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Asia and Pacific Commission on Agricultural Statistics

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Recent advancements in Agricultural Economic Statistics – Price and Investment domains

Contributed by: *FAO Statistics Division*

1. Price Statistics - Introduction

The 2007 food price crisis, with its implications for food security, underlined the importance in improving the monitoring of agriculture and food price transmissions across the value-chain. Though FAO is the main provider of internationally comparable data on agricultural producer prices, the need to better monitor agriculture food price transmissions requires it expand its previous work on agricultural prices in four key directions. These include: 1) improve the coverage, frequency and timeliness of price statistics to measure farm to fork food and agriculture prices; 2) improve dissemination and awareness of FAO price data by accompanying new data releases with statistical analysis; 3) develop, evaluate and disseminate a new set of derived indicators to better capture and monitor price dynamics, transmission and volatility; *and* 4) consolidate and disseminate these price datasets and indicators in price profiles to provide quick and easy access to price information for different geographic groupings.

This paper presents and describes the data currently collected on agricultural and food prices, the new dissemination strategy, and new indicators and price profiles currently under development. It also solicits discussion and advise from APCAS member countries on how to

improve underlying country-level data, and how FAO can best provide relevant and timely price information and analytical products to member countries.

2. Setting the context – Key Uses of Price Statistics

Agricultural prices influence public and private decisions related to the type and volume of agricultural policy and production, be it made by national governments, farmers and other agri-businesses, or international organizations.

National governments use agriculture price data to develop, monitor and evaluate food price subsidies as well as other agriculture support policies; to identify intra-country and international comparative advantage in the type and composition of agricultural production; and to identify population groups at risk as a result of price volatility or disruptions in the agriculture value-chain. Price data is also used to estimate the value of agricultural output, intermediate inputs, and agricultural value added, in both real and nominal terms, which in turn provides data essential for productivity analysis.

Farmers and agri-businesses use price information to inform decisions about agricultural production and composition; use and purchase of intermediate inputs, including feed, fertilizers, labour and machinery; and borrowing, farm management and investment decisions.

International organizations use agricultural price data for similar analytical and policy purposes as national governments. For their purposes, standardization in the methodologies behind data collection helps ensure that cross-country comparisons are able to identify differences in policies, environment, production, and productivity, and are not an artefact of differences in definitions or the manner in which data are collected, estimated or disseminated[1].

3. Current and planned work on Prices

a. Producer prices

FAO provides annual country-level data on producer prices for primary crop and livestock products dating back to 1991[2]; monthly producer prices beginning January 2010; and annual producer price indexes (PPIs) for 1999 to 2011. FAO's producer price database has the largest coverage of producer prices in the world, with a coverage of approximately 150 countries and about 200 commodities, representing roughly 97 percent of the world's value of agricultural production at 2004-2006 international dollar prices. Absolute producer prices are available in local currency, standard local currency and US dollars, with continuous efforts made to expand country coverage and improve data quality.

[1] More details available in "Farm and input prices: collection and compilation", FAO, 1980.
[2] An older database ("Producer Price Archive"), with historical data from 1966 to 1990 is also available on FAOSTAT. This database is not anymore maintained and updated.

Producer prices, collected annually through a price questionnaire, refer to prices received by farmers, known as "farm gate" or first-point-of-sale prices, when farmers participate in their capacity as sellers of their own products. To maximize international comparability, countries are requested to remain as close as possible to this concept. However, due to differences in data collection infrastructure and capacity, countries do vary from this concept by collecting, instead, wholesale or local market prices. While these may be good proxies of farm-gate prices when the marketing chain is very limited, they tend to be poorer proxies in economies where transport and commercial margins constitute a significant share of the final product price. At the far extreme, some countries report retail prices, which are typically very poor proxies for producer prices.

As FAO begins work on Cost of Production statistics and the Economic Accounts of Agriculture (EAA), the proximity of price data to the producer price concept will become increasingly important. Producer prices are an essential input into both statistical activities, and both are used by policy makers to evaluate comparative advantage within their country and against major competitors, in identifying productivity enhancing inputs, and in establishing agricultural support policies.

b. Consumer prices, and regional and global price indexes

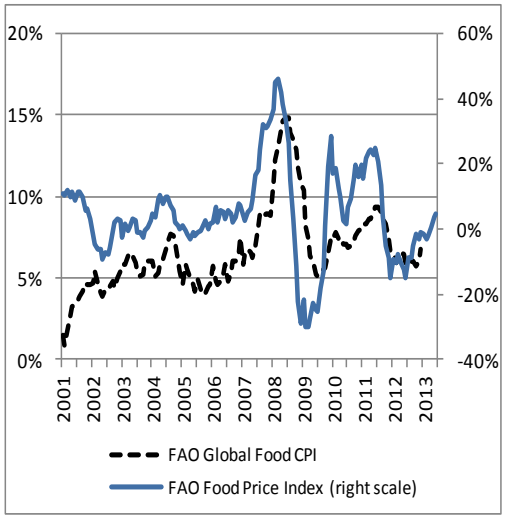
To extend statistical coverage of agricultural price statistics and better investigate price transmission, in 2011 FAO began to disseminate country-level data on Consumer Price Indices (CPI), using data compiled by the International Labour Organization (ILO), for the food and all-items index, for about 140 countries[3]. Since August 2013, FAO also began publishing regional and global food CPIs[4]. These indicators, compiled quarterly for FAO regions, add to the set of regional indices from other data domains, such as production and trade. In the near future, these set will be further enhanced with the addition of regional and global PPIs.

