.8% of total subsidies) were allocated to this subsector, followed by fruits and oil palm (respectively 10.4% and 10.2%).[9] In total, 79.4% of resources were assigned to perennial crops. The subsectors with the lowest allocations of resources were plantain, cereals, and other crops (respectively 0.03%, 0.04% and 0.24%). If productive capital subsidies are considered on their own, agricultural investment is by far the largest recipient of this type of subsidy (74.8%), followed by coffee (6.1%), rice (6%) and sugar cane (6%). In terms of irrigation subsidies, the largest beneficiaries are oil palm (22%), fruits (21.9%), sugar cane (10.6%) and cocoa (8.8%). Lastly, with respect to working capital subsidies, the largest subsidy amounts were allocated to rice (25.4%), cotton (22.8%), potatoes (12.5%), vegetables (10.2%) and corn (9.9%). Therefore, the program not only promotes capital intensification, but also tends to offer stronger support for perennial crops.[10]

Table 1. Government expenditures on subsidies and implicit subsidy rates (2008, millions)

Crop	Working capital subsidy:		Productive capital subsidy:		Irrigation subsidy:	
	Amount	Actual rate	Amount	Actual rate	Amount	Actual rate
Coffee	0.00	6.4	4.56	22.9	3.69	75.7
Cereals	0.04	2.1	0.02	12.4		
Corn	0.46	1.4	1.35	16.6	2.54	79.1
Rice	1.19	1.8	4.48	12.1	3.25	75.0
Potatoes	0.58	3.9	0.31	12.3	3.95	79.3
Legumes	0.21	5.4	0.12	13.2	2.75	79.2
Vegetables	0.48	11.2	0.83	12.9	4.00	78.2
Tubers	0.18	2.8	0.08	2.4	0.34	77.7
Bananas			0.37	11.0	2.59	67.2
Plantain			0.04	17.2		
Fruits	0.00	2.8	0.75	15.9	14.15	77.4
Oil palm			0.52	13.5	14.19	77.5
Oil seeds	0.04	1.4	0.41	19.9		
Other crops	0.00	3.1	0.30	18.1	0.05	40.1
Cocoa	0.00	0.0	0.17	23.6	5.70	74.9
Tobacco	0.44	4.4	0.03	20.4	0.32	72.7
Sugar cane			4.49	14.8	6.82	69.6
Cotton	1.07	1.6	0.01	21.4	0.17	77.0
Ag. Invest.			55.85	17.0		
Total	4.70		74.69		64.51	

Source: authors' calculations based on Ministry of Agriculture's data

4. Research objective and methodology

We aim to estimate the likely short run sector-specific impacts of agricultural policy, as well

[9] Fruit and oil palm are perennial crops, as are some other subsectors. The distinction here points to the fact that agricultural investment is an activity that includes the planting of new areas that, by definition, do not yield production yet. This can be compared with subsidies granted to activities producing perennial goods, and which are therefore expected to impact current production levels.

[10] Whether this apparent preference to support perennials is intended or not could be debated, as there is an important demand component at play.

as its likely effects on food security. More specifically, we aim to assess the potential impact of the main components of the program on the relative prices, quantities produced and real factor returns of agricultural goods as well as the effects these have on food security in terms of import dependence, product availability, and access to food.

Despite of the policy package being one of the largest of its kind in the history of Colombian agricultural policy, it is small relative to the size of the sector, with an annual budget of about 2.3% of value added in the sector. Its impact is therefore expected to be primarily felt in the agricultural sector and any induced changes at the aggregate level are likely to be relatively small in the short term. More significant macro effects may be generated by the policy in the longer run, since the rural sector may attract relatively more capital due to the types of incentives the policy creates and the time it takes for newly planted perennial crops to reach their productive age. Our focus here is on the short run (as specified below), so we expect the simulations to indicate relatively small macro impacts; however, it is still important to retain the general equilibrium focus as upstream and downstream linkages affect the final policy outcomes, and also differ from one crop to the next.

The simulation of sectoral policy changes uses the 2008 AIS/DRE allocation of resources to the different policy instruments, as illustrated above in table 1. The CGE model is based upon a Standard PEP CGE model (in this case the single country, static version: PEP-1-1). It has a neoclassical structure with equations that describe producers' production and input decisions, households' behavior, government demands, import demands, market clearing conditions for commodities and factor markets, and numerous macroeconomic variables and price indices. Supply and demand equations for private-sector agents are derived from optimization problems, in which agents are assumed to be price-takers in a competitive market. The model treats the external sector as a single region and adopts a "mild" version of the small country assumption.[11] Thorough documentation of the model can be found in Decaluwé et al (2009).

We make two main changes to the model. First, we modify the structure of production in the agricultural sector, allowing for a convenient representation of agricultural production. Second, we introduce a supply of land services so as to have a more realistic representation of land allocation between agricultural subsectors. However, our definition of agriculture excludes livestock, dairy production, meat production, forestry and fisheries.[12] The reasons for this are that we have no dependable information on land use for these subsectors (especially for livestock)

[11] In the sense that local producers can increase their share in international markets as long as they can offer a price that is competitive relative to the world price (in consideration of the price elasticity of export demand).
[12] However, these sectors are included in the model either independently or as part of other activities.

and the dominant mode of livestock production in Colombia, which affects land allocations among rural land-based subsectors[13]. The structure of agricultural production as well as the structure of the supply of land services are illustrated in figures 1 and 2 in the appendix.

