A Partial Appraisal of Agricultural Policy Changes in Colombia

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*Ricardo Arguello**

Abstract

Starting in the decade of 1990, Colombian agricultural policy shifted from taxing to subsidizing agricultural activities on average. Support for the sector has been mainly done through border measures. However, with the inception in 2007 of a new program, domestic support has gained importance and has been justified on the grounds of protecting farmers' income and enhancing productivity. This research aims to provide a partial assessment of the outcomes of this program. For this we use results from a simulation with a Computable General Equilibrium Model and contrast them to the actual performance of the agricultural sector and to a recent microeconomic evaluation of the program. In light of this, we conclude that the new policy appears to have low leverage for fulfilling its objectives.

Keywords: Agricultural policy, Computable General Equilibrium, Colombia.

*Professor Universidad del Rosario, Colombia; Visiting Scholar Regional Economics Applications Laboratory (REAL), University of Illinois at Urbana-Champaign.

1 Introduction

It has been noted that starting in the 1990s support for agricultural activities in Colombia has been rising, with a noticeable increase since the early 2000s (World Bank, 2008). While most support comes from border measures, domestic support was nil until 2007 when a new agricultural policy package was implemented (Agriculture Secured Income -AIS). The new policy, enacted to help farmers face distortions in international agricultural prices (basically due to domestic support measures and export subsidies) and to enhance competitiveness, is entirely based on domestic support measures.

As this policy not only increases the overall level of support but also hinges upon different dimensions of the decision making process by farmers, it is interesting to appraise what its likely impacts are in terms of changes in production levels, factor use, and sectoral composition. For this, we use three sets of information. First, the expected effects arising from the main components of the policy package are simulated by means of a Computable General Equilibrium Model specialized in the agricultural sector. Second, the information coming from the CGE model is contrasted with the actual performance of the agricultural sector, according to official statistics. Lastly, we use information from a recent evaluation of the program to help interpret the results coming from the two previous steps.

In general, we find that the estimated effects of the program at the activity level tend to be small and therefore its impact on output expansion is limited. This is partly the result of the relatively small size of the program, that yields, on average, low subsidization levels for activities. However, at the project (farmer) level, subsidization is relatively high allowing beneficiaries to potentially take significant cost advantage before non-beneficiary farmers. Actual changes in agricultural output levels in 2008 tend to be several times higher (in absolute terms) than the estimated effects arising from the program and frequently run in the opposite direction. Even though it is difficult to assert from aggregate information if the program has delivered the expected results, examination of an evaluation of the program at the micro level indicates that it has not done so.

The rest of the paper is structured as follows. Section two provides the policy background necessary for contextualizing the AIS program. Section three presents the estimated impacts arising from the program. It first briefly describes the CGE model used for simulating the effects of AIS and the modeling strategy followed for this end. Then, some general information on the structure of Colombian agriculture is presented, so that results from the model can be more clearly appreciated. Lastly, results from the simulation are summarized. In section four a discussion is developed with respect to actual changes in agricultural output during 2008 and results from an evaluation of the program are presented. Both are used as the basis for assessing the outcome of the program. Finally, in section five some concluding comments are provided.

2 Policy Background

According to the World Bank (2008) Colombia has transitioned from taxing agriculture to support it. During the 1960s and up to the end of the 1970s, the nominal rate of assistance to agriculture was negative. Then, during the 1980s it became positive with values around 5% during the first part of the decade and 0.2% during the second part. The 1990s marked the beginning of a period of rising assistance: 8.2% for the first half of the 1990s, 13.2% for the second half, and 25.9% for the first half of the 2000s. Most of this support was provided through border measures, while assistance through domestic market measures was almost nonexistent. This pattern is salient when contrasted to the behavior of other Latin American countries included in the World Bank study. Although some countries (Brazil, Dominican Republic and Ecuador) have also moved from taxing to protecting the agricultural sector, in no case this change started as early and has reached the levels it has in Colombia. Even countries that have traditionally protected the agricultural sector, like Chile, have tended to decrease the level of assistance.

Within this context, and in the wake of negotiations for establishing a Free Trade Agreement (FTA) with the United States, the Colombian government agreed with farmers' organizations that a policy package would be designed and put in place for smoothing the impact of the implementation period of the FTA and for boosting sectoral competitiveness. As the agricultural sector was deemed to be one of the losers from the agreement, farmers' organizations tend to either oppose its implementation or seek special treatment in terms of longer implementation periods or limited market access provisions. According to official statements for the press at the time negotiations where held between the government and sectoral representatives, the policy package was agreed as a way to compensate the losers from the agreement. Announced in March 2006, the program was put in place in April 2007 with the signing of a law that layed out its general principles and allocated a budget to it.[1] The program was assigned a budget of around US$217 million for 2007, that represented 35% of that year's total public sectoral budget (excluding debt servicing). By law, the budget assigned to the project has to keep its real value and hence it was indexed to the Consumer Price Index. Although in relative terms the size of the program is modest (around 2.3% of sectoral GDP) it is by far the largest policy instrument in sectoral policy in Colombia.

AIS has a relatively complex structure. Its two main components target different objectives. One of them is devoted to provide direct support for farmers in order to protect their income during the implementation period of the FTA with the US (Sectoral Direct Support Component -SDSC). The other is aimed at enhancing sectoral competitiveness, increasing its productivity and helping launch restructuring processes (Competitiveness Enhancement Component -CEC). Each component addresses a specific objective assigned to the program at its inception. Direct support is provided unconditionally to farmers

[1] Law 1133 of 2007.

and is set to be selective and temporary. The government reserves for itself the role of defining "in an objective manner" the subsectors eligible for this type of support, the amount of support to be given to each sub sector, and the conditions that beneficiaries must fulfill. It was also established that after six years of program operation, all direct support measures should have been phased out. On the other hand, competitiveness enhancement measures should be allocated no less than 40% of the program's total budget, and the governments assumes the commitment to give priority to Departments (States) that lag behind in terms of productivity and competitiveness indexes, while assuring there is an equitable regional distribution of resources from the program.

Each component has its own internal structure. CEC has three main policy instruments: productivity incentives, subsidized credit, and marketing support. Productivity incentives are aimed at enhancing technical assistance, technology development and transfer, implementing good agricultural practices, fostering associativeness, and land conversion, irrigation and drainage cofinancing. Subsidized credit is devoted to support productive restructuring, land conversion, productivity enhancement, and new investment for promoting agricultural modernization. Marketing support is targeted to the implementation of traceability systems, domestic absorption mechanisms, and other supplementary activities.

This set of instruments is basically channeled through nine subprograms, of which 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).[2] The SCL is a subsidized credit scheme aimed at supporting productivity improvements and restructuring (shift between agricultural activities) that is provided through the financial system. Credit conditions have varied through time, but on average imply significantly lower interest rates as compared to normal credit (between 12 and 5 percentage points, according to the type of farmer and the year). Small farmers tend to use it for planting and maintenance of crops, while large farmers for acquisition of machinery for primary transformation of products. Medium size farmers tend to be the main beneficiaries from this scheme (in terms of their share in the total amount disbursed by the program) and devote its resources to planting and maintenance of crops and to land preparation.

