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Hernando Zuleta González

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infocede@uniandes.edu.co
<http://economia.uniandes.edu.co>

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Coca, Cocaine and Drug Trafficking

Hernando Zuleta González¹

Abstract

The increase in the area cultivated with coca in Colombia has cast doubt on the country's anti-drug strategy and has encouraged skepticism about the possibility of a complete and definitive peace. Furthermore, this perception of failure has given rise to policy proposals based on the idea that illicit crops are a criminal issue, not a development one.

This paper is a complete review of the available evidence and aims at organizing the information related to this debate and shedding light on the convenience or inconvenience of certain policies. There are six highly relevant facts: (i) With respect to reducing cocaine supply, the efforts in seizures and destruction of infrastructure are more efficient than the efforts in eradication. (ii) Seizures and destruction of infrastructure may help in reducing coca plantations. (iii) There is no evidence to support the hypothesis that the consumption of cocaine in Colombia has increased. (iv) Most regions of the country have seen a decrease in the amount of coca crops. However, at least one armed group is present in the regions where the cultivated area has increased. (v) Coca growing municipalities are, on average, poorer than the rest of the country. These municipalities have a low tax revenue, and reduced levels of connectivity and institutional development. (vi) The increase in the consumption of cocaine in the United States is concentrated in a specific age group and in certain states. This fact makes it difficult to relate the increase in consumption to an exogenous increase in the supply.

JEL codes: H56, H71, K14, N46, O12, O13.

Keywords: Illicit crops, drug traffic, internal conflict, development.

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Hernando Zuleta, Centro de Estudios sobre Desarrollo Económico - CEDE Universidad de los Andes, h.zuleta@uniandes.edu.co

Coca, cocaína y narcotráfico.

Hernando Zuleta González²

Resumen

El aumento en el área cultivada con coca en Colombia ha puesto en duda la estrategia antidrogas del país y ha alentado el escepticismo sobre la posibilidad de una paz completa y definitiva. Además, esta percepción de fracaso ha dado lugar a propuestas de políticas basadas en la idea de que los cultivos ilícitos son un problema criminal, no de desarrollo.

Este documento es una revisión completa de la evidencia disponible y tiene como objetivo organizar la información relacionada con este debate y arrojar luz sobre la conveniencia o inconveniencia de ciertas políticas. Hay seis hechos altamente relevantes: (i) Con respecto a la reducción del suministro de cocaína, los esfuerzos en incautaciones y destrucción de infraestructura son más eficientes que los esfuerzos de erradicación. (ii) Las incautaciones y la destrucción de infraestructura pueden ayudar a reducir las plantaciones de coca. (iii) No hay evidencia que apoye la hipótesis de que el consumo de cocaína en Colombia ha aumentado. (iv) La mayoría de las regiones del país han visto una disminución en la cantidad de cultivos de coca. Sin embargo, al menos un grupo armado está presente en las regiones donde el área cultivada ha aumentado. (v) Los municipios productores de coca son, en promedio, más pobres que el resto del país. Estos municipios tienen bajos ingresos fiscales y niveles reducidos de conectividad y desarrollo institucional. (vi) El aumento en el consumo de cocaína en los Estados Unidos se concentra en un grupo de edad específico y en ciertos estados. Este hecho hace que sea difícil relacionar el aumento del consumo con un aumento exógeno del suministro.

Códigos JEL: H56, H71, K14, N46, O12, O13.

Palabras clave: cultivos ilícitos, narcotráfico, conflicto interno, desarrollo.

² Este documento no hubiera sido posible sin la ayuda de Daniela Santos, Claudia Rodríguez y Juan Felipe Godoy.

I. Introduction

The area cultivated with coca in Colombia has significantly increased in the last years. This fact has cast doubt on the country's anti-drug strategy and has encouraged skepticism about the possibility of a complete and definitive peace. Furthermore, a perception of failure has given rise to policy proposals based on the idea that illicit crops are a criminal issue and not a development one.

In the first place, vocal critics have argued that the increase in the cultivated area implies an utter failure of the drug policy. According to this hypothesis, such a failure implies an increase in cocaine and basuco consumption on a national level, and an increase in cocaine and crack consumption in the United States on an international level.

In the second place, there is a perception that the increase in crops will make it harder to implement the peace agreements and will promote violence in the region³. This perception is explained because FARC has been present in many of the coca growing municipalities and because there is a founded fear that other armed groups will try to establish territorial control in these regions.

Unfortunately, many of the aforementioned arguments rely on perceptions and preconceptions rather than evidence. For this reason, this document makes a detailed analysis of the available information, points out additional information needs and invites analysts and policymakers to contrast their arguments against the empirical evidence.

The main results of this analysis can be summed up in six points:

- (i) With respect to reducing cocaine supply, the efforts in seizures and destruction of infrastructure are more efficient than the efforts in eradication. Consequently, the indicator for success or failure should not be the cultivated area but the amount of cocaine that effectively reaches the market.
- (ii) Seizures and destruction of infrastructure also help in reducing the plantations of coca.
- (iii) There is no evidence to support the hypothesis that the consumption of cocaine in Colombia has increased.

³ Rafael Pardo, senior presidential advisor for the post-conflict, has said that coca is the main threat against peace.

(iv) Most regions of the country have seen a decrease in coca cultivation. However, one or more armed groups are present in the regions where cultivated area has increased. This implies that the increase in the cultivated area is related to the issue of territorial control.

(v) Coca growing municipalities are, on average, poorer than the rest of the country. These municipalities have a low tax revenue, and reduced levels of connectivity and institutional development. These circumstances suggest that it is necessary to make an effort to stimulate the development of the coca growing municipalities but also draws attention to the difficulties that crop substitution programs will face.

(vi) The increase in cocaine consumption in the United States is concentrated in a specific age group and in certain states. This fact makes it difficult to relate the increase in consumption to an exogenous increase in the supply.

This document is organized in eight sections of which this introduction is the first one. The second section presents a brief description of Colombia's anti-drug policy since the late 20th century. Different hypotheses for explaining the increase in illicit crops are described and analyzed in the third section. The fourth section points out how the change on a policy emphasis should be coupled to a change in the success indicators of the drug policy. The fifth section comprises an analysis of the relation between illicit crops, territorial control and violence. The sixth section presents information about the development indicators on coca growing municipalities. Lastly, the conclusions of the paper are presented.