The model uses a 2007 SAM with 31 subsectors and 31 commodities. Of these subsectors and commodities, 23 belong to or are directly related to the agricultural sector: nine are seasonal crops, nine are perennial crops, and the remaining five are perennials that are not yet productive (reflecting agricultural investment), livestock and poultry, forestry, agricultural services and agroindustry. The non-agricultural sectors include two services sectors (general services and financial services) and two sectors that produce agricultural inputs (fertilizers and other agrochemicals). There are three production factors: land, labor and capital. Land is only used by crops, so livestock and poultry, forestry and agricultural services only use labor and capital. Labor is split into four categories: rural unskilled, rural skilled, urban unskilled and urban skilled, and there is only one type of capital. Households are disaggregated into rural and urban households, each of which is further divided by income quintile, for a total of 10 household types. We do not consider self-consumption of agricultural goods produced by rural households.[14]

Regarding the labor market, the model allows for either full factor mobility or factor specificity. In the simulations, we assume that labor is perfectly mobile between sectors while capital is sector-specific. However, it must be kept in mind that there are two features in the model that result in limited labor mobility within the agricultural sector. As land allocation between agricultural subsectors is slow, labor mobility in the agricultural sector is lower. Also, as production in the agricultural sector uses a capital-labor composite factor with sector–specific capital, labor mobility tends to be limited. For these reasons, and for the purposes of our present objectives, we believe that it is suitable to achieve closure in the model's labor market through wages, with perfectly inelastic supply of labor, even though it is generally assumed that labor mobility between agriculture and other subsectors should be modelled as less than perfect. Also, specifying capital as sector–specific is convenient because we aim to evaluate the short run effects of the policy package under consideration.

In light of our discussion in section 3, we basically need to model three types of incentives

[13] Livestock activities in Colombia are predominantly extensive (i.e., based on natural and cultivated pastures and itinerant grazing) and are known to be used as a low cost and non-labor-intensive way to claim land, in addition to their function as an economic activity

[14] Consumption shares consistent with the LES system for each household type were estimated from household survey data, following Bibi et al (2009). A list of model parameter and elasticities is provided in the appendix.

created by the policy: subsidies which lower unit costs, subsidies which lower productive capital costs and subsidies which lower land use costs (including a productivity effect). We model all subsidies that effectively lower unit costs as creating a (negative) wedge between an subsector's unit cost and its basic price:

$$PT_j = \left(1 + ttip_j - SWK_j\right) * PP_j$$

where:

$PP_j = activity\ j\ unit\ cost$
$PT_j = basic\ price\ of\ industry\ j's\ output$
$SWK_j = rate\ of\ subsidy\ for\ working\ capital\ for\ activity\ j$
$ttip_j = tax\ rate\ on\ the\ production\ of\ activity\ j$

On the other hand, productive capital subsidies lower the cost of capital for beneficiary subsectors so the price of this factor decreases according to the implicit subsidy rate (across the entire subsector):

$$RTI_j = R_j\left(1 + ttik_j - SKD_j\right)$$

where:

$R_j = rental\ rate\ of\ capital\ in\ activiy\ j$
$SKD_j = rate\ of\ subsidy\ for\ capital\ used\ in\ activity\ j$
$ttik_j = tax\ rate\ on\ capital\ used\ in\ industry\ j$

Irrigation subsidies have two effects. One is that they lower the cost of using land and therefore act as a subsidy for productive capital. The second is that they are expected to improve productivity since enhanced water availability and management is expected to increase yields. These effects are modeled as follows:

$$TD_j = \left\{\left[\frac{\beta_j^{CT}}{1-\beta_j^{CT}}\right] * \left[\frac{PC_{fert}}{\left(RTT_j * \left(1 - STI_j\right)\right)}\right]\right\}^{\sigma_j^{CT}} * FD_j$$

$$CT_j = CTPF_j * B_j^{CT}\left[\beta_j^{CT} TD_j^{-\rho_j^{CT}} + (1-\beta_j^{CT}) FD_j^{-\rho_j^{CT}}\right]^{\frac{-1}{\rho_j^{CT}}}$$

where:

$CTPF_j = composite\ irrigated\ land\ productiviy\ factor\ in\ activity\ j$
$STI_j = subsidy\ rate\ on\ land\ rent\ due\ to\ irrigation\ subsidies\ in\ activity\ j$
$TD_j = demand\ for\ land\ by\ agricultural\ activity\ j$
$FD_j = demand\ for\ fertilizer\ by\ agricultural\ activity\ j$
$RTT_j = rental\ rate\ of\ land\ in\ ag.\ activity\ j$

$PC_{fert} = price\ of\ composite\ fertilizer$
$B_j^{CT} = scale\ parameter\ (CES - composite\ land)$
$\beta_j^{CT} = share\ parameter\ (CES - composite\ land)$
$\rho_j^{CT} = elasticity\ parameter\ (CES - composite\ land);\ -1 < \rho_{jag}^{CT} < \infty$