The IRC is intended to foster agricultural investment by means of a credit line that operates at market interest rates but that entails limited credit forgiveness. As a program, IRC existed before the implementation of AIS but the latter uses it to allocate part of its resources. It also extends the set of activities that are eligible, beyond the boundaries of the original IRC. Under its provisions, small producers are given 40% forgiveness on the value of credit devoted to activities included in a eligibility list. Medium size and large farmers are given 20% forgiveness subject to some exceptions (related to the activities carried on). In the case of construction, enlargement or rehabilitation of large irrigation projects, forgiveness is at the level of 40%, regardless of farmer size,

[2] The other subprograms are: Incentive for Technical Assistance, Livestock Sanitation, Coffee Extension Service, Forestry Incentive Certificate, Science and Technology, and a fertilizer program (Fertifuturo).

and there are no limits in the amount of the incentive.[3] The list of eligible activities includes land preparation 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 aimed at cofinancing irrigation and drainage projects that are tied to existing or prospective production. The amount of subsidy granted by the government varies according to the type of project (individual, cooperative, regional) and may reach up to 80% of direct costs. The rest of the costs have to be either covered by regional institutions or directly by the farmers or both. Funds for this program are allocated on a competitive basis. Proponents have to prepare a proposal, including an economic evaluation, and enter in a contest through which it is determined who gains access to the funds.[4]

Lastly, the SDSC uses some of the same subprograms that the CEC uses, specially the SCL and the IRC. As mentioned, a difference here is that funds from this component target specific sectors according to an evaluation performed by the government. The other difference is that the level of subsidization is higher in this case. Credit forgiveness for medium size and large farmers benefiting from IRC are higher, for instance (30% as compared to 20% under the CEC). In 2007, all resources of the component were directed to cereals and rice and disbursed in close proportions under the SCL and IRC (44% and 56% on average). In 2009, it was given priority to the cut flowers sector (for social and environmental purposes), to planting of corn for feedstock purposes, and to planting of beans in coffee growing areas.

In spite of the fact that negotiations for the FTA with the US ended in November 2006 and that only in October 2011 the treaty was approved by the US Congress (which implies that implementation could only begin in 2012), AIS entered into force in 2007 and has been in place since then.[5] To accommodate the fact that the trade pact was not in place and therefore there was a weak basis for implementing the SDSC, the government determined that 72% of the budget should be allocated to the CEC, 26% to the SDSC, and the remaining 2% to the administration of the program. This allocation rule, in the sense of

[3] Some of these conditions changed from time to time.

[4] This is the program that have mainly gave rise to criticism of AIS, since large farmers were better positioned to present good proposals than small farmers. Furthermore, large farmers fragmented their projects in order to violate the ceilings imposed on the amount of the subsidy, managing to illegally get access to a big proportion of resources.

[5] In 2009 the program came under fire when missallocation 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, big farmers where denied access and marginal changes were introduced in its operation. Its basic structure, organization, and policy instruments in use, continue being the same.

giving priority to the CEC, has been in place during the following years.[6]

3 Expected Effects of AIS

In this section we refer to the expected short run effects of the program on the agricultural sector. For this we use a Computable General Equilibrium (CGE) model specialized in agriculture, running on a 2007 Social Accounting Matrix (SAM) of the Colombian economy. Although the size of AIS makes it foreseeable that we will not find macro effects of significance, the use of a CGE is advisable since it allows capturing the feedback effects coming on each particular agricultural activity not only from other agricultural activities (as they compete for resources) but also from the whole economy.

3.1 The CGE Model

The CGE model is based upon the PEP Standard CGE model (single country, static; 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 indexes. Demand and supply equations for private-sector agents are derived from the solutions to optimization problems, in which it is assumed that agents are price-takers and markets competitive. The external sector is modeled as a single region and a "mild" version of the small country assumption is used.[7] A thorough documentation of the model is found in Decaluwé et al (2009).

The model is adjusted in two major senses. First, a new production structure is included for the agricultural sector, that allows for a convenient representation of agricultural production. Second, a structure for the supply of land services is added so as to have a more realistic behavior of land allocation between agricultural activities. However, our definition of agriculture here excludes livestock, dairy production, meat production, forestry and fisheries.[8] The reasons for this are that we have no dependable information for land use in this type of activities (specially for livestock) and the dominant nature of livestock production in Colombia, that impinges upon the way land is allocated between rural land-based activities.[9]

With respect to the structure of production, we have at the top that value added and a composite intermediate good are used in fixed proportions (Leon-

[6] Budget allocation for 2008 was as follows: 93.6% to CEC, 5.2% to SDSC, and 1.2% for administrative costs.

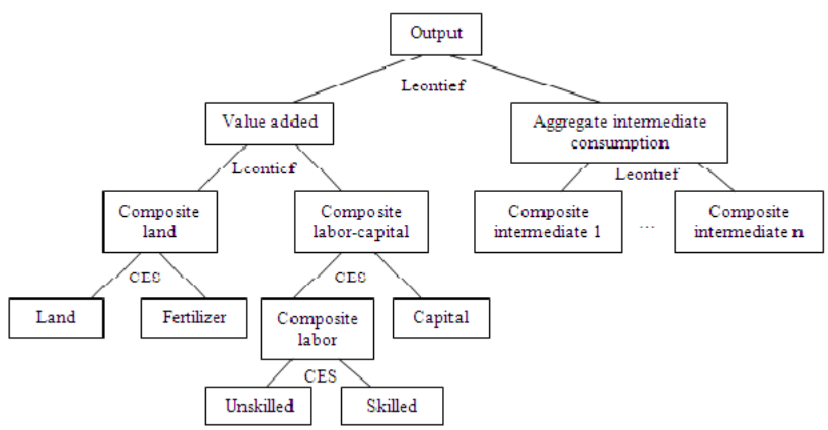
[7] In the sense that local producers can increase their share in international markets as long as they can offer a price that is advantageous with respect to the world price (and subject to a price elasticity of export demand).

[8] Although, these sectors are included in the model.

[9] Livestock activities in Colombia are predominantly of the extensive type (based on natural and cultivated pastures and itinerant grazing) and are known to be used not only as an economic activity but also as a way to claim land use in a relatively low cost and non labor intensive way.

tief). Then, in a second nest, value added is defined as a Leontief function of composite land and a composite of capital and labor. On the composite intermediate good side, the structure is described, again, by fixed proportions. This specification reflects the marked degree of complementarity that agricultural production tends to exhibit. Moving on to the value added nest, the composite of capital and labor is modeled as a Constant Elasticity of Substitution (CES) combination of composite labor and composite capital (third nest). Composite labor is in turn a CES combination of skilled and unskilled labor (fourth nest). While the model allows for a composite of several capital types, currently only one type of capital is used. On the other hand, composite land (third nest) is a CES combination of land and fertilizer, allowing for the latter to play a role in determining value added. The structure of agricultural production is represented in Figure 1.

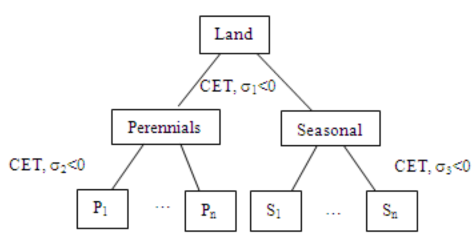
Fig. 1: Structure of Agricultural Production



As regards land services, agricultural land is assumed heterogeneous in the model and only land for agricultural use is considered (no land services for livestock, forestry, and industrial use are taken into account). However, crops compete for land services with no regard for the agroecological conditions that they require and land services are rendered to each crop type with certain restrictions. This feature responds to two considerations. First, it approximates the fact that land is heterogeneous: land availability is tied to climate and other characteristics that suite some crops but not others and, as a consequence, it cannot be freely "mobile" across crops. Second, agricultural land use is conditioned upon certain economic constraints. In particular, land use may depend on the easiness with which land can be allocated to different crop types, according to characteristics such as the way cash flows produced or required by the activity behave, or to the size of initial investments. Therefore, land allocation is “sluggish” in the model and a Constant Elasticity of Transformation (CET) function is used to represent it.