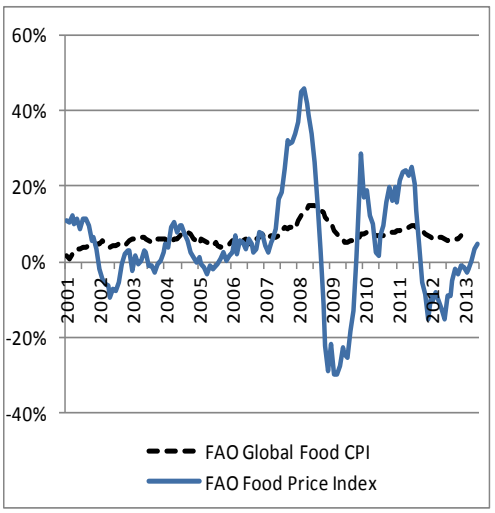
Such aggregate indicators help identify common trends across regions as well as country-level differences, and the drivers behind both. They can also serve to identify leading indicators of phenomenon such as food price hikes and food insecurity. For example, a comparison of the historical trend in the FAO Food Price Index (FPI) against the global food CPI suggests the FPI is a leading indicator of future consumer food price inflation, though the transmission is lagged, incomplete and varies considerably across regions (Figure 1 and Section 4.c).

[3] Some countries provide indices for urban or local areas only and a very limited number also provide categorical disaggregation (low income vs. high income households, etc).

[4] The data and corresponding analysis can be found in: www.fao.org/economic/ess/ess-economic/cpi/en/. Among other organizations that produce regional Food CPIs, the ILO, the OECD and Eurostat's indices have a more limited regional disaggregation or country coverage. Furthermore, while all these organizations use GDP weights to aggregate country data, FAO uses weights based on country population, which is best adapted to keep focus on food security.

Figure 1: The FPI as a leading indicator of the global food CPI[5]





In moving forward, these food CPIs will be complemented by regional and global PPIs. Still under discussion are two important methodological questions: 1) the choice of weights (population, GDP or other); and whether or not to produce global and regional PPIs at the commodity level.

c. Mobile data collection and the AMIS project

Under a project to strengthen Agricultural Market Information Systems (AMIS), FAO is developing a market monitor to track current and expected future trends in international markets. The project will develop and adapt data and analysis tools, for use at the global and country level, in sharing, analyzing and disseminating international and national data on market prices, as well as crop production forecasts and food stock estimates. This, in turn, can help governments and policy makers detect abnormal situations in agriculture markets, and monitor and evaluate impacts such as futures exchanges, price transmission, and food security.

One component of the AMIS project includes the use of digital and geo-referenced technologies, such as smart phones and mobile applications, to improve food price data collection. The use of digital mobile technology exploits the opportunity for real time data, and the use of ICT technology helps cost-effectively improve the speed of data collection, validation, processing, analysis and dissemination. Another component of AMIS includes strengthening of FAO's existing on-line GIEWS Food Price Data and Analysis Tool, to monitor basic staple food prices in 82 countries and conduct analysis of different data series in both nominal and real terms. Bangladesh, India and Nigeria are among the country-level partners piloting this project.

[5] The different scales on the left magnifies the food CPI to demonstrate the leading indicator aspect of the FPI; use of the same scale on the right demonstrates that FPI volatility is mitigated at the consumer level.

d. Price transmission and price volatility indicators

The understanding of how and to what extent price changes are transmitted from international to national markets (horizontal transmission) and along agricultural and food value-chains (vertical transmission) helps assess the exposition and vulnerability of market actors and consumers to price shocks. Quantification of vertical price transmission provides a measure of the size and speed of the pass-through of a price shock (producer level) to consumers (retail level). For horizontal price transmission, it provides a measure of the impact of a change in international prices on domestic prices (wholesale or retail level).