The productivity effect through irrigation should ideally be calibrated on a crop by crop basis. Unfortunately, the information to do this is neither abundant nor reliable enough, so we assume that the productivity effect is the same across all crops. Furthermore, the parameter is estimated on the basis of the (average) assumed yield gap between irrigated and non-irrigated land for several crops. Data on yield gaps come from information available for some crops and from experts' judgment.[15]

Lastly, it is worth mentioning some general characteristics of the simulation. We should start here by considering the financing of the program. This is done by assuming that public expenditures to subsidize agricultural activities are financed through direct taxes designed to raise the exact amount needed (i.e., tax rates for households and firms adjust endogenously). Second, the simulation uses the following closure rules: the nominal exchange rate is the numeraire, the supply of labor is fixed, fully utilized and freely mobile between all sectors, government spending is fixed, investment is savings-driven, the current account balance is fixed and total land demand is fixed.[16] We define our time horizon as short term, so capital is assumed to be sector-specific. This feature is not only consistent with the idea that most capital used in agricultural activities is more related to trees and plants than to machinery and equipment (in the Colombian case), but also with the fact that, even in the case of capital that is not strictly specific to an activity (like machinery), the timeframe considered in the simulation makes it unlikely that there could be any significant capital reallocation between the subsectors.

Given the above depiction of the type of policy instruments that are modeled and the timeframe some of them require to become fully operational, we should clarify what we mean by the short term for the purpose of this simulation. Here, we consider short term as up to two years, allowing enough time for new capital investments to be built and put into operation (particularly productive capital, land improvements and irrigation); the time is assumed to be too short for areas that are planted with perennials to enter their productive stage. This allows us to reconcile the static nature of the model with the main features of the policy package, making the simulation meaningful. In particular, we do not address the fact that some of the policy instruments aim to

[15] Given the nature of this information, a sensitivity analysis is conducted to evaluate the effect of changes in this parameter (see the appendix).
[16] Since we have land demand specified by a CES aggregate (of composite land) and land supply by a CET aggregate, the supply of land services must be endogenous.

promote the planting of new perennial crops or the entrance of previously planted areas into production, both of which would require use of a dynamic model (or a long run simulation).

5. Stylized facts about food security in Colombia and size of shocks

Before discussing the simulation results, it is useful to have an overview of the food security situation in Colombia as well as of the relative size of the policy shocks, by looking at the size of subsidies to each subsector as a share of total resources disbursed by the government.

Of the 31 products in the SAM, 12 correspond, totally or partially, to food. These products account for almost 25% of total final consumption (by households), 10% of intermediate consumption, 1.7% of demand for investment, 14.4% of total exports, and 8.6% of total imports. In average, food consumption represents 54.1% of total consumption expenses among rural households, ranging from 58% for households in the first income quintile to 45% for households in the fifth quintile, while it amounts to 25.3% of total consumption expenses among urban households, ranging from 31.6% for households in the first quintile to 16% for households in the fifth quintile. Hence there is a marked dispersion in consumption patterns, with rural households expending a high proportion of their income in food and low income rural and urban households showing the same relative behavior.

Table 2 presents the share of each household type in food consumption by product category. From these data, it follows that urban households concentrate more than 75% (and up to 85%) of consumption expenses in leguminous products, vegetables, bananas, fruits, oil seeds, and processed products (agroindustry). Furthermore, this concentration is especially high (above 40% of the total) in the top two urban quintiles in the cases of fruits, oil seeds, and processed products.

In terms of the composition of food expenses, corn, potatoes, tubers, plantain, and animal products tend to have more relative weight among rural households, while fruits and processed foods tend to have more weight in the case of urban households. Within rural households, expenses on tubers rank higher in low income than in higher income households, while for other product categories differences are less pronounced. In the case of urban households, the share of expenses in tubers also declines with income, as do expenses in plantain and animal products, while expenses in fruits and processed food increase with income.

The above roughly implies that rural households and low income (rural and urban) households tend to show a higher share of starchy foods within their diets and potentially a lack of food that is a good source of protein. According to the Colombian government (CONPES, 2008), around 36% of the population has some sort of deficiency in protein intake, energy intake is lower in rural areas and among low income households, 25% of the population has a higher than recommended intake of saturated fat, fruit and vegetable intake is lower than desirable, and calcium and zinc intake is, in general, deficient.

Table 2. Share in food expenses per food category and household type (percentages)

Product	Rural households in quintile:					Urban households in quintile:				
	1	2	3	4	5	1	2	3	4	5
Cereals	13.5	8.7	9.2	10.8	18.7	7.9	5.1	7.4	7.6	11.1
Corn	6.8	6.3	9.2	8.4	9.7	8.4	10.8	10.4	8.8	21.3
Potatoes	4.7	5.0	5.5	6.9	9.0	10.7	13.9	13.5	15.1	15.7
Leguminous	3.0	3.9	4.9	5.4	6.9	9.6	14.1	14.5	16.1	21.6
Vegetables	3.2	4.2	5.2	5.9	6.9	10.0	13.6	14.0	17.1	19.9
Tubers	5.5	8.0	7.4	9.0	7.3	11.9	13.1	12.5	12.7	12.5
Bananas	1.9	4.2	3.6	5.8	6.0	10.1	16.3	15.7	15.8	20.7
Plantain	4.4	6.0	7.3	7.9	8.0	11.3	13.5	12.6	15.0	14.1
Fruits	1.3	2.2	2.9	3.3	5.4	7.7	12.3	15.0	18.9	30.8
Oil seeds	1.0	2.2	8.9	2.8	4.9	4.7	3.0	10.9	5.6	56.0
Animal products	4.0	5.4	6.4	7.6	8.7	10.6	12.4	13.4	14.9	16.5
Processed products	2.2	2.8	3.2	3.8	4.8	9.6	13.0	15.7	18.6	26.2