II. From aspersion to interdiction

In 1999 an important change in Colombia's strategy towards the war on drugs took place. Goals, instruments and deadlines for reducing the national supply of cocaine were established within the framework of Plan Colombia. The main instrument used was the aerial aspersion of herbicides over coca fields. The results of this effort are well-known: the number of cultivated hectares was reduced from 160,000 to 80,000 between the years 2000 and 2005. However, this relative success was overshadowed by two events: first, Colombia's potential production of cocaine stayed stable during this same period and, second, the decrease in the cultivated area in Colombia coincided with a proportional increase of crops in neighboring countries (Mejía, 2011).

Other strategies were controlling chemical precursors, destroying cocaine producing laboratories and seizing shipments of the alkaloid. Even though these strategies played a secondary role at first, an analysis of the drug-trafficking business' value chain makes it possible to affirm that the effectiveness of these strategies is greater than that of crop eradication. In fact, the coca leaf's participation in the total business value is small (9%) whereas the larger part of the value is concentrated in cocaine trafficking (71%). As a result, when it comes to affecting the incentives for the actors involved in the drug trafficking business, it is more efficient to destroy the infrastructure that allows for the production of cocaine and to seize shipments on their way to the market (Mejía y Rico, 2011).

Besides the aforementioned considerations, other facts have led to a change of emphasis in the anti-drug policy since 2006. First, the effectiveness of the interdiction strategy increased rapidly: according to figures from UNODC, while 13% of the national cocaine production was seized in the year 2000, nearly 46% was seized in 2008. Second, aerial eradication is inefficient due to the cost of eradicating a hectare of coca using aerial aspersion because it is orders of magnitude more expensive than the cost of the market price for the coca leave grown in that hectare (Mejía, Restrepo y Roza, 2015). Third, the relationship between government institutions and communities in the crop regions is hindered because of the aspersions. This results in difficulties for bringing police and military presence, as well as public utilities, healthcare and education into these areas.

In this new scenario, the Colombian National Navy has stepped into a leading role due to the sea being the most used method for transporting cocaine from its production and storage zones to the consumer markets. According to Colombia's Drug Observatory, the seizures of coca-derived alkaloids increased 40% between the years 2006 and 2008⁴. In 2015, cocaine seizures reached 252 tons and over 300 tons in 2016.

Despite this, the metric with which the success of the policy against drugs is assessed is still the area of coca crops. In this context, the recent increase in the cultivated area has attracted a lot of attention and sparked a debate on the causes of the increase in coca crops.

⁴ The work of the Navy hasn't been easy, though. On the one side, the means of seaborne transport are increasingly sophisticated as well as the strategies used to evade justice. On the other side, neither international nor interinstitutional coordination on an internal level have been agile enough to face a transnational business that knows no bounds or institutions (Rincón, 2016).

III. Why the increase in the cultivated area?

A well accepted hypothesis states that the increase in the cultivated area is a consequence of the cessation of aerial aspersions with glyphosate. However, the chronological order of events does not seem to support this hypothesis. Figure 1 presents the evolution of the cultivated area (columns) coupled with the numbers for aerial eradication (orange line) and manual eradication (grey line). As can be observed, the number of hectares eradicated through aerial aspersion has been decreasing since 2006 and manual eradication begins to decrease in 2008. Despite this, there's a decrease in the cultivated area between 2007 and 2012. The increase in illicit crops can be observed in 2014, which is after several years of decrease in manual and aerial eradication. Overall, a statistically significant correlation between eradication (both manual and aerial) and the cultivated area was not found.

Figure 1: Illegal crops and eradication.

Source: National Drug Observatory and independent calculations.

Of course, it is impossible to prove causality from this visual analysis. Nevertheless, Cote (2017) uses an array of municipalities in a recent work for the period of 2000-2015 in order to analyze the factors that determine the coca cultivated area. Results show that aerial fumigations have no significant

effect on the cultivation of coca. Manual eradication, on the other hand, seems to have a negative but hardly substantial effect on the cultivated area.

According to another hypothesis, the peace talks in Havana have created expectations of grants and economic aids for the families involved in illicit crops, thus creating incentives for growing coca. Taking into account that in 2012 the decreasing trend for the cultivated area breaks, and starts to increase the following year, the hypothesis according to which the expectations created by the peace talks is the cause for the increase in the cultivated area seems more consistent with the evidence. Cote (2017) evaluates this hypothesis introducing dummy variables for 2014 and 2015 but the quotient of these variables is not significantly different from zero. Thus, there is no evidence that the peace process has had an effect on the cultivated area. However, this analysis does not include data from 2016. In a more recent paper, Guarín, López and Medina (2018) use an alternative methodology and include data from 2016. They find that between 2012 and 2016, the increase in coca cultivation was substantially higher (1,517 hectares on average) in municipalities where the FARC had continuous presence during the peace dialogues. They also found that government interventions to fight illicit crops were less intense in those municipalities. However, the authors explain that, even though the correlation is clear, the results do not imply causal effects and more research is needed in order to prove causality. However, taking their coefficients at face value, the peace process is associated with an increase of 30,000 hectares in the cultivated area.

A third hypothesis suggests that the increase in the cultivated area is an answer to the increase in seizures: given that the interdiction processes result in a lower proportion of the produced cocaine reaching the consumer market, it becomes necessary to produce more in order to satisfy the demand from international markets. The results from Cote (2017) suggest that interdiction has a negative effect on the coca crops for the following year. In particular, a destroyed cocaine processing facility reduces coca crops by around 10 hectares. Likewise, cocaine paste seizures reduce crops. In particular, every additional kilogram of seized cocaine paste causes a decrease of approximately 0.17 hectares in a municipality and seizing a kilogram of cocaine reduces coca crops by around 0.08 hectares.

Finally, there is a hypothesis according to which the increase in the cultivated area results in an increase in the internal demand for coca derivatives, meaning that micro-trafficking gangs are the main beneficiaries of the increase in crops. There are two main issues with this argument: 1.

According to figures from the National Planning Department (DNP), the internal market is around 20% of the total market and it is difficult to explain an increase in the cultivated area close to 100% this way. 2. There is no evidence of an increase in internal cocaine consumption.

Table 1, taken from the blog of Alejandro Gaviria, Minister of Health and Social Protection, shows information about the prevalence of cocaine consumption from the last year, or in other words, it shows the statistics for the answer to the question: Have you consumed cocaine in the last year?

The only survey that shows an increase in consumption is the youth consumption survey that encompasses from 2004 to 2011, which doesn't include the recent period of increased cultivated area and, on the contrary, coincides with the period of a downwards trend in illicit crops.