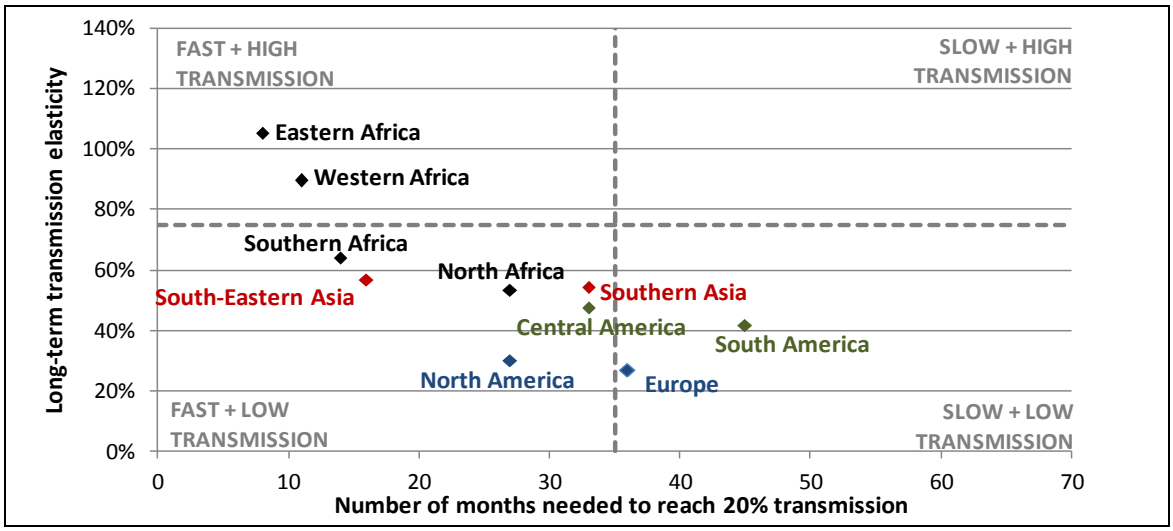
Price volatility indicators, on the other hand, matter both because they provide a statistical measure of price variability in agricultural and food markets, an indicator of prevailing market conditions, and a signal of the need for specific types of policy intervention. At the upstream/producer level, a high level of price volatility may indicate that commodity supply is insufficient to cover demand and/or that producers are exposed to price fluctuations in agricultural inputs (e.g. fuel, feed, etc.), which are transmitted to output prices. At the downstream/retail level, price volatility may be caused by a high rate of transmission of producer or international commodity prices to the retail level, possibly reflecting short value-chains. High price volatility can have several adverse impacts: lower levels of investment by producers uncertain about future revenues; less adaption of consumption behavior by consumers facing unclear price signals; and reduced effectiveness of agriculture and food policy interventions including price supports, strategic stocks, and regulation of commodity derivatives markets. The extent to which variability in producer prices is transmitted to food consumer prices essentially depends on the length of the value-chain, on the market power of each actors of the chain, on the nature of the demand for that commodity or product and on the existence of possible substitutes.

FAO is currently developing, testing and evaluating price transmission coefficients and price volatility indicators, based on a limited set of commodities and countries. These indicators would be first available at country-level, and then extend to higher levels of geography.

These price transmission indicators, developed using econometric models, show price transmission is lowest in developed economies characterized by extended food value-chains and a high share of processed products in households' food baskets. Over the long term, North America and Europe see only 30% of price increases of primary products on international markets transmitted to domestic consumer food prices; while the price transmission is 50% in Latin

America and Asia, and almost complete in Eastern and Western Africa. For Eastern Africa, more than 10% of the shock is passed-on after 4 months, and 20% after 8 months (Figure 2).

Figure 2*: *Response of regional food CPIs to a 1% shock in the FAO FPI



While these results suggest that price transmission is intrinsically linked to the characteristics of food value-chains and to the composition of food baskets, which is confirmed by other studies, they should be interpreted with caution for the following reasons. First, policy interventions - such as minimum or maximum purchase prices, export or import restrictions, and production and consumption subsidies - alter the degree of pass-through and may result in weakened transmission or inconclusive estimates. Second, these results measure price transmission between a limited number of internationally traded commodities and average food consumer prices at the regional level, and these may differ for specific countries and/or specific commodities. Third, the transmission does not yet take into account some important explanatory variables, such as food import dependency, region-specific food commodity baskets, or structural breaks in price co-movements. Fourth, more robust estimation of vertical price transmission suffers from the lack of available data across the value-chain, which requires a sufficient number of price quotations at the producer, wholesale and retail levels for the same or similar commodity; while horizontal transmission is best estimated for specific markets at the local level, where information is seldom available.[6]

Price volatility indicators, still under discussion, should capture the magnitude of consumer prices change overtime, giving equal weight to increases and decreases. These indicators can be standard statistical measures of observed volatility or dispersion (i.e. standard deviation, range, interquartile range, or median of absolute deviations from the median); or from the modeling of the volatility process (example in Box 1).

[6] Faminow, M.S. and Bruce L. Benson. *Spatial Economics: Implications for Food Market Response to Retail Price Reporting*. **Journal of Consumer Affairs**, V19:1, pp 1-19, 1985.

