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# Measuring agricultural GDP performance: a technical note

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## Summary:

Agricultural product and input prices have been on a rollercoaster for the last three years, impacting not only market incentives for production worldwide, but also access to food for consumers, especially those in low income brackets in developing countries. Both of these impacts have been studied by international institutions, which have analyzed price transmission and generated food security indicators. However, there is another important aspect that needs to be analyzed, the impact of this price variability on agricultural incomes, which is addressed in this technical note. It is shown how, with very simple calculations and using current national accounts, it is possible to obtain indicators of change in the income of the factors of production in agriculture by making adjustments in production volumes and in real agricultural prices. This can be very useful in designing policies, but further analysis is required of how agricultural performance, income generation and poverty alleviation are linked (Valdes *et al.* 2008).

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## Introduction

Agricultural product and input prices have been highly volatile for the last three years. A number of studies have been published on this topic. (Dutoit *et al*; Von Cramon-Taubadel *et al.* 2009; ECLAC 2009; FAO 2008, IFPRI 2008; IICA 2008) However, there is another important aspect not often analyzed in the technical literature: the impact of this price variability on agricultural income.

There is a generally accepted notion that countries that are net exporters of agricultural products will be winners and that countries that are net importers of such products will be losers as a result of rising prices for agricultural goods on the international market. This is related mostly to the implicit evolution of the external terms of trade and its effect on real gross domestic income (GDI). A country's status as a net exporter or net importer of agricultural products does not determine the possible impact on incomes in their agricultural sectors. This effect depends mostly on the degree to which international agricultural product and input prices are transmitted to domestic prices, on how the agricultural sector reacts and on the evolution of other prices in the economy with respect to agricultural prices (intersectoral terms of trade).

The reaction of the agricultural sector is normally defined as the growth of the Agricultural Gross Domestic Product



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(AGDP), in real terms or at constant prices, which is an important indicator of growth in the volume of production. However, it is just as important to analyze agricultural performance in terms of income generation, especially in times of great variability in the prices that have an impact on the value of the sale of products and on the cost of inputs.

With very simple adjustments, and using current national accounts, it is possible to obtain indicators of change in the income of the factors of production in agriculture by making adjustments in volumes of production volumes and in real agricultural prices. However, further analysis is required of how agricultural performance, income generation and poverty alleviation are linked. (Valdes *et al.* 2008)

## Real Gross Domestic Income and Terms of Trade

At the national aggregate level, there is a clear distinction between the real GDP (at market prices in constant terms) and the real (GDI). GDP at market prices in constant terms is essentially a measurement of

production volume, calculated each year for the economy as a whole, which uses the constant value of market prices in the base year. The concept of GDI goes further and attempts to measure the total real income residents derive from domestic production. The GDI represents the total buying power generated in the economy during the process of production. To arrive at GDI, it is necessary to add the external terms of trade effect to GDP.

When the external terms of trade of a country improve (the prices it receives for its exports grow more, relatively, than those paid for imports), it means that a given volume of its exports can cover a bigger portion of its imports.

“An improvement in the (external) terms of trade makes it possible for residents to acquire greater volume of goods and services out of the income generated by a given level of domestic production.” (Valdes *et al.* 2008)

An example will help to illustrate the importance of and relationship between these two indicators. Costa Rica and Peru both showed similar annual average growth in GDP (5.4%) from 2000-2007. However, during the same period, average growth in GDI in Peru (7.2%) was 1.8 percentage points higher than growth in GDP. In contrast, growth in GDI in Costa Rica (4.0%) was 1.4 percentage points lower than growth in GDP. The difference was due to a very positive evolution of the external terms of trade in Peru, and negative evolution of same in Costa Rica.