Source: 2007 SAM

The same governmental report points out that the 2005 National Health and Nutrition Survey indicates that 40.8% of Colombian population shows some sort of food insecurity. Of these population, 64% shows light forms of food insecurity, 27% shows moderate manifestations of food insecurity, and the remaining 9% shows severe food insecurity. It also indicates that food insecurity is higher in rural areas (58.2% incidence vs 36.5% in urban areas).

From the standpoint of sufficiency, table 3 reports the import penetration ratio for the product categories representing food products. The ratio is calculated as imports as percentage of total domestic use and a comparison is made with the export ratio. As follows, imports are the dominant source of food (more than 30% of absorption) in the cases of cereals, corn, and oil seeds (all products in which the country has experienced a high dependence on imports for a relatively long time). On the other hand, only leguminous foods show a relatively high export to absorption ratio, whose value is of about the same magnitude as the import penetration ratio. Bananas show the highest export ratio, which is an especial case since bananas has traditionally been an important agricultural export, basically operating as an enclave activity with relatively weak links to domestic absorption (that is essentially met through cultivation outside of the areas where export bananas are grown).

Table 3. Import penetration ratio and export ratio for food products in Colombia

Product	Import penetration ratio	Exports ratio
Cereals	0.777	0.006
Corn	0.584	0.007
Potatoes	0.013	0.024
Leguminous	0.211	0.267
Vegetables	0.029	0.022
Tubers	0.015	0.016
Bananas	0.017	13.487
Plantain	0.020	0.050
Fruits	0.063	0.032
Oil seeds	0.440	0.001
Animal products	0.005	0.042
Processed products	0.067	0.122

Source: 2007 SAM

From the above, it can said that food security problems in Colombia do not seem related to food availability but to access and lack of diet adequacy. In fact, Colombia ranks in 2012 among the countries with a Food Hunger Index under 5, which means that food insecurity (under this measure) is low. The country comes from an index of about 9.2 in 1990, to 6.8 in 1996, to 5.8 in 2001, and to less than 5 in 2012, showing a steady improvement (IFPRI, et al, 2012).

With respect to the size of the policy shock, subsidies presented in table 1, which, as mentioned, correspond to the rate calculated for the average project, generally get reflected in relatively small subsidy rates at the subsector level. Since the latter are the rates that matter for the simulation, they are presented in table 4.

Three features stand out from the numbers shown in this table. First, given the size of the program relative to sectoral GDP, there is a large gap between the subsidy rate given to the average program beneficiary and the subsidy rate for the subsector as a whole. For instance, the subsidy rate averages 22.9% among coffee producers who actually received subsidies, but this rate is just 0.72% across the subsector as a whole. The size of this gap depends upon the total amount of subsidies allocated to a subsector as a share of total production in the subsector. The relevant point here, however, is that beneficiaries from the program gain a significant advantage over non-beneficiaries and this effect is not captured in our evaluation, since we do not differentiate among different producers within a subsector or between beneficiaries and non-beneficiaries.

The second feature is that the most significant subsidies are those that reduce the cost of productive capital or of irrigated land use (as opposed to subsidies that do not tend to affect factor proportions), the latter being the most important in relative terms. Lastly, the largest subsidy for agricultural investment is for productive capital (i.e., new plantings of perennials), followed by corn and rice, while irrigation subsidies cover a larger variety of subsectors (eight subsectors receive land subsidies above 12%).

Table 4. Subsidy rates at the subsector level granted through the AIS/DRE program (%)

Subsector	Working capital	Productive capital	Land use	Productivity
Coffee	0.00	0.72	4.52	0.88
Cereals	0.09	0.09		
Corn	0.18	11.80	8.28	2.49
Rice	0.15	1.92	4.08	1.15
Potatoes	0.07	0.18	12.53	2.04
Beans	0.07	0.06	31.32	10.29
Vegetables	0.07	0.19	15.91	6.33
Tubers	0.01	0.01	0.42	0.20
Bananas		0.17	18.08	3.64
Plantain		0.01		
Fruits	0.00	0.07	23.97	6.06
Oil palm		0.15	36.61	10.54
Oilseeds	0.03	0.92		
Other crops	0.00	0.26	0.22	0.02
Cocoa		0.87	51.91	16.98
Tobacco	1.10	0.18	20.77	4.71
Sugar cane		0.45	2.13	0.98
Cotton	1.51	0.12	3.61	0.92
Ag. investment		41.09		