In particular, land allocation is done according to the degree of “easiness of entry” into a particular activity. Activities for which it is required to make sizable investments in land preparation or for which the maturing period is large, are deemed to experience lower propensities to be switched to from other uses. Hence, supply of land services at the top is divided among perennial and seasonal crops (first nest with an elasticity given by σ_1). This is a decision usually associated to the need for relatively lumpy investments and cash flow constraints, given that perennials take some time to begin producing. Then, in the second nest land is allocated to particular crops (both perennial and seasonal with elasticities given by σ_2 and σ_3, respectively). At this level, land allocation decisions differ according to the type of crop. Land allocation within seasonal crops is the most flexible given that investments required to switch from one crop to the other are relatively low. In contrast, land allocation between perennials is less easy as switching from one crop to the other entails incurring in higher costs. The following relationship holds for the three elasticities: $\sigma_1 < \sigma_2 < \sigma_3$. The structure of the supply of land services is shown in Figure 2.

Fig. 2: Supply of Land Services



The model uses a 2007 SAM with 31 activities and 31 commodities. 23 activities and commodities belong 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 productive yet (agricultural investment), livestock and poultry, forestry, agricultural services, and agroindustry. Among the non-agricultural sectors, there are two services sectors (services in general 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 used only 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 and each type is, in turn, split in income quintiles, for a total of 10 household types.

3.2 Modeling Strategy

Between 2007 and 2009, the program executed an accumulated budget of around US$704 million, 91% of which devoted to the CEC. As mentioned in the evaluation of the program that was contracted by the Ministry of Agriculture (Econometria, 2011), the majority of resources were used by four subprograms (irrespective of the component to which they were used for): 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 base line and the Econometria evaluation itself were limited to these four subprograms.[10]

All subprograms but the SCL, the IRC, and the CID, are expected to yield results that are difficult to pin down in an evaluation and more so by means of a CGE model. For instance, technical assistance (as enhanced through the ITA and the Coffee Extension Service) is expected to raise yields as better production techniques are supposed to be put in place, pest and insect control is fostered, and better use of inputs can be made. However, the extent to which yields may increase is uncertain and a priory estimates may be lacking. Therefore, use of the CGE model is restricted to an estimation of the expected impacts arising from the three subprograms mentioned above, providing a nice overlapping with the Econometria evaluation.

In spite of the institutional complexity of AIS (two components, eleven subprograms, different access rules and subsidization levels for each subprogram-component-beneficiary type combination), when it comes down to the economic incentives that it creates for farmers, the situation is relatively simple. Table 1 lists (in a simplified way) the main activities that were financed in 2008 through the three subprograms considered and groups them according to the type of incentive that they create.[11] A couple of comments are in order with respect to the classification provided in the table. First, since items that are eligible for a working capital subsidy are broad and tend to cover a wide range of productive

[10] The methodology used in this evaluation follows the general guidelines of an econometric program evaluation perspective.

[11] Items and activities change from year to year, but the way incentives work is similar in spite of this. We illustrate the situation for 2008 since this is the year we use as the basis for the simulation.

activities (ranging from inputs purchases, to outsourcing of different activities) it is convenient to represent the effects of this subsidy as spreading across the whole financing of the production process and, hence, as having the effect of lowering unit costs. Second, both investment financed through the SCL or through the IRC, is almost entirely devoted to support and enhance capital use and its effects are better represented as a subsidy on capital. There are, however, some exceptions to this. Investment subsidies allocated for planting and crop maintenance or for agricultural production, tend to be general in terms of items that are eligible and therefore behave in a manner similar to that of working capital subsidies, so their effects are also viewed as lowering unit costs. On the other hand, although subsidies for land adequation may include in some cases irrigation related activities, most of the times it only involve activities that do not comprise irrigation or water management. As we want to have a clear divide between irrigation related subsidies granted through the SCL or the IRC from those granted through the CID, we treat land adequation subsidies as capital subsidies.[12]

As there is no distinction in the model between farmer types, subsidies conveyed through the program are relevant only as aggregates. That is, for the modeling it is not important if a certain amount of subsidy corresponds to the 40% subsidy that is granted to small farmers benefiting from the IRC or to the 20% granted to large farmers. Instead, what matters is the whole subsidy amount granted to each agricultural activity in the model. The subsidy amounts disbursed by the program in 2008, as well as the actual subsidy rates implied, for each type of incentive, are reported in Table 2.[13] From there it follows that slightly more than half of the resources considered here were granted as productive capital subsidies (US$74.7 million representing 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 for uses that potentially entail some form of technological change, assuming that capital investments embody a particular technology choice.[14] While working capital subsidies can be expected to be neutral, productive capital subsidies clearly imply a capital intensification bias and its implication on labor use depends on whether capital and labor are complements or substitutes.

[12] Admittedly, this implies a distortion in the way we evaluate the expected impacts of the program. However, the effect of this assumption is negligible as irrigation financing through the SCL and the IRC is quite small (in relative terms) and it has an unpredictable effect on productivity, which as will be mentioned ahead is an important consideration in simulating the effects of the CID. In principle, the main implication of the assumption is that it understates the level of subsidization for land use and overstates that of capital use, a feature that has a negligible effect given that composite land and composite capital-labor are in fixed proportions in the model.

[13] Subsidy rates are calculated as the ratio of governmental contributions to total project values, expressed in percentage terms. Therefore do no represent the subsidization level granted for the whole of an agricultural activity, but rather the corresponding to the average project presented to the program.

[14] Clearly, this is not necessarily the case, as capital investment may be directed to replace same vintage capital.

Tab. 1: Incentives Created by the Program

Subprog	Item	Activity	Effect	Incentive
SCL	Working Capital	N.A.	W. capital subsidy	Lower unit cost
	Investment	Productive infrastructure	Capital subsidy	Lower capital cost
		Processing	Capital subsidy	Lower capital cost
		Machinery	Capital subsidy	Lower capital cost
		Land adequation	Capital subsidy	Lower capital cost
		Planting, maintenance	W. capital subsidy	Lower unit cost
		Agricultural production	W. capital subsidy	Lower unit cost
		Crop maintenance	W. capital subsidy	Lower unit cost
		Livestock acquisition	Not considered	N.A.
		Services infrastructure	Not considered	N.A.
		Livestock maintenance	Not considered	N.A.
	Credit refinancing	N.A.	Not considered	N.A.
IRC	N.A.	Agricultural machinery	Capital subsidy	Lower capital cost
		Production infrastructure	Capital subsidy	Lower capital cost
		Late yield perennials	Capital subsidy	Lower capital cost
		Land adequation	Capital subsidy	Lower capital cost
		Primary processing	Capital subsidy	Lower capital cost
		Livestock acquisition	Not considered	N.A.
CID		Irrigation	Land subsidy	Lower land cost
			Productivity enhancement	Higher productivity

Source: author's schematization.