### Income of production factors of agriculture and Intersectoral Terms of Trade

La misma lógica aplicada a toda la economía se puede aplicar a nivel sectorial, especialmente en el caso de la agricultura, la cual constituye la fuente The same

**Table 1. Relationship between GDP and GDI in Costa Rica and Peru, millions of US dollars.**

		2000	2001	2002	2003	2004	2005	2006	2007	Average Annual Growth 00-07
Costa Rica	GDP, at constant prices 2000=100	15 947	16 188	16 586	17 648	18 400	19 485	21 202	22 756	5.4%
	GDI (GDP adjusted to terms of trade)	15 947	16 009	16 359	17 153	17 713	18 341	19 623	20 990	4.0%
	GDP annual growth %		1.1%	2.9%	6.4%	4.3%	5.9%	5.8%	7.3%	
	GDI annual growth %		0.4%	2.2%	4.9%	3.3%	3.5%	7.0%	7.0%	
	External Terms of Trade (PX/PM)	100	98.2	96.7	94.1	92.2	88.6	85.7	85.0	-2.5%
Peru	GDP, at constant prices 2000=100	53 336	53 450	56 133	58 397	61 382	65 522	70 473	76 732	5.4%
	GDI (GDP adjusted to terms of trade)	53 336	53 225	56 015	58 686	63 155	68 464	77 647	84 883	7.2%
	GDP annual growth %		0.2%	5.0%	4.0%	5.1%	6.7%	7.6%	8.9%	
	GDI annual growth %		-0.2%	5.2%	4.8%	7.6%	8.4%	13.4%	9.3%	
	External Terms of Trade (PX/PM)	100	96.9	98.6	102.8	115.2	120.6	148.4	152	7.1%

Source: Authors, based on data from World Bank (WDI).



rationale applied to the economy as a whole can be applied at the sectoral level, especially in the case of agriculture, which is the main source of income for the poorest quintiles of the population in developing countries. In many cases, “real” agricultural GDP has been used as if it were an indicator of the level of well-being of agricultural families, even though it only represents the amount of net production (discounting all inputs) valued at the prices of a certain base year.



Therefore, because real AGDP is calculated at “constant prices,” changes from one year to the next in same only reflect changes in the “volume” of agricultural production and do not take into account changes in relative agricultural prices, which often have a greater impact on agricultural incomes. It is not uncommon in agriculture for increases in production levels to lead to decreases in the income of producers, inasmuch as agricultural prices also fall due to oversupply or other factors.

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This is part of the very nature of a sector in which supply is inelastic, and even more so in the short term. “Good” agricultural performance, from the point of view of the domestic supply of products, often leads to “unhappy farmers” who see their incomes decline as a result of lower prices. To consider only the AGDP paints a very limited picture of what is happening in the sector. It is necessary to adjust the real AGDP, taking into account the evolution of relative agricultural prices domestically (agricultural terms of trade - ATT), in order to obtain an indicator of the purchasing power generated by the volume of agricultural production achieved during the period<sup>4</sup>.

4 ATT can be defined as the ratio of an agricultural price index with respect to a non-agricultural price index. In this case, the “implicit” index of prices from the national accounts statistics is being used. Also, the agricultural GDP deflator is measured with the total GDP deflator, and not only with respect to prices of non-agricultural products.



*The concept of ANVA<sub>fc</sub> measures “the remuneration of all factors of production (land, capital and labor) and can be termed factor income, as it represents all the value generated by a unit engaged in a production activity.” EUROSTAT (1997)*

In order to adjust real AGDP to take into account the effect of the agricultural terms of trade, it is necessary to solve the following equation:

$$1) \text{ AGDP adjusted to the ATT} = \text{Real AGDP} \times \text{ATT}$$

But,

$$2) \text{ Real AGDP} = \frac{\text{Nominal AGDP}}{\text{AGDP deflator}}$$

and,

$$3) \text{ ATT} = \frac{\text{AGDP deflator}}{\text{GDP deflator}}$$

then, using equations (2) and (3):

$$4) \text{ AGDP adjusted to the ATT} = \frac{\text{Nominal AGDP}}{\text{GDP deflator}}$$

According to equation (4), to adjust “real” AGDP to the index of agricultural terms of trade is equivalent to dividing (deflating) the “nominal” or “current” AGDP by the GDP deflator. The “nominal” AGDP is equal to the gross value added of agriculture, which is the amount of agricultural production valued at basic prices, minus the amount of intermediate inputs valued at market prices, during the current period. This concept is commonly found in international data bases of national account statistics under the name “agricultural gross value added at

basic prices” (AGVA<sub>bp</sub>). It includes the returns on factors of production used in agriculture during a given period, but also includes the consumption of fixed capital (depreciation) during the period and the net amount of *taxes on production* (taxes minus subsidies)<sup>5</sup>.