Source: CGE simulation

6. Results

We begin with results relating to quantities. Table 5 shows changes in value added, demand for composite labor, demand for land, and demand for fertilizer for each food subsector. It must be recalled that value added is a fixed proportions combination of composite capital-labor and composite land; the percentage changes for these three variables are thus the same.[17] As all subsectors (but processed food) receive subsidies, value added may be expected to increase in all cases. However, the table shows that value added decreases for plantain, although only by 0.12%. From the supply side, the increase in production is limited by the fixed nature of capital, which largely determines the outcome presented in the table. Given the structure of agricultural production, any change in value added must be accounted for in the composite capital-labor nest as a change in demand for composite labor. As table 5 shows, changes in labor demand exceed the change in value added, the difference being driven by the share of labor in composite capital-labor (these changes are more similar when the share of labor is higher) and by the elasticity of substitution between composite labor and capital.[18]

[17] It is important to point out that the structure of production for processed food differs from the rest as this is a manufacturing sector. In this case, value added and intermediate consumption are Leontief, while value added is a CES aggregation of composite labor and capital.

[18] As the same elasticity value is assumed for all subsectors, there are no differences across sectoral behavior in this regard. We use an elasticity value of 1.5.

Changes in demand for land and fertilizer (composite land) need to move in the same direction as changes in composite capital-labor. However, as irrigation subsidies positively affect productivity, changes in demand for land and fertilizer do not necessarily always have the same sign as changes in demand for composite labor (as higher productivity has the same effect as an increase in composite land). In fact, when looking at the expected effects of irrigation subsidies on productivity, together with changes in land and fertilizer use, we can see that the increase (decrease) in demand for composite land lowers (raises) the increase in demand for composite land when the expected productivity effect is higher. This is particularly evident when observing lower fertilizer use.

Table 5. Value added and input usage in food production (percentage changes in quantities)

Subsector	Value added	Composite labor	Land	Fertilizer
Cereals	0.18	0.51	0.7	-0.5
Corn	2.42	2.70	2.6	-2.4
Potatoes	0.28	0.55	3.8	-3.3
Leguminous	0.37	1.79	0.3	-17.9
Vegetables	0.22	0.94	-2.7	-12.6
Tubers	0.01	0.05	0.0	-1.5
Bananas	0.41	0.95	1.4	-4.8
Plantain	-0.12	-0.25	-0.6	1.0
Fruits	0.24	0.88	1.1	-8.8
Oilseeds	0.24	0.95	0.4	-0.9
Animal products	-0.02	-0.28	N.A.	N.A.
Processed food	0.07	0.22	N.A.	N.A.

Source: CGE simulation

The overall increase in each agricultural subsector (value added) is determined by the amount of the subsidy allocated to that subsector, the combined effect of competition for resources, and the specific resource allocations required by each of these subsectors. The average increase in output is low (less than 0.4%) and it is also low at the aggregate level of the agricultural sector (0.2%).

We now describe some of the results in values. First, it is useful to observe the changes in unit costs. Table 6 shows both unit costs and base prices of each subsector. As mentioned before, the working capital subsidy creates a wedge between these two prices, lowering the base price, making agricultural output cheaper for other agents in the economy (as reflected in the decline in the unit cost of processed food). The sizes of the unit cost declines depend on the level of the subsidy to each subsector, the shares of the contribution of capital and land to production, and factor price changes.

The changes in the price of value added are determined by factor price changes and factor shares. For composite capital-labor, the capital rental rate paid by the subsectors increases despite the subsidy because capital is sector specific. On the other hand, wages increase marginally for all types of labor, the highest increases being those of rural unskilled labor (0.5%) and rural skilled labor (0.2%). This causes upward pressures on the price of value added. On the composite land side, the rental rate of land paid by the subsectors decreases due to the subsidy and the price of fertilizer also drops under declining demand. Hence, on this side we have downward pressures on the price of value added. The result is, as shown in table 6, that the second effect is generally larger and that the price of value added tends to fall, in most cases marginally.

Table 6. Percentage changes in prices and the value of value added

Subsector	Unit cost	Basic price	Capital rent	Paid capital rent	Land rent	Paid land rent	Value added price
Cereals	0.02	-0.07	0.87	0.77	-2.70	-2.70	0.16
Corn	-1.67	-1.85	15.90	2.23	-1.79	-9.92	-2.51
Potatoes	-0.67	-0.74	1.05	0.87	-1.20	-13.58	-1.00
Leguminous	-0.32	-0.39	1.73	1.67	-2.89	-33.31	-0.35
Vegetables	-0.32	-0.39	1.25	1.05	-4.36	-19.58	-0.38
Tubers	0.08	0.06	0.42	0.41	-3.03	-3.44	0.07
Bananas	-0.19	-0.19	0.98	0.81	7.19	-12.20	-0.35
Plantain	0.51	0.51	0.23	0.22	2.88	2.88	0.59
Fruits	-0.44	-0.44	1.04	0.97	6.54	-19.00	-0.49
Oilseeds	-0.18	-0.21	2.07	1.13	-2.87	-2.87	-0.31
Animal products	0.12	0.12	0.14	0.14	N.A.	N.A.	0.16
Processed food	-0.02	-0.02	0.22	0.22	N.A.	N.A.	-0.00

Source: CGE simulation

With respect to international trade, as domestic prices tend to fall, the ratio of FOB prices to international prices (exogenous) also falls and exports tend to increase in quantity. This is true for all subsectors aside from plantain. Nonetheless, exports only increase by a small amount with the exception of corn, as shown in table 7. Furthermore, the price paid for export crops relative to local prices determines the size of changes in the destination market. If local prices increase by more than export prices, the proportional change in the supply to the domestic market is higher than in the export market and vice versa. For the most part, the increase in exports tends to be higher than the increase in the supply to the domestic market. Lastly, the relationship between domestic and import prices determines the change in imports. This ratio decreases in most cases, leading to a limited decline of imports in most cases as shown in the table.