The numbers from the survey from Universidad de los Andes CESED's are the most recent ones. They're representative for Bogotá but not for all of Colombia. This information shows a decrease in the consumption of cocaine in the young population from the country's capital⁵.

Thus, the hypothesis according to which the increase in the cultivated area is boosted by internal consumption has no basis.

Table 1: Consumption of cocaine in Colombia and Bogotá

Source: <http://agaviria.blogspot.com.co/>

Population	Source	Base Year	Final Year	Trend
General population 2008-2013	National Consumption Survey	0,71	0,70	Stable
School population 2004-2011	Youth Consumption Survey	1,59	2,18	Increase
University population 2008-2013	National Consumption Survey	2,37	2,12	Decrease
Youth in Bogotá 2003- 2015	CESED	3,50	2,40	Decrease

In short, the empirical evidence suggests that seizures and the destruction of infrastructure are the most substantial variables in explaining coca-cultivated areas. Can these variables explain the increase in the cultivated area?

⁵ Basuco consumption is increasing but the prevalence of basuco consumption is very low when compared to cocaine consumption.

Figure 2 shows the evolution in the cultivated area (left axis) together with the numbers of destroyed infrastructure (right axis). Between 1999 and 2008, both an upwards trend in the destruction of infrastructure and a downwards trend in the cultivated area can be observed. In 2008, however, the trend in infrastructure destruction breaks and, after a decrease in 2009, shows little variation between 2010 and 2014.

Figure 3 shows the series of cultivated area, cocaine and cocaine paste seizures. Cocaine seizures have an upward trend from 1999 to 2009. However, there's a decrease in 2006 that precedes the increase in crops that takes place in 2007. Cocaine seizures drop between 2009 and 2014 but pick up in 2015. Cocaine paste seizures have an upwards trend until 2008, an atypical increase in 2010 and a slight decrease between 2011 and 2014.

Thus, a preliminary analysis is not enough to discard the hypothesis according to which the increase in the cultivated area can be explained by seizures and by the destruction of infrastructure.

Taking the coefficients estimated by Cote (2017) at face value:

- (i) A decrease of 1,098 units in infrastructure destruction (the difference between 2008 and 2014) explains an increase of 10,980 hectares in the cultivated area.
- (ii) A decrease of 95,000 kilograms in cocaine seizures (the difference between 2008 and 2014) generates an increase of 7,600 hectares in the cultivated area.
- (iii) A decrease of 13,700 kilograms in cocaine paste seizures results in an increase of 2,300 hectares in the cultivated area.

Therefore, according to the coefficients estimated by Cote, the total effect of the decrease in seizures and infrastructure destruction is a 21,000 hectares increase in the cultivated area. Together with the 30,000 hectares associated with the peace process, we could explain a total increase of 50,000 hectares, roughly half of the increase in the cultivated area that takes place between 2012 and 2016. The other 50% can be explained by other reasons such as the decrease in manual eradication or the drop in the price of gold.

Finally, if Cote's (2017) results are taken at face value, the 2015 increase in seizures and infrastructure destruction should create a decrease in crops of around 23,000 hectares in the upcoming years.

Figure 2: Crop and infrastructure destruction.
Source: National Drug Observatory and independent calculations.

Figure 3: Seizures and crops. Source: National Drug Observatory and independent calculations.

IV. Where to look at?

As previously stated, drug policy has changed during the first five-year period of the 21st century. Having understood that reducing the supply of cocaine is the main goal, authorities have concentrated their efforts in interdiction and the destruction of infrastructure. Despite this, the available information regarding these activities is frequently ignored.

Data from Colombia's Drug Observatory shows that coca leave seizures increased 74.25% between the years 2013 and 2015. Even though this number is lower than the 100% of increase in illicit crops recorded during the same period, it still is an impressive result. Besides, it shows that the effective supply of coca had a lower increase than the increase in crops.

In addition, for November of the current year, cocaine seizures rose to 308 metric tons, which is 47.3% of the potential cocaine production estimated by the United Nations Office on Drug and Crime for 2015 (646 tons).

The evolution in seizures shows the inconvenience of using the cultivated area as an indicative variable of the drug policy's success. It is necessary to evaluate a barrage of variables in order to give a diagnosis.

Figure 4 shows the result of a preliminary exercise in this direction. Using standard conversion factors, potential coca leaf production is estimated from the cultivated area and the amount of coca seizures is subtracted from this value.

The first coca harvest takes seven or eight months since sown and usually has a low yield. The second harvest takes between one and two months after the first one. After the second one, the time between harvests is of 40 or 60 days. Because of this, the increments in the cultivated area don't translate immediately into an increase in potential production.

The supply of cocaine paste is estimated once the net supply of coca is calculated from seizures. Again, the seizures of cocaine paste are subtracted and the conversion factor is applied to the result so the potential cocaine supply can be estimated. Finally, the number of cocaine seizures is subtracted.

Each process takes time and there are often periods of storage and transport. However, it is impossible to accurately calculate the time between cultivation and the moment cocaine enters the market. For this reason, Figure 4 shows two scenarios. The first scenario (dotted line) presupposes a two year delay and the second one (red line) a one year delay.

An increase in cocaine supply in 2010 is estimated in both scenarios, as well as a later decrease until 2014. The main difference between both estimates happens in 2015 where the decrease in the supply of cocaine is accentuated when supposing a two year delay but slightly picks up when supposing a one year delay. This means that a decrease in the availability of cocaine in the market can be seen since 2011 if we take into account seizures when assessing the drug policy, and that it even could have decreased between 2014 and 2015 as well.

In any case, this exercise draws attention to the need for including all available information when it comes to assessing the drug policy.

Figure 4: Estimates of the amount of cocaine in the market.

Source: National Drug Observatory and independent calculations.

Figure 5: Coca crops in the Andean area.

Source: UNODC.

One last consideration with regards to the recent evolution in illicit crops has to do with the transnational character of the drug-trafficking business and the so-called globe effect. Figure 5 shows recent information on illicit crops in Colombia, Peru and Bolivia. The numbers suggest that the pick-up in the cultivated area in Colombia was partially compensated by a decrease in crops in Peru in such a way that the supply in South America had a lower percentage increase than Colombia. Likewise, when analyzing the entire period, it is evident that the cultivated area in 2015 is the same as the cultivated area in 2011 in South America. This information becomes relevant because drug-trafficking is a transnational business and the war on drugs is, at least in theory, a global strategy. In practice, the source of coca becomes anecdotic when trying to identify the potential supply of cocaine.

V. Crops, guerilla and peace.

The inconvenience of using coca crops as an indicator of the failure or success of the war on drugs was shown in the previous sections. However, this variable is critical from the perspective of territorial control.