In order to arrive at a true measurement of agricultural “factor income,” it will be necessary to subtract from AGVA<sub>bp</sub> the amounts corresponding to fixed capital consumption and net taxes on production to obtain the “agricultural net value added at factor cost” (ANVA<sub>fc</sub>), as indicated below:

$$\text{ANVA}_{fc} = \text{AGVA}_{bp} - D - T + S$$

Where,

D = Consumption of fixed capital in agriculture (Depreciation)

T = Taxes on agricultural production

S = Subsidies on agricultural production

The concept of ANVA<sub>fc</sub> measures “the remuneration of all factors of production (land, capital and labor) and can be termed factor income, as it represents all

5 The concept of “agricultural gross value added at basic prices” (AGVA<sub>bp</sub>) already excludes net taxes minus subsidies on products, which refers to taxes or subsidies on goods and services (excluding value added tax and import and export taxes) that become payable as a result of the production, sale, transfer, lease or delivery of those goods or services, or as a result of their use for personal consumption or personal capital formation. These taxes must be differentiated from taxes or subsidies *on production*, which mainly consist of current taxes or subsidies on the labor or capital used in production. (OECD n.d.)

the value generated by a unit engaged in a production activity” EUROSTAT (1997)<sup>6</sup>. This measurement refers to the income generated by agricultural activities during a given fiscal year, even though the part related to the corresponding earnings could be postponed.

Factor Income is the sum of “employee compensation” (salaries and other labor costs) and “net operating surplus” (profits, leases on land, net interest, self-employment income, etc.). This definition does not take into account the residence or location of the owners of the factors of production. Also, factor income should not be confused with farmers’ household income, which includes other sources of income (non-agricultural activities, rent, income transfers) in addition to income from agricultural activities.

Although  $ANVA_{fc}$  is not always available in the national account statistics of many developing economies<sup>7</sup>, the nominal AGDP (or AGVAbp) could be used as a good “approximate value” if capital consumption is relatively low with respect to the value of production, and if the amount of taxes and subsidies on production are also low, as they usually are in developing economies. This rate of change could be a good estimator of the rate of change in the factor income<sup>8</sup>.

In order to use changes in the nominal AGVAbp as an approximate value of the changes in the “factor income” of agriculture, another step is involved to convert the nominal data to “real” figures, taking into account the evolution of relative agricultural prices. As indicated in equation (3), the nominal agricultural

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6 See Chapter IV Agricultural Income Indicators in EUROSTAT (1997).

7 The concept of  $ANVA_{fc}$  is not explicitly included in the System of National Accounts of the United Nations.

8 As an example, during 2000-07, in Peru, the percentage of fixed capital depreciation with respect to the value added of the agricultural sector was consistently below 2.5%, and the percentage of taxes, minus subsidies, was nil. In Costa Rica, the percentage of depreciation stayed within a narrow range (8.5% -10.0%) and taxes, minus subsidies, between 2.8% -3.0%. As a result, there was a strong correlation (0.99) between the growth rates of Agricultural GDP and the  $ANVA_{fc}$ .

GDP must be divided by the GDP deflator, which is a measurement of change in the prices of all domestically produced final goods and services in an economy. This adjustment provides a clearer picture

of the growth of the “factor income” of agriculture in real terms.