The above changes are limited in magnitude. Basic prices, which from the standpoint of consumers are the most relevant signal in terms of indirectly affecting their purchasing behavior, do not change much. In general, we found slight decreases for them, with the exception of tubers and plantain. At the level of consumer prices, there are, in general, price decreases below 1%, with the exception of tubers, plantain, and animal products that show slight increases (all bellow 1%). On the other hand, changes in factor returns reflect in households' consumption budgets, inducing scant increases in most cases (all bellow 0.3%) and meager decreases for the top three urban households quintiles. Table 8 shows percentage changes in purchased quantities of food products by household type.

Table 7. Changes in quantities traded (percentages)

Subsector	Exports	Domestic demand	Imports
Cereals	0.14	0.18	0.06
Corn	2.75	2.41	-0.58
Potatoes	0.66	0.22	-0.91
Leguminous	0.54	0.30	-0.45
Vegetables	0.39	0.22	-0.31
Tubers	0.02	0.02	0.11
Bananas	0.39	0.35	-0.09
Plantain	-0.48	-0.10	0.63
Fruits	0.43	0.24	-0.33
Oilseeds	0.30	0.23	-0.16
Animal products	-0.13	0.04	0.32
Processed food	0.03	0.05	0.02

Source: CGE simulation

Table 8. Percentage changes in purchased quantities of food products

Product	Rural households in quintile:					Urban households in quintile:				
	1	2	3	4	5	1	2	3	4	5
Cereals	0.079	0.092	0.113	0.107	0.105	-0.001		-0.004	-0.005	-0.004
Corn	0.196	0.209	0.230	0.223	0.221	0.120	0.119	0.116	0.115	0.116
Potatoes	0.253	0.267	0.287	0.281	0.279	0.179	0.177	0.174	0.173	0.174
Leguminous	0.167	0.181	0.201	0.195	0.193	0.090	0.090	0.086	0.085	0.087
Vegetables	0.334	0.363	0.407	0.394	0.389	0.169	0.168	0.160	0.158	0.161
Tubers	0.061	0.074	0.095	0.090	0.087	-0.018	-0.017	-0.022	-0.023	-0.022
Bananas	0.210	0.229	0.258	0.250	0.247	0.099	0.099	0.094	0.092	0.094
Plantain	-0.036	-0.023	-0.002	-0.007	-0.010	-0.118	-0.116	-0.121	-0.122	-0.121
Fruits	0.337	0.366	0.410	0.397	0.392	0.172	0.171	0.163	0.161	0.164
Oil seeds								0.017		0.017
Animal products	0.057	0.079	0.115	0.106	0.101	-0.081	-0.079	-0.087	-0.089	-0.086
Processed food	0.234	0.271	0.331	0.315	0.307	0.007	0.010	-0.003	-0.006	-0.002

Source: CGE simulation

As follows from the table, there are small increases in purchased quantities for most products and household types. Decreases are of a lower magnitude and concentrate in urban households. These are the cases of cereals, tubers, animal products, and processed food, while in the case of plantain there are decreases across all household types. These changes are insufficient to generate modifications in food consumption patterns and have, therefore, practically no effect on food security.

7. Conclusions

We attempt to provide an estimate of the sectoral and potential food security impacts of newly implemented reforms to Colombian agricultural policy, in particular the introduction of the Secure Agricultural Income Program (AIS), latter rebranded as Equitable Rural Development (DRE). For this, we use a computable general equilibrium model that is geared towards the agricultural sector.

Although sizable for Colombian agricultural policy standards, in terms of public sector budget allocations, the program is relatively small as compared to the size of the agricultural sector. While the latter implies relatively low subsidy rates and relatively low aggregate impacts at the sectoral level, the first feature often results in significant subsidies at the project (farmer) level, and may thus have large impacts at the individual level.

Therefore, access to the program is key in determining its distributive and food security effects. It is known that resources allocated to medium- and large-scale farmers are exhausted rapidly, once funds are allocated to the program by the government, while demand for funds by small farmers is limited. It is also known that disbursements for projects proposed by medium- and large-scale farmers comprise the largest share of funds. This makes it likely that the program is increasing the degree of concentration of production in certain subsectors. This issue does not fall within the scope of the present research, but should nevertheless be highlighted as an important area of research for Colombia.