Box 1: Volatility indicators based on the modeling of the volatility process

The price of a commodity or a group of commodities at one point in time can be decomposed into its expected mean given the information available up to the preceding period and a random term. This random term represents the unexpected shocks that affect prices and, in the case of commodity prices in particular, are likely to be correlated over time. These so-called GARCH processes (Generalized Autoregressive Conditional Heteroscedasticity) can be reproduced by setting and estimating the structure of this autocorrelation. In its simplest version, this approach can be expressed mathematically by:

$$\mathrm{p_t} = \bar{p}_t + \varepsilon_t \sigma_t \quad [1],$$

$$\sigma_t{}^2 = \alpha + \beta \varepsilon_{t-1}{}^2 \sigma_{t-1}{}^2 + \gamma \sigma_{t-1}{}^2 + \vartheta_t \quad [2].$$

where ε and ϑ are independently and identically distributed random terms and σ_t the conditional standard error.

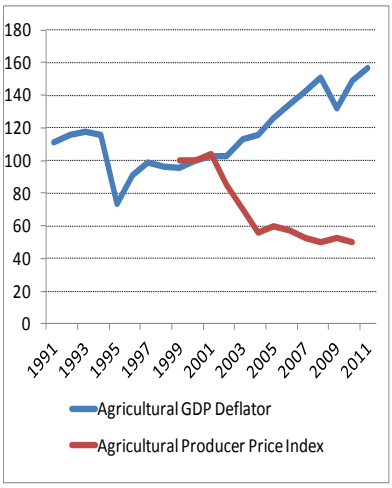
The coefficients of equation [2] are generally determined by Maximum Likelihood Estimation (MLE), after setting initial values for the conditional variance. The conditional variance is then estimated iteratively over the whole period.

e. Price profiles and other analytical products

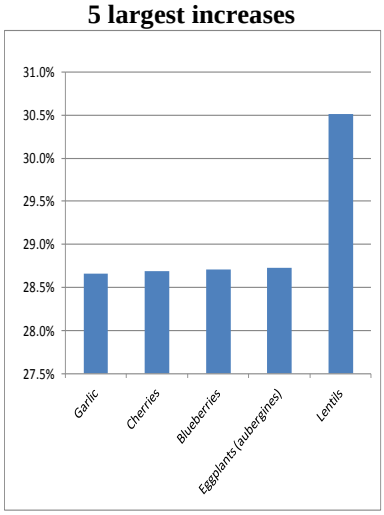
FAO has begun quarterly dissemination of regional and global food CPIs accompanied by a statistical analysis and media release to promote awareness of its new data series. As FAO progressively expands its price data and indicators, it plans to integrate and present them in country, regional and global price profiles. Country profiles would show country specific information on producer prices (absolute levels and indices), consumer prices (indices) and price transmission coefficients; while regional and global profiles would present regional and global PPIs and food CPIs, and average price levels for select commodities. Some possible mock-ups are provided below, for discussion.