The chapter on illicit drugs in the Final Agreement to the End of the Armed Conflict includes integral development plans with the participation of communities in the design, execution and evaluation

of plans for substitution and environmental recovery in areas affected by illicit crops. In this context, the aerial aspersions of herbicides can undermine the trust put in the government institutions by the communities and make it harder to implement the agreements. However, the presence of illicit crops and its recent expansion also pose important risks for the implementation of the agreements.

The agreement proposes an approach to the problem of illicit crops from a development and human rights perspective. In this sense, it is part of a diagnosis according to which growing coca is the only way out for the population of secluded regions where there is no provision of public goods, formal institutions or the possibility of articulation with the legal markets. Following this train of thought, the strategy of crop substitution should include providing public goods, funding of productive projects, job-creating projects and, in general terms, a development strategy.

If the agreement is fully implemented, the incentives families have for growing coca would disappear. However, since coca is one of the inputs that fuels a business dominated by criminal gangs, it is quite possible that these gangs will attempt to sabotage the implementation of the agreements and force families to keep growing coca. This can be a particularly violent scenario if a war between armed groups starts over the crops that used to be under FARC's control.

Map 1 shows the change in illicit crops between 2013 and 2015 on a municipal level. Most of the country's regions have had a decrease in the cultivated area and, thus, the nation-wide increase can be explained due to a few regions (Catatumbo, Nariño and Putumayo, for example).

Map 2 shows two panels. Panel A shows: (I) the municipalities where there are coca crops, and neither FARC nor ELN are present (green), (II) the municipalities where there are coca crops and both FARC and ELN are present (brown) and (III) the municipalities where there are no coca crops and both FARC and ELN are present (yellow).

Panel B shows: (I) the municipalities where there are coca crops and neither FARC nor BACRIM are present (green), (II) the municipalities where there are coca crops and both FARC and BACRIM are present (brown) and (III) the municipalities where there are no coca crops and both FARC and BACRIM are present (yellow).

When cross-referencing the information on illicit crops with the presence of armed groups, it becomes evident that there is more than one armed group present in the regions where there was

an increase in the cultivated area. BACRIM and FARC are present in all these regions and ELN in most of them.

Unfortunately, some violent groups are already occupying the zones left by FARC and are terrorizing the population.

How to guarantee that the agreements are fully implemented with regards to the chapter on drugs?

How to keep away the violent groups from the regions with coca crops?

Map 1: Change in the coca cultivated area.

Source: UNODC and independent calculations.

Change in coca crops 2013-2016

Map 2: Coca and presence of armed groups.

Source: UNODC, CEDE and independent calculations.

Panel A: FARC, ELN and Crops.

Panel B: FARC, BACRIM and Crops.

VI. Crops and Development.

Until now, the topic of illicit crops has been addressed as the first link in the drug-trafficking chain and as a main element in the struggle for territorial control. Nowadays, there is a profound issue associated with illicit crops that is essential when it comes to making a full diagnosis that allows deriving policy implications, even though it usually receives less attention: economic development.

According to figures by the National Planning Department (DNP), municipalities with coca crops score, on average, 87.3% on the Multidimensional Poverty Index, 58% have deficient connectivity and 86% are categorized as either rural or dispersed rural settlements.

These data suggest that the substitution programs must also be development programs that allow overcoming conditions of poverty in coca-growing municipalities.

How important is coca-derived income in producing municipalities?

Tax revenue gives an idea on the capacity municipal governments have for offering public services and meeting the population's needs. Likewise, the possibility of implementing long-term substitution programs relies on the amount and stability of the municipal governments' income. For these reasons, this section compares the value of tax revenue against the potential income derived from coca crops.

On another note, incentives for the substitution of illegal crops rely on the potential income for producers in legal activities and on the ability of the formal sector for attracting and integrating farmers into the legal economic system. Thus, it is also useful to compare the aggregate value of the different municipalities against the potential income derived from growing coca.

Given that the prices for the coca leave vary between municipalities and we do not have municipal information, we consider three scenarios:

- (i) The first scenario presupposes that the price of coca in all municipalities within a department is the same.
- (ii) The second scenario takes the lowest price from all the regions and supposes that is the price in each municipality.
- (iii) The third scenario takes the highest price from all regions and supposes that is the price in each municipality. These three scenarios give a maximum, a minimum and a most probable value.

Table 2 shows the statistics describing the ratio between the value of the coca leaf that can be produced, considering cultivated area, and both the aggregate value of coca-growing municipalities, first, and the tax revenue from coca-growing municipalities, second. The source of prices for the coca leave is c. The value for the national average of coca leaf was used for the departments that do not report prices.

Table 2: Ratio between the coca-leaf value and tax revenue.

Source: DANE, National Drug Observatory, CEDE and independent calculations.

Variable	Average	Minimum	Maximum
Value of coca leaf/ Aggregate value (2014)	2.7%	0.0002%	35.4%
Value of coca leaf/Tax revenue (2013)	582.9%	0.16%	5692.9%
Minimum value of coca leaf/Tax revenue (2013)	416.3%	0.08%	4344.5%
Maximum value of coca leaf/Tax revenue (2013)	789.4%	0.16%	8239.7%

Table 3: Municipalities with a higher ratio of potential income from coca/tax revenue.

Source: DANE, National Drug Observatory, CEDE and independent calculations.

Department	Municipality	Estimate	Minimum	Maximum ⁶
Nariño	Barbacoas	5692,923	4344,599	8239,757
Nariño	EL Charco	4697,664	3585,06	6799,251
Nariño	Roberto Payán (San José)	3288,116	2509,352	4759,115
Norte de Santander	Sardinata	2815,878	1484,736	2815,878
Guaviare	Miraflores	2214,63	1690,113	3205,386
Norte de Santander	Convención	2162,718	1140,342	2162,718
Norte de Santander	El Tarra	1486,915	784,0099	1486,915
Putumayo	Puerto Leguísimo	1364,479	1069,456	2028,279
Nariño	Mosquera	1364,245	1041,135	1974,566
Cauca	El Tambo	1271,196	970,1235	1839,889
Norte de Santander	Teorama	1254,17	661,2899	1254,17
Nariño	Francisco Pizarro (Salahonda)	1225,96	935,6008	1774,415
Nariño	Magüi (Payán)	1084,825	827,893	1570,142
Putumayo	Valle Del Guamuez (La Hormiga)	1082,915	848,7715	1609,739
Norte de Santander	El Carmen	1068,638	563,4639	1068,638
Nariño	Olaya Herrera (Bocas de Satinga)	920,8797	702,7767	1332,852
Nariño	El Rosario	805,0065	614,3472	1165,141
Caquetá	Solano	740,0071	580,0056	1100,011
Cauca	López	688,6199	525,5258	996,6868
Norte de Santander	San Calixto	682,0627	329,6331	682,0627

On average, the value of the coca leaf is 2.7% of the aggregate value. However, variance is high and the value of the coca leaf can represent up to 35% of the aggregate value. The income derived from the coca leaf is, on average, between 4 and 7 times the tax revenue in coca-growing municipalities. Besides, there are municipalities where the income derived from coca is 40 times higher than the tax revenue.