The results of the CGE simulation show that the expected impacts in terms of percentage changes in value added at the subsector level are small, and are generally less than 1%. Higher changes could be expected in terms of factor and input usage, with changes in demand ranging from 2.7% to -0.25% for composite labor, from 3.8% to -2.7% for land use, and range between 1% and -17.9% for fertilizer use. Despite these wider changes, unit costs decrease by just an average of 0.4%, and only in the case of corn unit costs decrease by more than 1%. Changes in import dependence are limited too and tend to move in the direction of higher food self-sufficiency. Changes in the export ratio move in the opposite direction as exports, relative to absorption, tend to increase; however, this impact is also limited.

The model yields some gains in wages and capital rents, a relatively larger increase in land rents, and limited labor reallocation, together leading to small disposable income impacts. The interaction between prices on one side and disposable income on the other, lead to general and small increases in purchased quantities of food products, unable to generate significant changes in the pattern of food consumption among households.

Even though improving food security is not an stated objective of recent agricultural policy changes in Colombia, the perceived bias in resource allocation that implementation of the new policies have in terms of favoring non-food crops could potentially deteriorate food security, especially for low income households. The assessment of this perception carried out in this paper, indicates that, at least in the short run, the reduced impacts that these policies have on the agricultural sector preclude the possibility that food security may deteriorate as a consequence of their implementation.

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Appendix

Figure A.1. Structure of agricultural production

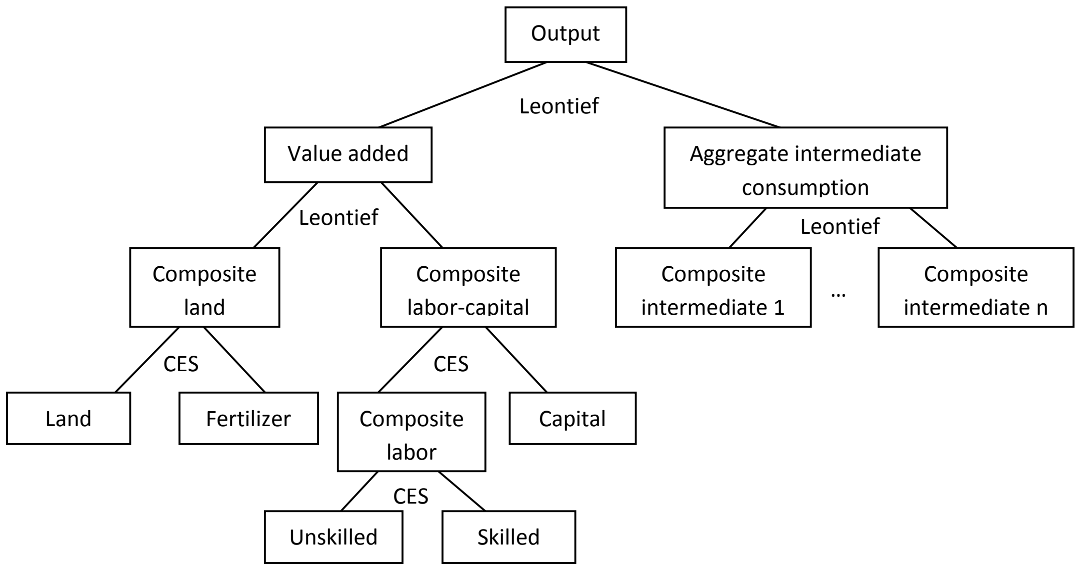
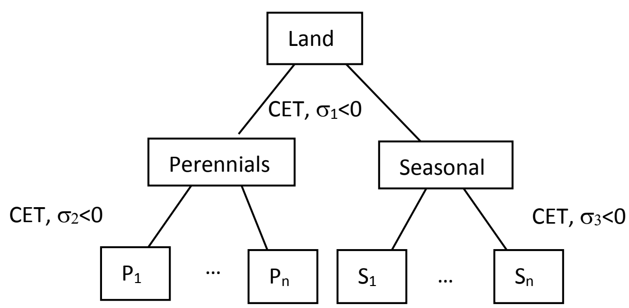


Figure A.2. Structure of supply of land services



B. Sensitivity of results from the CGE to productivity changes

One of the appealing features of the AIS program is that it is designed to enhance productivity. The AIS is expected to impact productivity through several mechanisms, the two most important of which are the CID and the ITA. As mentioned above, the simulation only accounts for the first of these and its impact is parameterized in the model on the basis of an average yield gap between irrigated and non-irrigated land that is assumed to be 20% across all agricultural subsectors. The productivity impacts shown in table 4 result from this assumed yield gap. Given the importance of this parameter in determining the results, we now present estimates when alternative assumptions that use extreme values for the yield gap are used (a 10% and a 30% value, equivalent to halving the base estimate and increasing it by half). The main results are presented in table A.1, which presents the difference between the resulting changes under the alternative assumptions and the 20% yield gap. A negative number indicates an estimate that is lower than for the 20% gap, and vice versa.