As an example, Table 2 shows three different cases of interaction among the

**Table 2. Interaction between real AGDP and intersectoral terms of trade, and their impact on agricultural factor income in Costa Rica, Peru and Jamaica.**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average Annual Growth 00-05	Average Annual Growth 05-08
<b>Costa Rica</b>											
Agric. GDP, at constant prices (2000=100)	423 053	428 949	414 948	445574	448806	467894	526188	563668	561502	2.1%	6.4%
Real Agric. Factor Income (adjusted Agric. GDP)	423 053	395 116	394 439	441721	441721	475249	527303	545976	526336	2.9%	3.5%
Agric. GDP Growth %		1.4%	-3.3%	0.7%	0.7%	4.3%	12.5%	7.1%	-0.4%		
Real Agric. Factor Income Growth %		-6.6%	-0.2%	2.6%	2.6%	7.3%	11.0%	3.5%	-3.6%		
Intersectoral terms of trade (P. agric / P. overall)	100	92.1	95.1	98.6	98.6	101.6	100,2	96.9	93.7	0.9%	-2.7%
Change in intersectoral terms of trade		-7.9%	3.2%	1.9%	1.9%	3.0%	-1.3%	-3.0%	3.2%		
<b>Peru</b>											
Agric. GDP at constant prices (2000=100)	12 775	12 855	13 639	14 045	14 076	14 746	15 830	16 340		3.0%	5.3%
Real Agric. Factor Income (adjusted Agric. GDP)	12 775	12 685	12 430	12 863	12 840	13 007	13 491	14 547		0.5%	5.8%
Agric. GDP Growth %		0.6%	6.1%	3.0%	0.2%	4.8%	7.4%	3.3%			
Real Agric. Factor Income Growth %		-0.7%	-2.0%	3.5%	-0.2%	1.3%	3.7%	4.4%			
Intersectoral terms of trade (P. agric / P. overall)	100	98.7	91.1	91.6	91,2	88.2	85.2	89.0		-2.4%	0.5%
Change in intersectoral terms of trade		-1.3%	-7.6%	0.5%	-0.4%	-3.3%	-3.4%	1.1%			
<b>Jamaica</b>											
Agric. GDP at constant prices (2000=100)	21 206	22 552	20 971	21 984	20 075	18 626	21 588	21 157		-2.7%	6.6%
Real Agric. Factor Income (adjusted Agric. GDP)	21 206	21 096	19 241	18 288	18 670	19 615	20 567	20 855		-2.3%	3.1%
Agric. GDP Growth %		6.3%	-7.0%	4.8%	-8.7%	-7.2%	15.9%	-2.0%			
Real Agric. Factor Income %		-0.5%	-8.8%	-5.0%	2.1%	5.1%	4.9%	1.4%			
Intersectoral terms of trade (P. agric / P. overall)	100	93.5	91.7	83.2	93	105.3	95.3	98.6		0.4%	-3.3%
Change in intersectoral terms of trade		-6.5%	-1.9%	-9.3%	11.8%	13.2%	-9.5%	3.5%			

Source: Authors, based on World Bank (WDI).



evolution of the volume of agricultural production (“real” AGDP), the evolution of domestic relative agricultural prices (intersectoral terms of trade), and the impact of both on the factor income of agriculture. These cases refer to Costa Rica, Peru and Jamaica during the period 2000 to 2007 (except for Costa Rica, which includes data for 2008). The time series have been divided into two sub-periods 2000-05 and 2005-07 (or 2008 in the case of Costa Rica), to show the change in domestic price trends and its relation to changes in international prices.

Note that, on average, from 2000-05, growth of “real” AGDP was greater in Peru (3.0%) than in Costa Rica (2.1%). However, the fact that relative agricultural prices (agricultural terms of trade) in their domestic markets evolved differently, the result in terms of agricultural factor income was reversed. Costa Rica grew at 2.9% a year, while Peru grew by only 0.5% a year during the period 2000-05. In Jamaica, the negative trend of real AGDP (-2.7%) was attenuated by a slight increase in agricultural terms of trade, and the impact on factor income was -2.3%.