Tab. 2: Government Expenditures in Subsidies and Implied Subsidy Rates (US$ million)

Crop	Working capital subsidy:		Productive capital subsidy:		Irrigation subsidy:	
	Amount	Rate	Amount	Rate	Amount	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			0.17	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		

Source: author's calculations based on Ministry of Agriculture data.

It can also be appreciated from the table, that the activity that received the highest amount of resources is agricultural investment, an activity that comprises new planted areas of perennials crops. US$55.9 million (38.8% of total subsidies) were allocated to this activity, followed by fruits and oil palm (with 10.4% and 10.2%, respectively).[15] In total, 79.4% of resources were assigned to perennial crops. The activities with the lowest allocations of resources were plantain, cereals, and other crops (0.03%, 0.04%, and 0.24%, correspondingly). If only productive capital subsidies are considered, agricultural investment is by far the largest recipient of subsidies (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 favors capital intensification but also tends to more heavily support perennial crops.[16] The extent to which these features weight in its expected impacts can be partially determined by means of the CGE simulation.

In light of the above, we model all subsidies having an effect akin to a lowering of unit costs as creating a (negative) wedge between an activity's unit cost and its basic price:

$$PT_j = (1 + ttip_j - SWK_j)PP_j \tag{1}$$

where:

PT_j: Activity j basic price

PP_j: Activity j unit cost

SWK_j: Working capital subsidy rate (endogenous)

$ttip_j$: Tax rate on activity j production (parameter)

On the other hand, productive capital subsidies lower the cost of capital for beneficiary activities so the price of this factor decreases according to the implied subsidy rate (for the whole activity):

$$RTI_j = R_j(1 + ttik_j - SKD_j) \tag{2}$$

where:

RTI_j: Rental rate of capital payed by activity j

[15] Fruit and oil palm, among other activities, are perennial crops. The distinction here points to the fact that agricultural investment is an activity that encompasses newly planted areas that, by definition, do not yield production yet. In contrast, subsidies granted to activities producing particular perennial goods are expected to have an impact on current production levels.

[16] Whether this bias in support for perennials is intended or not could be debatable, as there is an important demand component at play.

R_j: Rental rate of capital in activity j

SKD_j: Productive capital subsidy rate (endogenous)

$ttik_j$: Tax rate on capital used in activity j (parameter)

Irrigation subsidies entail two effects. On one side, they lower the cost of using land and therefore act in the same way as the subsidy for productive capital. On the other, they are expected to have an effect on productivity since enhanced water availability and management is expected to increase yields. These effects are modeled as follows:

$$RTT_j = RTS_j(1 + ttit_j - STI_j) \tag{3}$$

$$CT_j = CTPF_j Bct_j[\beta ct_j TD_j^{-\rho ct_j} + (1 - \beta ct_j)FD_j^{-\rho ct_j}]^{\frac{-1}{\rho ct_j}} \tag{4}$$

where:

RTT_j: Rental rate of land payed by activity j

RTS_j: Rental rate of land supplied to activity j

STI_j: Subsidy rate on land rent for activity j (endogenous)

CT_j: Composite land used in activity j

$CTPF_J$: Productivity parameter from irrigated land for activity j (endogenous)

TD_j: Land used by activity j

FD_j: Fertilizer used by activity j

$ttit_j$: Tax rate on land used by activity j

Bct_j: Scale parameter for activity j (CES-composite land)

βct_j: Share parameter for activity j (CES-composite land)

ρct_j: Elasticity parameter for activity j (CES-composite land)

The productivity effect arising from irrigation should ideally be calibrated on a crop by crop basis. Unfortunately there is no enough and reliable information for doing this and in the simulations it is assumed a single value for all crops. Furthermore, the parameter is estimated on the basis of the (average) yield gap that is deemed to exist between irrigated and non-irrigated land for several crops. Data on yield gaps come from information available for some crops and from experts' judgment.[17]

Lastly, it is worth mentioning the general characteristics of the simulation. First, it is given consideration to the financing of the program. For this, it

[17] Given the nature of this information, sensitivity analysis is conducted to appraise the effect of changes in this parameter (see subsection 3.5).

is assumed that governmental expenses incurred in for subsidizing agricultural activities are financed through direct taxes designed to raise the exact amount needed (therefore, the corresponding tax rates adjust endogenously). Second, the scenario is simulated using the following closure rules. The nominal exchange rate is the numeraire, labor is in fixed supply, fully utilized, and freely mobile between all sectors, government expending is fixed, investment is saving-driven, the current account balance is fixed, and total land demand is fixed.[18] We define our time horizon as short term, so capital is assumed sector specific. This feature is not only consistent with the idea that most capital used in agricultural activities relates to trees and plants and less so to machinery and equipment,[19] but also with the fact that, even in the case of capital that is not strictly specific to an activity (like machinery), the time span considered in the simulation makes it unlikely that there could be any significant capital reallocation between activities.

Given the above depiction of the type of policy instruments that are modeled and the time frame some of them require for being fully operational, it is convenient to clarify the scope of the short term nature of the simulation. We understand short term in this context as a time period of up to two years, allowing enough time for new capital investments to be built and operational (in particular productive capital and land improvements and irrigation), but not for new areas planted with perennials to enter their productive stage. In this way we reconcile the static nature of the model with the main features of the policy package, so the simulation is meaningful. In particular we do not deal with the fact that part of the policy instruments are aimed at fostering new planted areas of perennial crops or with the entrance of already planted areas into production, both of which would require use of a dynamic model.

3.3 General Structure of the Agricultural Sector and Size of Shocks

Before getting to the results from the simulation, it is useful to have an idea of the structure of the Colombian agricultural sector, so that the former can be put in the right perspective. Also, it is convenient to take a look at the relative size of the shocks that are implemented, that is, at the subsidization levels that arise on a subsectoral (activity) base given the amount of resources disbursed by the government. We provide these two pieces of information in the same order.

Table 3 shows some of the basic macro statistics at the sectoral level. From there it can appreciated that the services sector is by far the largest contributor to total value added (first column), followed by machinery and construction, and beverages and manufactures. The agricultural sector, including animals and forestry, accounts for slightly more than nine percent of total value added and for 5.7% if only crops are considered. The share of value added in total sectoral value (second column) is higher for the agricultural sector as compared

[18] Since we have land demand governed by a CES aggregate (of composite land) and land supply by a CET aggregate, land supply (supply of land services) has to be endogenous.

[19] At least for the Colombian case.

to other sectors in the economy. As an average, value added accounts for around 80% of total sectoral value in the agricultural sector, while it only reaches 49% for the rest of the economy. The largest value added shares are found in the oil palm, fruits, coffee, and legumes sectors.