Table A.1 Results from alternative values of the yield gap between irrigated and non-irrigated land

Subsector	Difference in value added		Difference in demand for composite labor		Difference in demand for land	
	10%-20%	30%-20%	10%-20%	30%-20%	10%-20%	30%-20%
Coffee	-0.01	0.01	-0.01	0.01	-0.36	0.35
Cereals	0.09	-0.09	0.25	-0.25	0.38	-0.37
Corn	0.11	-0.10	0.12	-0.11	0.64	-0.63
Rice	0.01	-0.01	0.04	-0.04	0.46	-0.45
Potatoes	0.01	-0.01	0.02	-0.01	0.67	-0.65
Beans	0.00	0.00	0.01	0.00	1.02	-1.00
Vegetables	0.01	-0.01	0.03	-0.03	0.67	-0.66
Tubers	0.02	-0.02	0.08	-0.07	0.14	-0.14
Bananas	-0.04	0.04	-0.10	0.10	-0.30	0.29
Plantain	-0.03	0.03	-0.07	0.07	-0.24	0.24
Fruits	-0.02	0.02	-0.08	0.08	-0.18	0.18
Oil palm	-0.06	0.06	-0.22	0.22	-0.10	0.09
Oilseeds	0.17	-0.17	0.65	-0.64	0.23	-0.23
Other crops	-0.02	0.02	-0.02	0.02	-0.43	0.42
Cocoa	-0.16	0.16	-0.26	0.25	-0.08	0.08
Tobacco	0.00	0.00	0.00	0.00	0.81	-0.79
Sugar cane	-0.05	0.05	-0.73	0.71	-0.15	0.15
Cotton	0.07	-0.07	0.10	-0.09	0.53	-0.51
Ag. investment	-0.01	0.01	-0.02	0.02	-0.44	0.44

Source: CGE simulation

As the new values for yield gaps are the same distance from the 20% value (10 percentage points below or above), the changes in productivity in each subsector also differ from the values reported in table 4 by the same amount in either direction. This also holds for changes in value added, demand for composite labor and demand for land. The main result of interest here, however, is that none of our estimates differ substantially from those when using the 20% benchmark. The absolute value of the largest differences are less than 0.2% for value added, are around 0.7% for composite labor demand, and are just over 1% for demand for land. Thus, even though these values may vary substantially at the individual level and in relative terms, they do not have a strong impact on the aggregate results of primary interest in this study. In summary, the different assumptions with respect to the values for the yield gap, although not innocuous, do not affect the direction of our estimates and have a nearly negligible impact on the final outcomes.

Table A.3 Main elasticities and parameters used in the model

Elasticity	Value	Comment
CES - composite labor-capital -ag activities	1.5	There are no recent available estimates for this elasticity for Colombia. Thirks (1974) estimation yields 1.42 across a set of seven crops. Boys et al (2007) finds an average international elasticity of substitution of 4.08.
CES - composite land -ag activities	0.5	There are no estimates for this elasticity in Colombia. According to Townsend (2010) it is 0.58 for the US and should be lower for a country as South Africa.
CES - composite labor	0.5	Recent estimates for Colombia report elasticities in the order of 1.16 to 1.47 (Medina and Posso, 2010). Unel (2007) uses a 1.5 elasticity for the US. Das reports elasticity values between 0.67 and 0.83 over a cross section of countries. We use a lower value than the one reported by Medina and Posso, to account for our short term horizon.
CET - land supply	0.5	There are no estimates for this elasticity in Colombia. We assume a low value reflecting scant land use substitutability between seasonal and perennial crops. Brooks et al (2010) use a 0.1 value (between permanent crops and rice in the DEVPEM model).
CES - composite commodity	1	According to Hernandez (1998) elasticities range from 0.85 to 0.13, while according to Lozano (2004) they range from 0.26 to 0.89. We use a value of 1 for allowing some latitude due to our time frame.
CET - land supply for perennials	0.5	There are no estimates for this elasticity in Colombia. Following the above (see land supply elasticity) we assign a low value given the significance of sunk costs in perennials production.
CET - land supply for seasonal	2	There are no estimates for this elasticity in Colombia. Following the above (see land supply elasticity) we assign a relatively high value given the easiness of switching from one to another seasonal crop.
CES - value added -nonag activities	1	The elasticity of factoral substitution in Colombia, according to Arango and Rojas (2004) is 0.7. We use a slightly larger elasticity considering our time horizon and based on Zuleta et al (2009), that finds evidence in favor of a larger than unity elasticity of substitution between capital and labor for the manufacturing sector.

Elasticity	Value	Comment
Income elasticity of consumption: Cereals	0.7	Income elasticities were calibrated from survey data (National Income and Expenditures Household Survey 2006-7)
Corn	0.7	
Potatoes	0.7	
Beans	0.7	
Vegetables	1.5	
Tubers	0.7	
Bananas	1	
Plantain	0.7	
Fruits	1.5	
Oil seeds	0.5	
Other	1	
Animals	1.2	
Forestry	1	
Agroindutry	2	
Basic products	1	
Beverages, tobacco, manufactures	1.5	
Fertilizers	0.7	
Agrochemicals	0.7	
Chemicals and minerals	1.2	
Machinery and construction	1.1	
Services	1.2	
Financial services	2.6	
Frisch parameter	-1.5	Calibrated from survey data (National Income and Expenditures Household Survey 2006-7)
Average yield gap between irrigated and non-irrigated land	1.2	Based on available information for some sectors and experts judgment.
Subsidy rate on irrigation projects	0.755	Calibrated from AIS' expenditures.