Country Profiles - Producer prices

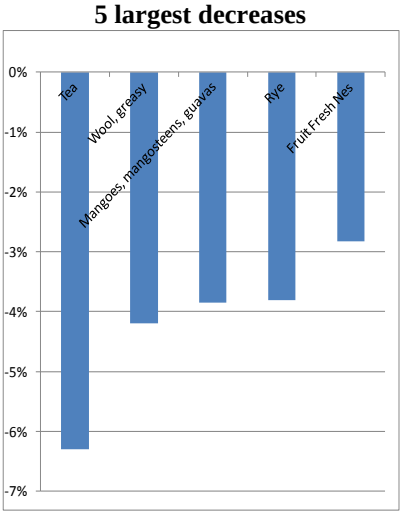
Price indicators



5 largest increases

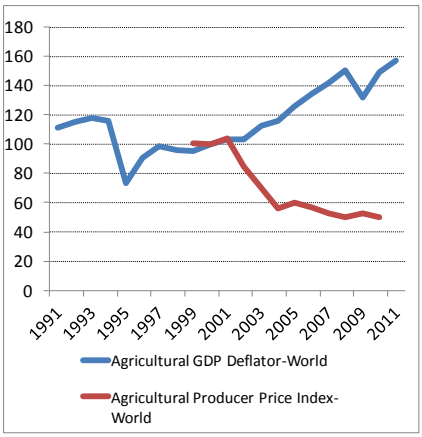


5 largest decreases

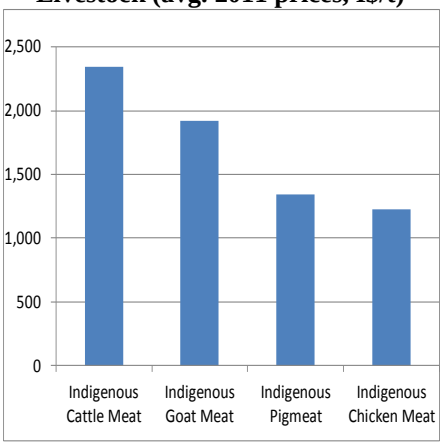


Global Profile - Producer Prices

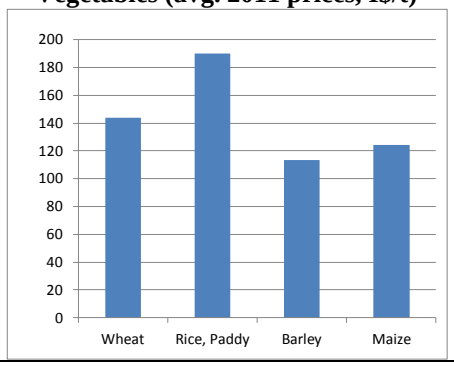
Price indicators



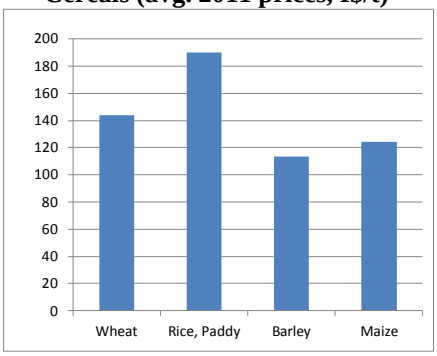
Livestock (avg. 2011 prices, I$/t)



Vegetables (avg. 2011 prices, I$/t)



Cereals (avg. 2011 prices, I$/t)

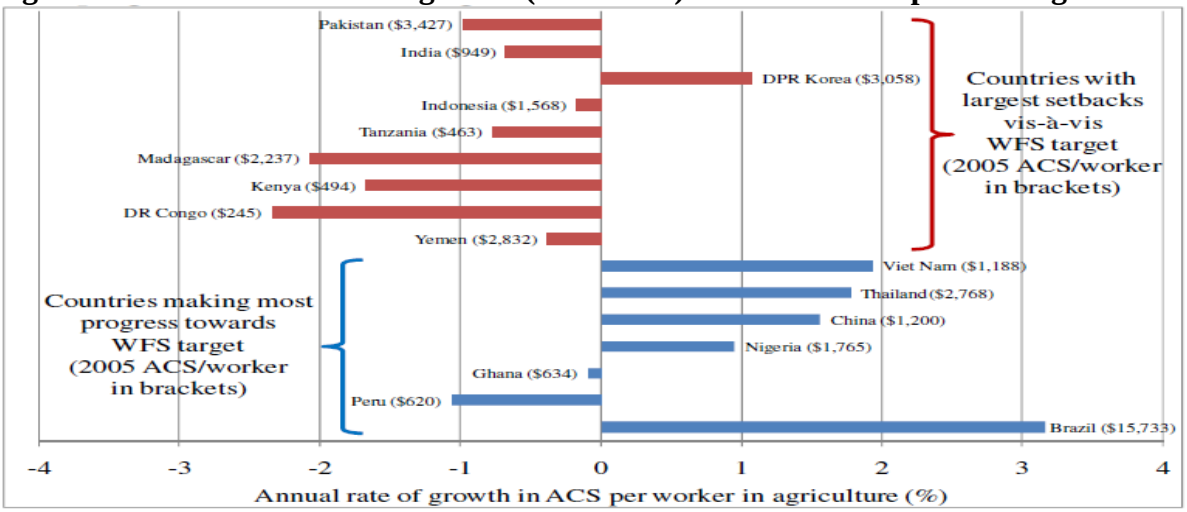


4. Investment Statistics - Introduction

Raising agricultural productivity is critical to increasing the real incomes necessary for better access to food[7]. In turn, increasing capital stock per worker, often known as the capital-labour ratio, or degree of capital intensity, is a critical to increasing agricultural productivity. In many instances, the income gap between high-income and low-income countries has widened as a result of low capital-labour ratios in low-income countries. This reflects both the higher relative costs of capital compared to labour in low-income countries, but more importantly, weaker credit markets that make it more difficult for agricultural producers to finance capital investments.

As shown in Figure 2, developing countries exhibit a strong positive correlation between investment in agriculture, as measured by capital accumulation, and hunger reduction, measured by the World Food Summit (WFS) goal to eradicate hunger and reduce the number of undernourished. The graph shows that all countries with the largest setback vis-à-vis the WFS goal, except DPR Korea, had a negative annual growth rate in Agricultural Capital Stock (ACS) per worker in agriculture for 1990-2005, while the opposite occurred in countries with the greatest progress towards the WFS goal.