Machinery and construction, as should be expected, make up for the bulk of investment, followed distantly by beverages and manufactures, and services. With respect to international trade, the majority of export value (almost 70%) is concentrated in three sectors: oil and minerals, beverages and manufacturing, and agroindustry (mainly green coffee). If exports of chemicals and nonmetals and machinery and construction are added, the five sectors account for almost 85% of total exports. On the import side, beverages and manufactures, machinery and construction, and chemicals and nonmetals, account for around 80% of total imports. As follows from the data, the share of the agricultural sector in international trade is low, 6.2% of total exports and 4.1% of total imports. The highest participation of an agricultural sector is found for exports of other crops (3.2%), a result due to fresh cut flower exports.[20]

In terms of factor usage proportions, the agricultural sector tends to show a lower capital-labor ratio than the rest of the economy. However, this variable exhibits high variability across sectors. The average capital-labor ratio for agriculture is 2.37 while it is 3.87 for the non-agricultural sector. The highest ratios for non-agricultural activities are found in the oil and minerals sector (16.13, the highest for the economy) and the animal production sector (11.04, the third largest). Within agriculture there is considerable variation: the highest ratio belongs to the sugar cane sector (14.64, the second largest in the economy) and the lowest to the corn sector (0.12, the lowest in the economy); the standard deviation of this variable within agriculture is 3.13. Table 4 shows the relevant figures for these and other factor related variables for the agricultural sector.

Land-labor ratios (second column in Table 4), tend to be low in Colombian agriculture. The highest ratio is found in the case of the sugar cane sector, while the lowest pertain to the agricultural investment sector. The average land-labor ratio is 0.58 and its standard deviation is 1.09. Lastly, capital-land ratios (third column) also show high variability within agriculture. The largest ratio shows up for the legumes sector, followed by the fruits, and banana sectors. The lowest ratio belongs to the corn sector, followed by the oil seeds sector, and the cocoa sector. The average ratio for agriculture is 8 and its standard deviation is 6.34.[21]

The agricultural sector's share in total factor use is relatively low, as can be inferred from its participation in value added. Agriculture accounts for 5.3% of total labor use and 4.5% of total capital use. Coffee has the highest share in labor demand, while several sectors have shares less than 0.1%. The highest shares in capital use belong to the fruits, sugar cane, tubers, and coffee sectors, while, as in the case of labor use, several sectors exhibit shares below 0.1%. With respect to land use, the sugar cane sector accounts for almost 34% of the

[20] This follows from the fact that in the SAM coffee exports (a traditionally important Colombian export) are made by a non-agricultural sector, since coffee processing belongs to agroindustry.

[21] It must be remembered that these are value (an not quantum) ratios.

Tab. 3: Sectoral Composition of Value Added, Investment, and Trade in Colombia, 2007

Activity	Share in value added	Value added share	Investment share	Exports share	Imports share
Coffee	0.9	92.2	0.4		
Cereals	0.0	79.3			1.0
Corn	0.1	66.6			1.6
Rice	0.2	60.7			
Potatoes	0.2	65.0		0.1	
Legumes	0.1	90.6		0.2	0.1
Vegetables	0.3	88.7		0.1	0.1
Tubers	0.5	83.6		0.1	0.1
Bananas	0.2	70.2		1.5	
Plantain	0.4	89.3		0.2	0.1
Fruits	0.8	92.2		0.3	0.5
Oil palm	0.3	94.4		0.5	
Oils seeds	0.0	73.1			0.3
Other crops	0.4	67.1		3.2	0.2
Cocoa	0.0	88.3			0.1
Tobacco	0.0	88.5			
Sugar cane	0.7	89.9			
Cotton	0.0	76.2			0.1
Ag. services	0.1	79.4			
Ag. invest.	0.2	66.9	1.5		
Anim prodn	3.4	74.8	0.5	0.9	0.1
Forestry	0.2	76.0			0.1
Agroindustry	3.5	27.7		11.1	4.8
Oil/minerals	7.1	74.4		30.8	0.9
Bever/manuf	9.1	43.9	9.3	26.4	35.4
Fertilizer	0.2	42.4		0.9	1.2
Agrochemic	0.1	46.3			1.1
Chemicals	2.6	37.3		8.2	14.7
Mach/constr.	9.7	46.4	84.9	8.0	30.0
Services	54.2	62.5	3.3	6.8	4.4
Financ serv.	4.2	58.9		0.6	3.1

Source: 2007 SAM

Tab. 4: Relative Factor Intensity Use in Agricultural Activities in Colombia, 2007

Activity	Capital/Labor ratio	Land/Labor ratio	Capital/Land ratio
Coffee	0.7	0.1	7.9
Cereals	1.9	0.4	4.4
Corn	0.1	0.4	0.3
Rice	3.2	1.1	2.8
Potatoes	1.0	0.2	5.5
Legumes	4.1	0.2	22.0
Vegetables	3.4	0.2	16.0
Tubers	2.8	0.3	8.6
Bananas	1.4	0.1	16.0
Plantain	1.2	0.3	3.5
Fruits	2.8	0.2	19.0
Oil plam	2.9	0.3	9.7
Oil seeds	3.1	2.0	1.5
Other crops	0.2	0.0	5.5
Cocoa	0.6	0.3	2.1
Tobacco	1.3	0.1	11.4
Sugar cane	14.6	4.6	3.2
Cotton	0.5	0.2	2.6
Ag. investment	0.3	0.0	9.4

Source: 2007 SAM

total, while the coffee, rice, tubers, and plantain sectors have shares between 8 and 10 percent, accounting for around 36%.

With respect to sectoral demand by labor type, the agricultural sector employs almost 50% of rural unskilled workers, near 18% of rural skilled workers, 2.6% of urban unskilled workers, and 0.8% of urban skilled workers. The largest agricultural user of rural unskilled workers is the coffee sector (15.8%) followed by the fruits (5.3%), and the plantain (4%) and agricultural investment (3.9%) sectors. In turn, the largest employer of rural skilled workers is the fruits sector (10.2%), followed by the coffee (1.7%) and other crops (1.6%) sectors. As can be expected from the above figures, the shares of agricultural subsectors in urban labor demand are quite modest.

Against this background, subsidies granted by the government (as presented in Table 2) yield, in general, relatively small subsidy rates at the activity level. Since the latter are the rates that matter for the simulation, they are shown in Table 5. Among the features arising from these figures, it is worth mentioning three. First, given the size of the program relative to sectoral GDP, there is a large gap between the subsidy rate that is given to the beneficiary from the program (presented in Table 2) and the ensuing subsidy rate for the activity as a whole. For instance, while the subsidy rate granted to the average coffee producer that benefits from subsidies for productive capital is 22.9%, the corresponding subsidy rate for the coffee sector amounts to just 0.72%. The size of this gap depends upon the total amount of subsidies allocated to a sector as a proportion of sectoral GDP. What is relevant, however, is that beneficiaries from the program gain a significant advantage against non-beneficiaries and this effect is not captured in our evaluation, since we do not differentiate among different producers within an activity 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 tend to be neutral in terms of generating factor usage biases), being the latter the most important i relative terms. Lastly, productive capital subsidies are the most important for agricultural investment (that is, new plantings of perennials), followed by corn and rice, while irrigation subsidies are more widespread across activities in terms of their importance (eight activites receive land subsidies above 12%).