During 2005-07, average growth in real AGDP was strong in all three countries (more than 5.3% yearly), but the trend in relative agricultural prices was negative in Costa Rica (-2.7%) and Jamaica (-3.3%), and slightly positive in Peru (0.5%). These results attenuated the effect on income in the first two countries and increased the quantitative effect on agricultural growth in Peru.

## Conclusions

- Growth of Agricultural GDP, as it is normally published, is an important economic indicator used to measure progress in or the rate of expansion of the agricultural sector’s capacity to produce and supply finished products for consumption and intermediate use. However, it is just as important to look at the income generated by growth of agricultural GDP (measurement of “income”), as an indication of future consumption possibilities for agricultural households and as a means of improving their standard of living. As a result, it is necessary to link the evolution of “real” agriculture and market prices to their impact on the incomes and poverty of those who depend primarily on the agricultural sector.
- There is an urgent need to incorporate the analysis of prices more effectively into the analysis of agricultural policies, which must be based mostly on an appraisal of physical dimensions such as real GDP, production, yields, area under cultivation, etc. National account statistics are a good source of processed data for conducting a sectoral analysis, because the information on those accounts is usually provided by the ministries themselves.





- By making very simple adjustments, it is possible to make better use of agricultural national accounts, which can have important implications for policy design. There is much to gain from closer interaction between the statistical offices of the agricultural sector and those institutions responsible for social or national accounts, and from the periodic dissemination of their results to policymakers, researchers and other stakeholders.

## References

Central Bank. 2006. National Accounts of Costa Rica 1991-2005. Economics Division, Social Accounting Department.

Dutoit, L.; Hernandez, K.; Urrutia, C. 2009. Transmisión de precios para los mercados de maíz y arroz en América Latina. CL, ECLAC.

ECLAC (Economic Commission for Latin America and the Caribbean). 2009. El proceso de liberalización comercial y su efecto sobre el mercado centroamericano del maíz: un análisis espacial de precios. MX, ECLAC. Forthcoming..

EUROSTAT (Statistical Office of the European Communities).1997. Manual on the Economic Accounts for Agriculture and Forestry, EAA/EAF 97 (Rev 1).

\_\_\_\_\_. 2006. Real Agricultural Income estimates for 2006. News Release 169/2006.

FAO (United Nations Food and Agriculture Organization). 2008. Food situation in Latin American and the Caribbean. Consulted April 16, 2009. Available at [http://www.rlc.fao.org/iniciativa/pdf/bolobs2\\_en.pdf](http://www.rlc.fao.org/iniciativa/pdf/bolobs2_en.pdf).

IFPRI (International Food Policy Research Institute). 2008. Local Impacts of a Global Crisis: Food Price Transmission and

Poverty Impacts in Ghana. Discussion Paper 00842. Washington DC.

IICA (Inter-American Institute for Cooperation on Agriculture). 2008. Higher food prices and their possible impact on agricultura in Latin America and the Caribbean. COMUNIIC 4(1). Year 4: 10-29.

IMF (International Monetary Fund). 2008. Globalization, Commodity Prices, and Developing Countries. Consulted April 16, 2009. Available at <http://www.imf.org/external/pubs/ft/weo/2008/01/pdf/c5.pdf>.

Instituto Nacional de Estadística e Informática. 2008. Oferta y Demanda Global 1991-2007: Año base 1994. Lima, PE, National Accounts Office.

Ireland Central Statistics Office. 2000. Output, Input, and Income in Agriculture: 2000 Advance estimate. IE.

Kohli, U. Real GDP, Real GDI, and Trading Gains: Canada 1981-2005, International Productivity Monitor 13.

Norton, RD. 1988. Policy Analysis for Agricultural Development: Basic Data Series and their Use.FAO. (Training Materials for Agricultural Planning 14)

OECD (Organization for Economic Cooperation and Development). No date. Glossary of Statistical Terms. Available at <http://stats.oecd.org/glossary>

United Nations. 1993. System of National Accounts. Statistics Division.