Figure 2: Annual rates of ACS growth (1990-2005): best and worst performing countries



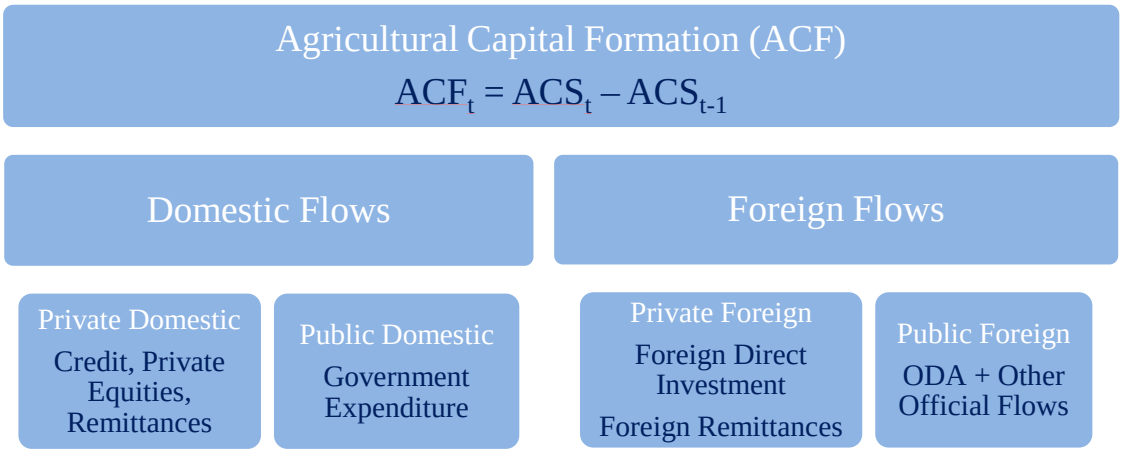
Source: Von Cramon-Taubadel et al. (2009)

To support analysis of ACS, and its' associated sources of investment financing, FAO Statistics Division (ESS) is developing a new and more robust methodology to measure ACS , a new global Investment Dataset comprised of five main elements - Credit to Agriculture, Government Expenditures on Agriculture, Official Development Assistance to Agriculture,

[7] For a review of the magnitude of, trends in, and data gaps pertaining to investment in agriculture, see ESA Working Paper No.11-19 Financial Resource Flows to Agriculture (http://www.fao.org/docrep/015/an108e/an108e00.pdf) and the 2012 State of Food and Agriculture (http://www.fao.org/publications/sofa/en/)

Foreign Direct Investment in Agriculture, and Foreign Remittances, and country-level profiles on both growth in agricultural capital stock and its financing sources. A key feature of this initiative is the harmonization of FAO work with that of other international organizations that are compiling relevant datasets, as presented in the following sections. The FAOSTAT's framework of agricultural investment flows is illustrated in the following hierarchical chart.

Figure 1. FAOSTAT's Agricultural Investment Data Framework[8]



5. Current and planned work on Investment

a. AGRICULTURAL CAPITAL STOCK

FAO's previous database on ACS was based on FAOSTAT's physical inventories, which included the following components: land development, plantation crops, machinery and equipments, livestock, and structures for livestock. These data excluded the forestry and fishery subsectors and greenhouse production structures, mainly due to lack of information. The more significant problem in the ACS database, however, came from limitations in the underlying data sources, much of which was found in agricultural machinery and equipment data, the methodology of which is currently being reviewed.

To build a more robust global ACS database, the Statistics Division of FAO (ESS) will develop a methodology based on national accounts information, and draw on national accounts data and estimates compiled by the UN Statistics Division and the OECD. To estimate capital stock data for the agriculture, forestry and fisheries sectors from a national accounts perspective, it will use country-level data and estimates of the following variables: value-added, gross output, gross fixed capital formation (GFCF), capital stock, employment and labour compensation. As a result, the revised methodology would enable FAO to better estimate agricultural capital stock

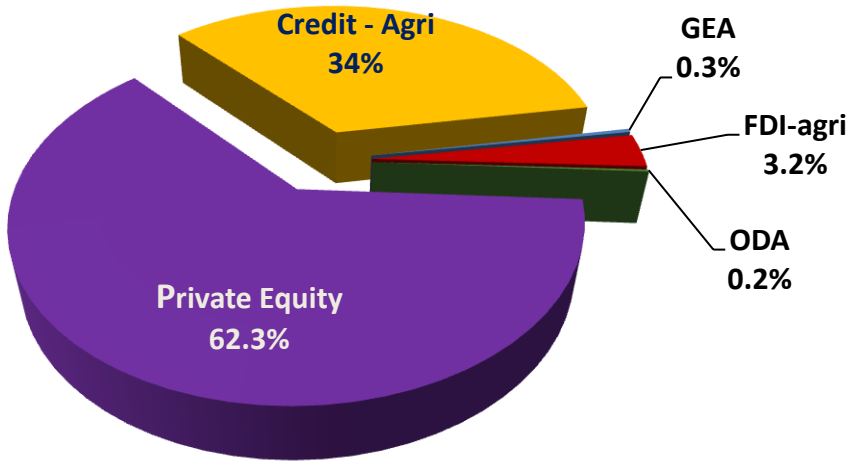
[8] This framework could be further expanded by including other financing sources as Tax Expenditures (Marginal Tax Revenue Forgone) in Public Domestic or Savings and Firm Product Financing in Private Domestic.

encompassing agriculture, forestry, and fishing activities more broadly, and thereby enabling better analysis of productivity and investment financing in the broad agricultural sector.