Table 3 shows 15 municipalities for which the Value of coca leaf/Tax revenue ratio is higher. In all of them, potential income from coca is 10 times the tax revenue.

Table 4 shows the number of municipalities where the tax revenue is less than or equal than the income from coca. This number is between 45 and 49 from a total of 205 municipalities, which is to

⁶ For the “Estimate” scenario, we assume that the price of coca is the same for all the municipalities in a department, the “Minimum” scenario takes the lowest price amongst all regions and supposes that it is the price in each municipality and, finally, the “Maximum” scenario takes the highest price amongst all regions and supposes that it is the price in each municipality.

say that between 22% and 26% of coca-growing municipalities have a tax revenue that is less than or equal than the income derived from coca.

The fact that many of the municipalities in Table 3 also appear in Table 4 shouldn't come as a surprise. The tax revenue has a positive correlation with the municipal product.

Table 4: Number of municipalities with potential income from coca/ tax revenue values over 100%.

Source: DANE, National Drug Observatory, CEDE and independent calculations.

Variable	Number of municipalities
Estimated number	49
Minimum number	45
Maximum number	53
Total of coca-growing municipalities	205

Table 5: Municipalities with a higher rate of potential income from coca/aggregate value.

Source: DANE, National Drug Observatory, CEDE and independent calculations.

Department	Municipality	Aggregate value (Thousands of millions)	Coca leaf value (Thousands of millions)	Coca leaf vs. Aggregate value
Nariño	Olaya Herrera	64	22,6596	35,4
Guaviare	Miraflores	49	14,37656	29,34
Nariño	Roberto Payán	79	17,98496	22,77
Cauca	Argelia	108	20,82304	19,28
Nariño	El Charco	119	19,80384	16,64
Nariño	Santa Bárbara	38	5,77024	15,18
Amazonas	Puerto Alegría	8	1,20768	15,1
Norte de Santander	El Tarra	68	9,61092	14,13
Caquetá	Solano	70	9,155835	13,08
Cauca	López	84	10,75648	12,81
Guaviare	El Retorno	98	11,968	12,21
Cauca	El Tambo	324	39,54496	12,21
Nariño	San Andres de Tumaco	1185	140,5398	11,84
Putumayo	Puerto Caicedo	65	7,54689	11,61
Caquetá	La Montañita	86	9,632025	11,2
Putumayo	Leguízamo	86	9,20634	10,71
Nariño	Barbacoas	204	20,8544	10,22
Cauca	Piamonte	93	9,43936	10,15
Nariño	Magüi	92	9,18848	9,99
Norte de Santander	Tibú	361	35,60436	9,86

Finally, Table 5 shows the municipalities for which the Value of coca leaf/Aggregate value ratio is higher. The potential income derived from growing coca represents more than 10% of the aggregate value in almost all of these municipalities and is higher than 20% in three of them.

These numbers draw attention on the limited possibilities for substitution in the aforementioned municipalities.

Municipalities in which a higher proportion of the income comes from coca leaf instead of “municipal income” can be seen in Map 3. Panel A shows these municipalities ordered by *coca leaf value/aggregate value* ratio and Panel B shows them ordered by *coca leaf value/tax revenue* ratio.

Moreover, the map shows that the regions where there is a higher opportunity cost for illicit crops are also regions where crops have increased and where armed groups are present: Catatumbo, southern Pacífico and Putumayo-Caquetá-Guaviare. Even though there is no total coincidence in municipalities, the regions are indeed the same.

Map 3: Municipalities with a higher income from coca/aggregate value and tax revenue ratio.

Source: DANE, National Drug Observatory, CEDE and independent calculations.

Panel A: Aggregate value.

-

Panel B: Tax revenue.

In short, the spending capacity of municipal governments is very small when compared to the income derived from coca. This fact reduces the real power legitimate authorities have and makes

it more difficult to implement substitution plans. Likewise, the ratio between aggregate value and the income from coca per state imply that eradicating coca entirely would cause an important decrease in the income of the communities in several of these municipalities.

Institutional development.

There is a line of research that seeks to identify the deep determining factors for development. Even though there is plenty of current debate on the subject, the institutionalist explanation is widely accepted. North (1990) defines institutions as the rules of gameplay in a society and points out that institutions give structure to the system of incentives in the exchange between humans, whether it is economic, social or political.

Some authors have proved that the existence of distributive conflicts (the absence of an institutions accepted by all members of a society) has profound implications on economic growth. Other academics have focused on the perfection and penetration of markets and their effect on the assignation of productive factors.

Along these lines, when exploring options for economic development and crop substitution, it is useful to analyse the indicators of institutional development for the cultivating municipalities.

The Open Government Index (IGA) is a transparency indicator devised by the Office of the Inspector General of Colombia that seeks to express, in a number, the good practices surrounding the handling of information in local governments. The IGA focuses on three areas: organization of the information, exposition of the information and discussion of the information. The first component refers to the fulfillment of internal rules for information control and to the proper handling and organization of the documents produced. The second component reflects the visibility and transparency of the contracting process, the management competences of territories and the quality of the administrative and financial information systems. Finally, discussion of the information refers to the means of circulation and socialization of the information that help towards democratizing the operation. The IGA, being a combination of these three components, takes values between 0 and 100, where a score closer to 100 means that the municipality has better transparency and information handling practices.

Table 6 shows an exercise in median differences of IGA scores in 2014, which shows that municipalities where coca crops are present have, on average, an IGA score 2.4 points lower than municipalities where there are no illicit crops. This difference is statistically significant.

In addition, Map 4 shows how the IGA is distributed across the national territory. Some of the areas with high presence of illicit crops have a low IGA, i.e., several municipalities on the southwest of the country that belong to the Putumayo, Nariño and Caquetá departments.

Table 6: IGA t-Test between municipalities with and without coca crops.