Valdés, A.; Foster, W.; Pérez, R.; Rivera, R. 2008 Evolución del Ingreso Agrícola Real en América Latina, 1990-2005: Evidencia en base a Cuentas Nacionales y Encuestas de Hogares". ECLAC.

Von Cramon-Taubadel, S.; Ihle, R.; Amijuzuno, J. Price Transmission in the Eastern Africa Maize Market. DE, University of Göttingen.

World Bank. Statistical Manual, National Accounts, Terms of Trade Adjustment. Available at <http://www.bancomundial.org/>

## Mesure des fluctuations du PIB agricole : note technique

Ces trois dernières années, les prix des produits et des facteurs de production agricoles ont connu une forte volatilité, qui a eu un impact non seulement sur les incitations du marché à la production mondiale mais aussi sur l'accès des consommateurs aux aliments, notamment sur l'accès des consommateurs à faibles revenus des pays en développement. Diverses institutions internationales ont étudié ces deux aspects avec les techniques des prix de transfert et des indicateurs de sécurité alimentaire. Il existe cependant un autre aspect non négligeable de l'analyse portant sur l'impact sur les revenus agricoles de cette variabilité des prix, aspect qui est abordé dans la présente note technique. Celle-ci montre comment, avec des calculs simples et en utilisant les comptes nationaux en vigueur, il est possible d'obtenir des indicateurs du changement intervenu dans les revenus des facteurs de production et dans les prix agricoles réels. Cela peut s'avérer d'une grande utilité pour la formulation de politiques, même s'il faut procéder à une analyse plus profonde des liens entre les résultats de l'agriculture, la création de revenus et la diminution de la pauvreté (Valdez et d'autres, 2008).

## Como medir o desempenho do PIB agrícola: uma nota técnica

Durante os últimos três anos, os preços dos produtos e insumos agrícolas sofreram uma forte volatilidade, causando impactos não apenas nos incentivos de mercado para a produção em nível mundial, mas, também, no acesso aos alimentos por parte dos consumidores, principalmente daqueles de baixa renda nos países em desenvolvimento. Esses dois aspectos vêm sendo estudados por diversas instituições internacionais mediante técnicas de análise de transmissão de preços e indicadores de segurança alimentar. No entanto, há outro aspecto de análise significativo, relacionado com o impacto dessa variabilidade de preços na renda agrícola, que é tema desta nota técnica. Aqui se mostra como, mediante cálculos simples e utilizando as contas nacionais em vigor, podem ser obtidos indicadores da mudança na renda dos fatores de produção na agricultura, para cujo efeito são utilizados ajustes nos volumes de produção e nos preços agrícolas reais. Isso pode ser muito útil na formulação de políticas, embora sejam necessárias maiores análises dos vínculos entre desempenho agrícola, geração de renda e redução da pobreza (Valdez et al. 2008).

## Midiendo el desempeño del PIB agrícola: una nota técnica

Durante los últimos tres años, los precios de los productos y los insumos agrícolas han experimentado una fuerte volatilidad, que ha impactado no solo los incentivos de mercado para la producción a nivel mundial, sino también el acceso a los alimentos por parte de los consumidores, en especial de aquellos con un bajo nivel de ingreso en los países en desarrollo. Ambos aspectos han sido estudiados por diversas instituciones internacionales mediante técnicas de análisis de transmisión de precios e indicadores de seguridad alimentaria. Sin embargo, existe otro aspecto significativo de análisis relacionado con el impacto de esta variabilidad de precios en el ingreso agrícola, el cual se aborda en la presente nota técnica. Aquí se muestra cómo mediante cálculos simples y utilizando las cuentas nacionales vigentes, se pueden obtener indicadores del cambio en el ingreso de los factores de producción en la agricultura, para lo cual se utilizan ajustes en los volúmenes de producción y en los precios agrícolas reales. Esto puede ser de mucha utilidad en el diseño de políticas, aunque se requieren mayores análisis de los vínculos entre el desempeño agrícola, la generación de ingresos y la reducción de la pobreza (Valdez et al. 2008).