3.4 Results

We first refer to results relating to quantum. Table 6 shows changes in value added, demand for composite labor, demand for land, and demand for fertilizer, for each agricultural activity. It must remembered that value added is a fixed proportions combination of composite capital-labor and composite land, therefore percentage changes for these three variables are the same. As all activities receive subsidies it could be expected that value added would increase in all cases. However, as follows from the table, this is not true: the quantum of value added decreases for plantain, other crops, and agricultural investment, although in very low proportions (between 0.08% and 0.14%). From the supply side, the

Tab. 5: Subsidy Rates at the Activity Level Granted through the Program

Activity	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
Legumes	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 plam		0.15	36.61	10.54
Oil seeds	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

Tab. 6: Changes in Value Added and Input Usage in Agriculture (percentage changes in quantities)

Activity	Value added	Composite labor	Land	Fertilizer
Coffee	0.06	0.10	-0.4	-1.0
Cereals	0.18	0.51	0.7	-0.5
Corn	2.42	2.70	2.6	-2.4
Rice	0.16	0.66	0.8	-2.4
Potatoes	0.28	0.55	3.8	-3.3
Legumes	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
Oil plam	0.89	3.43	2.3	-14.9
Oil seeds	0.24	0.95	0.4	-0.9
Other crops	-0.14	-0.17	-1.1	0.0
Cocoa	3.13	4.88	5.2	-21.5
Tobacco	1.09	2.51	4.7	-7.1
Sugar cane	0.01	0.22	-1.0	-0.8
Cotton	1.80	2.58	2.5	-0.2
Ag. investment	-0.08	-0.11	-1.1	0.0

Source: CGE simulation

feature limiting output expansion is capital fixity and it largely determines the outcome presented in the table. Given the structure of agricultural production, any change in value added must be accommodated in the composite capital-labor nest as a change in demand for composite labor (LDC). As Table 6 shows, changes in labor demand exceed the change in value added, the difference being driven by the share of labor in the composite capital-labor (the larger the labor share, the more close these two changes are) and by the elasticity of substitution between composite labor and capital.[22]

Prices accommodate to ensure optimality at all stages of production and to keep with the fixed proportions assumption between composite capital-labor

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

and composite land. For this reason, 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 have a positive effect on productivity, there are cases in which changes in demand for land and fertilizer do not necessarily have the same sign as changes in demand for composite labor (as greater productivity amounts to an increase in composite land). In fact, a comparison between the expected effects on productivity arising from irrigation subsidies, as presented in Table 5, and changes in land and fertilizer demand shows that the higher the expected productivity effect, the lower the increase (or the higher the decrease) in demand for composite land (specially as reflected in lower fertilizer use).

The behavior of changes in demand for land and fertilizer is explained by two main factors. First, the degree of complementarity or substitutability between them. In this particular case, we assume that land and fertilizer are weak substitutes,[23] so these changes tend to roughly move in the same direction. However, as we have relatively sizable subsidization levels for land use (as illustrated in Table 5), relative prices within composite land show high variations and substitutability between land and fertilizer is enhanced yielding several cases in which land and fertilizer demand move in opposite directions. The average change in relative prices between land and fertilizer arising from the shock is 11.3%, with extreme cases as high as 30% to 40% and as low as 0.3%, basically depending on the size of the subsidy to land use.

The second factor impinging upon land and fertilizer substitutability comes from the side of supply of land services. As allocation of land services is more "sluggish" between perennials and seasonal crops, and more "sluggish" within perennials than within seasonal, competition for land services is more intense among perennials. As land is not easily reallocated from seasonal to perennial crops, there are cases in which even though a perennial crop benefits from a relatively high subsidy to land use, its demand for land decreases as other perennials have higher subsidies and can expand land use at its expense. This is the case of coffee, that shows a 4.52% subsidy for land use but its demand for land decreases by 0.4%.

The case of agricultural investment is worth a short comment, as this activity secures the highest subsidy rate for productive capital use but its output shrinks. This result is driven by several factors. First, as capital is sector specific, the subsidy on capital has no impact on demand for this factor. Instead, the behavior of demand for composite capital-labor depends on the change in the relative price between capital and composite labor. In this particular case (as is also true in the cases of plantain and other crops), this relative price decreases leading to a reduction in composite labor use and to a decline in output. On the demand side, agricultural investment enters, in fixed proportions

[23] We assume the same elasticity of substitution for all activities, at the level of 0.5. This is in line with the view that fertilizer and land infrastructure can be regarded as complements while fertilizer and land as substitutes (Ruttan, 2001). As we do not have the means to distinguish between land and land infrastructure, we adopt a midway substitutability/complementarity relationship.

(in value), into the economy's investment account so its expansion is limited on that side too as the model is saving-driven.

In summary, agricultural activities tend to increase their output (measured as quantity of value added) and do so in a way consistent with the relative level of subsidies each of them receive and the competition for resources that the particular mix of subsidies and resource allocation restrictions impose. Overall, the average percentage increase in output is low (0.6%) and it is also low at the aggregate level of the agricultural sector (0.2%).

For completeness, we now describe a few results in value terms. First, it is useful to observe the behavior of unit costs for all agricultural activities. Table 7 shows both activities unit costs and their basic prices. As mentioned before, the working capital subsidy creates a wedge between these two prices, lowering the basic price, making agricultural output cheaper for other agents in the economy. As can be verified from the figures in the table, the difference between these two prices corresponds to the working capital subsidy level granted to each activity. It can also be observed that unit costs decline on average (by 0.7%, unweighted average) as a consequence of the other two types of subsidies granted through the program. The size of declines in unit costs not only depends on the subsidy levels that each activity enjoys and on the shares that both capital and land have in the production structure, but also on factor price changes. In general, activities benefiting from the highest subsidy levels show the highest declines in unit costs. For instance, cocoa registers a 7.2% decline in unit costs that is basically driven by a high subsidization level for land (almost 52% as shown in Table 5), since the level of the productive capital subsidy the activity receives is relatively low (much lower than that of the activities getting the highest productive capital subsidies, but well above the average with respect to the rest of activities). Divergences between price wedges as can be calculated from Table 7 (that is, the differences between the capital rental rate and the rental rate paid by each activity, and between the rental rate of land and the rental rate paid by each activity) and subsidization levels (as presented in Table 5) is due to price changes for these two factors as activities compete for their use.

The behavior of changes in the price of value added is determined by factor price changes and factor shares. On the composite capital-labor side, the rental rate of capital paid by the activities increases in spite of the subsidy as capital is sector specific. On the other hand, wages for all labor types increase marginally, the highest increases being those of unskilled rural labor (0.5%) and skilled rural labor (0.2%). Therefore, on this side there is an upward pressure on the price of value added. On the composite land side, the rental rate of land paid by the activities decreases as a consequence of the subsidy and the price of fertilizer decreases too as its demand drops. Hence, on this side we have a downward pressure on the price of value added. The result is, as Table 7 shows, that in general the second effect dominates and the price of value added tends to fall, in most cases marginally.