Source: Office of the Inspector General of Colombia and National Drug Observatory.

IGA	Median
Municipalities with coca crops	67.5361
Municipalities without coca crops	69.97309
Difference	-2.436983
p-value	0.0019

Map 4: Open Government Index (IGA)

Office of the Inspector General of Colombia

Access to electricity.

Electricity is a fundamental service for the welfare of individuals and an essential production factor for production in several activities. Many empirical works have found causal relations between economic growth and access to electricity. Karanfil and Li (2014) present a complete review of these findings.

Because of this, both the welfare of communities and their development possibilities are tied to the access to electricity and, thus, a geographical characterization of the national electric system coverage is convenient. Map 5 shows such a characterization.

There are two categories in the Colombian electrical sector for describing the status of connectivity in the country's regions. These are the National Interconnected System (SIN, shown in dark green) and the Non-Interconnected Zones (shown in light green).

Map 5: Municipalities not connected to the National Interconnected System.

Source: Colombian Electrical Information System.

Table 7: Percentage of users connected to the SIN.

Source: Colombian Electrical Information System, National Drug Observatory and independent calculations.

SIN	Median
Municipalities with coca crops	.626214
Municipalities without coca crops	.965065
Difference	-.33885
p-value	0.0000

Tertiary roads per one thousand inhabitants.

According to the National Road Network, tertiary roads are those that link municipal seats with their villages or link villages with each other. These roads are of vital importance in agricultural economies since they are the simplest way of transporting products to markets by truck and these roads are the ones that connect producers with their markets.

The data on kilometers of tertiary roads per municipality is available and, in order to make a proper comparison between coca-growing and non-coca-growing municipalities, they're weighted by the municipality's population so the calculation of kilometers per 1000 inhabitants is obtained. Table 9 shows that municipalities with coca crops have, on average, 4km less tertiary roads per 1000 inhabitants than those without. These results are significant to the 1%.

Map 6 shows that in the central and eastern part of the country there is a higher amount of tertiary roads per 1000 inhabitants than in the other regions. In most coca-growing zones, i.e., Nariño, Putumayo and Catatumbo, there are few tertiary roads per 1000 inhabitants. Some municipalities in Caquetá and Vichada, in the east, where there are more tertiary roads than the previously mentioned regions but also have coca crops are worthy of note.

Table 8: t-Trial of tertiary roads between municipalities with and without coca crops.

Source: Ministry of Transport, National Drug Observatory and independent calculations.

Tertiary roads	Median
Municipalities with coca crops	7.9188
Municipalities without coca crops	12.1149
Difference	-4.196
p-value	0.0000

In short, coca-growing municipalities have a much lower development level than the rest of municipalities in the country. Income level, spending capacity of municipal governments,

institutional development and public infrastructure are some of the dimensions where differences are significant. The issue of development is related to a lack of effective power of legitimate authorities and makes it difficult to implement substitution plans.

A series of questions arises in these circumstances: Should the emphasis of policy be on the crops or on development? Is it possible to bring roads and connection to the SIN to all the coca-growing municipalities? Is it efficient from an economic standpoint?

Map 6: Tertiary roads in municipalities.

Source: Ministry of Transport.

Tertiary roads per 1000 inhabitants

VII. What is happening with consumption in the U.S?

Several media outlets have recently echoed a hypothesis according to which there has been a strong increase in cocaine consumption in the U.S. due, fundamentally, to the increase of supply derived from crops in Colombia. This explanation is based on three hypotheses: (i) the increase in the cultivated area in Colombia has caused a significant increase in the supply of cocaine in the U.S., (ii) the increased supply has caused a drop in prices and (iii) the drop in prices caused an increase in consumption.

Does cocaine consumption in the U.S. depend on coca crops?

Three hypotheses would need to be proved for verifying if this argument is true. Limited information makes this, however, a hard task. That said, it is possible to perform Granger causality tests with the available information in order to verify if the increase in illicit crops causes, in Granger's sense, an increase in cocaine consumption in the U.S.

These causality tests are in the annex to this document. The tests show that: (i) changes in illicit crops in Colombia cause no changes in the consumption of cocaine in the U.S.; (ii) changes in illicit crops in South America cause no changes in the consumption of cocaine in the U.S. The results show that the increase in the cultivated area has no effect on the prevalence of either month or year. These results, however, must be interpreted with caution since only twelve observations were available for establishing statistical causality.

Because of this, it is convenient to make a qualitative analysis of the main argument.

Is there a generalized increase in consumption?

One of the sources quoted in support of this hypothesis is the National Institute on Drug Abuse. The following tables were taken from its website. Table 9 shows the prevalence of consumption in students and Table 10 shows the prevalence of consumption in different age groups. The numbers between brackets show statistically significant differences between one year and another. The numbers in red stand for decreases in prevalence and the numbers in purple for increases in prevalence.

Table 9: Prevalence of cocaine consumption in students.

Source: National Institute on Drug Abuse.

Drug	Time Period	8th Graders				10th Graders				12th Graders			
		2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Cocaine	Lifetime	1.70	1.80	1.60	1.40	3.30	2.60	2.70	2.10	4.50	4.60	4.00	3.70
	Past Year	1.00	1.00	0.90	0.80	1.90	1.50	1.80	1.30	2.60	2.60	2.50	2.30
	Past Month	0.50	0.50	0.50	0.30	0.80	0.60	0.80	0.40	1.10	1.00	1.10	0.90
Crack Cocaine	Lifetime	1.20	1.20	1.00	0.90	1.50	[1.00]	1.10	0.80	1.80	1.80	1.70	1.40
	Past Year	0.60	0.70	0.50	0.50	0.80	[0.50]	0.70	[0.40]	1.10	1.10	1.10	0.80
	Past Month	0.30	0.30	0.30	0.20	0.40	0.30	0.30	0.20	0.60	0.70	0.60	0.50

Table 10: Prevalence of cocaine consumption in different age groups.

Source: National Institute on Drug Abuse.