In addition to improving data on capital stock/physical investment, ESS is also expanding its coverage of sources of investment financing, looking at both public and private sources, as well as domestic and foreign sources, as outlined in Figure 1. This is a critical first step in assessing how the *composition* of financing sources impacts total investment in agriculture, as well as investment across different sizes and types of agricultural producers.

Having a good picture of total physical investment (ACS) as well as its financing sources will help put together country investment profiles. A preliminary example for Bangladesh, based on historic ACS data, shows that private equity (savings of agricultural producers, borrowing from informal markets, share-cropping, etc) accounts for almost two-thirds of all investment financing to agriculture (Figure 3). While private equity accounts for similarly large shares in other countries, difficulties in direct data collection means that this source of investment financing is calculated residually, making good estimates of ACS that much more important, as the changes in ACS, which measure the value of agricultural capital formation (ACF), also provide a guide as to the total volume of investment financing required. In the near future, ESS will consult with FAO member countries to determine how best to build these country-level investment profiles.

Figure 3: Agricultural Capital Formation in Bangladesh 2007, (Total = $6,227 million USD)



* Private Equity estimated as a residual (*PE = ACS - GEA - ODA - FDI - Credit*)

b. CREDIT TO AGRICULTURE

The extent to which formal private sector credit markets provide investment financing has a direct and positive correlation with growth in agricultural capital stock, and in turn, with agricultural productivity growth. This occurs because financial institutions in formal credit markets are better able to diversify and absorb risks across time, across borrowers, and across sectors, thereby lowering financing costs to borrowers, and better allocating savings. This source of financing is of particularly importance in sectors, such as agriculture, where producers face high risks not only in terms of the timing between the need to finance investments and the realization of income to repay loans, but also from the significant supply-side uncertainties that arise from climate and weather conditions (droughts, floods, etc), price volatility of their output, and the impact of pests and disease, which affect the volume and quality of their output.

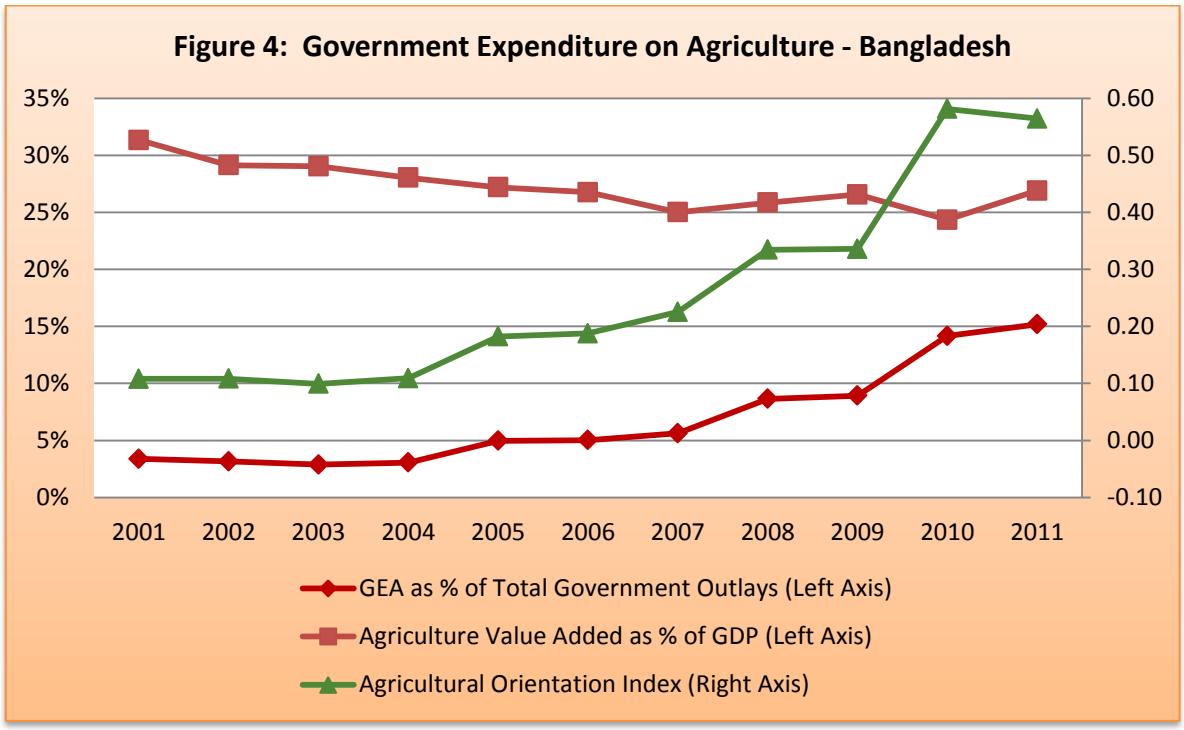
Data on formal credit extended to agriculture — including finance to corporations and firms for onward financing to farmers, agricultural cooperatives and agri-related businesses — is generally available through monetary and financial statistics. This data, which serves as a benchmark indicator of formal domestic private sector investment activity, is being developed by FAO's Statistics Division into a comprehensive credit to agriculture dataset, harvesting official data from Central Banks websites. Data challenges exist for countries that lack legislative reporting requirements for this type of data, or where reported data lack the necessary level of sector detail. Across all countries, a significant challenge also exists in differentiating agricultural loans for investment purposes, and those for consumption purposes.