As domestic prices tend to fall, the ratio of FOB prices to international prices (exogenously given) also falls and exports tend to increase in quantity. This is true for all activities but plantain and other crops. Nonetheless, the

Tab. 7: Percentage Changes in Prices and the Value of Value Added

Activity	Unit cost	Basic price	Capital rent	Paid capital rent	Land rent	Paid land rent	Value added price
Coffee	0.16	0.16	1.26	0.53	3.25	-1.42	0.17
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
Rice	-0.82	-0.96	2.76	0.79	-2.65	-6.62	-1.20
Potatoes	-0.67	-0.74	1.05	0.87	-1.20	-13.58	-1.00
Legumes	-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
Oil plam	-1.71	-1.71	2.69	2.53	8.93	-30.95	-1.84
Oil seeds	-0.18	-0.21	2.07	1.13	-2.87	-2.87	-0.31
Other crop	01.0	0.10	0.33	0.07	1.07	1.75	0.12
Cocoa	-7.19	-7.19	4.63	3.71	15.32	-44.54	-8.04
Tobacco	-0.33	-1.40	1.99	1.81	-0.82	-21.42	-0.59
Sugar cane	0.01	0.01	0.88	0.43	2.10	-0.08	-0.01
Cotton	-0.12	-1.62	2.20	2.09	-1.86	-5.40	-0.06
Ag. invest.	0.19	0.19	70.24	0.30	1.88	1.88	0.24

Source: CGE simulation

Tab. 8: Changes in Quantities Traded (percentages)

Activity	Exports	Domestic demand	Imports
Coffee		0.06	
Cereals	0.14	0.18	0.06
Corn	2.75	2.41	-0.58
Rice	1.05	0.10	-1.79
Potatoes	0.66	0.22	-0.91
Legumes	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
Oil plam	2.19	0.08	-4.09
Oil seeds	0.30	0.23	-0.16
Other crops	-0.16	-0.06	0.19
Cocoa	9.12	2.96	-9.03
Tobacco	1.82	0.77	-1.93
Sugar cane	0.00	0.07	
Cotton	2.47	1.79	-1.30

Source: CGE simulation

extent to which exports increase is relatively low with the exception of cocoa, corn, cotton, and oil palm, as shown in Table 8. Furthermore, the ratio of prices received by export crops to local prices determines the relative size of changes in the market of destination. If local prices increase more than export prices, the proportional change in supply to the domestic market is higher than that to the export market and vice versa. In general, the increase in exports tend to be higher than the increase in supply to the domestic market, with a few exceptions. Lastly, the ratio of the domestic price to the import price, determines the behavior of imports. In most cases this ratio decreases, leading to a decline in imports that, with some exceptions, tends to be small (the relevant figures are presented in Table 8).

Finally, it should be mentioned that, as expected, the impact of the program at the macro level is nill. Nominal GDP increases 0.021% while the GDP deflator increases 0.019%. The size of the direct tax needed for financing the program is negligible.

3.5 The Role of Productivity Changes

One of the appealing features of the program, as designed, is its potential for enhancing productivity. There are several mechanisms through which it is expected that AIS can have an impact on productivity, the two most important being the CID and the ITA. As mentioned, only the former is taken into account in the simulation and its impact is parametrized for the model based upon an assumed average yield gap between irrigated and non-irrigated land for all agricultural activities. The results shown above are based on an average yield gap of 20%, that generates the productivity impacts already shown in Table5. Given the importance of this parameter in determining the results, in this subsection we report estimates arising from two somehow extreme alternative assumptions for the yield gap, a 10% and a 30% value, equivalent to halving the base estimate and increasing it by 50%. The basic results are presented in Table 9, where the figures correspond to the difference between the percentage change attained under the new yield gap and the 20% gap. Therefore, a negative number means that the new estimate is lower than that corresponding to the 20% gap, and vice versa.

As the new values for yield gaps spread symmetrically from the 20% value (10 percentage points bellow or above), the change in productivity attained at the activity level also spreads symmetrically around the values reported in Table 5. As a consequence, changes in value added, demand for composite labor, and demand for land, as reported, tend to be symmetrical too. The important fact arising from the figures is that there are no cases in which we obtain estimates that depart in a significant manner from those attained under the 20% benchmark. The higher differences amount to less than 0.2% in absolute value for value added, around 0.7% for the demand for composite labor, and slightly more than 1% for the demand for land. Hence, even though at the individual level and in relative terms there are cases in which estimated values may greatly differ, these differences have very low leverage for modifying the aggregate results on which we concentrate here. In summary, the assumption of different values for the yield gap, although not innocuous, does not affect the direction of our estimates and change their level in a negligible way.

4 Sectoral Performance and Evaluation of AIS

We now turn to the actual performance of the agricultural sector, as reflected in official statistics. Clearly, the actual behavior of the sector cannot be directly compared to the estimations arising from the CGE model, as there are many factors affecting it and we just model the likely impact arising from the program. However, the direction of changes in production levels and their size should provide an indication about as to whether the program has the expected effects. Table 10 shows percentage changes in agricultural output and the contribution

Tab. 9: Results from Alternative Values of the Yield Gap Between Irrigated and Non-irrigated Land

Activity	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
Legumes	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 plam	-0.06	0.06	-0.22	0,22	-0.10	0.09
Oil seeds	0.17	-0.17	0.65	-0.64	0.23	-0.23
Other crop	-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. invest.	-0.01	0.01	-0.02	0.02	-0.44	0.44

Source: CGE simulations

Tab. 10: Actual Changes in Agricultural Production in Colombia

Activity	Growth in 2008	Growth in 2009	Contribution of harvested area in 2008	Contribution of yields in 2008
Coffee	-9.0	-32.0	-0.9	-8.1
Cereals	-48.0	-6.3	-14.9	-33.1
Corn	-2.6	-3.0	0.5	-3.2
Rice	12.0	10.0	0.8	11.3
Potatoes	-0.9	6.7	-0.5	-0.4
Legumes	-5.9	2.4	0.7	-6.6
Vegetables	2.9	1.1	-6.2	9.0
Tubers	-0.1	1.6	0.3	-0.4
Bananas	11.1	0.1	5.7	5.4
Plantain	3.5	-1.0	-1.9	5.4
Fruits	-4.7	1.4	-4.0	-0.7
Oil plam	6.1	3.2	-4.6	10.7
Oil seeds	0.7	12.2	40.0	-39.3
Other crops	-2.2	6.7	2.4	-4.6
Cocoa	2.3	2.4	0.6	1.8
Tobacco	-23.4	-28.0	-2.5	-20.8
Sugar cane	-8.4	17.4	-0.4	-8.0
Cotton	-17.2	-16.6	-1.5	-15.7

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

of changes in areas planted and in yields to output change. As we take a short term perspective and use 2008 AIS data, changes corresponding to 2008 seem the most appropriate for contrasting with the estimations arising from the model.

It follows from the table that in 2008 most activities show declines in output levels while in 2009 the contrary is true. Among the 18 activities included, only seven show actual changes moving in the same direction that our estimates, most with high differences in levels.[24] Given the small size of most changes predicted by the model, it is presumed that changes in market or other conditions (actual

[24] The number reduces to six if it is noted that cut flowers, the most important activity within the group other crops, had to be excluded from the table since there is no information available for decomposing its output change among area and yield contributions. Cut flowers output increases by 0.3% and 0.2% in 2008 and 2009 respectively, while the model predicts a 0.14% decrease.

or expected prices, weather, pests, etc.) can easily override the expected effects from the program.

There is no particular pattern in the behavior of output, in the sense that both perennial and seasonal crops show decreases and increases in output, except for the fact that the contribution of changes in yields tends to be higher than the contribution of changes in harvested areas. In this respect, there is scant correlation between actual changes in yields and those estimated for the model, frequently running in the opposite direction.[25]

From the above, it follows that there is practically no way to assess if the program delivered the expected results by looking at the actual aggregate behavior of agricultural activities. Therefore, the question arises as to whether there are different performances between farmers benefiting from the program and farmers that do not benefit from it (and that, on average, generate the results just commented). For this, we now conduct a brief review of the evaluation of the program that the Ministry of Agriculture ordered and was carried out recently (Econometria, 2011).