Drug	Time Period	Ages 12 or Older			Ages 12 to 17			Ages 18 to 25			Ages 26 or Older		
		2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Cocaine	Lifetime	14.30	14.80	14.50	0.90	0.90	0.80	11.60	11.10	11.70	16.50	17.10	16.60
	Past Year	1.60	1.70	1.80	[0.50]	0.70	0.60	4.40	4.60	5.40	1.20	1.40	1.30
	Past Month	0.60	0.60	0.70	0.20	0.20	0.20	1.10	1.40	1.70	0.50	0.50	0.60
Crack Cocaine	Lifetime	3.40	3.60	3.40	0.10	0.10	0.10	1.60	1.60	1.50	4.10	4.30	4.10
	Past Year	[0.20]	0.30	0.30	0.00	0.10	0.00	0.30	0.40	0.30	0.30	0.30	0.30
	Past Month	0.10	0.10	0.10	0.00	0.00	0.00	0.10	0.10	0.10	0.20	0.20	0.20
	Past Month	0.50	0.60	0.60	0.30	[0.70]	0.50	1.30	1.20	2.20	0.40	0.50	0.40

The following observations can be derived from these tables: (i) no high-school group has had statistically significant prevalence increases. (ii) No age group has had statistically significant prevalence increases. (iii) The number of individuals that affirms having consumed cocaine at least once in their life increased for the age group between 18 and 25 yet decreased for all the other groups. Despite this, the change isn't statistically significant in any of the cases. (iv) The number of individuals that affirms having consumed cocaine at least once in the last year increased for the age group between 18 and 25 yet decreased for all the other groups. Despite this, the change isn't statistically significant in any of the cases. (v) The number of individuals that affirms having consumed cocaine at least once in the last month increased for all groups with the exception of the age group between 12 and 17; however, the change isn't statistically significant in any of the cases.

It can be seen on the same page that the consumption for high-school student decreases between 2006 and 2011 and does not present any statistically significant variations since then.

Map 5: States with a statistically significant increase in cocaine consumption.

Source: National Institute on Drug Abuse.

The other information source on the consumption of cocaine in the U.S. is the National Survey on Drug Use and Health. According to this survey, there is a statistically significant increase in the rates of cocaine consumption. However, results vary between states. As is evident in Map 5, most states have not had a statistically significant increase in consumption.

Besides, according to surveys from this same agency, the use of illicit drugs in 2015 was boosted mainly by the use of marihuana and the abuse of prescription drugs. The use of cocaine in 2015 was similar to that in most states between 2007 and 2013 but greater than in 2014. The estimate for crack usage in 2015 is similar to the estimates for most years between 2008 and 2014. Finally, the increase in consumption is owed almost in its entirety to the youths between 18 and 25 years.

In short, there has been an increase in consumption of illicit substances in the U.S but there has been no increase in the generalized consumption of cocaine. There has been, however, an increase in certain regions and in certain age groups. In these circumstances, it is difficult to establish a clear causal relation between the recent evolution of illicit crops in Colombia and the increase of cocaine consumption in the U.S.

Particularly, if the increase in supply is the cause for an increase in consumption, a decrease in prices across all of the U.S. should be noticeable, especially in states that are an entry route such as California and Florida. How can we explain that consumption has not increased in these states but has increased in Alaska, Montana and Maine? How can we explain that there has not been any increase in cocaine consumption for high-school students but in youths between 18 and 25?

On what does cocaine consumption depend?

The first step for answering these questions is probably to check the empirical evidence on the determining factors of drug consumption. Despite the complexity of the issue, there is evidence that allows pinpointing groups with a high risk of consumption: homeless people, prostitutes, child and teenager school drop-outs, delinquent youths, children from families with parents or older brothers that abuse substances and youths with depressive conduct disorder (Lloyd, 1998). This evidence implies that it is useful to analyze the evolution of these age groups in order to explain the recent increased levels of consumption and analyzing if they have increased in the same states where drug consumption has increased as well.⁷

On the other hand, the lifestyle of parents and the relationship between them and their children seem to have an influence in the likeliness of consumption. Once teenagers begin using drugs, attempts by their parents to stop them from consuming drugs are ineffective.

Socioeconomic status is also relevant. Bushmueller and Zuvekas (1998) made an interesting study that determined that income has a positive effect on regular but moderate drug use. However, income level has a negative effect on the consumption of heavy drugs: People with lower income consume drugs more frequently. Finally, Gill and Michaels (1991) suggest that there is a strong relation between occupation type and drug consumption.

In short, empirical evidence suggests the need for analyzing the information concerning socioeconomic conditions in order to identify the causes of changes in consumption patterns.

⁷ Literature on drug addiction also points out that it's important to distinguish between drug consumption and drug abuse (Spooner, 1999). Those who use drugs do not necessarily become regular users and, in turn, regular users not necessarily become addicts (Gorusch, 1980). Thus, causes for each stage of drug use can be different.

VIII. Conclusions.

There has been a shift in the national drug policy and its main instruments since the second five-year period of the 21st century. Given that the participation of the coca leaf's value in the drug-trafficking business is very small, efforts from authorities have focused on other links in the value chain. Specifically, interdiction has become the main instrument in the fight against narcotic-trafficking gangs.

Despite the technological versatility and the reaction capacities of cocaine transport, national authorities have managed to hit criminal organizations hard. Thus, around 300 metric tons of cocaine were seized in 2016, close to 46% of the potential production value for 2015. This fact can be explained mostly due to an international cooperation effort and a strategy based on research.

From the perspective of the national drug policy's new emphasis, the all-time record in seizures is a resounding success. However, the metric by which media outlets and several analysts assess the success of the policy is stuck in the past. First, because it usually presupposes that seizure technology is constant and that there has not been any increase in efficiency or resources involved in this task and, second, because the usual indicator is still the cultivated area. Any policy implication grounded in a diagnosis based on these fallacies will lead to regrettable mistakes.

An indicator that reflects the evolution of the final goal of the policy against drugs is required due to the aforementioned reasons.

These thoughts also shed light on the hypothesis according to which the increase in crops is causing an increase in consumption. If the increase in the cultivated area isn't reflected in an increase in cocaine supply, or if there had been an increase in cocaine supply and it wasn't reflected in a drop in prices, it is impossible to relate the changes in crops with the changes in consumption. This argument, coupled with the available evidence regarding the behavior of consumption, casts serious doubts on the validity of the aforementioned hypothesis.

On the other hand, it's undeniable that the increase in coca crops creates risks associated with the implementation of the Havana agreements. A full implementation of the agreements in regards to illicit crops can eliminate the incentives for growing coca and promote development in the communities that are involved in this activity. However, the value of the drug-trafficking business

and the presence of various violent groups in the areas with crops pose a risk for the implementation of the agreements and, in this sense, for achieving a lasting peace. Following this train of thought, the great public order challenge is to protect the communities that become involved in substitution programs and to keep the violent groups away from coca-growing zones.

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Annex: Granger causality tests.