c. GOVERNMENT EXPENDITURES ON AGRICULTURE

Although the private sector mobilizes most investment financing in agriculture, the public sector — general government units and public (financial and nonfinancial) corporations — also plays a role. The efficiency of these expenditures, whether measured in relation to agricultural GDP, to total government outlays, or the agricultural labour force, remains a key element of the overall policy mix. Well targeted government expenditures can create a conducive environment for private investment (economic incentives) and can ensure sufficient availability of public goods (basic rural infrastructure and market openness), particularly when these investments address market failures.

The share of government expenditures on agriculture (GEA) is not related in any simple way to the size of the agricultural sector, and depends *inter alia* on the overall importance given to economic functions in governments' budgets. By bringing together the data on agriculture's shares in GDP and overall government expenditure we can construct an "***agricultural orientation index***" by dividing the agricultural expenditure share of total government expenditures by the agriculture

share of GDP, which reflects the relative importance that government places on its agricultural sector. In Bangladesh, for example, the agriculture share of GDP was significantly higher than the agricultural share of government expenditures (Figure 4), leading to an agricultural orientation index up to 5% from 2001 to 1007, rising steadily to 15% in 2011 following the food price crisis.



Despite the need for comprehensive time series data on government expenditures on agriculture and rural development, such data remain scarce. To address this gap and ensure comparable data aligned with international standards, ESS, in collaboration with the IMF Statistics Department, developed a Government Expenditures on Agriculture questionnaire based on the *Government Finance Statistics Manual, 2001* (*GFSM 2001*) methodology. ESS launched this questionnaire globally in 2012, requesting additional detail on the agriculture subsectors of agriculture, forestry and fisheries, as well as data on environmental protection. The questionnaire also looks for additional detail on recurrent and capital expenditures, in order to proxy the amount of expenditures allocated for investment. The second annual global data collection is currently underway.

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d. OFFICIAL DEVELOPMENT ASSISTANCE TO AGRICULTURE

Official Development Assistance to Agriculture (ODA) from major bilateral and multilateral donors is an important complement to domestic sources of agricultural financing. To obtain this data, ESS harvests data from the OECD's Creditor Reporting System (CRS), which records ODA

and Other Official Flows (OOF) at the project level. By extracting the subset of the data relevant for agriculture, rural development and food security, ESS is able to obtain necessary data without creating duplication across international organizations, or imposing additional response burden on countries. Where data gaps exist, ESS will work with the OECD to identify and address these gaps. The first comprehensive ODA to agriculture data will be available in FAOSTAT in the near future.

e. FOREIGN DIRECT INVESTMENT

A fourth source of agricultural investment financing comes from foreign direct investment (FDI). A host of factors, including spikes in food and fuel prices, a desire by countries dependent on food imports to secure food supplies in the face of uncertainty, and speculation on land and commodity price increases, recently prompted a sharp increase in investment involving significant use of agricultural land, water, and forested areas in developing and transition countries. In the coming year, ESS will work with data from UNCTAD to develop a database on FDI to agriculture, and examine data gaps and challenges, along with strategies to address them.

f. FOREIGN REMITTANCES

A fifth source of investment financing comes from foreign remittances, or the money sent to home countries by migrants. Last October the World Bank estimated that developing countries would receive $414 billion US in foreign remittances in 2013, an increase of 6.3% over the previous year. To put this in perspective, foreign remittances to Tajikstan would account for half of its GDP, and for three times the FDI to India, which received $71 billion in remittances. As such, foreign remittances are important due to their size, but also because they act as an automatic economic stabilizer, rising in value when domestic currency weakens. A challenge that faces ESS in including this source of investment financing is the determination of the share goes towards financing agriculture, and the subset that finances agricultural investment.

6. INVITATIONS TO APCAS MEMBER COUNTRIES

APCAS member countries are requested to provide comments and feedback on these existing and new lines of work, and suggestions on improvements and opportunities for collaboration in the domains of price and investment statistics.

Questions, inputs and advice can be e-mailed to Ms. Dubey (Sangita.Dubey@fao.org), Franck Cachia (Franck.Cachia@fao.org) or Fabiana Cerasa (Fabiana.Cerasa@fao.org) or Price-Statistics@fao.org