The Econometria study surveyed 1,865 beneficiaries that entered into the program between January and May of 2008[26] and 4,057 non-beneficiaries allowing for having two control groups against which to test the behavior of beneficiaries. One of the control groups is integrated by farmers located in areas in the proximity of beneficiaries and the the other by farmers located far away so spillover effects can be controlled for. The distinction between controls that had access to and used credit and those that did not have access to credit was also taken into account. Around 43% of the sample of beneficiaries obtained subsidies through the SCL, 28% from the IRC, 28% from the CID, and the remaining 1% from the ITA.[27] As a number of beneficiaries surveyed for the study was also included in the sample for constructing the base line, both Propensity Score Matching and Difference-in-Difference techniques were employed for analyzing the data. The survey was conducted between October and December 2010.

Among the variables analyzed in the Econometria study, there are four that are of interest for us: competitiveness (measured as monthly production costs per hectare), productivity (measured as monthly net income per hectare), productive investment (measured as total investment made in agricultural activities), and employment (measured as working days devoted to in-farm agricultural activities). In summary, the findings from the study are the following. First, small farmers showed increases in costs per hectare, lower investment levels and in spite of attaining higher gross incomes, these were insufficient for increasing net income. On the other hand, large producers kept their investment levels, decreased production costs, and sustained their net income. Employment

[25] It must be remembered that changes in productivity in the CGE were calculated based on estimates of the yield gap between irrigated and non-irrigated land and on the size of governmental intervention (subsidization) for each activity.

[26] Which amount to around 5.6% of total beneficiaries from the program.

[27] The sampling took into account the proportion of projects benefiting from each subprogram as well as geographical and farmer size characteristics.

levels increased in the case of small farmers and also in the general case in which the activity is based on perennial crops.

No effects were found in the case of both demand for technical assistance and systematic use of technical training. There is, however, greater evidence of increased use of machinery when producers are firms (as opposed to households), regardless of the type of activity, and in the case of individual producers (households) when they grow perennials. In the case of firms, it is also observed that they sustained high investment levels and, in some cases, attained positive net income effects. Lastly, there were found no spillover effects.

The above implies that, in general, use of subsidized credit from the program has either no significant or negative effects on outcomes for producers (specially in terms of competitiveness and productivity), and that positive effects tend to concentrate in firms and producers whose activities are based on perennial crops. As the study highlights, of a total of 2,012 possible impacts, only in 350 cases (17.4% of the total) there were significant effects and half of them point away from the expected direction.

As a consequence, it can be said that, on average, the program has no significant effects on beneficiaries and therefore does not generate a difference between beneficiaries and non-beneficiaries outcomes (with the possible exception of certain firms and producers). Therefore, from either the macro perspective (the assessment using the CGE model) or from the micro perspective (the program evaluation just reviewed), we attain the same conclusion: the AIS policy package does not seem to deliver, at least in the short run, the expected results in terms of increasing Colombian agricultural competitiveness.

5 Concluding Comments

We carry out a partial appraisal of agricultural policy changes in Colombia. In particular, we provide a general assessment of AIS, a policy package put in place for compensating the potential losers from a FTA with the US and for enhancing agricultural competitiveness. We do this as a two-steps process. First, we use a CGE model specialized in agriculture to estimate the potential effects from the program and compare the results of the simulation with the actual performance of the agricultural sector in 2008. Second, we review the results from a recent evaluation of the program based on microdata in order to have a more complete view of its outcomes.

Although sizable for Colombian agricultural policy standards, in terms of public sector budget allocation, the program is relatively small as compared to the size of the agricultural sector. While the first feature results in relatively high subsidization levels at the project (farmer) level, the second reflects in relatively low subsidy rates at the sectoral level, leading to a potentially low ability to generate significant aggregate (sectoral) impacts but, simultaneously, to potentially high impacts at the individual level.

Results from the CGE simulation show that expected impacts in terms of percentage changes in value added at the activity level are small, most of them in the range bellow 1%. Higher changes could be expected in terms of factor and input usage, with demand for composite labor ranging from 4.9% to -0.25%, demand for land use oscillating between 5.2% and -2.7%, and demand for fertilizer changing in between 1% and -21.5%. However, in spite of these wider changes, resulting unit costs decrease 0.68% on average and only in three cases yield decreases above 1%. If the effect of subsidies on working capital is taken into account, the number of activities for which basic prices decline by more than 1% increases from three to five (out of 19). Estimated changes in productivity, arising from increases in land under irrigation an drainage projects and parametrized outside of the CGE, lead to yield average gains around 4.5% with cases as high as 17% and as low as 0.2%.

Observation of the actual behavior of agricultural production during 2008 shows that output of most activities shrank. The average growth rate was -4.7% and only seven activities showed increases (5.5% on average). While there are many variables that may impinge upon these outcomes, it is also true that the size of the estimated impacts from the program are small enough so as to easily be overridden by the impact of factors such as price fluctuations, weather changes, or farmers' expectations. As a consequence, at the aggregate level only the direction of changes could be used as a proxy to judge program outcomes. This comparison leads to the idea that the program does not fulfill its objectives, specially if the contributions from areas planted and yields to output changes are taken into account (since both show very low coincidence with the estimated results).

Clearly, this way of appraising the impact from the program is unsatisfactory as we cannot isolate the root causes of the observed behavior of the agricultural sector. In particular, there is the question about the capability of the program to generate positive results for its beneficiaries while not being able to replicate this outcome at the aggregate level. For answering this question we examined the results from an evaluation of the program ordered by the Colombian Ministry of Agriculture. The general result from this evaluation is that only in 17.4% of the cases the program was able to generate outcomes for its beneficiaries that were significantly different from those of the control group, and that in about half of them they run in a direction opposite to what was expected.

In light of this, it seems safe to infer that AIS is not generating the expected outcomes and that it is reasonable to question its capability for truly enhancing the competitiveness of the Colombian agricultural sector (as well as its capability for protecting farmers incomes in light of the upcoming implementation of the FTA with the US).

In the face of harsh criticism of the program due to a relative concentration of benefits in the hands of large farmers and of breaches in program controls that allowed particular interests to illegally increase the share of large farmers in benefits, the program was partly restructured and rebranded in 2010 as Rural Equitable Development (DRE by its acronym in Spanish), which started operating in 2011. The restructuring of AIS essentially concentrated on introducing adjustments to policy instruments, the establishment of new rules for their operation, and the establishment of new checks on program operation. According to the Ministry of Agriculture (2011), the program was refocused for being the axis of Colombian rural development policy. Access conditions were improved for small farmers (including an amendment to the way small farmers are identified, so more farmers fit into this definition), more favorable conditions were put in place for joint projects between large and small farmers,[28] and an emphasis on crops considered important for food security was added (somehow morigerating the bias toward perennial crops). However, the general structure of the program, in terms of policy instruments, was kept and with it the incentives given to producers. Therefore, aside from a greater emphasis on small farmers and integrative projects, the essence of AIS, at least from an aggregate (sectoral or activity) point of view was preserved and an analysis of DRE would follow the same lines of the one we conducted here by means of the CGE model.

Given the above, it is likely that the expected impacts from DRE would look very similar to those we estimated here. Hence, unless the greater support envisioned for small farmers[29] or the effect of joint projects between large and small farmers prove very effective (perhaps generating strong spillover effects), it is likely that DRE will not have the capability for becoming a true axis for rural development policy in Colombia.

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[28] Large farmers can have access to the program only jointly, in integrated projects, with small farmers and the share of the latter in these projects cannot be bellow 60% in value.

[29] 4.8% of DRE's resources are devoted to small farmers tutoring.