Hectares in Colombia and consumption in the U.S for the last year. With 1 lag:

Variables	(1) Change in crops in Colombia (t)	(2) Change in consumers for last year (t)
Change in crops in Colombia (t-1)	0.214 (0.323)	0.014 (0.010)
Change in consumers for last year (t-1)	16.389 (9.302)	-0.261 (0.299)
Constant	-3,241.493 (4,348.678)	80.106 (139.955)
Observations	12	12

Standard errors in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in Colombia	Change in consumers for last year	3.1	0.11
Change in consumers for last year	Change in crops in Colombia	1.89	0.20

The hypothesis of there not being any Granger causality is not rejected.

Hectares in Colombia and consumption in the U.S for the last year. With 3 lags:

Variables	(1) Change in crops in Colombia (t)	(2) Change in consumers for last year (t)
Change in crops in Colombia (t-1)	-1.048 (0.861)	0.013 (0.037)
Change in crops in Colombia (t-2)	-1.658 (1.113)	-0.004 (0.048)
Change in crops in Colombia (t-3)	-0.722 (0.655)	-0.013 (0.028)
Change in consumers for last year (t-1)	27.246 (13.288)	-0.305 (0.578)
Change in consumers for last year (t-2)	32.210 (21.108)	-0.046 (0.918)
Change in consumers for last year (t-3)	37.201 (27.734)	-0.118 (1.206)
Constant	-2,760.876 (7,346.551)	198.031 (319.448)
Observations	10	10

Standard errors in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in Colombia	Change in consumers for last year	1.65	0.34
Change in consumers for last year	Change in crops in Colombia	0.34	0.78

The hypothesis of there not being any Granger causality is not rejected.

Hectares in Colombia and consumption for the last month. With 1 delay:

Variables	(1) Change in crops in Colombia (t)	(2) Change in consumers for last month (t)
Change in crops in Colombia (t-1)	0.206 (0.377)	0.008 (0.006)
Change in consumers for last month (t-1)	9.403 (21.465)	-0.022 (0.322)
Constant	-1,762.657 (4,945.248)	13.183 (74.079)
Observations	12	12

Standard errors in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in Colombia	Change in consumers for last month	0.19	0.67
Change in consumers for last month	Change in crops in Colombia	1.9	0.20

The hypothesis of there not being any Granger causality is not rejected.

Hectares in Colombia and consumption in the U.S for the last month. With 3 lags:

Variables	(1) Change in crops in Colombia (t)	(2) Change in consumers for last month (t)
Change in crops in Colombia (t-1)	0.196 (1.320)	0.024 (0.013)
Change in crops in Colombia (t-2)	0.042 (0.969)	0.005 (0.010)
Change in crops in Colombia (t-3)	-0.320 (0.831)	-0.002 (0.008)
Change in consumers for last month (t-1)	11.403 (38.413)	0.342 (0.379)
Change in consumers for last month (t-2)	42.738 (36.335)	-0.557 (0.358)
Change in consumers for last month (t-3)	-13.493 (64.206)	-0.887 (0.633)
Constant	-2,866.595 (9,824.478)	73.652 (96.897)
Observations	10	10

Standard errors in parenthesis
 *** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in Colombia	Change in consumers for last month	0.86	0.54
Change in consumers for last month	Change in crops in Colombia	2.05	0.28

The hypothesis of there not being any Granger causality is not rejected.

Hectares in South America and consumption for the last year. With 1 lag:

Variables	(1) Total change in crops (t)	(2) Change in consumers for last year (t)
Total change in crops (t-1)	0.114 (0.327)	0.005 (0.012)
Change in consumers for last year (t-1)	13.937 (9.166)	-0.273 (0.329)
Constant	-2,187.572 (4,334.400)	105.394 (155.527)
Observations	12	12

Standard errors in parenthesis
 *** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in South America	Change in consumers for last year	2.31	0.16
Change in consumers for last year	Change in crops in South America	0.14	0.78

The hypothesis of there not being any Granger causality is not rejected.

Hectares in South America and consumption for the last year. With 3 lags:

Variables	(1) Change in crops (t)	(2) Change in consumers for last year (t)
Total change in crops (t-1)	-0.289 (0.584)	-0.005 (0.023)
Total change in crops (t-2)	-0.665 (0.593)	-0.015 (0.023)
Total change in crops (t-3)	-0.006 (0.513)	-0.019 (0.020)
Change in consumers for last year (t-1)	13.929 (13.446)	-0.368 (0.527)
Change in consumers for last year (t-2)	13.212 (16.035)	0.112 (0.628)
Change in consumers for last year (t-3)	19.848 (18.163)	0.128 (0.712)
Constant	-3,049.238 (7,696.530)	211.764 (301.512)
Observations	10	10

Standard errors in parenthesis
 *** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in South America	Change in consumers for last year	0.89	0.53
Change in consumers for last year	Change in crops in South America	0.43	0.74

The hypothesis of there not being any Granger causality is not rejected.

Hectares in South America and consumption for the last month. With 1 lag:

Variables	(1) Total change in crops (t)	(2) Change in consumers for last month (t)
Total change in crops (t-1)	0.148 (0.398)	0.007 (0.007)
Change in consumers for last month (t-1)	12.664 (22.029)	0.061 (0.365)
Constant	-1,251.292 (4,829.584)	7.510 (79.977)
Observations	12	12

Standard errors in parenthesis
 *** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in South America	Change in consumers for last month	0.33	0.57
Change in consumers for last month	Change in crops in South America	1.12	0.31

The hypothesis of there not being any Granger causality is not rejected.

Hectares in South America and consumption for the last month. With 3 lags:

Variables	(1) Change in crops (t)	(2) Change in consumers for last month (t)
Total change in crops (t-1)	-0.145 (0.928)	0.001 (0.010)
Total change in crops (t-2)	-0.176 (0.653)	-0.010 (0.007)
Total change in crops (t-3)	-0.285 (0.728)	-0.010 (0.008)
Change in consumers for last month (t-1)	1.213 (40.148)	0.014 (0.435)
Change in consumers for last month (t-2)	39.631 (33.285)	-0.342 (0.361)
Change in consumers for last month (t-3)	6.311 (47.762)	-0.025 (0.518)
Constant	-847.017 (8,759.993)	146.328 (94.945)
Observations	10	10

Standard errors in parenthesis
 *** p<0.01, ** p<0.05, * p<0.1

Granger causality Test:

Dependent variable	Independent variable	F	p-value
Change in crops in South America	Change in consumers for last month	0.50	0.70
Change in consumers for last month	Change in crops in South America	1.48	0.37

The hypothesis of there not being any Granger causality is not rejected.